Neoen Australia Pty Ltd

Crystal Brook Energy Park - Development Application

Volume 2 - Project Description and Impact Assessment Findings

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Flora and Fauna

Crystal Brook Energy Park Project

Flora and Fauna Assessment

Crystal Brook Energy Park Project Flora and Fauna Assessment

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Prepared by EBS Ecology for NEOEN

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GLOSSARY AND ABBREVIATION OF TERMS

BDBSA	Biological Database of South Australia (managed by DEWNR)
DEWNR	Department of Environment, Water and Natural Resources
DoEE	Department of the Environment and Energy
EBS	EBS Ecology
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
HA	Heritage Agreement
NPW Act	*National Parks and Wildlife Act 1972*
NRM Act	*Natural Resources Management Act 2004*
SEB	Significant Environmental Benefit
ssp.	Sub-species
spp.	Species (plural)
Project area	proposed wind farm project area as outlined by the client
var.	Plant variety

EXECUTIVE SUMMARY

The proposed Crystal Brook Energy Park site was first investigated in 2003 by Origin Energy and was divided into Crystal Brook North Wind Farm and Crystal Brook South Wind Farm, a larger footprint than the revised layout presented within this report. Biosis Research Pty Ltd first undertook ecological investigations at these sites after 2003 which were then followed on by subsequent and more detailed investigations in 2009 with additional studies undertaken by Sinclair Knight Merz (SKM) in 2011. The 2012 ecological assessment report by Biosis was a compilation of information relevant to the Crystal Brook site, obtained as part of these previous studies.

EBS Ecology was engaged by NEOEN to undertake a review of the previous ecological assessments completed at the site with a focus on limiting factors such as threatened flora and fauna species and communities that had the potential to occur on site or were recorded within previous studies. EBS Ecology subsequently embarked on an updated field assessment of the revised Crystal Brook Energy Park site focussing on terrestrial flora and fauna. The key objective was to identify ecological constraints for the project to inform the project design.

An EPBC Protected Matters Search was completed for the project area (5 km buffer) to identify matters of national environmental significance that may be relevant to the project site. The search highlighted 20 nationally rated species, one Threatened Ecological Community (TEC) and nine migratory species as potentially occurring, or having potential habitat occurring within the search area.

A Biological Database of South Australia (BDBSA) search identified 84 threatened flora species previously recorded within 10 km of the project area. Of these, eight are nationally listed and 81 are state listed. Ten threatened flora species were determined as known or likely to occur within the project area.

Two bird species with a state conservation rating are known to the project area, Diamond Firetail (*Stagonopleura guttata*) and Hooded Robin (*Melanodryas cucullata)*. Three bird species and one mammal listed from the BDBSA 10km search were known to the project area from previous assessments (Biosis 2012). These include the Jacky Winter (*Microeca fascinans fascinans)*, White-winged Chough (*Corcorax melanorhamphos)*, Elegant Parrot (*Neophema elegans*) and Common Brushtail Possum (*Trichosurus vulpecula)*. There were five fauna species that were determined as likely to occur within the project area, Scarlet Robin (*Petroica boodang boodang*), Painted Button-quail (*Turnix varius*), Musk Duck (*Biziura lobata*), Peregrine Falcon (*Falco peregrinus*) and Crested Shrike-tit (*Falcunculus frontatus*).

The flora and fauna field survey for the Crystal Brook site was undertaken from the 27th February to the 2nd of March 2017 with follow up surveys undertaken in May 2017 and February 2018. Ten vegetation associations were represented within the project area. The dominant vegetation cover was provided by *Austrostipa* spp. (tussock) Grasslands and *Eucalyptus porosa* (Mallee Box) Woodlands. Ninety-six indigenous flora species were observed within the project area. No species of national conservation significance were observed however two species were rated rare at state level, *Aristida australis* (Wire Grass) and *Logania saxatilis* (Rock Logania).

A total of 211 individual bird observations were made, represented by 38 species. Two species were of state conservation significance, Diamond Firetail (*Stagonopleura guttata*) and Hooded Robin (*Melanodryas cucullata*). Four individual Wedge-tailed Eagles were observed during the 2017 survey; this species is rated as rare in the Northern and Yorke region. Two Wedge-tailed Eagle nests were recorded during the initial field surveys in Mallee Woodland / Open Woodland. Both of the nests were inactive at the time of the first observation, but were considered potentially active in future breeding seasons as Wedge-tailed Eagles are known to reuse nests over several years. One nest was subsequently destroyed during a storm when a branch failure led to the nest falling leaving the solitary nest within the project area. Recommendations for mitigation include provision of a 500m buffer / protection zone around both nests.

The following recommendations have been made to alleviate impacts associated with the proposed Crystal Brook Energy Park using a standardised mitigation hierarchy of avoid, minimise, restore and offset in regards to native vegetation, threatened species and ecological communities:

- All *Eucalyptus odorata* Woodlands should be avoided as part of the proposed wind farm as most are either potentially TEC's or amenable to rehabilitation
- Retain woodland, mallee and scrub habitats on site and implement a 100m buffer zone around these areas to reduce impacts on avian species with particular reference to threatened species such as Diamond Firetail and Hooded Robin;
- Implement a 500m protective buffer zone around the remaining Wedge-tailed Eagle nest;
- Retain any existing water sources for birds, including Diamond Firetail, but not within 100m of turbines.

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1 INTRODUCTION

EBS Ecology was engaged by NEOEN to undertake an assessment of the proposed Crystal Brook Energy Park site. The assessment was focused on terrestrial flora and fauna with the key objective being to identify potential ecological constraints for the project to inform the project design. EBS was also engaged to undertake a review of previous assessments completed at the site, which was to help formulate any potential issues and flora and fauna species that may be relevant to this latest survey work.

The Crystal Brook Energy Park project area is located north of Crystal Brook in the Mid North Region of South Australia, approximately 180 km north of the Adelaide CBD (Figure 1). The general layout of the project area lies along a low range which runs in a generally north south alignment and forms part of the southern Flinders Ranges. The landform is undulating low range with moderate depth soils with minimal stone outcropping present throughout the project area.

Initial field surveys were conducted in February / March 2017 by EBS Ecologists with follow up refinements to the layout undertaken to avoid ecological constraints identified which included a raptor nest, threatened flora species and vegetation communities. Additional turbine locations were assessed in late April 2017. A new layout was proposed in early 2018 within the existing footprint however with the new Native Vegetation Regulations 2017 legislation which came into effect from 1st July 2017, follow up surveys to ensure compliance with the new legislation was required. This report describes all ecological values applicable to the most current project extent (Figure 1).

1.1 Objectives

The objectives of the study were to:

- Review existing reports and mapping (from previous ecological studies for the site)
- identify and map the native vegetation associations (composition and condition)
- identify and map any threatened species or communities that may be present
- identify the extent and significance of wildlife habitat
- identify species of national and state conservation significance known or likely to occur in the area and provide details on possible impacts
- search for raptor nests
- record opportune fauna sightings
- identify significant pest plants and animals.

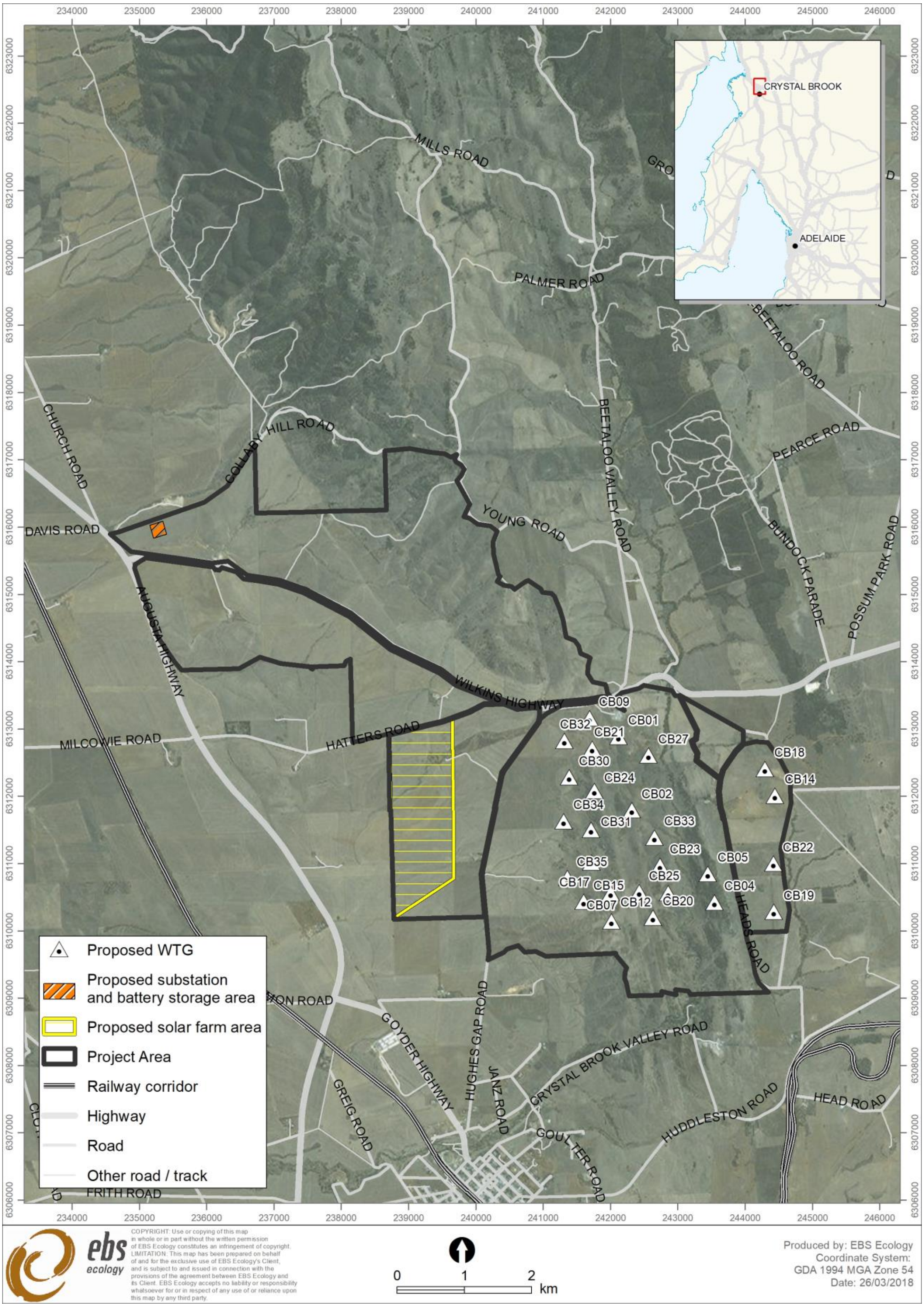


Figure 1. Location of the Crystal Brook Energy Park pro ect area.

2 COMPLIANCE AND LEGISLATIVE SUMMARY

The conservation status of flora and fauna species is specified at three geographic scales: national (*Environment Protection and Biodiversity Conservation Act 1999)* (EPBC Act), state (*National Parks and Wildlife Act 1972*) (NPW Act) and regional (Gillam 2009). National and state conservation ratings are recognised under legislation. Regional conservation ratings are informal ratings assigned by DEWNR. Whilst regional ratings are not recognised under legislation, they can give a better understanding of the status and trend of a species within the local area, and hence help assess the potential impact of proposed developments.

Threatened ecological communities are recognised under the EPBC Act. There are no formal ratings for threatened ecological communities under the NPW Act, however informal state and regional ratings were developed by the Department for Environment and Heritage (DEH) (2005).

This report focuses on flora and fauna species recognised as threatened under legislation. A summary of relevant Commonwealth and state environment legislation is provided below.

2.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides protection for matters of national environmental significance. The matters of national environmental significance protected under the EPBC Act are:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines)

Under the EPBC Act, any actions that have, or are likely to have, a significant impact on a matter of national environmental significance require approval from the Australian Government Minister for Environment and Energy. The minister will decide whether assessment and approval is required under the EPBC Act.

2.2 Native Vegetation Act 1991

Native vegetation within the project area is protected under the *Native Vegetation Act 1991* and *Regulations 2003*. Any proposed clearance of native vegetation in South Australia (unless exempt under the regulations) is to be assessed against the Principles of Clearance under the Act, and requires approval from the Native Vegetation Council (NVC). A net environmental benefit is generally conditional on an approval being granted.

An assessment against the Native Vegetation Clearance Principles may not be required if the clearance is considered to comply with *Regulation 5(1)(d) Building or provision of infrastructure in the Public Interest*. However, even if this is the case, an application for approval under *Regulation 5(1)(d)* is still required to the NVC.

There were no existing Heritage Agreements in the project area managed under the *Native Vegetation Act 1991*. Heritage Agreements are established by agreement between the landholder and the Minister for Environment and Conservation.

2.3 National Parks and Wildlife Act 1972

Native plants and animals in South Australia are protected under the *National Parks and Wildlife Act 1972*. Under this Act, it is an offence to take a native plant or protected animal without approval. Conservation significant flora and fauna species listed on Schedules 7, 8, or 9 of the *National Parks and Wildlife Act 1972* are known from the proposed project area.

Mt Remarkable Conservation Park, which is located 11km to the north of the project area, is protected under this Act and managed by DEWNR.

2.4 Natural Resources Management Act 2004

Under the *Natural Resources Management Act 2004* (NRM Act), landholders have a legal responsibility to manage declared pest plants and animals and prevent land and water degradation.

This Act will have relevance in relation to the control of pest plant and animal species during construction and site remediation. The project area falls within the Northern and Yorke NRM region.

3 BACKGROUND INFORMATION

3.1 Site details

The project area spans approximately 4 km in a north to south direction and an average width of 3 km.

The project area is used for a variety of agricultural pursuits and therefore is primarily cleared of overstorey vegetation in most areas and remnant woodland areas largely devoid of understorey. The topographic structure is relatively steep on the primary ranges western facing slopes with the topography continuing eastwards with a similar low range profile.

The project area is theoretically divided into a north and south section by the Port Pirie to Gladstone Road. The most up to date provisional wind farm layout is comprised of 26 wind turbines.

3.2 Environmental setting

3.2.1 Interim Biogeographical Regionalisation of Australia (IBRA)

Interim Biogeographical Regionalisation of Australia (IBRA) is a landscape-based approach to classifying the land surface across a range of environmental attributes, which is used to assess and plan for the protection of biodiversity (DotEE, 2017). The project area falls within the Flinders Lofty Block IBRA Bioregion, Southern Flinders Subregion, and the Mount Remarkable IBRA Environmental Association. Native vegetation remnancy within the Mount Remarkable Environmental Association is moderate (6 %). Landscape and remnancy descriptions are summarised in Table 1.

Table 1. IBRA bioregion, subregion, and environmental association environmental landscape summary.

Flinders Lofty Block IBRA bioregion	
Temperate to arid Proterozoic ranges, alluvial fans and plains, and some outcropping volcanics, with the semi-arid to arid north supporting native cypress, black oak (belah) and mallee open woodlands, *Eremophila* and *Acacia* shrublands, and bluebush/saltbush chenopod shrublands on shallow, well-drained loams and moderately-deep, well-drained red duplex soils. The increase in rainfall to the south corresponds with an increase in low open woodlands of *Eucalyptus obliqua* and *E. baxteri* on deep lateritic soils, and *E. fasciculosa* and *E. cosmophylla* on shallower or sandy soils.	
Southern Flinders IBRA subregion	
This subregion is characterised by a series of high quartzite hogback ridges with shallow loamy soils and intervening plains and lowlands with red duplex soils. To the south, intermontane plains are extensive, commonly with flat alluviated floors. Native pine (*Callitris glaucophylla*), mallee (*Eucalyptus socialis, E. oleosa* and *E. brachycalyx*) and black oak (*Casuarina pauper*) dominate the slopes of the ridges although in the south these communities merge with eucalypt forests (*E. cladocalyx, E. goniocalyx* and *E. leucoxylon*). The understorey of the ridge is generally sparse, with scattered shrubs including *Dodonaea viscosa* ssp. *angustissimus*, wattles (eg *Acacia rivalis*) and porcupine grass (*Triodia irritans*), giving way near the summits to yacca (*anthorrhoea quadrangulata*).	
Remnant vegetation	Approximately 75% (540,906 ha) of the subregion is mapped as remnant native vegetation, of which 5% (25,971ha) is formally conserved
Landform	Ranges and hills with extensive rock outcrop and shallow soils; stony pediments and small basin plains; some remnants of stony downs; narrow valleys, some with gorges. Ranges and hills in form of hogback ridges in quartzite

Geology	Bare rock; some alluvium & colluvium (sand, silt & clay); less common dune sand & some sand mantles. Calcreted gravels derived from silcrete deposits & probably equate with Ripon Calcrete. Younger Telford gravels (Middle Pleistocene)
Soil	Loamy soils with weak pedologic development, Crusty loamy soils with red clayey subsoils
Vegetation	Assumed native vegetation cover
Conservation significance	45 species of threatened fauna, 110 species of threatened flora. 1 wetlands of national significance.
Mt Remarkable IBRA environmental association	
Remnant vegetation	Approximately 79% (95,062 ha) of the association is mapped as remnant native vegetation, of which 23% (21,858ha) is formally conserved
Landform	High strike ridges on quartzite and lower rounded ridges on shale.
Geology	Quartzite, shale and alluvium.
Soil	Reddish dense loam sand hard pedal red duplex soils.
Vegetation	Open forest of long-leaved box and SA blue gum or sugar gum, woodland of SA blue gum and grey box or river red gum.
Conservation significance	28 species of threatened fauna, 87 species of threatened flora. 0 wetlands of national significance.

3.2.2 Protected areas

No Heritage Agreements were recorded within the project area however a number are located within close proximity to the area in the Beetaloo Valley approximately 4km north of the project area. A property immediately north of Collaby Hill Road has significant intact vegetation however this is not formally protected under any state legislation. The Mount Remarkable National Park lies 11 km north of the project area and covers an area of 18,329 hectares.

3.2.3 Administrative boundaries

The project area falls within the Port Pirie council area, the Northern and Yorke Natural Resource Management Region and the Hundreds of Napperby and Howe (Naturemaps 2017).

3.3 Climate

The region experiences a Mediterranean climate with warm dry summers and cool wet winters. The closest climate dataset is from the Snowtown (Rayville Park) (021133) weather station approximately 20 km south-west of the proposed Ceres Wind Farm site. The mean annual rainfall for the area (2001-2011) is 380.6 mm, with June through to September typically the wettest months (Figure 2). The mean minimum temperature was 9 C and the mean maximum temperature ranges from 15.2 C (July) to 32.8 C (January) (BOM 2017).

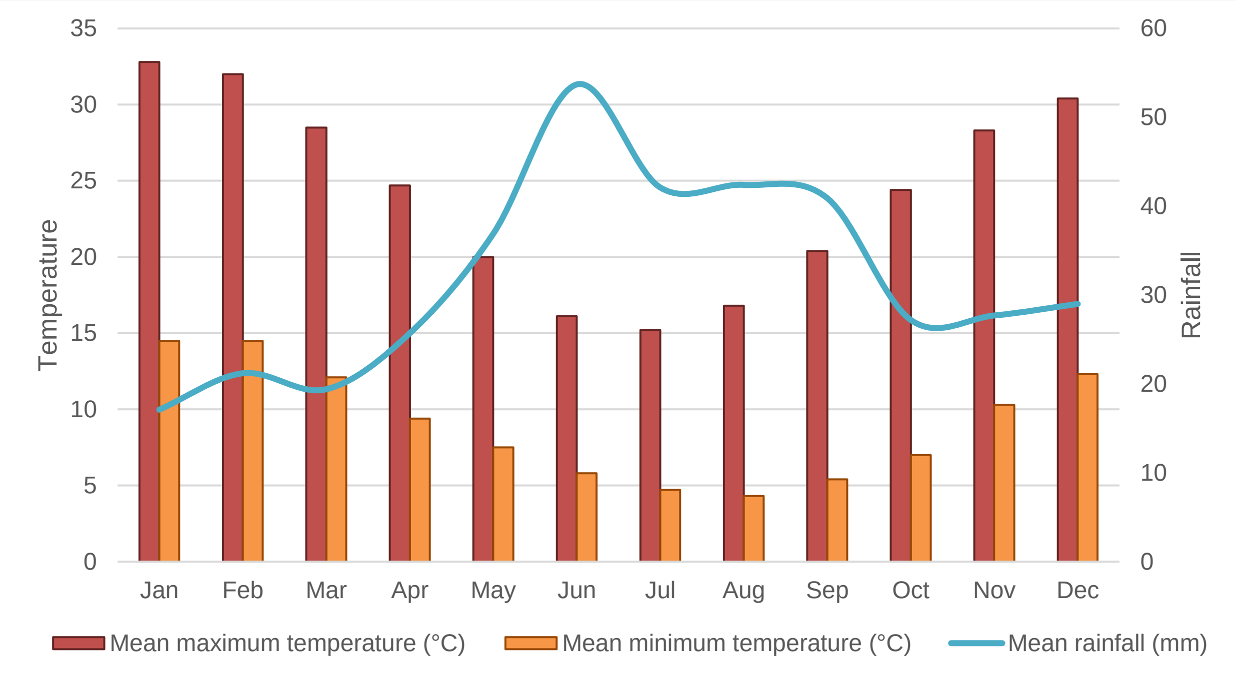


Figure 2. Average monthly rainfall and temperature data for Snowtown weather station (138.22E, 33.77S).

3.4 Previous studies

Biosis Research Pty. Ltd. undertook investigations at the proposed Crystal Brook Energy Park site in 2003, when a larger wind farm incorporating the present site was proposed. At that stage, Origin Energy was the company who was proposing that the Crystal Brook Energy Park be built, which at the time was divided into Crystal Brook North Wind Farm and Crystal Brook South Wind Farm. Subsequent and more detailed investigations were carried out at the site by Biosis Research in 2009 and by Sinclair Knight Merz (SKM) in 2011; the 2012 report by Biosis was a compilation of information relevant to the Crystal Brook site, obtained during the course of the studies mentioned above.

Methodology for the site assessments included:

- Undertaking targeted surveys for species of flora and fauna listed as threatened under the NPW Act and the EPBC Act including: Pale Leek Orchid *Prasophyllum pallidum*; Swollen Spear Grass *Austrostipa gibbosa*; *Crassula sieberiana*; Flinders Worm-lizard *Aprasia pseudopulchella* and Pygmy Bluetongue Lizard *Tiliqua adelaidensis*;
- Undertaking targeted surveys for ecological communities listed under the EPBC Act, namely Iron-grass Natural Temperate Grassland of South Australia and Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia; and
- Obtain information about species of bats using the site.

An assessment of native vegetation was undertaken, where present, at each proposed turbine site. This involved identification of native vegetation (floristic) mapping units and native vegetation clearance significant environmental benefit (SEB) ratios were determined. Fauna surveys at the turbine locations included:

- Anabat® remote bat call detectors;

- Funnel traps targeting reptiles;
- Searches for Flinders Worm Lizard;
- Searches for Pygmy Bluetongue Lizard; and
- Bird census.

3.5 Threatening processes

The major threats to biodiversity in and around the local area may include:

- Fragmentation and isolation, with the probability of disturbance such as fire, removing entire remnants;
- poor recruitment / lack of genetic variability;
- grazing with lack of regeneration;
- fertiliser drift from surrounding cultivation;
- disturbance activities such as construction, road maintenance, weed spraying and mining, potentially causing small-scale clearing and reduced sub-population sizes;
- weed invasion e.g. competition with environmental weeds such as *Lycium ferocissimum* (Boxthorn), *Asparagus asparagoides* (Bridal Creeper), *Avena barbata* (Wild Oats) and *Ehrharta* sp. (Veldt Grass); and
- pest animals (e.g. rabbits, foxes, cats) presenting a threat to native plant and animal species through grazing, competition and predation.

4 METHODS

4.1 Database searches

The online Protected Matters Search Tool (accessed 25th January 2017) was used to identify any flora species or ecological communities of national environmental significance under the EPBC Act that may occur or may have suitable habitat within the project area. A 5 km buffer was applied to the search.

A search of the Biological Database of South Australia (BDBSA) maintained by the Department of Environment, Water and Natural Resources (DEWNR) was obtained (3rd March 2017) to identify threatened flora species previously recorded within a 10 km buffer around the project area (DEWNR 2017). The BDBSA is comprised of an integrated collection of corporate databases which meet DEWNR standards for data quality, integrity and maintenance. In addition to the DEWNR biological data, the BDBSA also includes data from partner organisations. This data is included under agreement with the partner organisation for ease of distribution but they remain owners of the data and should be contacted directly for further information.

4.2 Background information

Existing information relevant to the project was reviewed, including:

- Aerial imagery;
- Spatial datasets: DEWNR biological survey sites, vegetation cover, protected areas, NVIS floristic mapping, Transport SA roadside vegetation survey;
- DotEE website for Species Profiles and Threats (SPRATs), recovery plans, conservation advices and policy statements for nationally listed species and ecological communities;
- Web-based literature, journal articles and other published information on bird migration patterns and bird collision risk associated with wind turbines (cited in the text where used);
- Reports and plans, key references being:
    - A Regional Species Conservation Assessment Process for South Australia - Phase 2: Species Prioritisation, Northern and Yorke (Gillam 2009);
    - Biodiversity Plan for the Northern Agricultural Districts (Graham et al. 2001);
    - Conservation Assessment of the Northern and Yorke Coast (Government of South Australia 2007);
    - Flora and terrestrial fauna assessment of Crystal Brook North Wind Farm (Biosis Research, January 2012); and
    - Flora and terrestrial fauna assessment of Crystal Brook South Wind Farm (Biosis Research, January 2012).

This information was used to build a picture of:

- native vegetation cover within the project area and immediate surrounds;

- previous survey effort in the area;
- vegetation associations present (including associations of significance);
- flora and fauna species (including species of national, state or local conservation significance) known or likely to occur in the area;
- potential ecological constraints and opportunities for the project; and
- key threatening processes (e.g. weeds, pest animals) that may require specific management.

Species nomenclature in this report follow that used in the DEWNR taxonomic lists (last updated February 2017).

4.3 Field survey

Follow up flora and fauna field surveys for the Crystal Brook site were undertaken from the 27th February to the 2nd of March 2017. Subsequent micro siting and uptake of recommendations resulted in further follow up surveys in the area and changes to the project boundaries. These were undertaken as a single day survey on the 11th May, 2017 and a two day survey on the 22-23rd May 2017.

In July 2017 the new Native Vegetation Regulations 2017 were employed which meant that clearance assessments of areas required updating and refinement in accordance with some additional turbine relocations was undertaken on the 5th and 6th February, 2018. The February 2018 assessment acted as an on ground revision of the project area with the vegetation survey performed in accordance with the Bushland Assessment Manual method by accredited ecologists (NVC 2017). This methodology produces an SEB area and value for payment in to the Native Vegetation Fund derived from the clearance of native vegetation. The overall calculation is based upon the following parameters:

- Landscape context;
- Vegetation condition;
- Conservation significance score;
- Mean annual rainfall; and
- Area of clearance.

The factors which comprise each of these parameters are described in Table 2.

Table 2. The factors which influence the values for the five parameters which calculate the total SEB area and value.

Parameter	Factors
Landscape context	• Percentage vegetation cover within 5 km • Block shape • Distance to remnant of >50 ha • Remnancy of IBRA Association • Percentage of vegetation protected within the IBRA Association • The presence of riparian vegetation, swamps or wetlands
Vegetation condition	• Native species diversity • Number of native lifeforms and their cover

	• Number of regenerating species • Weed cover and the level of invasiveness of dominant species • Cover of bare ground, fallen timber, exotic species in the understorey • Tree health and the number of individuals supporting hollows
Conservation significance score	• The presence of federal or state listed threatened ecological communities, and their conservation rating. • Number of threatened plant species recorded at the site, and their conservation rating • Number of threatened fauna species for potential habitat occurs within the site, and their conservation rating.
Mean annual rainfall	The mean annual rainfall for the site.
Area of clearance	The area of native vegetation (ha) to be cleared for the project.

4.3.1 Threatened flora

Native vegetation within the project area was surveyed for nationally and state threatened flora species that possibly occurred within the area. The locations of historic BDBSA threatened flora records within the project area were visited. A drive-by survey was undertaken along the public roads, with survey undertaken on foot in selected and representative areas considered as potential habitat for threatened species. The survey was also undertaken on foot in larger patches of native vegetation. A ramble survey method was adopted (i.e. randomly walking through areas of vegetation, attempting to cover different topography and habitats) to ensure best coverage of the patches of vegetation within the time available.

The following information was recorded for all threatened flora observed:

- Location and extent of the population (GPS); and
- Vegetation association and additional habitat observations where relevant.

4.3.2 Threatened ecological communities

The EPBC Protected Matters database identified *Eucalyptus odorata* (Peppermint Box) Grassy woodlands of South Australia as being a nationally threatened ecological community that has the potential to occur within the project area. As part of the overall mapping of vegetation on site, a targeted survey was undertaken in areas of *Eucalyptus odorata* (Peppermint Box). Table 3 details the minimum criteria used for listing the Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia.

Areas of Condition Class A are considered the highest quality representation of the community. Condition Class B areas are also of high quality, but do not have the native species diversity of Condition Class A. Classes A and B are indicative of the listed ecological community. Condition Class C areas, which are typically significantly degraded (low condition), are not included as the listed ecological community, and therefore, do not trigger the ‘significant test’ of the EPBC Act. Condition Class C areas are still considered to be amenable to rehabilitation through measures such as weed control, natural regeneration and protection from grazing.

Table 3. Condition classes for Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia.

Condition Class	Minimum Size	Diversity of Native Species[1]	No. of Broad-leaved Herbaceous Species[1] in addition to identified disturbance resistant species[2]	No. of Perennial Grass Species[1]
Listed ecological community				
A	0.1 ha	> 30	+10	≥5
B	1 ha	> 15	+3	≥2
Degraded patches amenable to rehabilitation				
C		> 5	No minimum	≥1

[1] As measured in a 50 m X 50 m quadrat;

[2] The following species are identified as disturbance resistant species: *Ptilotus spathulatus* forma *spathulatus; Sida corrugata; Oxalis perennans; Convolvulus erubescens; Euphorbia drummondii;* and, *Maireana enchylaenoides.*

4.3.3 General bird surveys

Given that a detailed bird census was previously conducted by Biosis (2012), an opportune bird survey was undertaken across the site, focusing on areas of potential habitat, such as surface water sources and large patches of vegetation. Observed raptor nests were recorded and checked for breeding activity.

4.3.4 General fauna survey and habitat assessment

All fauna species observed opportunistically during the 2017 survey were recorded, including comments on the location, habitat and number of individuals observed. The native vegetation within the project area was assessed in terms of its fauna habitat value. This involved:

- Reviewing the 2017 field survey results and database records;
- Assessing the habitat value of the vegetation during the field survey to determine the fauna species likely to occur within the project area; and
- Highlighting any areas of significant fauna value.

Searches for the Flinders Ranges Worm Lizard (FRWL) (*Aprasia pseudopulchella)* and Pygmy Blue-tongue Lizard (PBTL) (*Tiliqua adelaidensis)* were conducted as part of the survey work reported on by Biosis (2012). As such, no additional targeted surveys for these species were completed during the latest survey work.

Bats were targeted as part of the survey work reported on by Biosis (2012) on site, therefore Anabat remote bat detectors were not used as part of this current survey. A current database search was conducted in order to determine what bat species may utilise the project area.

4.4 Limitations

The findings and conclusions expressed by EBS Ecology are based solely upon information in existence at the time of the assessment. Field data collected during the field survey, combined with database records and background research, is considered to provide an adequately detailed assessment of the flora and fauna that occur and are likely to occur within the project area.

Existing flora and fauna records were sourced from the Biological Database of South Australia (BDBSA). The BDBSA only includes verified flora and fauna records submitted to DEWNR or partner organisations. Although much of the BDBSA data has been through a variety of validation processes, the lists may contain errors and should be used with caution. DEWNR give no warranty that the data is accurate or fit for any particular purpose of the user or any person to whom the user discloses the information.

It is recognised that knowledge is poorly captured in the BDBSA. Consequently there is uncertainty in relation to the status of species, and additional species are likely to occur that are not reflected by database records. The spatial precision of the BDBSA data ranges from 0 m to over 25 km. Hence the location of mapped BDBSA records may not reflect their true location. Fauna species, in particular birds, have the ability to traverse large distances and thus may not be detected within the 10 km buffer applied to the database search.

The vegetation association descriptions and SEB condition ratings assigned are broad scale and based on the average condition of vegetation. The association and condition of the vegetation may vary within areas of vegetation.

The information obtained from this survey and database records represent limited fauna survey effort over small snapshots in time. Additional species, such as migratory birds, could utilise or fly over the area that may not be captured by current records. It is likely that additional fauna species would be recorded at different times of the year. These limitations, whilst recognised, can be said for any chosen survey period.

5 RESULTS

5.1 Database searches

5.1.1 EPBC Protected Matters database search

A Protected Matters database search was performed for the project area (within a 5 km buffer) to identify matters of national environmental significance that may be relevant to the project. A summary of the database search results is provided in Table 4 below.

The database search identified the following species of national significance as potentially occurring or having suitable habitat potentially occurring within the area:

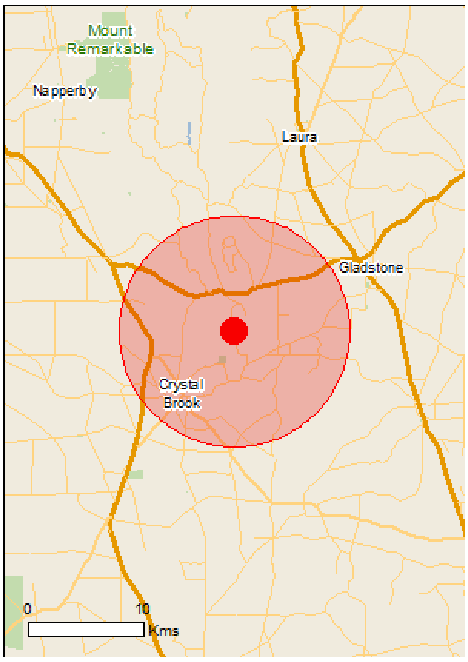
- 10 threatened plants;
- 8 threatened birds; and
- 2 threatened reptiles.

A summary of each species, their conservation status and their likelihood of occurrence within the project area is provided in Table 5. This assessment focused on the potential terrestrial impacts of the project. Many of the threatened and migratory bird species are marine and coastal specialists. Whilst they are unlikely to utilise the terrestrial areas of the project area, their movement and migration pathways and subsequent collision risk with turbines is not well understood.

The EPBC Protected Matters database identified nine listed migratory species as possibly occurring, or having habitat possibly occurring within the search area. The results do not include migratory species that are very widespread, vagrant, or only occur in small numbers (DotEE 2017). The Pygmy Blue-tongue Lizard (PBTL) (*Tiliqua adelaidensis)* (nationally endangered) did not register within the Protected Matters Search of 5km.

The EPBC Protected Matters database identified *Eucalyptus odorata* (Peppermint Box) Grassy woodlands of South Australia as being a nationally threatened ecological community that has the potential to occur within the project area. *Eucalyptus odorata* (Peppermint Box) Woodland was mapped on site as vegetation association 6; it was in moderate condition with a SEB rating range of 4:1-5:1. It covered approximately 18 ha of the overall site and was determined as possibly qualifying as a TEC, if surveyed at an optimal time of the year.

Table 4. Summary of EPBC Protected Matters database search.

Search Area	Matter of significance under the EPBC Act	Confirmed within or near the project area	Potential impact from proposed action
	World Heritage properties	×	×
	National Heritage properties	×	×
	Wetlands of International Significance	×	×
	Nationally threatened species	20 species identified as possibly occurring, or having habitat possibly occurring within the search area*	Removal of potential habitat, potential fauna disturbance/ collision associated with turbine operation/ construction
	Nationally threatened ecological communities	*Eucalyptus odorata* (Peppermint Box) Grassy woodlands of South Australia	Removal of potential communities within access tracks
		Iron-grass Natural Temperate Grassland of South Australia	Removal of potential communities within access tracks
	Listed migratory species	9 species identified as possibly occurring, or having habitat possibly occurring within the search area*	Removal of potential habitat, potential fauna disturbance/ collision associated with turbine operation/ construction

*search area is defined as within a 10km buffer of the project area.

Table 5. Nationally listed conservation significant species potentially occurring within the pro ect area.

Scientific name	Common name	Conservation status (AUS)	Likelihood of occurrence*
Birds			
Apus pacificus	Fork-tailed Swift	Ma	Possible
Botaurus poiciloptilus	Australasian Bittern	EN	Unlikely
Calidris ferruginea	Curlew Sandpiper	CE, Mi (W)	Unlikely
Gallinago hardwickii	Latham's Snipe	Mi (W)	Unlikely
Grantiella picta	Painted Honeyeater	VU	Unlikely
Motacilla cinerea	Grey Wagtail	Mi	Possible
Motacilla flava	Yellow Wagtail	Mi	Unlikely
Myiagra cyanoleuca	Satin Flycatcher	MI	Unlikely
Numenius madagascariensis	Eastern Curlew	CE, Mi (W)	Unlikely
Pandion haliaetus	Osprey	Mi (W)	Unlikely
Pedionomus torquatus	Plains wanderer	CE	Unlikely
Pezoporus occidentalis	Night Parrot	EN	Unlikely
Rostratula australis	Australian Painted Snipe	VU, Ma, Mi (W)	Unlikely
Tringa nebularia	Common Greenshank	Mi (W)	Unlikely

Scientific name	Common name	Conservation status (AUS)	Likelihood of occurrence*
oothera lunulata halmaturina	Bassian thrush	VU	Unlikely
Reptiles			
Aprasia pseudopulchella	Flinders Ranges Worm-lizard	VU	Possible
Notechis scutatus ater	Krefft's Tiger Snake	VU	Unlikely
Plants			
Acanthocladium dockeri	Spiny everlasting	CE	Unlikely
Caladenia gladiolata	Bayonet Spider-orchid	EN	Unlikely
Caladenia macroclavia	Large-club Spider-orchid	EN	Possible
Caladenia tensa	Green comb Spider-orchid	EN	Unlikely
Caladenia woolcockiorum	Woolcock's spider orchid	VU	Possible
Caladenia xantholeuca	White Rabbits	EN	Possible
Prasophyllum pallidum	Pale Leek-orchid	VU	Possible
Pterostylis lepida	Halbury Greenhood	EN	Unlikely
Senecio megaglossus	Superb Groundsel	VU	Possible
Swainsona pyrophila	Yellow Swainson-pea	VU	Possible

Conservation Codes: CE: Critically Endangered. **EN:** Endangered. **VU:** Vulnerable. **Mi**: Migratory. **Mi (W)** – Migratory Wetlands, **Ma:** Marine.*likelihood of occurrence is based on any known records to the area, most recent record and potential habitat for the species on site.

5.1.2 Biological Database of South Australia Search

The BDBSA search identified 84 threatened flora species previously recorded within 10 km of the project area (DEWNR 2017). Of these, eight are nationally listed and 81 are state listed. It should be noted that the accuracy of these records ranges from 5 m to >25 km and thus the mapped location of some records could be inaccurate. A number of the records are from the Mulburra Park National Trust Reserve.

A summary of the BDBSA threatened flora and fauna records and their likelihood of occurrence within the project area are provided in Table 6 and Table 7 (consecutively). The location of threatened flora and fauna records from the BDBSA are shown in Figure 3 and Figure 4. Discussion on species known to occur or possibly occurring within the project area is provided in section 6.

Four species are known to be present within the project area boundary and a further seven are considered likely to be present based on vegetation habitats available and the presence of other records nearby (**Table** 6).

Appendix 1 tabulates the flora species recorded from the local area and includes Biosis Research records from the study area. Database searches encompassed a 5km radius

Two bird species, with a state conservation rating, were recorded during the 2017 survey and are therefore known to the project area. These were the Diamond Firetail (*Stagonopleura guttata*) and Hooded Robin (*Melanodryas cucullata)* (Table 7). These species are discussed in the results section of this report (section 5.2.6 and in more detail under section 6). Three bird species and one mammal listed from the BDBSA 10km search, were known to the project area from previous assessments (Biosis 2012). The Jacky Winter (*Microeca fascinans fascinans)*, White-winged Chough (*Corcorax melanorhamphos)* and Elegant Parrot (*Neophema elegans*) have been previously recorded on site and are therefore listed as known in Table 7. The Common Brushtail Possum (*Trichosurus vulpecula)* was recorded by Biosis in 2003, and therefore is noted as a known species to the project area. These species are not discussed in this report and should be referred to as part of the terrestrial fauna assessment of Crystal Brook Energy Park (Biosis 2012) (Appendix 2). There are also five species that were determined as likely to occur within the project area, which has been influenced by not only the current survey but the likelihoods that were determined for these species by Biosis (2012). These were the Scarlet Robin (*Petroica boodang boodang*), Painted Button-quail (*Turnix varius*), Musk Duck (*Biziura lobata*), Peregrine Falcon (*Falco peregrinus*) and Crested Shrike-tit (*Falcunculus frontatus*). Appendix 3 lists the fauna of national or state significance recorded, or predicted to occur, within 5km of the study area. These five species are discussed in more detail in section 6.

Table 6. Threatened flora species records from BDBSA (5km buffer) (sorted by conservation rating, from highest to lowest).

Species name	Common name	AUS	SA	NY	Likelihood of occurrence*
Olearia pannosa ssp. pannosa	Silver Daisy-bush	VU	V	VU	Possible
Acacia spilleriana	Spiller's Wattle	EN	E	EN	Unlikely
Caladenia tensa	Inland Green-comb Spider-orchid	EN		NE	Possible
Acanthocladium dockeri	Spiny Everlasting	CR	E	CR	Unlikely
uncus radula	Hoary Rush		V	VU	Possible
Ozothamnus scaber	Rough Bush-everlasting		V	VU	Possible
Phyllangium sulcatum	(blank)		V	VU	Possible
Austrostipa pilata	Prickly Spear-grass		V	RA	Possible
Pycnosorus globosus	Drumsticks		V	EN	Likely
Swainsona behriana	Behr's Swainson-pea		V	EN	Possible
Santalum spicatum	Sandalwood		V	CR	Unlikely
Swainsona procumbens	Broughton Pea		V	CR	Possible
Spyridium bifidum ssp. bifidum	Marble Range Spyridium		V		Possible
Trachymene thysanocarpa	Native Parsnip		R	VU	Likely
Eucalyptus cajuputea	Green Mallee		R		Possible
Austrostipa multispiculis	Many-flowered Spear-grass		R	VU	Possible
Dianella longifolia var. grandis	Pale Flax-lily		R	VU	Possible
Eucalyptus albens	White Box		R	VU	Unlikely
Leptorhynchos elongatus	Lanky Buttons		R	VU	Likely
Utricularia australis	Yellow Bladderwort		R	VU	Possible
Acacia gracilifolia	Graceful Wattle		R	RA	Unlikely
Acacia iteaphylla	Flinders Ranges Wattle		R	RA	Possible
Asperula syrticola	Southern Flinders Woodruff		R	RA	Likely
Austrostipa densiflora	Fox-tail Spear-grass		R	RA	Possible
Austrostipa gibbosa	Swollen Spear-grass		R	RA	Likely
Cladium procerum	Leafy Twig-rush		R	RA	Possible
Cryptandra campanulata	Long-flower Cryptandra		R	RA	Likely
Elatine gratioloides	Waterwort		R	RA	Possible
Eucalyptus percostata	Ribbed White Mallee		R	RA	Possible
Poa drummondiana	Knotted Poa		R	RA	Possible
Sclerolaena muricata var. villosa	Five-spine Bindyi		R	RA	Unlikely
Logania saxatilis	Rock Logania		R	NT	Present
Aristida australis	Wire Grass		R	NE	Present
Brachyscome ciliaris var.			R	NE	Possible
Rytidosperma tenuius	Short-awn Wallaby-grass		R	NE	Possible
Anogramma leptophylla	Annual Fern		R	LC	Possible

Species name	Common name	AUS	SA	NY	Likelihood of occurrence*
Austrostipa breviglumis	Cane Spear-grass		R	LC	Likely
Ptilotus erubescens	Hairy-tails		R	LC	Possible
Eucalyptus behriana	Broad-leaf Box		R	EN	Likely
Olearia pannosa ssp. cardiophylla	Velvet Daisy-bush		R	EN	Possible
Olearia picridifolia	Rasp Daisy-bush		R	EN	Likely
Solanum eremophilum	Rare Nightshade		R	EN	Possible
Thelymitra batesii	(blank)		R	EN	Possible
Thelymitra grandiflora	Great Sun-orchid		R	EN	Possible
Veronica decorosa	Showy Speedwell		R	EN	Possible
Acacia montana	Mallee Wattle		R	CR	Possible
Brachyscome parvula	Coast Daisy		R		Possible
Eremophila subfloccosa ssp. glandulosa	Green-flower Emu-bush		R		Unlikely
Eucalyptus polybractea	Flinders Ranges Box		R		Possible
Haeckeria cassiniiformis	Dogwood Haeckeria		R		Possible
Hovea purpurea	Tall Hovea		R		Possible
Myoporum parvifolium	Creeping Boobialla		R		Possible
Swainsona sericea	Silky Swainson-pea		E	RA	Possible
Thelymitra aristata	Great Sun-orchid		E		Possible
Pycnosorus chrysanthes			E	NE	Possible
Maireana decalvans	Black Cotton-bush		E	EN	Possible

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). **SA:** South Australia (*National Parks and Wildlife Act 1972*). **NY**: Northern and Yorke regional rating. **Conservation Codes: CR:** Critically Endangered. **EN E:** Endangered. **VU V:** Vulnerable. **R RA:** Rare. **NE**: Not evaluated. **NT**: Near threatened. **LC:** Least concern. *likelihood of occurrence is based on any known records to the area, most recent record and potential habitat for the species on site.

Table 7. Threatened fauna species records from BDBSA (10km buffer) (sorted by conservation rating, highest to lowest).

Species	Common	AUS	SA	NY	Likelihood of occurrence*
Birds					
Stagonopleura guttata	Diamond Firetail		V	EN	Known - 2017
Grus rubicunda	Brolga		V		Unlikely
Melanodryas cucullata	Hooded Robin		R	VU	Known - 2017
Microeca fascinans fascinans	Jacky Winter		R	VU	Known – Biosis 2012
Petroica boodang boodang	Scarlet Robin		R	VU	Likely
Corcorax melanorhamphos	White-winged Chough		R	VU	Known – Biosis 2012
Neophema elegans	Elegant Parrot		R	VU	Known – Biosis 2012
Porzana tabuensis	Spotless Crake		R	VU	Unlikely
Turnix varius	Painted Button-quail		R	VU	Likely
Biziura lobata	Musk Duck		R	RA	Likely
Falco peregrinus	Peregrine Falcon		R	RA	Likely
Falcunculus frontatus	Crested Shrike-tit		R	EN	Likely
Myiagra inquieta	Restless Flycatcher		R	EN	Possible
Burhinus grallarius	Bush Stone curlew		R	CR	Unlikely
Falco hypoleucos	Grey Falcon		R	CR	Unlikely
Ardea intermedia	Intermediate Egret		R		Possible
Glossopsitta pusilla	Little Lorikeet		E		Unlikely

Species	Common	AUS	SA	NY	Likelihood of occurrence*
Reptiles					
Aprasia pseudopulchella	Flinders Ranges Worm-lizard	VU		LC	Possible
Varanus varius	Lace Monitor		R	VU	Unlikely
Vermicella annulata	Common Bandy Bandy		R	RA	Unlikely
Mammals					
Tachyglossus aculeatus	Short-beaked Echidna	ssp		NT	Possible
Trichosurus vulpecula	Common Brushtail Possum		R	EN	Known – Biosis 2012
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat		R		Possible
Pseudophryne bibronii	Brown Toadlet		R	RA	Unlikely

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). **SA:** South Australia (*National Parks and Wildlife Act 1972*). **NY**: Northern and Yorke regional rating. **Conservation Codes: CR:** Critically Endangered. **EN E:** Endangered. **VU V:** Vulnerable. **R RA:** Rare. **NE**: Not evaluated. **NT**: Near threatened. **LC:** Least concern. *likelihood of occurrence is based on any known records to the area, most recent record and potential habitat for the species on site.

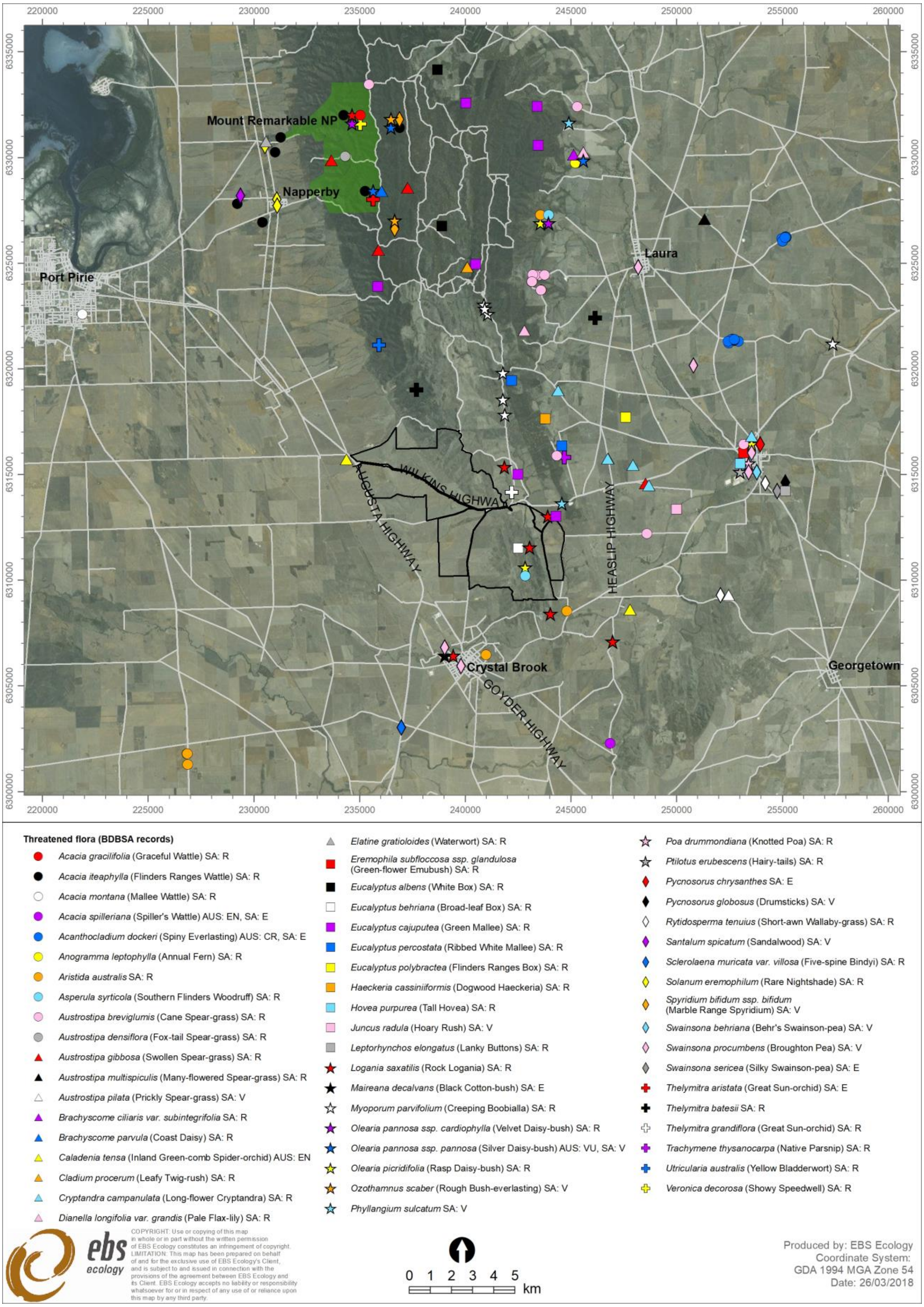


Figure 3. Flora records from the BDBSA search.

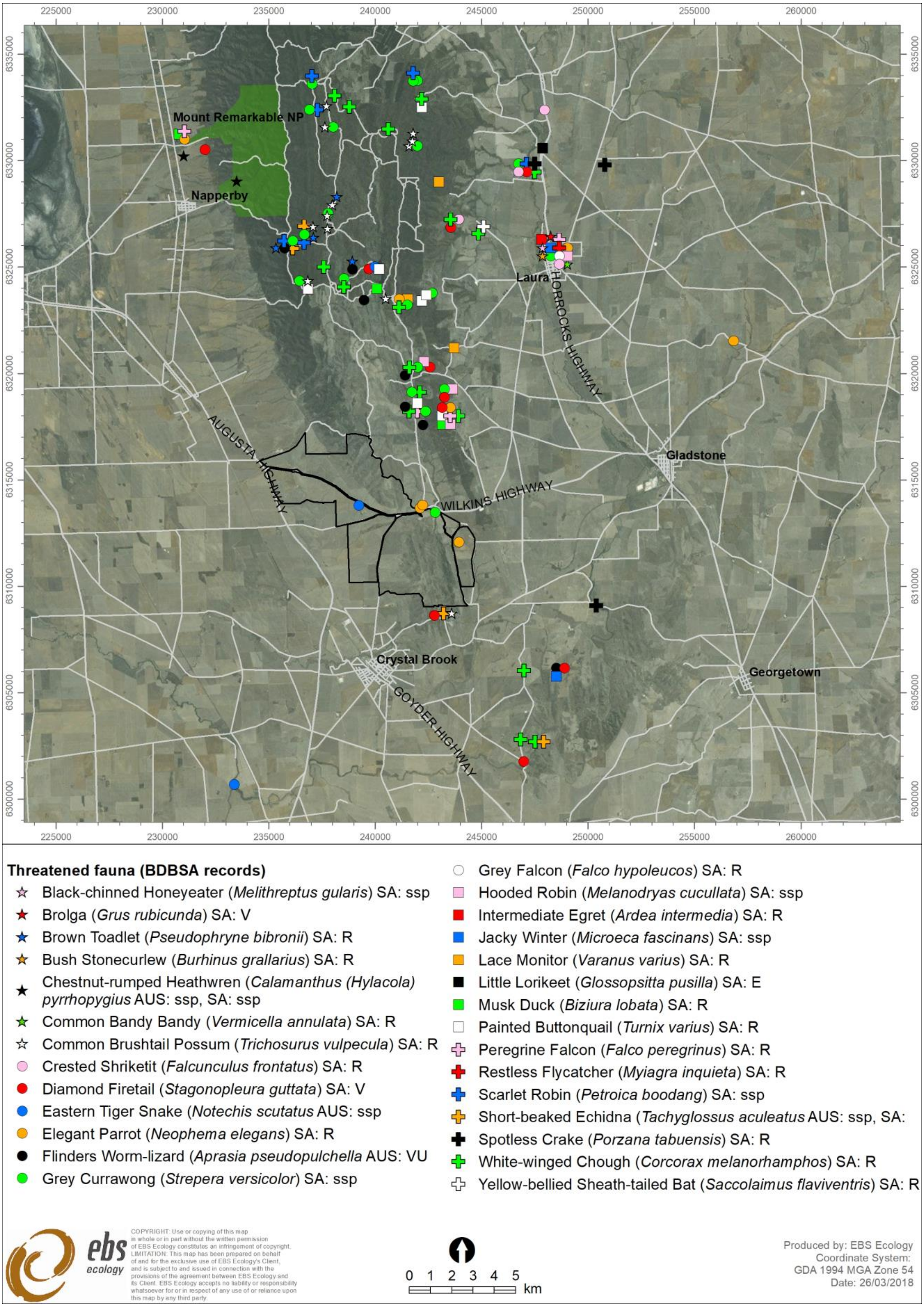


Figure 4. Fauna records from the BDBSA search.

5.2 Field survey

The existing vegetation located within the project area was dominated by grasslands interspersed with open woodlands and remnant intact mallee. This is a direct result of clearing for agricultural purposes. Foot slopes associated with the range are commonly utilised for cereal and legume cropping where soil depth is suitable. Higher elevation areas are primarily utilised for grazing purposes due to steep topography and shallower soil depth in comparison to lower elevation areas. Due to difficulty in operating heavy machinery and agricultural implements in steep areas, pasture improvement measures such as phosphate additions and soil disturbance has been limited. This has resulted in grasslands which were still largely dominated by the indigenous grass species remnant from pre clearance periods.

5.2.1 Vegetation associations

Twelve broad vegetation associations were represented within the project area. The dominant indigenous cover was *Austrostipa* spp. (tussock) Grasslands and *Eucalyptus porosa* (Mallee Box) Woodlands. See Table 8 below for a summary of these.

Table 8. Vegetation association summary.

Assoc. Number	Description
1	*Austrostipa* spp. (Spear Grass) Open (tussock) grassland
2	*Eucalyptus leucoxylon* ssp. *pruinosa* (South Australian Blue gum) +/- *Eucalyptus odorata* (Peppermint Box) Woodland
3	*Eucalyptus porosa* (Mallee Box) Woodland
4	*Bursaria spinosa* (Christmas Bush) / *Cassinia spp.* (Curry Bush) / *anthorrhoea quadrangulata* (Yacca) Shrubland +/- *Allocasuarina verticillata* (Drooping she-oak)
5	Cropland
6	*Eucalyptus odorata* (Peppermint Box) Woodland
7	*Triodia* spp. (Spinifex) Closed Hummock Grassland
8	*Eucalyptus* spp. Mixed Mallee
9	*Eucalyptus phenax* ssp. *phenax* (White Mallee) Open Mallee
10	*Acacia victoriae* (Elegant Wattle) Shrubland
11	*Allocasuarina verticillata* (Drooping She-oak) / *Bursaria spinosa* (Christmas Bush) / *Melaleuca lanceolata* (Moonah) Low Woodland
12	Amenity plantings as windbreaks and biodiversity corridors

Vegetation Association 8 was present as an intact community that represented areas of high ecological value. It was recorded as the dominant cover on the ridge line in the south section of the project area, immediately east of the Mercowie Creek and Heysen Trail. The association was generally observed to have intact overstorey structures and higher than average understorey diversity in many instances. This community was also prime sites for potential presence of nationally listed species such as orchids and herbaceous species if assessed in season.

Vegetation association 4 was observed as intact communities and these are typically located in the areas which were most difficult to clear in being either very shallow soils or steep terrain. These also provided the structure for two of the threatened vegetation species observed (see section 5.2.3). The following section summarises the ten vegetation associations which are represented in Figure 17 to Figure 19.

Association 1. *Austrostipa* spp. (Spear Grass) Open (tussock) Grassland

Figure 5. Austrostipa spp. Open (tussock) Grassland.

Overstorey and midstorey	*Austrostipa spp. (Spear Grass)*
Understorey	Common native species included: • *Rhytidosporum ssp.* (Wallaby-grass) • *Austrostipa* sp. (Spear-grass) • *Aristida behriana* (Bristle Wire Grass) • *Themeda triandra* (Kangaroo Grass) • *Maireana enchylaenoides* • *Neurachne alopecuroidea* • *Lomandra effusa* (Scented Mat Rush)
Exotic species	Common weed species included: • *Asteriscus spinosus* (Golden Pallensis) • *Avena barbata* (Bearded Oat) • *Carthamus lanatus* (Star Thistle) • *Marrubium vulgare* (Horehound) • *Piptatherum miliaceum* (Rice Millet) • *Salvia verbenaca* (Wild Sage)
Conservation significant species	No conservation significant species recorded
Vegetation condition	Very Poor (2:1) to Moderate (4:1)
Habitat value	Low to moderate due to high cover of exotic annual grass species.

Association 2: *Eucalyptus leucoxylon* ssp. *pruinosa* (South Australian Bluegum) - *Allocasuarina verticillata* (Drooping She-oak) Woodland

Figure 6. South Australian Blue gum Open Woodland.

Overstorey and midstorey	*Eucalyptus leucoxylon* (SA Blue gum), *Eucalyptus odorata* (Peppermint Box), *Callitris preissii* (Native Pine), *Acacia pycnantha* (Golden Wattle)
Understorey	Common native species included: • *Bursaria spinosa* (Christmas Bush) • *Triodia* sp. (Spinifex) • *Scaevola humilis* (Fan Flower) • *Alectryon oleifolius* (Bullock Bush) • *Dianella revoluta* (Flax Lily) • *Lomandra collina* (Mat rush)
Exotic species	Common weed species included: • *Asteriscus spinosus* (Golden Pallensis) • *Heliotropium glauca (Potato Weed)* • *Avena barbata* (Bearded Oat) • *Marrubium vulgare* (Horehound) • *Piptatherum miliaceum* (Rice Millet) • *Salvia verbenaca* (Wild Sage)
Conservation significant species	No conservation significant species observed
Vegetation condition	Very Poor (2:1) to Moderate (6:1)
Habitat value	Moderate to high. Good bird and bat habitat with numerous hollows (small, medium, large).

Association 3: *Eucalyptus porosa* (Mallee Box) Woodland

Figure 7. *Eucalyptus* spp. Mixed Mallee.

Overstorey and midstorey	*Eucalyptus porosa* (Mallee Box)
Understorey	Common native species included: • *Austrostipa spp. (Spear Grass)* • *Rhagodia parabolica* (Ruby saltbush) • *Einadia nutans* (Berry Saltbush) • *Grevillea huegelii* (Spider Grevillea)
Exotic species	Common weed species included: • *Solanum elaeagnifolium* (Silver leaf Nightshade) • *Lepidium africanum (Peppercress)* • *Avena barbata* (Bearded Oat) • *Lycium ferocissimum* (African Boxthorn)
Conservation significant species	No conservation significant species observed
Vegetation condition	Poor (4:1) to moderate (6:1)
Habitat value	Moderate to high. Good bird and bat habitat with foraging, roosting and refuge habitat present.

Association 4: *Bursaria spinosa* (Christmas Bush) *Cassinia spp.* (Curry Bush) *Xanthorrhoea uadrangulata* (Yacca) Shrubland - *Allocasuarina verticillata* (Drooping she-oak)

Figure 8. *Bursaria* over *Triodia* dominant community with *Allocasuarina verticillata* in the background.

Overstorey and mid storey	*Allocasuarina verticillata* (Drooping She-oak), *Bursaria spinosa* (Christmas Bush), *anthorrhoea quadrangulata* (Yacca)
Understorey	Common native species included: • *Cassinia laevis* (Curry Bush) • *Olearia decurrens* (Daisy) • *Pimelea microcephala* (Riceflower) • *Lepidosperma viscidum* (Sword Sedge) • *Tricoryne elatior* • *Callistemon teretifolius* (Bottlebrush) • *Acacia oswaldii* • *Acacia hakeoides*
Exotic species	Common weed species included: • *Asteriscus spinosus* (Golden Pallensis) • *Avena barbata* (Wild Oats)
Conservation significant species	*Callistemon teretifolius*
Vegetation condition	Poor (4:1) to Moderate (6:1)
Habitat value	Moderate to high. Good bird habitat with numerous foraging resources

Association 5: Cropland

Figure 9. Cropland post-harvest.

Overstorey and midstorey	Exotic cereal crops
Understorey	No native understorey present
Exotic species	Common weed species included *Avena barbata*, *Heliotropium glauca* and *Solanum elaeagnifolium*
Conservation significant species	None
Vegetation condition	Very Poor (0:1)
Habitat value	Low

Association 6: *Eucalyptus odorata* (Peppermint Box) Woodland

Figure 10. Peppermint Box Dominant Grassy Woodland.

Overstorey and midstorey	*Eucalyptus odorata* (Peppermint Box)
Understorey	Common native species included: • *Rytidosperma* sp. (Wallaby-grass) • *Austrostipa* sp. (Spear-grass) • Triodia sp. (spinifex)
Exotic species	Common weed species included: • *Hypericum perforatum* (St John's Wort) • *Heliotropium europaea* (Potato Weed) • *Avena barbata* (Bearded Oat) • *Marrubium vulgare (Horehound)* • *Piptatherum miliaceum (Rice Millet)* • *Salvia verbenaca (Wild Sage)*
Conservation significant species	*Aristida australis* (Wire Grass)
Vegetation condition	Moderate (5:1)
Habitat value	Moderate to high. Good bird and bat habitat with numerous hollows (small, medium, large).

Association 7: *Triodia* spp. (Spinifex) Closed Hummock Grassland

Figure 11. Spinifex Grassland.

Overstorey and midstorey	*Triodia irritans (Spinifex)*
Understorey	Common native species included: • *Rytidosperma* sp. (Wallaby-grass) • *Aristida behriana* (Brush wire Grass) • *Austrostipa* sp. (Spear-grass)
Exotic species	Common weed species included: • *Asteriscus spinosus* (Golden Pallensis) • *Avena barbata* (Bearded Oat) • *Lycium ferocissimum* (African Boxthorn) • *Marrubium vulgare* (Horehound) • *Piptatherum miliaceum* (Rice Millet) • *Salvia verbenaca* (Wild Sage)
Conservation significant species	No conservation significant species
Vegetation condition	Moderate (5:1)
Habitat value	Moderate, refuge habitat for small reptile species

Association 8: *Eucalyptus* spp. Mixed Mallee

Figure 12. Mixed Mallee community in eastern section of pro ect area.

Overstorey and midstorey	*Eucalyptus calycogona* (Square Fruited Mallee), *Eucalyptus dumosa*, *Eucalyptus socialis* (Red Mallee), *Myoporum platycarpum* (False Sandalwood)
Understorey	Common native species included: • *Austrostipa spp. (Spear Grass)* • *Rhagodia parabolica* (Ruby saltbush) • *Acacia cupularis* (Umbrella Wattle) • *Olearia pimeleoides* () • *Dodonaea baueri* (Hop Bush) • *Pultenaea largiflorens* (Bush Pea) • *Grevillea huegelii* (Spider Grevillea)
Exotic species	Common weed species included: • *Lepidium africanum (Peppercress)* • *Avena barbata* (Bearded Oat) • *Lycium ferocissimum* (African Boxthorn) • *Marrubium vulgare* (Horehound) • *Piptatherum miliaceum* (Rice Millet) • *Salvia verbenaca* (Wild Sage)
Conservation significant species	*Daviesia benthamii* ssp. *humilis (Mallee Bitter –pea)*
Vegetation condition	Poor (4:1) to Good (8:1)
Habitat value	Moderate to high. Good bird and bat habitat

Association 9: *Eucalyptus phenax* ssp. *phenax* (White Mallee) Open Mallee

Figure 13. *Eucalyptus phenax* Mallee.

Overstorey and midstorey	*Eucalyptus phenax* (White Mallee)
Understorey	Common native species included: • *Austrostipa* sp. (Spear-grass) • *Acacia victoriae* (Elegant Wattle) • *Bursaria spinosa* (Christmas Bush) • *Rhagodia parabolica* (Seaberry Saltbush) • *Enchylaena tomentosa* (Ruby saltbush) • *Triodia irritans* (Spinifex)
Exotic species	Common weed species included: • *Avena barbata* (Bearded Oat) • *Heliotropium europaeum (Potato weed)* • *Marrubium vulgare* (Horehound) • *Carthamus lanatus* (Star thistle) • *Limonium lobatum (Statice)* • *Salvia verbenaca* (Wild Sage)
Conservation significant species	No conservation significant species
Vegetation condition	Poor (4:1)
Habitat value	Moderate

Association 10: *Acacia victoriae* (Elegant Wattle) Shrubland

Figure 14. Elegant Wattle in drainage depression.

Overstorey and midstorey	*Acacia victoriae (Elegant Wattle)*
Understorey	Common native species included: • *Walwhalleya* sp. • *Dysphania pumilio* • *Calostemma purpurea* (Garland Lily) • *Enneapogon nigricans* (Bottlewashers) • *Austrostipa* spp. (Spear Grass)
Exotic species	Common weed species included: • *Avena barbata* (Bearded Oat) • *Asphodelus fistulosus* (Onion Weed) • *Cynara cardunculus* (Wild Artichoke) • *Solanum elaeagnifolium* (Silver leaf Nightshade) • *Marrubium vulgare* (Horehound) • *Salvia verbenaca* (Wild Sage)
Conservation significant species	No
Vegetation condition	Very Poor (2:1)
Habitat value	Low

Association 11: *Allocasuarina verticillata* (Drooping She-oak) *Bursaria spinosa* (Christmas Bush) *Melaleuca lanceolata* (Moonah) Low Woodland

Figure 15. *Allocasuarina verticillata* Low Woodland

Overstorey and midstorey	*Allocasuarina verticillata* (Drooping She-oak), *Bursaria spinosa* (Christmas bush), *Callitris preissii* (Native Pine), *Melaleuca lanceolata* (Moonah)
Understorey	Common native species included: • *Enchylaena tomentosa* (Ruby Saltbush) • *Lomandra collina* (Matrush) • *Olearia pimeleoides* (Pimelea Daisy) • *Vittadinia gracilis* (Woolly New Holland Daisy) • *Hibbertia sp.* (Guinea Flower) • *Pimelea microcephala*
Exotic species	Common weed species included: • *Avena barbata* (Bearded Oat) • *Asphodelus fistulosus* (Onion Weed) • *Marrubium vulgare* (Horehound) • *Salvia verbenaca* (Wild Sage)
Conservation significant species	No
Vegetation condition	Moderate (6:1)
Habitat value	High

Association 12: Amenity plantings as windbreaks and biodiversity corridors

Figure 16. Typical roadside planted tree corridor

Overstorey and midstorey	Native tree species such as *Eucalyptus cladocalyx* (Sugar Gum)
Understorey	Understorey was typically limited to exotic grass species however some natural regeneration of indigenous species had occurred in isolated patches along some roadsides.
Exotic species	Common weed species included: • *Avena barbata* (Bearded Oat) • *Asphodelus fistulosus* (Onion Weed) • *Cynara cardunculus* (Wild Artichoke) • *Solanum elaeagnifolium* (Silver leaf Nightshade) • *Marrubium vulgare* (Horehound) • *Salvia verbenaca* (Wild Sage)
Conservation significant species	No
Vegetation condition	Very Poor (0:1)
Habitat value	Low

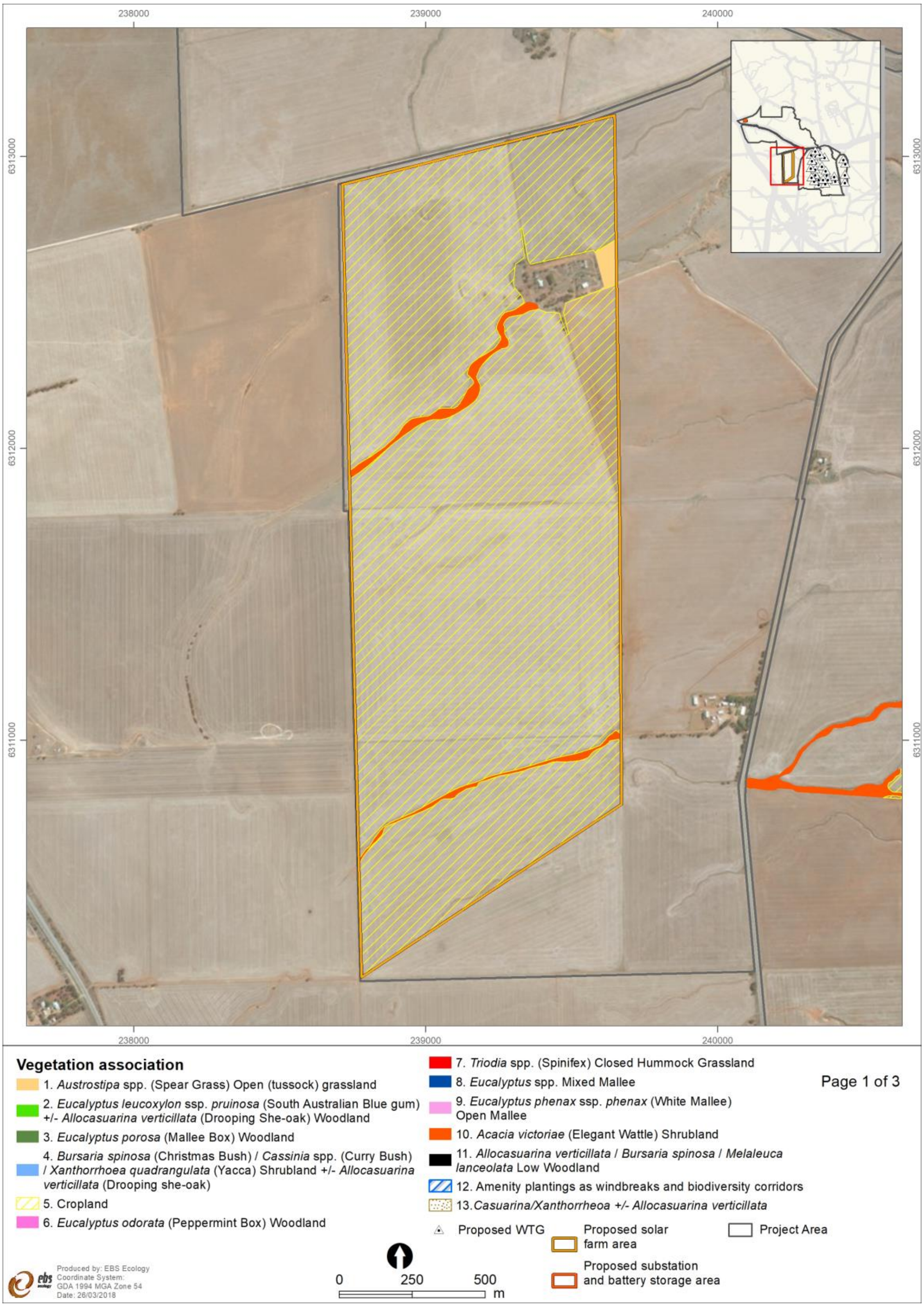


Figure 17. Vegetation association mapped within the pro ect area (map 1 of 3 in the association series).

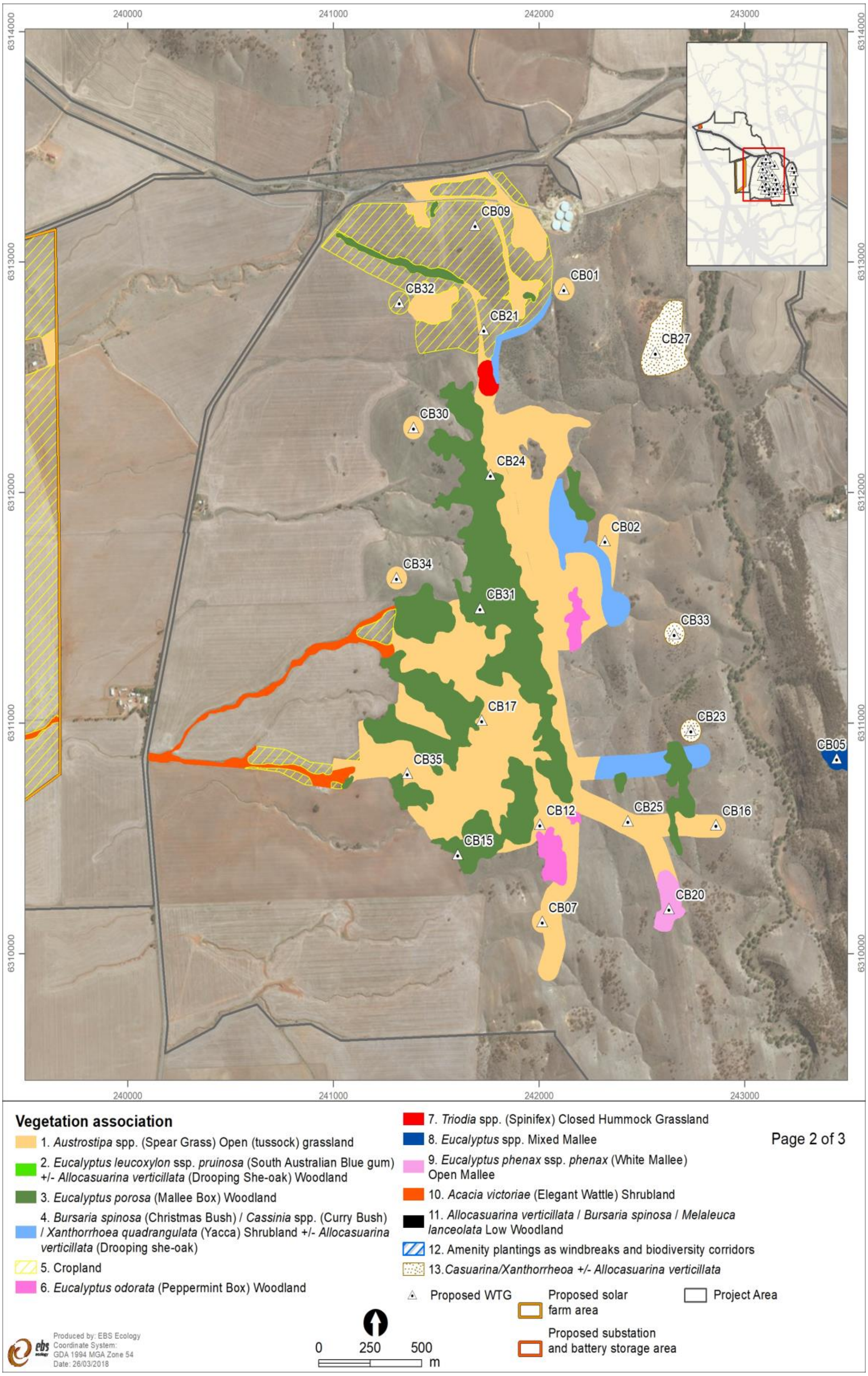


Figure 18. Vegetation association mapped within the pro ect area (map 2 of 3 in the association series).

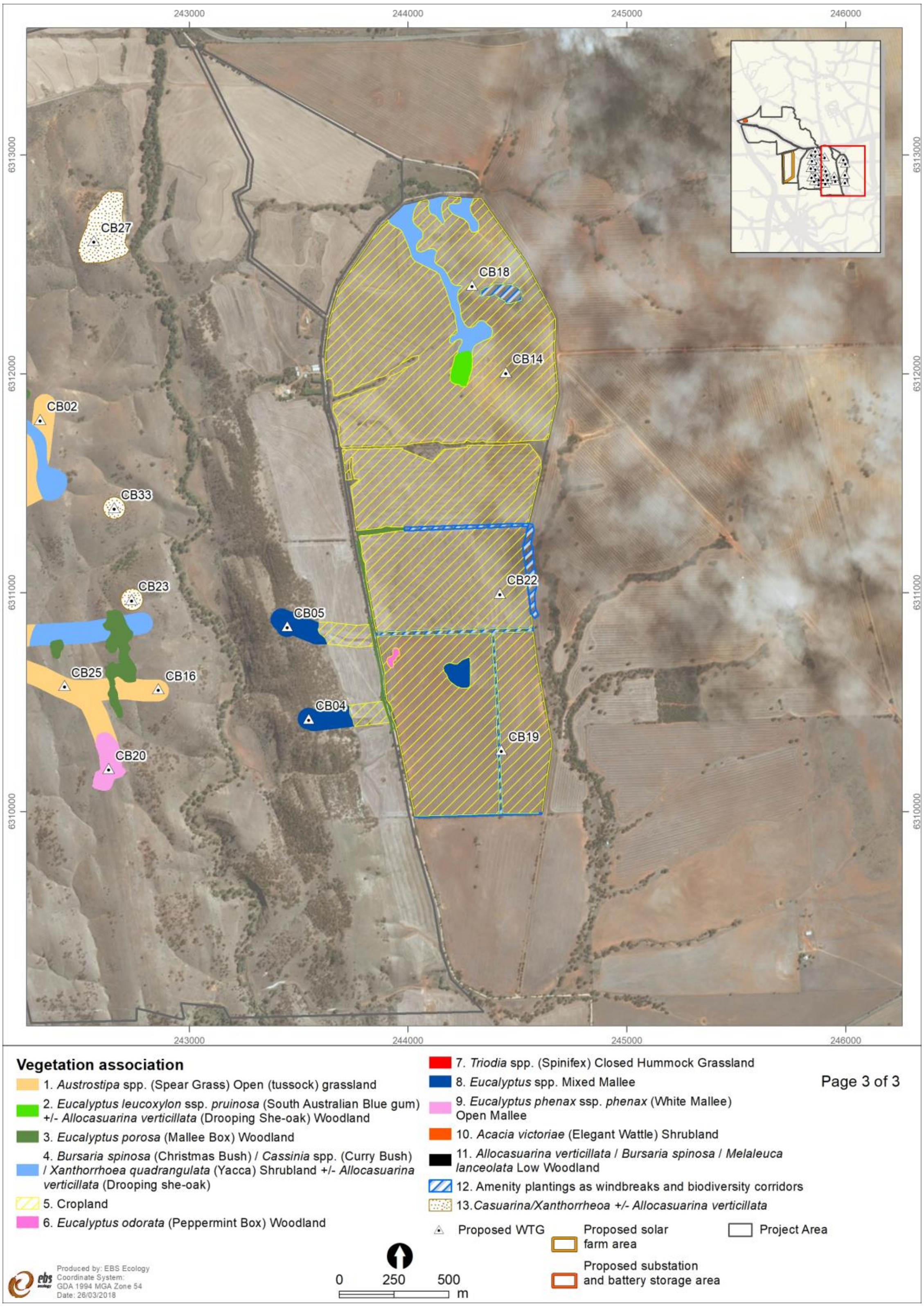


Figure 19. Vegetation association mapped within the pro ect area (map 3 of 3 in the association series).

5.2.2 Flora species

Ninety six indigenous flora species were observed within the project area (Table 9). Three of these were rated rare at state level. No species of national conservation significance were observed.

Table 9. Indigenous flora species observed within the pro ect area boundary.

Species	Common	AUS	SA	NY
Aristida australis	Wire Grass		R	NE
Logania saxatilis	Rock Logania		R	NT
Acacia argyrophylla	Silver Mulga-bush			RA
Acacia calamifolia	Wallowa			LC
Acacia continua	Thorn Wattle			LC
Acacia cupularis	Cup Wattle			NT
Acacia hakeoides	Hakea Wattle			LC
Acacia oswaldii	Umbrella Wattle			LC
Acacia paradoxa	Kangaroo Thorn			LC
Acacia pycnantha	Golden Wattle			LC
Acacia rupicola	Rock Wattle			LC
Acacia spinescens	Spiny Wattle			DD
Acacia victoriae ssp. victoriae	Elegant Wattle			LC
Alectryon oleifolius ssp. canescens	Bullock Bush			LC
Allocasuarina verticillata	Drooping Sheoak			LC
Alyogyne huegelii	Native Hibiscus			
Amyema miquelii	Box Mistletoe			LC
Aristida behriana	Brush Wire-grass			LC
Aristida contorta	Curly Wire-grass			LC
Arthropodium fimbriatum	Nodding Vanilla-lily			LC
Atriplex semibaccata	Berry Saltbush			LC
Austrostipa sp.	Spear-grass			
Beyeria lechenaultii	Pale Turpentine Bush			LC
Boerhavia dominii	Tar-vine			
Brassica tournefortii	Wild Turnip			
Bursaria spinosa ssp. spinosa	Sweet Bursaria			LC
Callistemon teretifolius	Needle Bottlebrush			LC
Callitris gracilis	Southern Cypress Pine			NT
Calocephalus citreus	Lemon Beauty-heads			NT
Carpobrotus rossii (NC)	Native Pigface			
Carthamus lanatus	Saffron Thistle			
Cassinia laevis	Curry Bush			LC
Chamaesyce drummondii (NC)	Caustic Weed			
Cheilanthes austrotenuifolia	Annual Rock-fern			LC
Chloris truncata	Windmill Grass			LC
Chrysocephalum apiculatum	Common Everlasting			
Clematis microphylla	Old Man's Beard			
Convolvulus remotus	Grassy Bindweed			LC
Correa glabra var. turnbullii	Smooth Correa			RA
Cullen australasicum	Tall Scurf-pea			VU
Cyperus gymnocaulos	Spiny Flat-sedge			LC
Daviesia genistifolia	Bitter Pea			NT

Species	Common	AUS	SA	NY
Dianella revoluta var. revoluta	Black-anther Flax-lily			LC
Dodonaea baueri	Crinkled Hop-bush			LC
Dodonaea viscosa ssp. spatulata	Sticky Hop-bush			LC
Dysphania pumilio	Small Crumb weed			LC
Einadia nutans ssp. nutans	Climbing Saltbush			LC
Enchylaena tomentosa var.	Ruby Saltbush			
Enneapogon nigricans	Black-head Grass			LC
Eucalyptus calycogona ssp. trachybasis	Square-fruit Mallee			VU
Eucalyptus camaldulensis ssp.	River Red Gum			
Eucalyptus cladocalyx ssp.	Sugar Gum			
Eucalyptus dumosa	White Mallee			LC
Eucalyptus leptophylla	Narrow-leaf Red Mallee			
Eucalyptus leucoxylon ssp. pruinosa	Inland South Australian Blue Gum			LC
Eucalyptus odorata	Peppermint Box			
Eucalyptus phenax	Sessile-fruit White Mallee			
Eucalyptus porosa	Mallee Box			LC
Eucalyptus socialis ssp. socialis	Beaked Red Mallee			LC
Gonocarpus elatus	Hill Raspwort			LC
Gonocarpus tetragynus	Small-leaf Raspwort			LC
Goodenia sp.	Goodenia			
Grevillea huegelii	Comb Grevillea			VU
Halgania cyanea	Rough Blue-flower			LC
Hypoxis sp.	Yellow Star-lily			
uncus subsecundus	Finger Rush			LC
Lepidosperma viscidum	Sticky Sword-sedge			LC
Lomandra effusa	Scented Mat-rush			LC
Lomandra multiflora ssp. dura	Hard Mat-rush			LC
Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe			LC
Maireana enchylaenoides	Wingless Fissure-plant			LC
Melaleuca lanceolata	Dryland Tea-tree			NT
Myoporum platycarpum ssp. platycarpum	False Sandalwood			LC
Neurachne alopecuroidea	Fox-tail Mulga-grass			RA
Olearia decurrens	Winged Daisy-bush			LC
Olearia pimeleoides	Pimelea Daisy-bush			NT
Oxalis perennans	Native Sorrel			LC
Pimelea microcephala ssp. microcephala	Shrubby Riceflower			LC
Pomaderris paniculosa ssp.	Pomaderris			
Pultenaea largiflorens	Twiggy Bush-pea			LC
Rhagodia parabolica	Mealy Saltbush			LC
Rhagodia spinescens	Spiny Saltbush			LC
Rytidosperma sp.	Wallaby-grass			
Salvia verbenaca var. verbenaca	Wild Sage			
Scaevola humilis	Inland Fanflower			LC
Sida corrugata var.	Corrugated Sida			
Templetonia aculeata				
Teucrium racemosum	Grey Germander			LC
Themeda triandra	Kangaroo Grass			LC
Thysanotus baueri	Mallee Fringe-lily			LC

Species	Common	AUS	SA	NY
Triodia irritans complex	Spinifex			
Triodia sp.	Spinifex			
Vittadinia australasica var.	Sticky New Holland Daisy			
Wahlenbergia gracilenta	Annual Bluebell			LC
Walwhalleya proluta	Rigid Panic			
anthorrhoea quadrangulata	Rock Grass-tree			LC
ygophyllum apiculatum	Pointed Twinleaf			LC

VU = Vulnerable

R/RA = Rare

NE = Not evaluated

DD = Data deficient

LC = Least Concern

NT = Near threatened

5.2.3 Threatened flora species

Two threatened flora species were recorded within the project area (Table 10). *Aristida australis* (Wire Grass) was recorded throughout the wider area, primarily on roadsides and in disturbed areas. It was only recorded at one location within the project area. *Logania* was recorded on an intact patch of vegetation on the eastern side of a stony ridge. It is likely that these species are more widespread than these observations. The location of where these threatened species were found are shown in Figure 20.

Table 10. Threatened flora species observed within pro ect area.

Species	Common	AUS	SA	NY
Aristida australis	Wire Grass		R	NE
Logania saxatilis	Rock Logania		R	NT

R = Rare

NE = Not evaluated

NT = Near threatened

5.2.4 Threatened ecological communities

Within the Biosis report of 2012, it was concluded that Iron-grass Natural Temperate Grassland of South Australia and Peppermint Box *(Eucalyptus odorata)* Grassy Woodland of South Australia, did not qualify as the threatened ecological community.

One vegetation association of potential conservation significance, *Eucalyptus odorata* (Peppermint Box), was observed within the project area during the 2017 survey. Any potential issues surrounding these patches can be managed either by re-routing or other means of avoidance or alternatively undertake an assessment and risk the TEC listing.

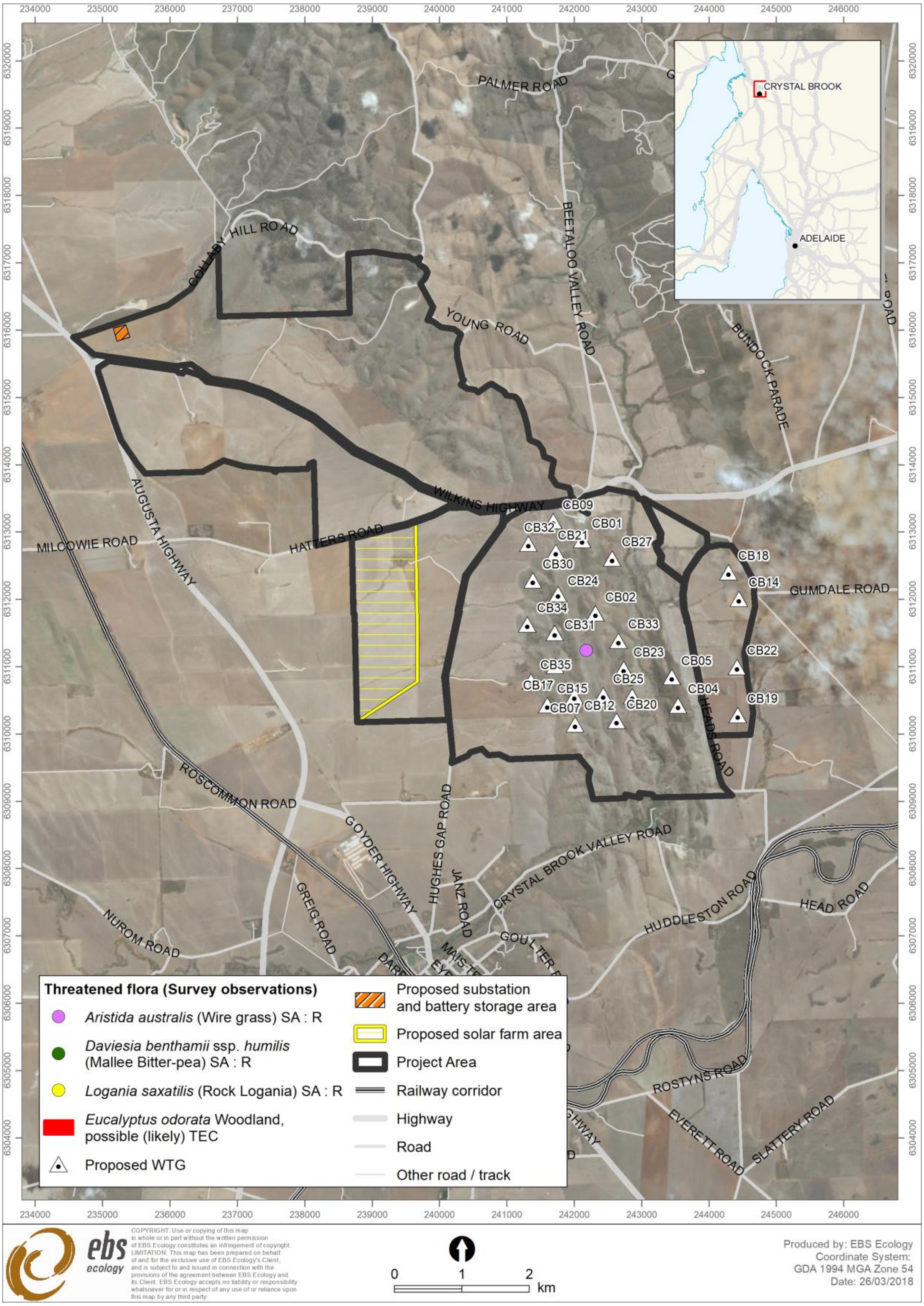


Figure 20. Flora field results including threatened flora records and potential Peppermint Box TEC.

5.2.5 Exotic flora species

Twenty three exotic species were recorded within the project area (Table 11). Four of these are declared plants under the *Natural Resources Management Act 2004*.

Table 11. Exotic species observations within pro ect area boundary.

Species	Common	Declared
Arctotheca calendula	Cape Weed	
Asphodelus fistulosus	Onion Weed	
Avena barbata	Bearded Oat	
Bromus sp.	Brome	
Carrichtera annua	Ward's Weed	
Centaurea calcitrapa	Star Thistle	
Cichorium intybus	Chicory	
Citrullus lanatus	Bitter Melon	
Conyza bonariensis	Flax-leaf Fleabane	
Diplotaxis tenuifolia	Lincoln Weed	✓
Heliotropium europaeum	Common Heliotrope	
Lactuca serriola f. serriola	Prickly Lettuce	
Lepidium africanum	Common Peppercress	
Limonium lobatum	Winged Sea-lavender	
Lycium ferocissimum	African Boxthorn	✓
Medicago sp.	Medic	
Piptatherum miliaceum	Rice Millet	
Rosa canina	Dog Rose	✓
Sisymbrium sp.	Wild Mustard	
Solanum elaeagnifolium	Silver-leaf Nightshade	✓
Sonchus oleraceus	Common Sow-thistle	
Trifolium sp.	Clover	
Vulpia sp.	Fescue	

5.2.6 Fauna

Fauna based surveys were largely based on opportunistic bird observations made during the 2017 survey. The reason for this was because Biosis compiled two reports in 2012 (covering the north and south areas of the proposed Crystal Brook Energy Park), which covered off on a number of species. These included:

- Anabat remote bat call detectors were used to determine bat species within the project area;
- Funnel traps targeting reptiles;
- Searches for Flinders Ranges Worm-lizard;
- Searches for Pygmy Blue-tongue Lizard; and
- Bird census.

For results of these targeted survey components, refer to Biosis (2012) as well as Appendices 2 and 3 of this report for relevant species lists.

A total of 211 bird observations were recorded on the site, comprising of 38 species, with most of these being commonly occurring and widespread (Table 12). Two of these were of state conservation significance:

- Diamond Firetail (*Stagonopleura guttata*) – vulnerable in SA
- Hooded Robin (*Melanodryas cucullata*) – rare in SA.

Twenty-four individual Diamond Firetail were recorded during the field survey (Table 12); 23 of these were at water-troughs within cropping land and one individual was in roadside vegetation. Two individual Hooded Robins were recorded within *Allocasuarina verticillata* (Drooping Sheoak) woodland (Table 12). Locations of where these two conservation rated species were found are shown in Figure 20. Flora field results including threatened flora records and potential Peppermint Box TEC.; these two species are discussed further below (refer section 6).

Three of the 38 species recorded during the survey were introduced; these were Common Starling (*Sturnus vulgaris*), House Sparrow (*Passer domesticus*) and Feral Pigeon (*Columba livia*).

All of the birds recorded in the project area during the field survey are listed below.

Table 12. Bird species recorded within the pro ect area boundary (listed alphabetically by Latin name).

Species name	Common name	Habitat	AUS	SA	NY	No.
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	*Bursaria spinosa* / *Cassinia* spp. Shrubland			LC	1
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	*Bursaria spinosa* / *Cassinia* spp. Shrubland and Cropland			LC	13
Anthochaera carunculata	Red Wattlebird	Mallee / Woodland			LC	2
Anthochaera chrysoptera	Little Wattlebird	Mallee / Woodland			LC	1
Anthus australis	Australian Pipit	Cropland and Mallee			LC	1
Aquila audax	Wedge-tailed Eagle	Cropland			RA	4
Artamus cyanopterus	Dusky Woodswallow	Mallee / Woodland			RA	17
Barnardius zonarius	Australian Ringneck	Mallee / Woodland / Grassland			NT	8
Cincloramphus cruralis	Brown Songlark	Creekline and Cropland			LC	1
Columba livia	Feral Pigeon [Rock Dove]	Mainly around water troughs and sheds			-	-
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Mallee / Woodland			LC	7
Corvus coronoides	Australian Raven	Widespread			NT	-
Corvus mellori	Little Raven	Cropland / Mallee			LC	1
Elanus axillaris	Black-shouldered Kite	Mallee / Woodland / Cropping			LC	3
Eolophus roseicapilla	Galah	Cropland / Mallee			LC	1
Epthianura albifrons	White-fronted Chat	Fly over			NT	12
Falco berigora	Brown Falcon	Mallee / Woodland			LC	3
Falco cenchroides	Nankeen Kestrel	Open Grassland / Cropping / steep gully (native vegetation)			LC	6
Gavicalis virescens	Singing Honeyeater	Mallee / Woodland			LC	3
Gymnorhina tibicen	Australian Magpie	Cropland / Mallee			LC	1
Hirundo neoxena	Welcome Swallow	Cropland / Mallee			LC	2

Species name	Common name	Habitat	AUS	SA	NY	No.
Malurus lamberti	Variegated Fairy-wren	Mallee / Woodland			LC	8
Manorina melanocephala	Noisy Miner	Fly over			LC	2
Melanodryas cucullata cucullata	Hooded Robin	*Allocasuarina verticillata* Woodland		R	VU	2
Mirafra javanica	Horsfield's Bush Lark	Mallee / Woodland / Cropland			RA	3
Nymphicus hollandicus	Cockatiel	Cropland			NT	8
Ocyphaps lophotes	Crested Pigeon	Fly over Mallee / Woodland			LC	3
Pardalotus striatus	Striated Pardalote	Mallee / Woodland			LC	7
Passer domesticus	House Sparrow	Mainly around water troughs and sheds			-	-
Petrochelidon nigricans	Tree Martin	Mallee			LC	6
Phaps chalcoptera	Common Bronzewing	Cropland			LC	2
Platycercus elegans	Crimson Rosella	Cropland			LC	6
Psephotus haematonotus	Red-rumped Parrot	Mallee / Woodland / Cropland			NT	26
Ptilotula penicillata	White-plumed Honeyeater	Mallee / Woodland			LC	3
Rhipidura leucophrys	Willie Wagtail	Mallee / Woodland / Cropland			LC	2
Smicrornis brevirostris	Weebill	Mallee / Woodland			LC	8
Stagonopleura guttata	Diamond Firetail	Cropland / Roadside vegetation		V	EN	24
Sturnus vulgaris	Common Starling	Cropland / Mallee			-	14
					Total:	**211**

*indicates an introduced species

SA: South Australia (*National Parks and Wildlife Act 1972*). **NY**: Northern and Yorke regional rating. **Conservation Codes: EN:** Endangered **V VU:** Vulnerable. **R RA:** Rare. **NT**: Near threatened. **LC:** Least concern.

Raptor nests

Four individual Wedge-tailed Eagles were observed during the 2017 survey (Table 12) and one was sighted within the footprint during the 2018 survey. Wedge tailed Eagles are rated as rare in the Northern and Yorke region. Two Wedge-tailed Eagle nests were recorded during the 2017 field survey in Mallee Woodland / Open Woodland. Both of the nests were inactive at the time of survey, but were considered possible in becoming active in future breeding seasons as Wedge-tailed Eagles are known to reuse nests over several years. The western nest has since fallen down after a structural tree limb was broken in a storm leaving only a single nest within the project area (Figure 21 & Figure 22).

Wedge-tailed Eagles are at risk of collision with wind turbines and is discussed further below (section 6). Recommendations for mitigation include provision of a 500m buffer / protection zone around both nests (refer to section 7).

Figure 21. Wedge-tailed Eagle nest in open woodland.

Figure 22. Wedge-tailed Eagle nest.

6 DISCUSSION

The primary issues within the project area include the disturbance of intact vegetation communities, threatened flora species, threatened bird species and the location of Wedge-tailed Eagle nest.

The following section discusses those species that have been identified as likely to occur or are known to the project area. The following section discusses potential impacts of this proposal on these species.

6.1 Wedge-tailed Eagle

Although Wedge-tailed Eagle (*Aquila audax*) does not have a rating under legislation, it is regionally rated as rare in the Northern and Yorke region and it is recognised that there is risk for individuals to be killed as a result of collision with moving rotor blades (Smales, 2006). Four sightings of the Wedge-tailed Eagle was made during the survey, typically flying above cropland and across the project area as a whole.

Two Wedge-tailed Eagle nests were originally recorded within the project area, however this has been reduced to one with the limb failure at the nest one site. The remaining nest was located in the southern part of the project area on the eastern side of the transmission line. Neither of the nests located were active at the time of the original surveys and did not appear to have been used for the most recent breeding season due to the loose structure of the nests, absence of any animal material at the base of the tree and lack of whitewash. However, the nest was in moderate to good condition and it was considered possible that the nest would become active again in the future as Wedge-tailed Eagles reuse their nests over a period of several years.

As Wedge-tailed Eagles are particularly vulnerable to strikes by turbines, it is recommended that a 500m buffer protection zone is provided around the nest. This is a precautionary approach based on available research, to reduce the likelihood of impact associated with the construction and operation of the wind farm. Raptor species such as the Wedge-tailed Eagle are considered significant when assessing bird interactions with wind farms, as they conduct regular flights at heights coinciding with turbine rotor swept areas (where turbine blades operate).

The benefit of a buffer around nests is as follows:

- Buffers are generally focussed around areas of high activity; these are where the species may potentially nest;
- During the construction of the proposed wind farm, raptor species are more likely to be at risk of disturbance from activities conducted within close proximity to nest locations. By implementing a buffer, this would contribute to decreasing disturbance levels to these species;
- Wedge-tail Eagles are territorial and typically return to the same area to nest each year. By placing a buffer distance around each of the two nest locations, this would assist with lessening disturbance levels to this species; and
- Juveniles are particularly susceptible to collision, as newly fledged chicks have not learnt how to forage on their own nor avoid structures such as turbines. Buffers around nest sites will assist in decreasing the chance of a juvenile eagle colliding with a turbine.

6.1.1 Collision risk

One of the principal risks to birds posed by turbines is the potential for individuals to be killed as a result of collision with moving rotor blades (Smales 2006). However, a published study from Tasmania by Hull *et al* (2013) suggests that the likelihood of collision for different species is not related to their abundance on site. Findings showed that approximately 18% (of 85 species) and 21% (of 77 species) of all bird species recorded at two sites were reported to have collided with a turbine. The number of species found during carcass searches is likely to be higher, with 82 and 14 records (at the two sites) not being able to be identified to species level (feather spots were recorded).

There are also complexities in the assessment of collision risk for bird species, with species clearly displaying avoidance behaviour within wind farms. Hull and Muir (2013) found that whilst avoidance behaviours varied dependent on species and site, raptors generally displayed a high avoidance rate. This means that they have actively changed their behaviour to avoid turbines. The study by Hull and Muir (2013) concentrated on White-bellied Sea-eagles (*Haliaeetus leucogaster*) and Wedge-tailed Eagles (*Aquila audax fleayi* (Tasmanian subspecies)) and found that both species actively change their flight paths to avoid turbines. It was also found that Wedge-tail Eagles have a higher avoidance rate in bad weather (rainy and windy weather) (Hull and Muir 2013).

6.2 Diamond Firetail

The state vulnerable and regionally endangered Diamond Firetail was observed during the March 2017 survey, with 24 individuals observed. The birds were observed mainly at water-troughs within cropland and one individual was recorded in roadside vegetation. Diamond Firetails live in a wide range of eucalypt dominated vegetation communities that typically have a grassy understorey, including woodland, forest and mallee and are therefore likely to rely on the areas of woodland and mallee on the site, in addition to the water-troughs in the cropping land. They are ground-feeders that predominantly eat ripe and half-ripe seeds of various grasses but are also known to feed on seeds of herbs, bushes and trees as well as insects and worms (Immlemann, 1982; Read, 1994.)

Recommendations to reduce impacts on Diamond Firetail include retaining eucalypt communities on the project area and implementing a buffer zone of 100m around any woodland or mallee habitats. A buffer of 100 m between turbines and woodland habitat is generally recommended; however there are no legislative requirements to provide such a buffer. Further mitigation may include retention of existing water troughs in appropriate areas (not within 100m of turbines). Collision risk for this species is considered low; the main impacts are likely to be loss of habitat and / or disturbance from turbines situated too close to their existing habitat.

This species was also observed by Biosis in 2009 (Biosis 2012). As part of the reporting by Biosis, it was detailed that at some potential turbine locations, indigenous vegetation included scattered trees. Removal of trees at these few turbine locations (or for associated infrastructure) would entail very minor loss of perching and foraging habitat for the Diamond Firetail (Biosis 2012). It was also concluded by Biosis (2012) that the Diamond Firetail would rarely if ever fly at rotor-swept heights of modern wind turbines; this was based on extensive investigations (completed by Biosis Research) of the height of bird flights undertaken for wind farm proposals across south-eastern Australia.

6.3 Hooded Robin

Hooded Robin (south-eastern species) is listed as rare under the NPW Act and is rated as vulnerable in the Northern and Yorke region. Two Hooded Robin were recorded within the project area in *Allocasuarina verticillata* (Drooping Sheoak) woodland (Vegetation Association 2 and 4). This species prefers lightly wooded country, usually eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas and requires structurally diverse habitats, featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall grasses (NSW Office of Environment and Heritage, 2017). The birds are therefore likely to rely on the woodland, mallee and scrub communities on the site.

In general, the effects of a wind farm on woodland bird species are related to possible loss of habitat and disturbance from turbines if close to woodlands. Direct interaction with turbine blades is considered low for woodland specific bird species that rarely fly above canopy height. Recommendations for this species are made below (refer section 7), including implementation of a 100m buffer zone around areas of woodland, mallee and scrub on the site to ensure that habitat is retained for this species.

This species was also observed by Biosis in 2001 (Biosis 2012). As part of the reporting by Biosis, it was detailed that at some potential turbine locations, indigenous vegetation included scattered trees. Removal of trees at these few turbine locations (or for associated infrastructure) would entail very minor loss of perching and foraging habitat for the Hooded Robin (Biosis 2012). It was also concluded by Biosis (2012) that the Hooded Robin would rarely if ever fly at rotor-swept heights of modern wind turbines; this was based on extensive investigations (completed by Biosis Research) of the height of bird flights undertaken for wind farm proposals across south-eastern Australia.

6.4 Vegetation communities

The provisional layout avoids most areas of intact vegetation and potentially impacts state threatened species in the vicinity of turbines CB 23. Turbines CB25, 04 and 05 were also within areas of intact vegetation and planning to avoid or minimise the impacts on these communities should be implemented. Areas of high value were often located in the steeper gullies where access was difficult or soils were shallow with exposed rock outcropping which meant that areas of highest value often avoided interaction with the prime turbine locations.

In most instances, the open woodlands were remnant as overstorey only with very low density herbaceous and woody shrub species present due to extended periods of grazing and degradation. *Solanum elaeagnifolium* (Silver-leaf Nightshade), was in high density across all the surveys and was certainly the most common and widespread weed species within the project area. This species is declared under the *Natural Resources Management Act 2004*. Indigenous and exotic grasses formed the remainder of the dominant understorey cover in these communities and as such, the SEB condition ration assigned to these areas was generally 4:1.

The mallee vegetation on the eastern side of the Mercowie Creek was intact and in moderate condition with substantial understorey species diversity despite evidence of ongoing grazing. While this area was not surveyed extensively, this area is considered to be of high conservation value due to the likelihood of annual and ephemeral threatened species being present as well as being a substantial intact patch to which any fragmentation would reduce local biodiversity values through increased edge effects, disruption of animal movement pathways and potential changes in hydrology.

Other areas within the project footprint are suitable for wind farm type development based on the lack of intact patches, low flora species diversity and high levels of clearance historically. All areas are currently utilised for grazing which provides significant disturbance and cause ongoing management issues such as weed dispersal and outbreaks, soil surface disturbance and pest species through artificial water sources. While development associated with wind farms has been identified as a potential problem with mortality and movement of fauna, researchers have struggled to provide data that supports significant decreases in either of these processes. Variables such as turbine layout design, blade length, tower height, tip speed etc. all contribute to changes in mortality and movement of fauna (Kuvlesky et. al, 2007). The low value of the vegetation communities within the project layout will reduce the incidence of impacts associated with turbines. Migratory species will most likely follow coastal pathways however studies such as Masden et. al, (2009) showed migratory species will often find alternate pathways away from turbine locations which reduces the risk of strike occurring to these species.

7 RECOMMENDATIONS

The following recommendations have been made to mitigate any potential impacts associated with the development of the proposed Crystal Brook Energy Park on native vegetation, threatened species and ecological communities. These are based on a hierarchy of mitigation being avoid, minimise, restore and offset.

- Avoid intact mallee habitat on site and implement a 100m buffer zone around this area to reduce impacts on Diamond Firetail and Hooded Robin;
- Avoid area of *Eucalyptus odorata* Woodland due to sensitivity as a possible Threatened Ecological Community (TEC);
- Maintain existing 500m protective buffer zone around the intact Wedge-tailed Eagle nest.
- Ensure existing water sources for birds, including Diamond Firetail, exceed 100m buffer from turbines through micrositing or movement of water source,
- Development a Weed Management Plan/Rehabilitation Plan:
    - When an SEB offset is determined (when a Native Clearance Report is prepared for the Native Vegetation Council), a Weed Management Plan or Rehabilitation Plan will assist with this.
- Implement a Construction Environmental Management Plan (CEMP);
- Employ best practice environmental management measures:
    - Best practice environmental management measures should be adopted during and following the construction phase. For example, vehicles and equipment should be cleaned to ensure they are free of plant material and soil, to reduce the dispersal of exotic flora species into, out of, and within the project area. Control of declared and environmental weeds found within the site may be required. The construction footprint should be minimised, e.g. along access roads, in turn-around areas and around turbine pads.
- Ensure staff training and awareness:
    - Staff working in the project area should be aware of the threatened flora and fauna species and ecological communities present and potentially present, and the potential and actual impacts of construction, operation and maintenance of the proposed wind farm on flora and fauna species and habitats. Training should reinforce staff expectations to minimise potential impacts related to on-site works, and encourage staff to report significant flora and fauna sightings e.g. any bird strike observations or carcasses.

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9 APPENDICES

Appendix 1. Flora species recorded from the local area (Biosis 2012).

A1.1 Flora species recorded from local area

Table A1.1. Vascular flora recorded from the local area. Biosis Research records are all from the study area.

Database searches encompassed a 5 km radius & were undertaken on 24/04/2009 and 10/09.

BDSA Biological Database of South Australia.

• introduced species

Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Acacia calamifolia	Wallowa		1992	2003/2009
Acacia continua	Thorn Wattle		2001	
Acacia ligulata	Umbrella Bush		1992	
Acacia microcarpa	Manna Wattle		1992	
Acacia notabilis	Notable Wattle		1992	2009
Acacia oswaldii	Umbrella Wattle		1992	
Acacia paradoxa	Kangaroo Wattle			2003
Acacia pravifolia	Coil-pod Wattle		1992	
Acacia pycnantha	Golden Wattle		1992	2003/2009
Acacia rupicola	Rock Wattle		2001	2003
Acacia victoriae subsp. *victoriae*	Elegant Wattle		1997	2009
Acacia wattsiana	Dog Wattle		2001	2003/2009
Acaena echinata	Sheep's Burr		2001	2009
Acaena echinata var. *retrorsumpilosa*	Sheep's Burr		1992	
Acianthus caudatus	Mayfly Orchid		2001	
Acianthus pusillus	Mosquito Orchid		2001	
Acrotriche patula	Prickly Ground-berry		1992	2009
Actinobole uliginosum	Flannel Cudweed		1992	
Aira cupaniana	Small Hair-grass	*	2001	2009
Ajuga australis	Australian Bugle		2001	2009
Ajuga australis f. A (A.G.Spooner 9058)	Australian Bugle		1996	
Allocasuarina verticillata	Drooping Sheoak		2001	2003/2009
Alyogyne huegelii	Native Hibiscus		1992	2009
Amphipogon caricinus var. *caricinus*	Long Grey-beard Grass		1992	
Amyema miquelii	Box Mistletoe		2001	2003/2009
Anagallis arvensis	Pimpernel	*	2001	2009
Arctotheca calendula	Cape Weed	*	2001	2009
Aristida behriana	Brush Wire-grass		1997	2009
Aristida contorta	Curly Wire-grass		1997	
Arthropodium strictum	Common Vanilla-lily		2001	2003/2009
Asparagus asparagoides	Bridal Creeper	*	2001	2003/2009
Asperula conferta	Common Woodruff		1997	2003/2009
Asteridea athrixioides f. *athrixioides*	Wirewort		1992	
Astroloma humifusum	Cranberry Heath		2001	2009

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Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Austrodanthonia auriculata	Lobed Wallaby-grass		1992	
Austrodanthonia caespitosa	Common Wallaby-grass		2001	2003/2009
Austrodanthonia eriantha	Hill Wallaby-grass		2001	
Austrodanthonia pilosa	Velvet Wallaby-grass		1992	
Austrodanthonia pilosa var. *paleacea*	Velvet Wallaby-grass		2001	
Austrodanthonia pilosa var. *pilosa*	Velvet Wallaby-grass		1996	
Austrodanthonia setacea	Small-flower Wallaby-grass		2001	
Austrodanthonia sp.	Wallaby-grass		2001	2003/2009
Austrostipa acrociliata	Graceful Spear-grass		1992	
Austrostipa blackii	Crested Spear-grass		2001	2009
Austrostipa curticoma	Short-crest Spear-grass		1992	
Austrostipa drummondii	Cottony Spear-grass		2001	
Austrostipa elegantissima	Feather Spear-grass		2001	2003/2009
Austrostipa eremophila	Rusty Spear-grass		1997	2009
Austrostipa flavescens	Coast Spear-grass		1996	
Austrostipa gibbosa	Swollen Spear-grass		1992	
Austrostipa mollis group	Soft Spear-grass		2001	
Austrostipa nitida (Balcarra)	Spear-grass		2001	
Austrostipa nodosa	Tall Spear-grass		1992	
Austrostipa scabra	Rough Spear-grass		2001	
Austrostipa scabra subsp. *falcata*	Slender Spear-grass		2001	2003
Austrostipa scabra subsp. *scabra*	Rough Spear-grass		1992	2009
Austrostipa semibarbata	Fibrous Spear-grass		1992	
Austrostipa setacea	Corkscrew Spear-grass		2001	
Austrostipa sp.	Spear-grass			2003
Austrostipa trichophylla	Spear -grass		2001	
Avellinia michelii	Avellinia	*	2001	
Avena barbata	Bearded Oat	*	2001	2009
Avena sp.	Oat	*		2003
Billardiera versicolor	Yellow-flower Apple-berry		2001	
Blennospora drummondii	Dwarf Button-flower		2001	
Boerhavia dominii	Tar-vine		1997	
Bossiaea prostrata	Creeping Bossiaea		2001	
Brachypodium distachyon	False Brome	*	2001	
Brachyscome goniocarpa	Dwarf Daisy		2001	
Brachyscome lineariloba	Hard-head Daisy		2001	
Brassica sp.	Mustard	*		2003/2009
Briza maxima	Large Quaking-grass	*	2001	
Briza minor	Lesser Quaking-grass	*	2001	
Bromus diandrus	Great Brome	*	1992	2003/2009
Bromus madritensis	Compact Brome	*	2001	2009
Bromus rigidus	Rigid Brome	*	1997	
Bromus rubens	Red Brome	*	1992	
Bulbine bulbosa	Bulbine-lily		2001	
Bursaria spinosa subsp. *spinosa*	Sweet Bursaria		2001	2003/2009
Caesia calliantha	Blue Grass-lily		2001	
Caladenia carnea	Pink Fingers		2001	
Caladenia clavula	Caladenia		1992	

Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Caladenia tentaculata	King Spider-orchid		2001	
Calandrinia calyptrata	Pink Purslane		2001	
Calandrinia eremaea	Dryland Purslane		1992	
Callistemon rugulosus	Scarlet Bottlebrush		1980	
Callistemon teretifolius	Needle Bottlebrush		1992	
Callitris gracilis	Southern Cypress Pine		2001	2003/2009
Calocephalus citreus	Lemon Beauty-heads		2001	
Calostemma purpureum	Pink Garland-lily		1992	
Calytrix tetragona	Common Fringe-myrtle		2001	2009
Carduus tenuiflorus	Slender Thistle	*	1992	
Carex breviculmis	Short-stem Sedge		1996	
Carthamus lanatus	Saffron Thistle	*	1997	2003/2009
Cassinia laevis	Curry Bush		2001	2009
Cassinia uncata	Sticky Cassinia		2001	2009
Cassytha flindersii	Flinders Ranges Dodder-laurel		2001	
Cassytha melantha	Coarse Dodder-laurel		2001	
Cassytha peninsularis	Peninsula Dodder-laurel		1992	2009
Catapodium rigidum	Rigid Fescue	*	2001	
Centaurea melitensis	Malta Thistle	*	1992	
Cerastium glomeratum	Common Mouse-ear Chickweed	*	1992	
Cerastium pumilum	Chickweed	*	2001	
Cerastium semidecandrum	Small Mouse-ear Chickweed		2001	
Chamaesyce drummondii	Caustic Weed		2001	2003/2009
Cheilanthes austrotenuifolia	Annual Rock-fern		2001	2009
Cheilanthes lasiophylla	Woolly Cloak-fern		1997	2009
Cheilanthes sieberi subsp. *sieberi*	Narrow Rock-fern		2001	2009
Chenopodium desertorum subsp. *microphyllum*	Small-leaf Goosefoot		2001	
Choretrum glomeratum	Sour-bush		1996	
Chrysocephalum apiculatum	Common Everlasting		2001	
Chrysocephalum semipapposum	Clustered Everlasting		1992	2003/2009
Clematis microphylla var. *microphylla*	Old Man's Beard		1992	2003/2009
Convolvulus erubescens	Australian Bindweed		1980	2003
Convolvulus erubescens/remotus	Native Bindweed		1992	
Convolvulus remotus	Grassy Bindweed		2001	
Cotula australis	Common Cotula		1992	
Craspedia glauca	Billy-buttons		2001	
Crassula colorata	Dense Crassula		1992	2009
Crassula decumbens var. *decumbens*	Spreading Crassula		2001	
Crassula sieberiana complex	Australian Stonecrop		2001	
Crassula sieberiana subsp. *tetramera*	Australian Stonecrop		2001	
Critesion sp.	Barley Grass	*		2003
Cymbonotus preissianus	Austral Bear's-ear		1992	
Cynara cardunculus	Spanish Artichoke	*		2003
Cyperus vaginatus	Stiff Flat-sedge		1980	
Dampiera dysantha	Shrubby Dampiera		2001	
Dampiera lanceolata var. *lanceolata*	Grooved Dampiera		2001	
Dampiera rosmarinifolia	Rosemary Dampiera		1980	
Daucus glochidiatus	Native Carrot		2001	2009

Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Daviesia genistifolia	Broom Bitter-pea		1992	
Daviesia leptophylla	Narrow-leaf Bitter-pea		2001	2009
Dianella brevicaulis/revoluta	Black-anther Flax-lily		1996	
Dianella revoluta	Black-anther Flax-lily		2001	2009
Dianella revoluta var. *divaricata*	Broad-leaf Flax-lily		1992	
Dianella revoluta var. *revoluta*	Black-anther Flax-lily		1992	
Dichelachne crinita	Long-hair Plume-grass		1996	
Digitaria brownii	Cotton Panic-grass		1997	
Dodonaea viscosa	Sticky Hop-bush		2001	2009
Dodonaea viscosa subsp. *angustissima*	Narrow-leaf Hop-bush		1996	
Dodonaea viscosa subsp. *spatulata*	Sticky Hop-bush		2001	
Drosera auriculata	Tall Sundew		2001	
Drosera glanduligera	Scarlet Sundew		2001	
Drosera peltata	Pale Sundew		1996	
Echium plantagineum	Salvation Jane	*	2001	2003/2009
Ehrharta calycina	Perennial Veldt Grass	*	2001	2009
Ehrharta longiflora	Annual Veldt Grass	*	2001	2009
Einadia nutans	Climbing Saltbush		2001	
Einadia nutans subsp. *nutans*	Climbing Saltbush		2001	2003/2009
Elymus scaber var. *scaber*	Native Wheat-grass		2001	2009
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush		1997	2009
Enneapogon nigricans	Black-head Grass		1997	2003/2009
Erodium botrys	Long Heron's-bill	*	1992	
Erodium cicutarium	Cut-leaf Heron's-bill	*	1992	
Eucalyptus brachycalyx	Gilja		1992	2003
Eucalyptus camaldulensis	River Red Gum		1980	2003/2009
Eucalyptus cladocalyx	Sugar Gum		1992	2009
Eucalyptus goniocalyx	Long-leaf Box		2001	
Eucalyptus intertexta	Gum-barked Coolibah		1980	
Eucalyptus leptophylla	Narrow-leaf Red Mallee		1992	2009
Eucalyptus leucoxylon	South Australian Blue Gum		2001	2003/2009
Eucalyptus leucoxylon subsp. *leucoxylon*	South Australian Blue Gum		2001	
Eucalyptus leucoxylon subsp. *pruinosa*	Inland South Australian Blue Gum		1996	
Eucalyptus odorata	Peppermint Box		2001	2003/2009
Eucalyptus oleosa	Red Mallee		1992	2003/2009
Eucalyptus porosa	Mallee Box		2001	2003/2009
Eucalyptus socialis	Beaked Red Mallee		1992	2009
Euchiton gymnocephalus	Creeping Cudweed		1992	
Eutaxia microphylla	Common Eutaxia		2001	
Exocarpos cupressiformis	Native Cherry		2001	2009
Exocarpos sp.	Native Cheery			2009
Exocarpos sparteus	Slender Cherry		1992	2009
Fumaria capreolata	White-flower Fumitory	*	2001	2009
Galium aparine	Cleavers	*	2001	2009
Galium divaricatum	Slender Bedstraw	*	1996	
Galium gaudichaudii	Rough Bedstraw		2001	2009
Galium migrans	Loose Bedstraw		1992	
Galium murale	Small Bedstraw	*	2001	

Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Galium spurium subsp. *ibicinum*	Bedstraw	*	1992	
Geranium retrorsum	Grassland Geranium		2001	
Glycine rubiginosa	Twining Glycine		2001	2009
Gonocarpus elatus	Hill Raspwort		1996	
Gonocarpus tetragynus	Small-leaf Raspwort		2001	2009
Goodenia pinnatifida	Cut-leaf Goodenia		2001	
Goodenia robusta	Woolly Goodenia		2001	
Goodenia varia	Sticky Goodenia		1992	
Hakea carinata	Erect Hakea		2001	
Halgania cyanea	Rough Blue-flower		2001	2009
Hedypnois rhagadioloides	Cretan Weed	*	2001	
Helichrysum leucopsideum	Satin Everlasting		1992	
Heliotropium asperrimum	Rough Heliotrope		1997	
Hibbertia exutiacies	Prickly Guinea-flower		1996	
Hibbertia sericea	Silky Guinea-flower		2001	
Homopholis proluta	Rigid Panic			2003
Hyalosperma demissum	Dwarf Sunray		2001	
Hybanthus floribundus subsp. *floribundus*	Shrub Violet		2001	
Hydrocotyle callicarpa	Tiny Pennywort		2001	
Hydrocotyle laxiflora	Stinking Pennywort		2001	
Hypericum perforatum	St John's Wort	*		2003
Hypochaeris glabra	Smooth Cat's Ear	*	2001	2003
Hypochaeris radicata	Rough Cat's Ear	*	2001	2009
Indigofera australis var. *australis*	Austral Indigo		2001	
Isolepis marginata	Little Club-rush	*	1992	
Juncus sarophorus	Broom Rush		1980	
Kennedia prostrata	Scarlet Runner		2001	
Lachnagrostis avenacea var. *avenacea*	Common Blown-grass		1996	2009
Lactuca serriola	Prickly Lettuce	*	1992	
Lagenophora huegelii	Coarse Bottle-daisy		2001	
Lamium amplexicaule var. *amplexicaule*	Deadnettle	*	1992	
Lepidium africanum	Common Peppercress	*	2001	2009
Lepidosperma laterale	Sharp Sword-sedge		1980	
Lepidosperma viscidum	Sticky Sword-sedge		2001	2009
Leptorhynchos squamatus subsp. *squamatus*	Scaly Buttons		2001	
Levenhookia dubia	Hairy Stylewort		2001	
Linum marginale	Native Flax		1997	
Lobelia gibbosa	Tall Lobelia		1996	
Logfia gallica	Narrow Cudweed	*	1996	
Lolium perenne x *rigidum*	Hybrid Ryegrass	*	1992	
Lolium rigidum	Wimmera Ryegrass	*	2001	2003/2009
Lomandra collina	Sand Mat-rush		1992	2009
Lomandra densiflora	Soft Tussock Mat-rush		2001	
Lomandra effusa	Scented Mat-rush		2001	2009
Lomandra multiflora	Many-flower Mat-rush		2001	
Lomandra multiflora subsp. *dura*	Hard Mat-rush		2001	2003/2009
Lomandra sp.	Mat-rush			2003
Lotus australis	Austral Trefoil			2009

Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Luzula meridionalis	Common Wood-rush		1992	2009
Lycium ferocissimum	African Boxthorn	*	1992	2003/2009
Lysiana exocarpi subsp. *exocarpi*	Harlequin Mistletoe		2001	
Maireana brevifolia	Short-leaf Bluebush		2001	2003/2009
Maireana enchylaenoides	Wingless Fissure-plant		2001	
Malva parviflora	Small-flower Mallow	*		2003
Marrubium vulgare	Horehound	*	1997	2003/2009
Medicago polymorpha var. *polymorpha*	Burr-medic	*	1992	
Melaleuca lanceolata subsp. *lanceolata*	Dryland Tea-tree		1992	2003/2009
Melaleuca uncinata	Broombush		1992	
Microseris lanceolata	Yam Daisy		2001	
Microtis arenaria	Notched Onion-orchid		2001	2009
Microtis parviflora	Slender Onion-orchid		1996	
Microtis unifolia complex	Onion-orchid		1992	
Millotia tenuifolia var. *tenuifolia*	Soft Millotia		2001	
Mitrasacme paradoxa	Wiry Mitrewort		1992	
Moraea setifolia	Thread Iris	*	2001	
Myoporum montanum	Native Myrtle		2001	
Myoporum platycarpum	False Sandalwood		1992	
Myoporum viscosum	Sticky Boobialla		2001	
Neurachne alopecuroidea	Fox-tail Mulga-grass		2001	2009
Olearia decurrens	Winged Daisy-bush		2001	2009
Olearia pimeleoides subsp. *pimeleoides*	Pimelea Daisy-bush		1992	
Olearia ramulosa	Twiggy Daisy-bush		2001	
Olearia teretifolia	Cypress Daisy-bush		2001	
Onopordum acanthium	Scotch Thistle	*	1980	2003
Opercularia turpis	Twiggy Stinkweed		2001	
Oxalis corniculata subsp. *corniculata*	Creeping Wood-sorrel	*	2001	
Oxalis perennans	Native Sorrel		2001	2003/2009
Oxalis pes-caprae	Soursob	*	2001	2009
Parapholis incurva	Curly Ryegrass	*	1992	
Parietaria debilis	Smooth-nettle		1992	
Pentaschistis airoides	False Hair-grass	*	2001	
Petrorhagia dubia	Velvet Pink	*	2001	2009
Phyllangium divergens	Wiry Mitrewort		2001	
Phyllanthus saxosus	Rock Spurge		1992	
Pimelea glauca	Smooth Riceflower		2001	2009
Pimelea micrantha	Silky Riceflower		1997	
Pimelea microcephala subsp. *microcephala*	Shrubby Riceflower		2001	
Pimelea sp.	Riceflower			2003
Pimelea stricta	Erect Riceflower		1980	
Pittosporum angustifolium	Native Apricot		1992	2009
Plantago gaudichaudii	Narrow-leaf Plantain		2001	
Plantago hispida	Hairy Plantain		1996	
Plantago sp. B (R.Bates 44765)	Little Plantain		1992	
Plantago varia	Variable Plantain		2001	2009
Poa crassicaudex	Thick-stem Tussock-grass		2001	
Podotheca angustifolia	Sticky Long-heads		2001	

Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Pogonolepis muelleriana	Stiff Cup-flower		2001	
Pomaderris paniculosa subsp. *paniculosa*	Mallee Pomaderris		2001	2009
Poranthera microphylla	Small Poranthera		1992	
Prasophyllum fitzgeraldii	Fitzgerald's Leek-orchid		1992	
Prasophyllum odoratum	Scented Leek-orchid		2001	
Pseudognaphalium luteoalbum	Jersey Cudweed		1992	2009
Pterostylis biseta	Two-bristle Greenhood		1992	
Ptilotus spathulatus f. *spathulatus*	Pussy-tails		1997	2009
Pultenaea densifolia	Dense Bush-pea		2001	
Pultenaea largiflorens	Twiggy Bush-pea		2001	2009
Ranunculus sessiliflorus var. *sessiliflorus*	Annual Buttercup		2001	
Raphanus raphanistrum	Wild Radish	*	1992	2009
Rapistrum rugosum	Turnip Weed	*		2003
Rhagodia parabolica	Mealy Saltbush		1992	2003/2009
Rhodanthe laevis	Smooth Daisy		2001	
Romulea minutiflora	Small-flower Onion-grass	*	2001	
Rosa canina	Dog Rose	*	2001	2009
Rosa rubiginosa	Sweet Briar	*	1980	2009
Rostraria cristata	Annual Cat's-tail	*	1992	
Rumex brownii	Slender Dock		2001	
Salsola tragus	Roly-poly	*		2003/2009
Salvia verbenaca	Wild Sage	*	1997	2003/2009
Salvia verbenaca var. *verbenaca*	Wild Sage	*	2001	
Santalum acuminatum	Quandong		1992	
Scaevola aemula	Fairy Fanflower		1997	
Scaevola albida	Pale Fanflower		1996	
Scaevola humilis	Inland Fanflower		1992	2003/2009
Schenkia australis	Spike Centaury		1992	
Sebaea ovata	Yellow Sebaea		2001	
Senecio glossanthus	Annual Groundsel		2001	
Senecio quadridentatus	Cotton Groundsel		2001	2009 (s.s.)
Senecio tenuiflorus	Woodland Groundsel		2001	2009 (s.l.)
Senna artemisioides subsp. *coriacea*	Broad-leaf Desert Senna		1996	
Setaria constricta	Knotty-butt Paspalidium		1997	
Sida corrugata var. *corrugata*	Corrugated Sida		2001	2003
Silene gallica	French Catchfly	*	1992	
Silene gallica var. *gallica*	French Catchfly	*	2001	2009
Silene nocturna	Mediterranean Catchfly	*	1992	
Sisymbrium erysimoides	Smooth Mustard	*	1992	
Sisymbrium officinale	Hedge Mustard	*	1992	
Solanum aviculare	Kangaroo Apple	*	1980	
Sonchus asper	Rough Sow-thistle	*	1992	
Sonchus oleraceus	Common Sow-thistle	*	2001	2003/2009
Spyridium parvifolium	Dusty Miller		1992	
Stackhousia monogyna	Creamy Candles		2001	
Stellaria media	Chickweed	*	2001	
Templetonia aculeata	Spiny Mallee-pea		1996	
Teucrium racemosum	Grey Germander		1992	

Scientific Name	Common Name	Origin	Most recent database record (BDSA)	Biosis Research record
Thelymitra nuda	Scented Sun-orchid		2001	
Themeda triandra	Kangaroo Grass		2001	2003/2009
Thysanotus patersonii	Twining Fringe-lily		2001	
Trachymene thysanocarpa	Native Parsnip		1992	
Tricoryne elatior	Yellow Rush-lily		1996	2003
Trifolium angustifolium	Narrow-leaf Clover	*	2001	2003/2009
Trifolium arvense var. *arvense*	Hare's-foot Clover	*	2001	2009
Trifolium campestre	Hop Clover	*	1996	2003
Trifolium glomeratum	Cluster Clover	*	1992	
Trifolium subterraneum	Subterranean Clover	*	2001	2009
Triodia irritans	Spinifex		1996	2009
Triodia scariosa	Spinifex		2001	2009
Triodia sp.	Spinifex			2003/2009
Tripteris clandestina	Tripteris	*	2001	
Urospermum picroides	False Hawkbit	*	2001	
Veronica plebeia	Trailing Speedwell		2001	
Vicia hirsuta	Hairy Vetch	*	1992	
Vicia monantha	Spurred Vetch	*	1992	
Vicia sativa	Common Vetch	*		2003
Vittadinia blackii	Narrow-leaf New Holland Daisy		2001	2009
Vittadinia cervicularis var. *cervicularis*	Waisted New Holland Daisy		1992	
Vittadinia cuneata	Fuzzy New Holland Daisy		1992	2009
Vittadinia cuneata var. *cuneata* f. *cuneata*	Fuzzy New Holland Daisy		1997	
Vittadinia gracilis	Woolly New Holland Daisy		1996	2003/2009
Vittadinia megacephala	Giant New Holland Daisy		2001	
Vittadinia sp.	New Holland Daisy			2009
Vulpia bromoides	Squirrel-tail Fescue	*	1992	
Vulpia muralis	Wall Fescue	*	2001	
Vulpia myuros f. *myuros*	Rat's-tail Fescue	*	2001	2009
Wahlenbergia gracilenta	Annual Bluebell		2001	2009
Wahlenbergia luteola	Yellow-wash Bluebell		2001	
Wahlenbergia sp.	Bluebell			2003
Wahlenbergia stricta subsp. *stricta*	Tall Bluebell		2001	
Wurmbea biglandulosa subsp. *flindersica*	Flinders Ranges Nancy		2001	
Wurmbea dioica subsp. *dioica*	Early Star-lily		1992	
Xanthorrhoea quadrangulata	Rock Grass-tree		2001	2009
Xanthorrhoea sp.	Grass-tree			2003
Zygophyllum angustifolium	Scrambling Twin-leaf			2009

Appendix 2. Fauna species recorded from the local area (Biosis 2012).

A2.1 Fauna species recorded from local area

Table A2.1. Vertebrate fauna recorded from the local area. Biosis Research records are all from study area.

Sources: BDSA Biological Database of South Australia and BA Birds Australia database. Searches undertaken on 24/04/2009

Database searches encompassed a 5 km radius.

* introduced species

Scientific Name	Common Name	Source	Most recent database record	Biosis Research / SKM record
Birds				
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	BDSA	2001	2003/2009
Acanthiza apicalis	Inland Thornbill	BDSA	2001	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	BDSA	2001	2003/2009
Acanthiza nana	Yellow Thornbill	BDSA	2001	
Acanthiza uropygialis	Chestnut-rumped Thornbill	BDSA	2001	
Acanthorhynchus tenuirostris	Eastern Spinebill	BDSA	2001	
Accipiter cirrocephalus	Collared Sparrowhawk	BA	2001	
Accipiter fasciatus	Brown Goshawk	BA	2008	
Acrocephalus australis	Australian Reed-Warbler	BA	2006	
Aegotheles cristatus	Australian Owlet-nightjar			2011
Alauda arvensis	Skylark *			2003
Anas gracilis	Grey Teal	BA	2006	
Anas superciliosa	Pacific Black Duck	BA	2001	
Anthochaera carunculata	Red Wattlebird	BDSA	2001	2003/2009
Anthus novaeseelandiae	Australasian Pipit	BA	2001	
Anthus novaeseelandiae	Richard's Pipit			2003/2009
Aquila audax	Wedge-tailed Eagle	BA	2004	2003/2009
Ardea pacifica	White-necked Heron	BA	2001	
Artamus cinereus	Black-faced Woodswallow	BA	2001	
Artamus cyanopterus	Dusky Woodswallow	BDSA	2001	2009
Artamus personatus	Masked Woodswallow	BA	2001	
Artamus superciliosus	White-browed Woodswallow	BDSA	2001	2003
Barnardius zonarius	Australian Ringneck	BDSA	2001	2003/2009
Biziura lobata	Musk Duck	BA	2001	
Cacatua galerita	Sulphur-crested Cockatoo	BDSA	2001	2003
Cacatua sanguinea	Little Corella	BA	2008	
Cacomantis flabelliformis	Fan-tailed Cuckoo	BA	2001	2003/2009
Cacomantis pallidus	Pallid Cuckoo	BA	2001	
Carduelis carduelis	European Goldfinch *	BDSA	2001	2003
Chalcites basalis	Horsfield's Bronze-cuckoo	BDSA	2001	
Chalcites osculans	Black-eared Cuckoo	BDSA	2001	2003/2009
Chenonetta jubata	Australian Wood Duck	BA	2006	2009
Cincloramphus cruralis	Brown Songlark	BA	2001	2009
Cincloramphus mathewsi	Rufous Songlark	BDSA	2001	2003

Scientific Name	Common Name	Source	Most recent database record	Biosis Research / SKM record
Circus assimilis	Spotted Harrier	BA	2001	2009
Climacteris picumnus	Brown Treecreeper	BA	2006	
Colluricincla harmonica	Grey Shrike-thrush	BDSA	2001	2003
Columba livia	Rock Dove *	BA	2001	
Coracina novaehollandiae	Black-faced Cuckoo-shrike	BDSA	2001	2009
Corcorax melanorhamphos	White-winged Chough	BDSA	2001	2003/2009
Corvus bennetti	Little Crow	BA	2001	
Corvus coronoides	Australian Raven	BA	2008	2009
Corvus mellori	Little Raven	BDSA	2001	2003/2009
Coturnix pectoralis	Stubble Quail	BA	2001	
Cracticus tibicen	Australian Magpie	BDSA	2001	2003/2009
Cracticus torquatus	Grey Butcherbird	BA	2008	2003
Dacelo novaeguineae	Laughing Kookaburra	BDSA	2001	2003/2009
Daphoenositta chrysoptera	Varied Sittella	BA	2001	
Dicaeum hirundinaceum	Mistletoebird	BDSA	2001	
Drymodes brunneopygia	Southern Scrub-robin	BA	2001	
Egretta novaehollandiae	White-faced Heron	BDSA	2001	2009
Elanus axillaris	Black-shouldered Kite	BDSA	2001	2003/2009
Eolophus roseicapillus	Galah	BDSA	2001	2003/2009
Falco berigora	Brown Falcon	BA	2008	2003/2009
Falco cenchroides	Nankeen Kestrel	BA	2008	2003/2009
Falco peregrinus	Peregrine Falcon	BA	2006	
Falcunculus frontatus	Crested Shrike-tit	BA	1999	
Fulica atra	Eurasian Coot	BA	2001	
Geopelia striata	Peaceful Dove	BDSA	2001	2003/2009
Glossopsitta concinna	Musk Lorikeet	BA	2006	
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	BDSA	2001	2003
Glyciphila melanops	Tawny-crowned Honeyeater	BDSA	2001	
Grallina cyanoleuca	Magpie-lark	BDSA	2001	2003/2009
Hirundo neoxena	Welcome Swallow	BDSA	2001	2003/2009
Lalage sueurii	White-winged Triller	BDSA	2001	2009
Lichenostomus chrysops	Yellow-faced Honeyeater	BDSA	2001	
Lichenostomus ornatus	Yellow-plumed Honeyeater			2009
Lichenostomus penicillatus	White-plumed Honeyeater	BDSA	2001	2003/2009
Lichenostomus virescens	Singing Honeyeater	BDSA	2001	2003/2009
Malurus cyaneus	Superb Fairy-wren	BA	2002	
Malurus lamberti	Variegated Fairy-wren	BDSA	2001	
Malurus splendens	Splendid Fairy-wren	BA	2001	
Manorina flavigula	Yellow-throated Miner	BA	2006	2009
Melanodryas cucullata	Hooded Robin	BDSA	2001	
Melithreptus brevirostris	Brown-headed Honeyeater	BDSA	2001	2003
Melithreptus lunatus	White-naped Honeyeater	BA	2001	
Melopsittacus undulatus	Budgerigar	BDSA	2001	2003
Merops ornatus	Rainbow Bee-eater	BA	2008	
Microcarbo melanoleucos	Little Pied Cormorant	BA	2001	2009
Microeca fascinans	Jacky Winter			2009
Milvus migrans	Black Kite	BA	2008	2003/2009
Mirafra javanica	Horsfield's Bushlark	BA	2001	2009
Neophema elegans	Elegant Parrot	BDSA	2001	2009
Ninox novaeseelandiae	Southern Boobook	BA	2008	2009
Nymphicus hollandicus	Cockatiel	BDSA	2001	

Scientific Name	Common Name	Source	Most recent database record	Biosis Research / SKM record
Ocyphaps lophotes	Crested Pigeon	BDSA	2001	2003/2009
Oriolus sagittatus	Olive-backed Oriole			2009
Pachycephala pectoralis	Golden Whistler	BA	2001	2003
Pachycephala rufiventris	Rufous Whistler	BDSA	2001	2003
Pardalotus striatus	Striated Pardalote	BDSA	2001	2003/2009
Passer domesticus	House Sparrow *	BDSA	2001	2003
Pavo cristatus	Indian Peafowl *	BA	2008	
Petrochelidon ariel	Fairy Martin	BDSA	2001	2009
Petrochelidon nigricans	Tree Martin	BDSA	2001	2003/2009
Petroica boodang	Scarlet Robin	BA	2006	
Petroica goodenovii	Red-capped Robin	BDSA	2001	2009
Phalacrocorax varius	Pied Cormorant	BA	2001	
Phaps chalcoptera	Common Bronzewing	BDSA	2001	2003/2009
Phaps elegans	Brush Bronzewing			2009
Phylidonyris novaehollandiae	New Holland Honeyeater	BDSA	2001	2003
Platycercus elegans adelaidae	Adelaide Rosella	BDSA	2001	2003/2009
Podargus strigoides	Tawny Frogmouth	BA	2001	2003
Poliocephalus poliocephalus	Hoary-headed Grebe	BA	2001	
Pomatostomus superciliosus	White-browed Babbler	BDSA	2001	
Psephotus haematonotus	Red-rumped Parrot	BDSA	2001	2003/2009
Purnella albifrons	White-fronted Honeyeater	BDSA	2001	
Rhipidura albiscapa	Grey Fantail	BDSA	2001	2003/2009
Rhipidura leucophrys	Willie Wagtail	BDSA	2001	2003/2009
Smicrornis brevirostris	Weebill	BDSA	2001	2003/2009
Stagonopleura guttata	Diamond Firetail	BDSA	2001	2009
Strepera versicolor	Grey Currawong	BDSA	2001	
Streptopelia chinensis	Spotted Dove	BA	2007	
Struthidea cinerea	Apostlebird	BA	2008	2003/2009
Sturnus vulgaris	Common Starling *	BDSA	2001	2003/2009
Taeniopygia guttata	Zebra Finch	BA	2005	
Todiramphus pyrrhopygius	Red-backed Kingfisher	BA	2001	2009
Todiramphus sanctus	Sacred Kingfisher	BDSA	2001	
Tribonyx ventralis	Black-tailed Native-hen	BA	2001	2009
Trichoglossus haematodus	Rainbow Lorikeet	BDSA	2001	
Turdus merula	Common Blackbird *	BA	2008	2003
Turnix varius	Painted Button-quail	BDSA	2001	
Tyto alba	Barn Owl	BDSA	1905	2003
Zosterops lateralis	Silvereye	BDSA	2001	
Mammals				
Tachyglossus aculeatus	Short-beaked Echidna	BDSA	2001	2009
Macropus fuliginosus	Western Grey Kangaroo	BDSA	2001	2003/2009
Macropus robustus	Euro	BDSA	2001	2003/2009
Trichosurus vulpecula	Common Brushtail Possum	BDSA	2001	
Tadarida australis	White-striped Freetail Bat			2003/2009/2011
Chalinolobus gouldii	Gould's Wattled Bat			2009/2011
Chalinolobus morio	Chocolate Wattled Bat			2009
Mormopterus species 3	Southern Freetail Bat sp. 3			2009
Mormopterus species 4	Southern Freetail Bat sp. 4			2009
Vespadelus regulus (?)	Southern Forest Bat			2009
Vespadelus baverstocki (?)	Inland Forest Bat			2009
Nyctophilus geoffroyi	Lesser Long-eared Bat			2009

Scientific Name	Common Name	Source	Most recent database record	Biosis Research / SKM record
Scotorepens balstoni (?)	Inland Broad-nosed Bat			2009
Vulpes vulpes	Red Fox *	BDSA	2001	2003/2009
Felis catus	Feral Cat *			2003/2009
Capra hircus	Feral Goat *	BDSA	2001	
Mus musculus	House Mouse *	BDSA	2001	2011
Lepus capensis	Brown Hare *			2003/2009
Oryctolagus cuniculus	European Rabbit *	BDSA	2001	2003/2009
Reptiles				
Ctenophorus decresii	Tawny Dragon	BDSA	2001	2009
Pogona vitticeps	Central Bearded Dragon	BDSA	2001	2003/2009
Varanus varius	Lace Monitor	BDSA	2001	2009
Aprasia pseudopulchella	Flinders Worm-lizard	BDSA	2001	
Delma molleri	Adelaide Snake-lizard	BDSA	2001	2003/2009
Delma butleri	Spinfex Snake-lizard			2009
Lialis burtonis	Burton's Legless Lizard	BDSA	2001	2009
Christinus marmoratus	Marbled Gecko	BDSA	2001	2011
Gehyra lazelli	Southern Rock Dtella	BDSA	2001	2009/2011
Diplodactylus vittatus	Eastern Stone Gecko			2009
Heteronotia binoei	Bynoe's Gecko			2009/2011
Nephrurus milii	Barking Gecko			2011
Cryptoblepharus pannosus	Speckled Wall Skink	BDSA	2001	2003/2009
Ctenotus robustus	Eastern Striped Skink	BDSA	2001	2003/2009/2011
Hemiergis decresiensis	Three-toed Earless Skink	BDSA	2001	2003/2009
Lampropholis guichenoti	Garden Skink	BDSA	2001	
Lerista bougainvillii	Bougainville's Skink	BDSA	2001	
Lerista dorsalis	Southern Four-toed Slider	BDSA	2001	
Menetia greyii	Dwarf Skink	BDSA	2001	2009/2011
Morethia boulengeri	Common Snake-eyed Skink	BDSA	2001	2009
Morethia obscura	Mallee Snake-eyed Skink	BDSA	2001	
Tiliqua rugosa	Sleepy Lizard	BDSA	2001	2003/2009/2011
Tiliqua scincoides	Eastern Bluetongue			2003/2009
Ramphotyphlops bicolor	Southern Blind Snake	BDSA	2001	2011
Ramphotyphlops bituberculatus	Prong-snouted Blind Snake			2009
Demansia psammophis	Yellow-faced Whipsnake	BDSA	2001	2009
Parasuta nigriceps	Mitchell's Short-tailed Snake			2009
Pseudonaja textilis	Eastern Brown Snake	BDSA	2001	2003/2009
Amphibians				
Crinia signifera	Common Froglet	BDSA	2001	
Neobatrachus pictus	Burrowing Frog	BDSA	2001	2009
Pseudophryne bibronii	Brown Toadlet	BDSA	2001	

Appendix 3. Significant fauna species (Biosis 2012).

A2.3 Significant fauna species

Table A2.3. Fauna of national or state significance recorded, or predicted to occur, within 5 kilometres of the study area.

Sources: BDSA Biological Database of South Australia
BA Birds Australia database
DEWHA database (EPBC Act Protected Matters Search Tool)

- Database searches encompassed a 5 km radius. Searches undertaken on 24/04/2009.

Status of species:

CR critically endangered
EN endangered
VU vulnerable
R rare

Sources for species status:

EPBC Act *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
NPW Act *National Parks and Wildlife Act 1972* Advisory (S.A.) Schedules 7, 8, 9.

species whose geographic range encompasses the study area as indicated by EPBC the DEWHA database, but with no records from local area.

Scientific name	Common name	Most recent record	EPBC Act	NPW Act	Likelihood of occurrence
National significance:					
Petrogale xanthopus xanthopus	Yellow-footed Rock-wallaby	#	VU	VU	Negligible
Pedionomus torquatus	Plains-wanderer	#	VU	EN	Negligible
Rostratula australis	Australian Painted Snipe	#	VU	VU	Negligible
Aprasia pseudopulchella	Flinders Worm-lizard	2001	VU		High
Notechis ater ater	Krefft's Tiger Snake (Flinders Ranges)	#	VU		Low
State significance:					
Trichosurus vulpecula	Common Brushtail Possum	2009		R	Present (recorded Biosis 2003)
Stagonopleura guttata	Diamond Firetail	2009		VU	Present (recorded Biosis 2009)
Corcorax melanorhamphos	White-winged Chough	2009		R	Present (recorded Biosis 2003/2009)
Falco peregrinus	Peregrine Falcon	2006		R	High
Falcunculus frontatus	Crested Shrike-tit	1999		R	High
Melanodryas cucullata cucullata	Hooded Robin	2001		R	High
Petroica boodang boodang	Scarlet Robin	2006		R	High
Microeca fascinans fascinans	Jacky Winter	2009		R	Recorded present by Biosis 2009, but area is edge of range for subspecies & records are possibly of *M. f. assimilis*.
Biziura lobata	Musk Duck	2001		R	High
Neophema elegans	Elegant Parrot	2001		R	Present (recorded Biosis 2009)

Scientific name	Common name	Most recent record	EPBC Act	NPW Act	Likelihood of occurrence
Turnix varius	Painted Button-quail	2001		R	High
Varanus varius	Tree Goanna	2001		R	Present (recorded Biosis 2009)
Pseudophryne bibronii	Brown Toadlet	2001		R	High

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Landscape and Visual Impact

GREEN BEAN DESIGN *landscape architects*

CRYSTAL BROOK ENERGY PARK

LANDSCAPE AND VISUAL ASSESSMENT

Prepared for:

Neoen Australia Pty Ltd

Prepared by:

GREEN BEAN DESIGN
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DOUCMENT CONTROL

ITEM	DETAIL
Project Name:	**Crystal Brook Energy Park**
Report Title:	**Landscape and Visual Impact Assessment**
Project Number:	**17-228**
Version Number:	**v3**
Status:	**FINAL**
Author:	**Andrew Homewood**, Registered Landscape Architect, AILA *Graduate Diploma Landscape Management, Bachelor Science (Dual Honours)* *Landscape Design and Archaeology, National Diploma Horticulture*
Date	**29 March 2018**

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Glossary

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

Table 1 Glossary

Cumulative effects	The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.
Magnitude	A combination of the scale, extent and duration of an effect.
Mitigation	Measures, including any processes, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual effects of a development project.
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.
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 changes in the character of the available views resulting from the development or the changes in visual amenity of the visual receivers.
Visual Impact Assessment	A process of applied professional and methodical techniques to assess and determine the extent and nature of change to the composition of existing views that may result from a development.
View location	A place or situation from which a proposed development may be visible.
Visual receiver	Individual and/or defined groups of people who have the potential to be affected by a proposal.
Visual significance	A measure of the importance or gravity of the visual effect culminating from the degree of magnitude and receiver sensitivity.

Executive Summary

Green Bean Design Pty Ltd (GBD) was commissioned by Neoen Australia Pty Ltd (the Proponent) to undertake a Landscape and Visual Impact Assessment (LVIA) for the proposed Crystal Brook Energy Park and associated infrastructure.

The Crystal Brook Energy Park (the Project) principal assets would comprise up to 26 wind turbines, a 150MW solar facility and a lithium-ion battery storage facility. These assets would also include a range of ancillary infrastructure such as access roads, site office, workshop, terminal substation, wind monitoring towers, temporary construction compounds, temporary concrete batching plants and temporary laydown areas.

GBD understand that if the renewable hydrogen facility is considered feasible, the Proponent intends to submit a variation or subsequent DA, accompanied by appropriate further supporting work including a landscape and visual impact assessment.

The proposed wind turbines have been modelled and assessed with an overall blade tip height of up to 240 metres (m) and would be the most visible component of the Project. The 240m tip height comprises:

- maximum hub height of the wind turbine is 161m above ground level and
- maximum wind turbine rotor blade length is 79m.

This LVIA has determined that the landscape within, and immediately surrounding the Project Site, is generally robust and defined by visually strong forms and patterns and is considered to exhibit attributes which tend to result in a moderate sensitivity with some potential to accommodate change.

Whilst the broader regional Flinders Ranges landscape displays characteristics which are highly valued and have a high degree of visual amenity, the Projects immediate landscape character is represented by a partially modified agricultural landscape, comprising lower rounded and sparsely timbered, grassed and cropped hills. The Project Site landscape character is commonly found, and generally ubiquitous, within the broader landscape.

It is unlikely that works involved with the construction of the Project, including removal of small amounts of existing vegetation, would have any significant impact on existing landscape values within, or beyond the Project Site. The removal of vegetation would be relatively minor in the context of the landscape and largely restricted to the construction of access roads and wind turbine hardstands. This would result in no significant change to the extent or context of existing views.

This LVIA has determined that the visual effect of the Project is likely to be moderate from the majority of publicly accessible locations surrounding the Project, and that the proposed Project:

- would have an overall moderate visual effect on the Crystal Brook township and the small number of localities beyond the Project Site
- would have no significant visual effect on view locations within Port Pirie located around 22 kilometres to the north west of the Project Site

- would result in low to moderate (albeit short term and transitory impacts) effects on views from the Princes and Wilkins Highway
- would result in generally low visual effects on short duration views from the majority of local roads, including the Gladstone and Beetaloo Valley Roads, where some views would be fully or partially and/or filtered by roadside tree planting and/or landform
- would not have a significant, or long term, visual effect from local public reserves, recreational areas and walking tracks, including any available views from state significant landscape areas such as State Reserves and National Parks
- would not result in significant cumulative visual impacts given the visual separation distance to other operational wind farm projects
- would not result in any significant level of shadow flicker for non-host residential dwellings.

The Project would have potential to result in a range of visual effects on a small number of residential dwellings and homesteads surrounding the Project Site. These impacts would be dependent on a number of physical and environmental characteristics (e.g. landform and vegetation) surrounding the residential dwellings which would determine overall visibility and prominence of the Project within specific views.

This LVIA has determined that the overall visual effect of the proposed solar farm, and battery storage facility, is likely to be low (and predominantly negligible) for the majority of surrounding residential dwellings and publicly accessible locations (roads). The low visual effect generally reflects the smaller scale of constructed elements within the solar farm and battery storage facility. Overall, the solar farm and battery storage facility would:

- have no significant visual effect on residential dwelling view locations
- have a no significant visual effect on the principal rural townships within the surrounding landscape
- result in no significant visual effect on views from local roads and highways
- result in no significant cumulative visual effect and
- result in no significant visual impact from scenic areas, lookouts or public reserves.

Although some mitigation measures are considered appropriate to minimise the visual effects for a number of ancillary structures associated with the Project (including the solar farm, battery storage and terminal substation), it is acknowledged that the degree to which the wind turbines may be visually mitigated is limited by their scale and position within the landscape relative to surrounding view locations. Mitigation measures, such as screen planting, would have a greater degree of efficacy for other Project infrastructure including the solar farm, terminal substation and battery storage facility.

As the renewable hydrogen production facility is subject to further feasibility studies, it has not been assessed in this LVIA; however, the potential for overall visual effects associated with this facility has been considered with regard to its general locality and potential visibility from surrounding view locations.

Introduction

Section 1

1.1 Introduction

This LVIA has been prepared by GBD on behalf of the Proponent to accompany a development application for the proposed Crystal Brook Energy Park. This LVIA is an assessment of the suitability of the Project and its principal assets within the landscape surrounding the Project Site, as well as considering the potential extent and degree of visual effects on people living in, and travelling through, the surrounding landscape.

This LVIA has been prepared with regard to the following documents and guidelines to identify and consider potential landscape and visual impacts:

- Wind Farm Development Guidelines for Developers and Local Government Planners (2014), Central Local Government Region of South Australia and
- Port Pirie Regional Council Development Plan, Renewable Energy Facilities (Consolidated 31 October 2017)

In addition, this LVIA has also considered landscape and visual impact 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 August 2017, Scottish Natural Heritage
- Visual Representation of Wind Farms, Version 2.2 February 2017, Scottish Natural Heritage

1.2 Port Pirie Regional Council Development Plan

The Project and its principal assets would be located in the Port Pirie Regional Council Primary Production Zone. This LVIA notes the Port Pirie Council Regional Council Development Plan states that wind farms and ancillary development are an envisaged form of development within this zone, and further states that:

Such facilities may be of a large scale, comprise a number of components and require an extended and/or dispersed development pattern. These facilities will need to be located in areas where they can take advantage of the natural resource upon which they rely and, as a consequence may be need to be:

- *located in visually prominent locations such as ridgelines*
- *visible from scenic routes and valuable scenic and environmental areas*
- *located closer to roads than envisaged by generic setback policy.*

This, coupled with the large scale of these facilities (in terms of both height and spread of components), renders it difficult to mitigate the visual impacts of wind farms to the degree expected of other types of development. Subject to implementation of management techniques set out by general / council wide policy regarding renewable energy facilities, these visual impacts are to be accepted in pursuit of benefits derived from increased generation of renewable energy.

In consideration of Renewable Energy Facilities, the Port Pirie Council Regional Council Development Plan also notes that:

The visual impacts of wind farms and ancillary development (such as substations, maintenance sheds, access roads and wind monitoring masts) should be managed through:

(a) wind turbine generators being:

(i) setback at least 1000 metres from non-associated (non-stakeholder) dwellings and tourist accommodation

(ii) setback at least 2000 metres from defined and zoned township, settlement or urban areas (including deferred urban areas)

(iii) regularly spaced

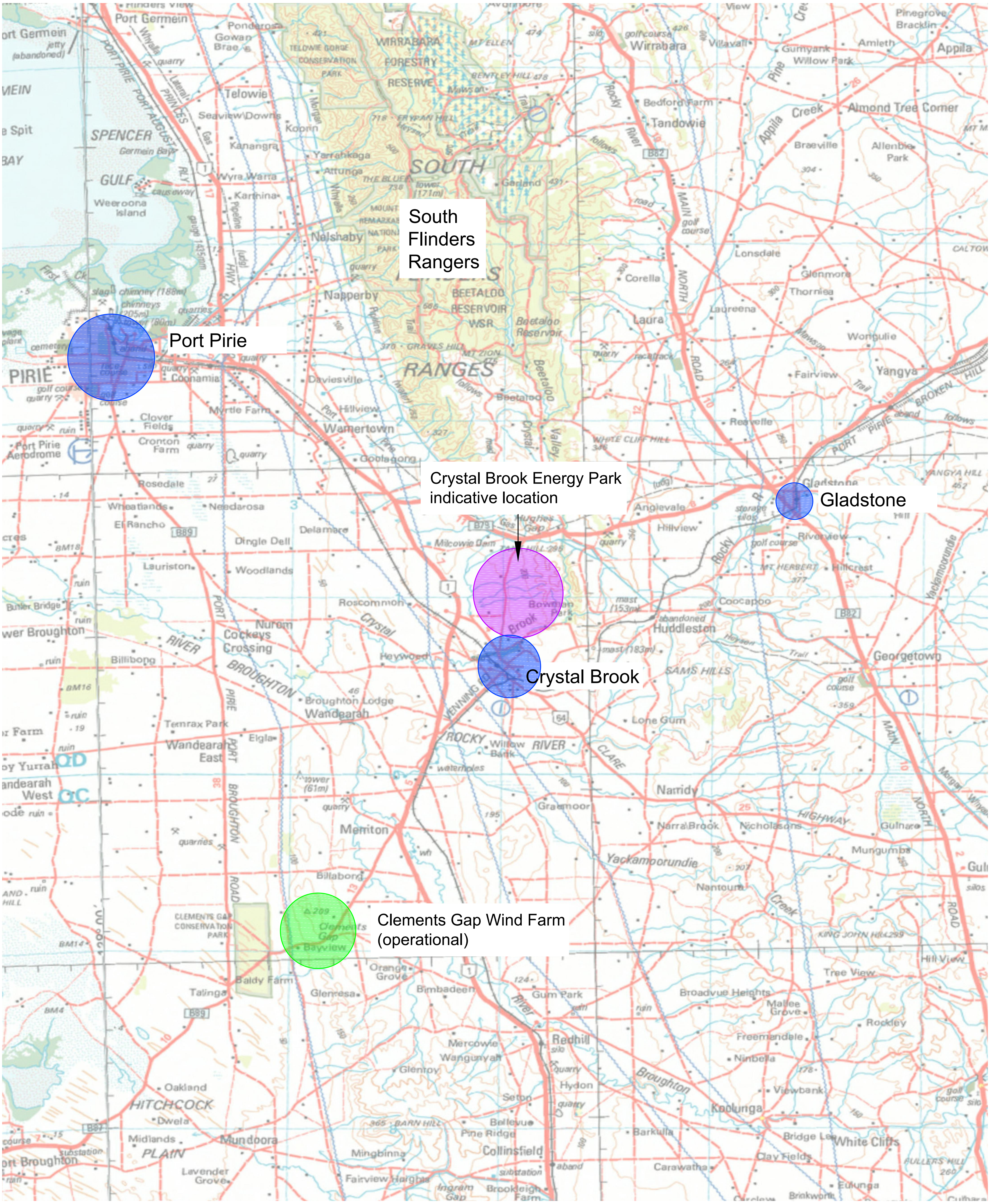
(iv) uniform in colour, size and shape and blade rotation direction

(v) mounted on tubular towers (as opposed to lattice towers)

(b) provision of vegetated buffers around substations, maintenance sheds and other ancillary structures.

The Project Site regional locality is illustrated in **Figure 1**.

Source: Copyright Commonwealth of Australia (Geoscience Australia) 2012 http://mapconnect.ga.gov.au/MapConnect/250K/



Crystal Brook Energy Park, Regional locality

Figure 1
Crystal Brook Energy Park,
Regional locality

Crystal Brook Energy Park

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Methodology and report structure

2.1 Methodology

The methodology employed for this LVIA has been based on existing guidelines identified in Section 1.1. The methodology is also based on professional judgement and assessment of multiple wind farm projects undertaken by GBD within Queensland, New South Wales, Victoria and Tasmania. The key tasks incorporated into the LVIA methodology are identified in **Table 2**.

2.2 Report structure

This LVIA report been structured into 14 parts as follows:

Table 2 – Report structure

Report section	Description
1 – Introduction	This section provides an introductory section that describes the intent and purpose of the LVIA.
2 – Methodology and report structure	This section sets out the structure and methodology employed in the LVIA preparation.
3 – Project description	This section describes the regional and local position of the Project relative to existing landscape features and places and describes the key visible components of the Project.
4 – Viewshed	This section identifies the area of land surrounding the wind farm which may be potentially affected by the Project.
5 – Panorama photographs	This section illustrates the LVIA with panorama photographs taken during the site inspection. The panorama photographs are provided to illustrate the general appearance of typical landscape characteristics that occur within and surrounding the Project Site.
6 – Landscape Character Assessment	This section describes the physical characteristics of the landscape surrounding the Project Site and

Table 2 – Report structure

Report section	Description
	determines the overall sensitivity of the landscape to the Project.
7 – Zone of theoretical visibility	This section identifies a theoretical area of the landscape from which wind turbines may be visible within the viewshed, and describes a range of factors which may influence the Project's visibility within the viewshed.
8 – Visual effects (key view points)	This section describes and determines the potential visual effect of the Project on key viewpoints within the viewshed.
9 – Cumulative assessment	This section describes the potential impact of alternate existing and/or known wind farm developments within proximity to the Project Site.
10 – Solar panel sun-glint, glare and lighting	This section describes the potential visual effect of sun glint, glare and lighting associated with the solar panels within proximity to the Project Site.
11 – Shadow flicker and blade glint assessment summary	This section presents a summary of the shadow flicker and blade glint assessment prepared by DNV-GL.
12 – Wind turbine photomontages	This section presents photomontage of the proposed wind turbines to illustrate potential views toward the Project from surrounding public view locations.
13 – Pre-construction and construction	This section describes the activities associated with pre-construction and during construction which may create visual impacts.
14 – Mitigation measures	This section outlines potential mitigation measures to minimise visual impacts arising from the Projects development.

Table 2 – Report structure

Report section	Description
15 – Conclusion	Conclusions are drawn on the overall visual effect of the Project.
Appendix A	Appendix A presents the detailed Shadow flicker and blade glint assessment prepared by DNV-GL.

Project description

3.1 Project description (wind turbines)

The key visual Project components would comprise:

- up to 26 wind turbines to a maximum 240 metre tip height
- terminal substation and associated infrastructure
- operations and maintenance building (site office and workshop) with car parking
- wind monitoring towers
- crane hardstand areas
- on site access roads for construction, operation and ongoing maintenance and
- signage.

Temporary works associated with the construction of the Project that may be visible during construction phases include:

- temporary site offices and construction compounds
- temporary concrete batching plant
- temporary wind monitoring towers
- temporary laydown areas temporary wind monitoring towers and
- mobile concrete batching plant and rock crushing facilities.

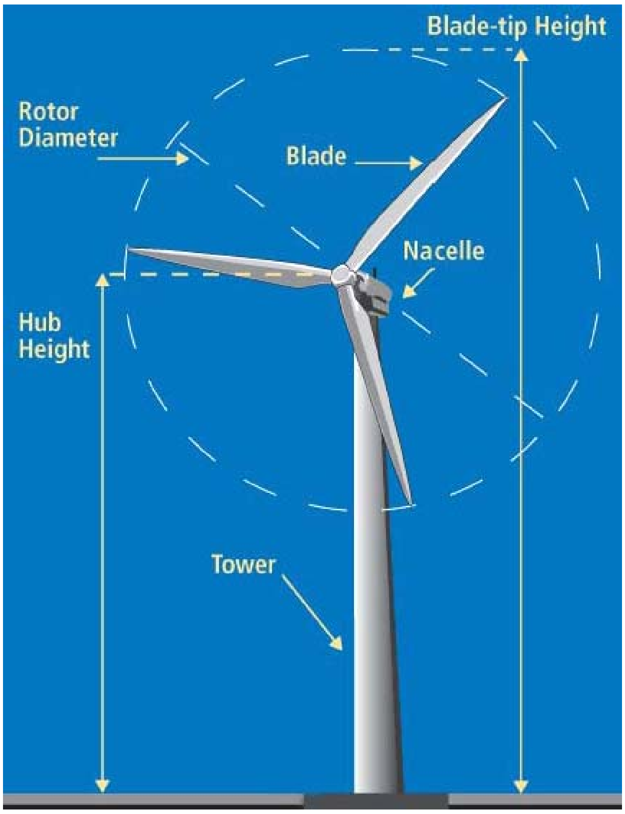
The indicative Project wind turbine layout is illustrated in **Figure 5**.

3.2 Wind turbines

The specific elements of the wind turbines typically comprise:

- concrete foundations
- tubular tapering steel and/or concrete towers
- nacelles at the top of the tower housing electrical generator and gearbox (depending on design)
- a hub attached to the nacelle with three blades attached and
- three composite material blades attached to the hub.

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



Configuration and components of a typical wind turbine

3.3 Project description (solar facility)

The key solar infrastructure components of the project would include:

- photo voltaic panels at around 3 metres high
- Power Conversion Blocks (PCB) (Inverters 1 – 2.5MW capacity, step-up transformers and switchgear)
- collection circuits, underground cables for connection to the terminal substation
- safety fencing, fencing of the entire facility with a chain mesh fence
- access track (up to 5m wide) to and from site and within solar arrays and to PCBs and
- temporary construction compound, offices and laydown area.

Typical photos illustrating key visual components commonly associated with solar facilities are included in **Figures 2** to **4**.

3.4 Aviation obstacle lighting

The Proponent commissioned an Aviation Impact Statement (AIS) which was completed by Chiron Aviation Consultants Pty Ltd (March 2018). The AIS included a detailed consideration with regard to obstacle lighting needs and requirements for the installation and operation of obstacle lighting. The AIS 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 AIS concluded that no obstacle lighting is required for wind turbines. Accordingly, this LVIA has not undertaken an assessment of potential visual effects associated with obstacle lighting.

3.5 Wind monitoring masts

Wind monitoring masts would be installed on-site, extending up to the wind turbine hub height. The permanent wind monitoring masts are expected to be of a guyed, narrow lattice or tubular steel design. The permanent wind monitoring masts would not create a significant visual impact in the context of the overall wind farm development.

3.6 On-site access roads

On-site access roads would be constructed to provide access to turbine locations across the site during construction and operation. During construction, the running width of access roads would be approximately 6 m and wider on corners. Following construction, the disturbance will be rehabilitated leaving a road of sufficient a running width to accommodate turbine delivery.

The access road design is developed on a number of environmental grounds, including minimising the potential for visual impact by considering:

- the overall length and extent
- the use of existing farm track route and laneways
- the need for clearing vegetation
- the potential for erosion
- the extent of cut and fill and
- the potential to maximise rehabilitation at the completion of the construction phase.

3.7 Electrical services plan and infrastructure

Power and communication cables would be generally installed underground between the turbines and connect back to the terminal substation. A short section of overhead transmission line would extend to a cut in point to the existing transmission line to the north west of the wind turbine cluster.

A renewable battery storage facility would be constructed in proximity to the terminal substation. The terminal substation and battery storage facility would tend to be visually contained by landform rising to the east the Project Site. The terminal substation and battery storage facility are unlikely to form significant visual elements in the existing landscape from surrounding sensitive view locations including a very small number of residential dwellings around 1.5 kilometres from the facilities, as well as indirect views from the Princes and Wilkins Highways.

Plate 1 – Typical battery storage facility, Hornsdale SA (Image: Neoen Australia Pty Ltd 2017)

3.8 Construction

There are potential visual impacts that could occur during both pre-construction and construction phases of the project. 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 Project include:

- ongoing detailed site assessment including sub surface geotechnical investigations
- various civil works to upgrade local roads and access point
- 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 plant
- excavation and earthworks and
- various construction activities including erection of wind turbines, monitoring masts and terminal substation with associated electrical infrastructure works.

The majority of pre-construction and construction activities, some of which will result in physical changes to the landscape, are generally temporary in nature and are typically restricted to various discrete areas within or just beyond the immediate Project Site. The majority of pre-construction and construction activities will be unlikely to result in an unacceptable level of visual impact given their duration and temporary nature.

Plate 1 - Typical view toward photo voltaic panels and inverter units

Inverter unit

Plate 2 - Typical detail view toward photo voltaic panels and inverter units

Figure 2
Typical photo voltaic panels and converters

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Plate 3 - Typical view toward photo voltaic panels (single axis face and underside)

Plate 4 - Typical detail view toward photo voltaic panels and inverter units

Figure 3
Typical photo voltaic panel profiles

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Plate 5 - Typical view toward photo voltaic panel face (single axis track)

Plate 6 - Typical security fence detail

Figure 4
Typical photo voltaic panel face and security fence

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Viewshed

Section 4

4.1 Viewshed

For the purpose of this LVIA the viewshed is defined as the area of land surrounding and beyond the Project Site which may be potentially affected by the Project's assets. In essence, the viewshed defines this LVIA study area. The overall viewshed for the Project has been illustrated at a distance of 3km extending across the landscape away from the wind turbines. The 3km viewshed extends to illustrate the location of residential dwellings and farms to the east and north north-east of the Project Site.

It is important to note that the wind turbines would be visible from areas of the landscape beyond the 3km viewshed; however, within the general parameters of normal human vision, a wind turbine at a maximum tip height of 240m to the tip of the rotor blade would occupy a relatively small proportion of a person's field of view from distances in excess of 3km and result in a relatively lower level of perceived visual significance. The relationship between the Project viewshed and residential dwellings is illustrated in **Figure 24**.

Panoramic photographs

Section 5

5.1 Panoramic photographs

A series of individual and panorama digital photographs and aerial images were taken during the course of the fieldwork to illustrate existing views in the vicinity of the Project and to give a sense of the overall site in its setting. The panorama photographs and aerial images were digitally stitched together to form a segmented panorama image to provide a visual illustration of the existing view from each photo location.

The panoramic photographs presented in this LVIA have been annotated to identify local features within and beyond the Project Site. The photograph and aerial image locations are illustrated in **Figures 5** and **13**, and the photographs illustrated in **Figures 6** to **12** and **14** to **18**.

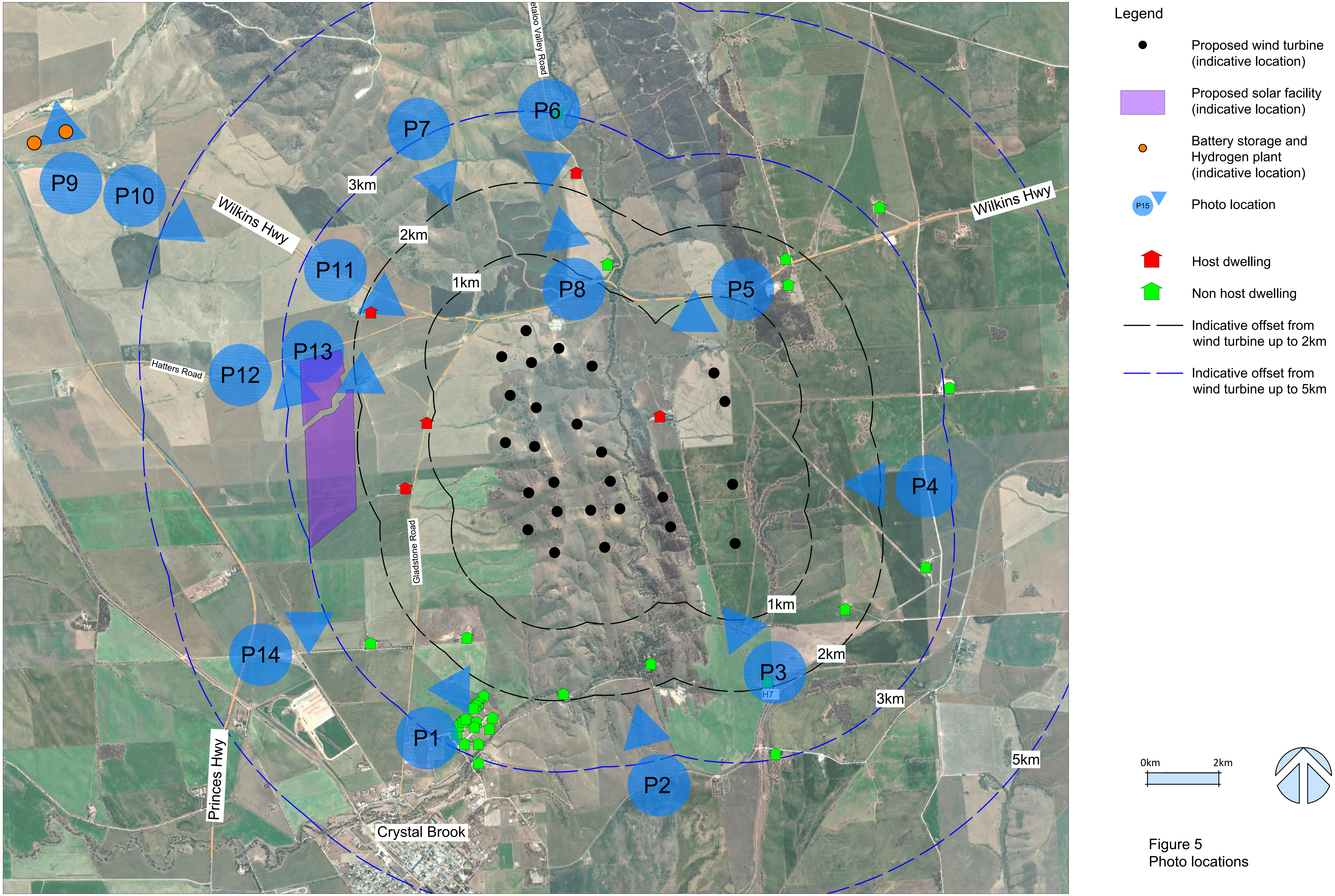

Figure 5
Photo locations

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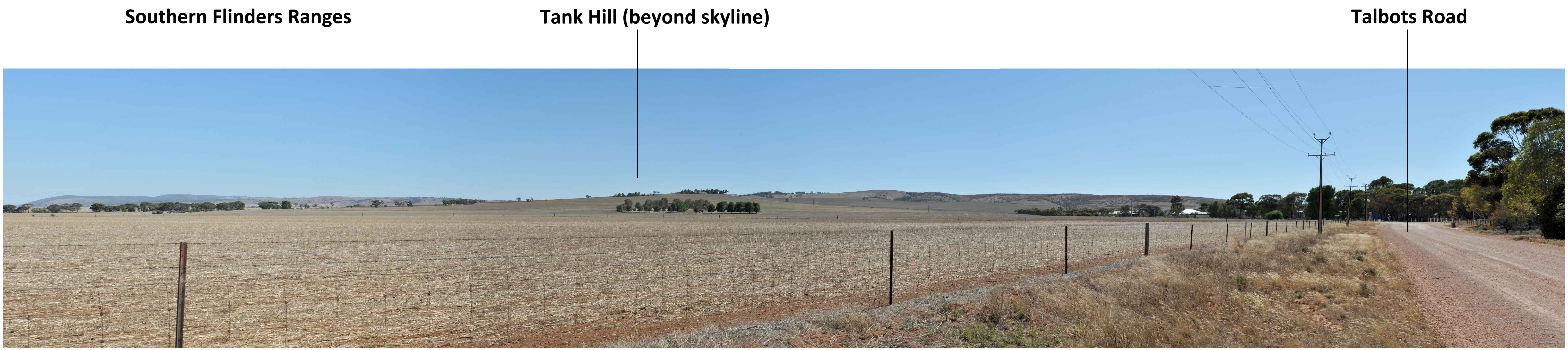

Photo location P1 - View north to north east from Talbots Road, Crystal Brook

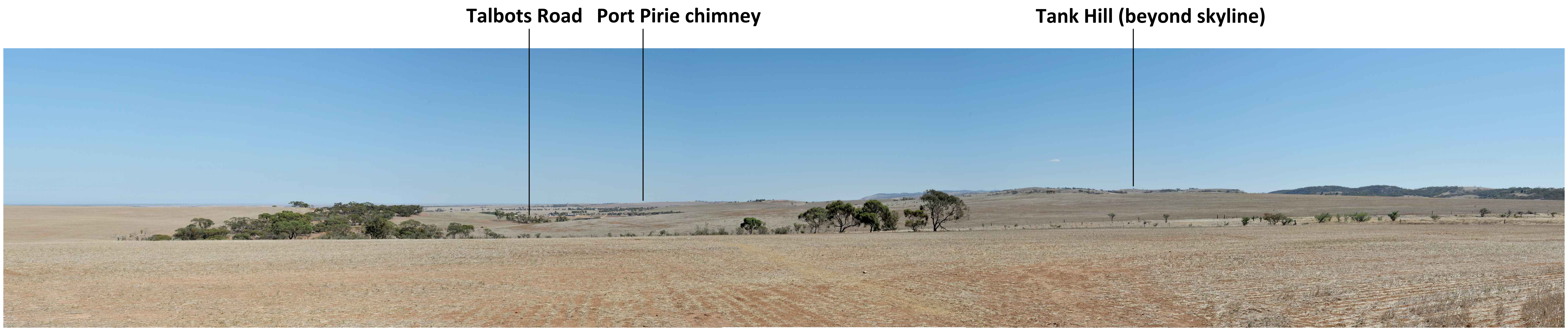

Photo location P2 - View north west to north east from Huddlestone Road

Figure 6 -
Photo sheet 1

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Photo location P3 - View north west/west to north from Heads Road

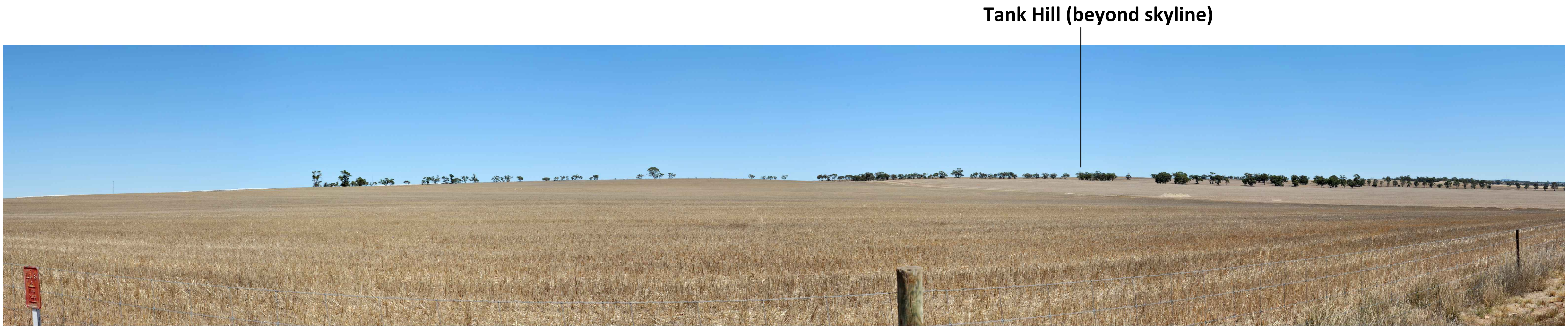

Photo location P4 - View west from Heaslips Road

Figure 7
Photo sheet 2

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Photo location P5 - View south west to west from Wilkins Highway

Photo location P6 - View south east to south west from Beetaloo Valley Road

Figure 8
Photo sheet 3

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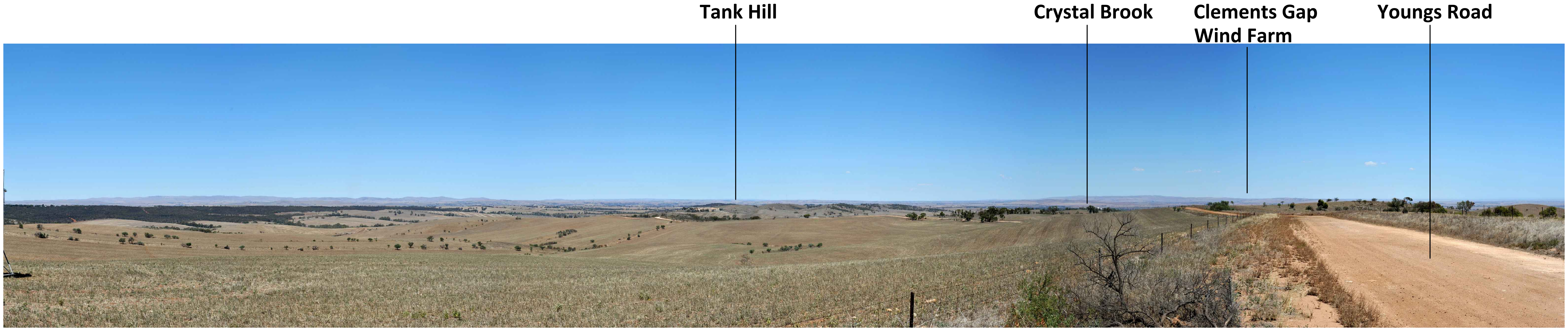

Photo location P7 - View south east to south/south west from Youngs Road
Clements Gap Wind Farm around 26km from photo location

Photo location P8 - View north west to east from Youngs Road toward Beetaloo Valley

Figure 9
Photo sheet 4

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Photo location P10 - View north to north east from Wilkins Highway

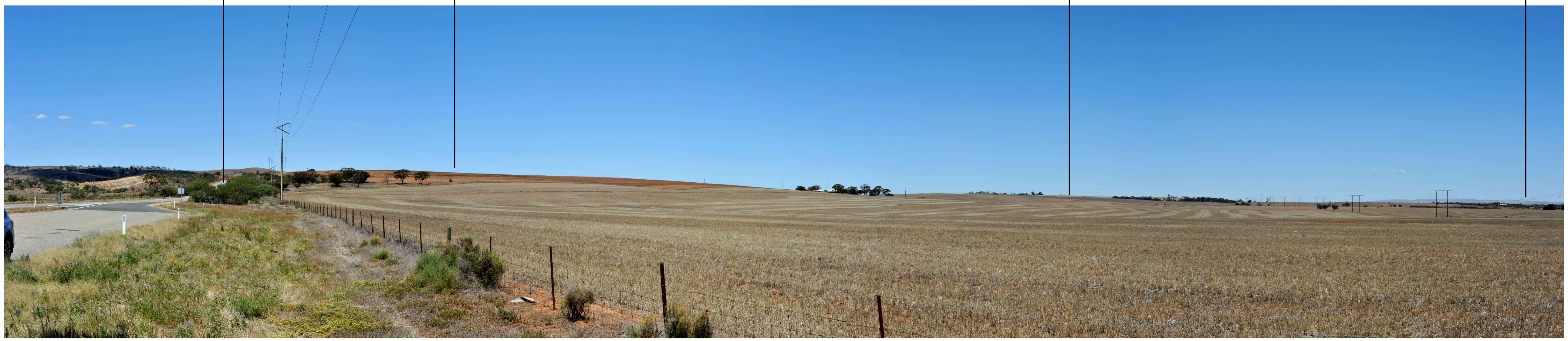

Photo location P11 - View east to south from Wilkins Highway

Figure 10
Photo sheet 5

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Photo location P12 - View east to south from Wilkins Highway

Photo location P13 - View east to south from Hatters Road

Figure 11
Photo sheet 6

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Photo location P14 - View east to south from Hatters Road

Photo location P15 - View north to south from Goyder Highway

Figure 12
Photo sheet 7

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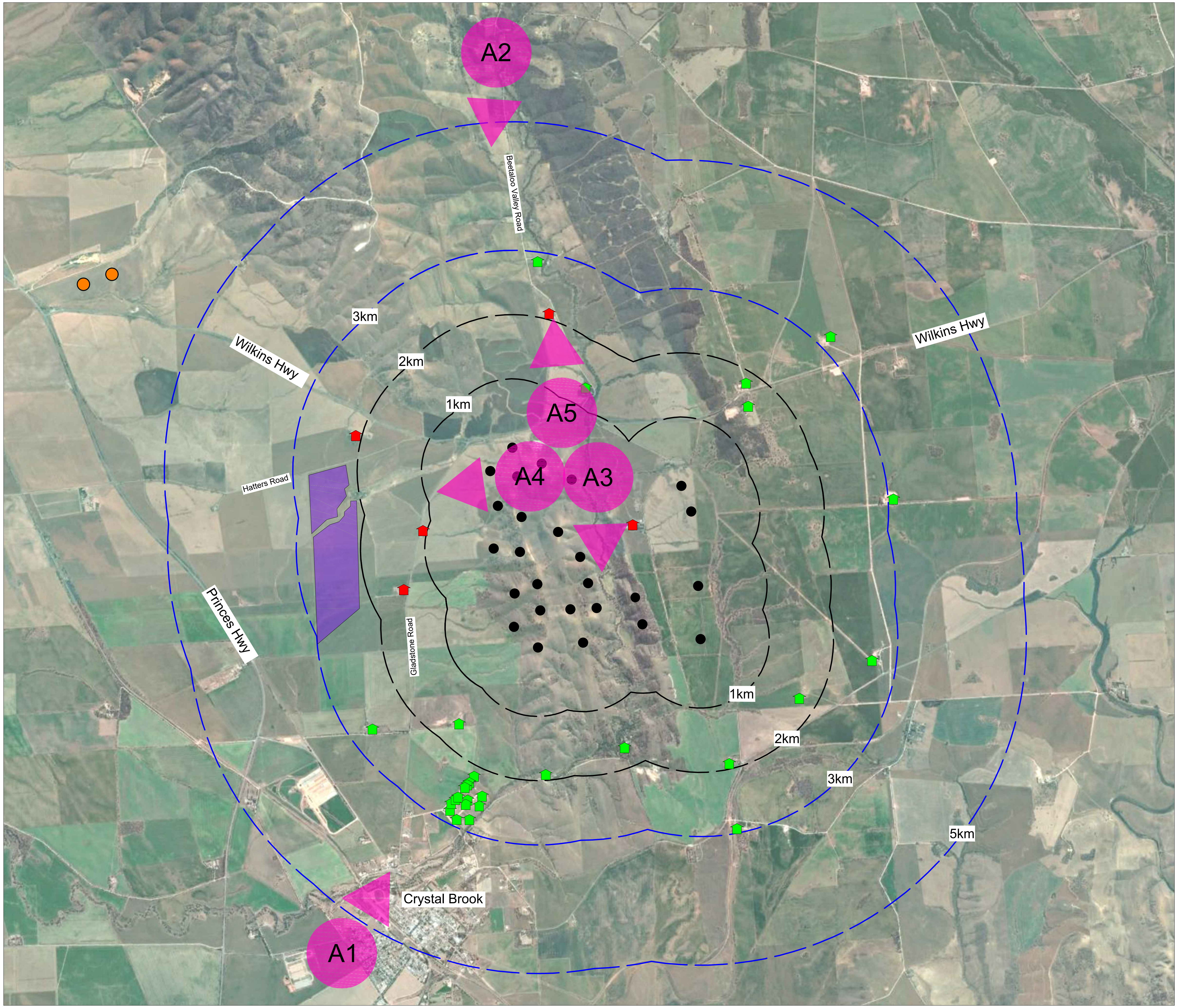

Legend

Figure 13
Aerial photo locations

Crystal Brook Energy Park

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Gladstone Road

Talbots Road

Frith Road

Crystal Brook

Aerial photo viewpoint A1 - Aerial view north east from west of Crystal Brook (distance around 5.4 km)

Wind turbine indicative extent

Figure 14
Crystal Brook Energy Park
Aerial photo location A1

Crystal Brook Energy Park

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Aerial photo viewpoint A2 - Aerial view south from Beetaloo Valley (distance around 6.5 km)

Wind turbine indicative extent

Figure 15
Crystal Brook Energy Park
Aerial photo location A2

Crystal Brook Energy Park

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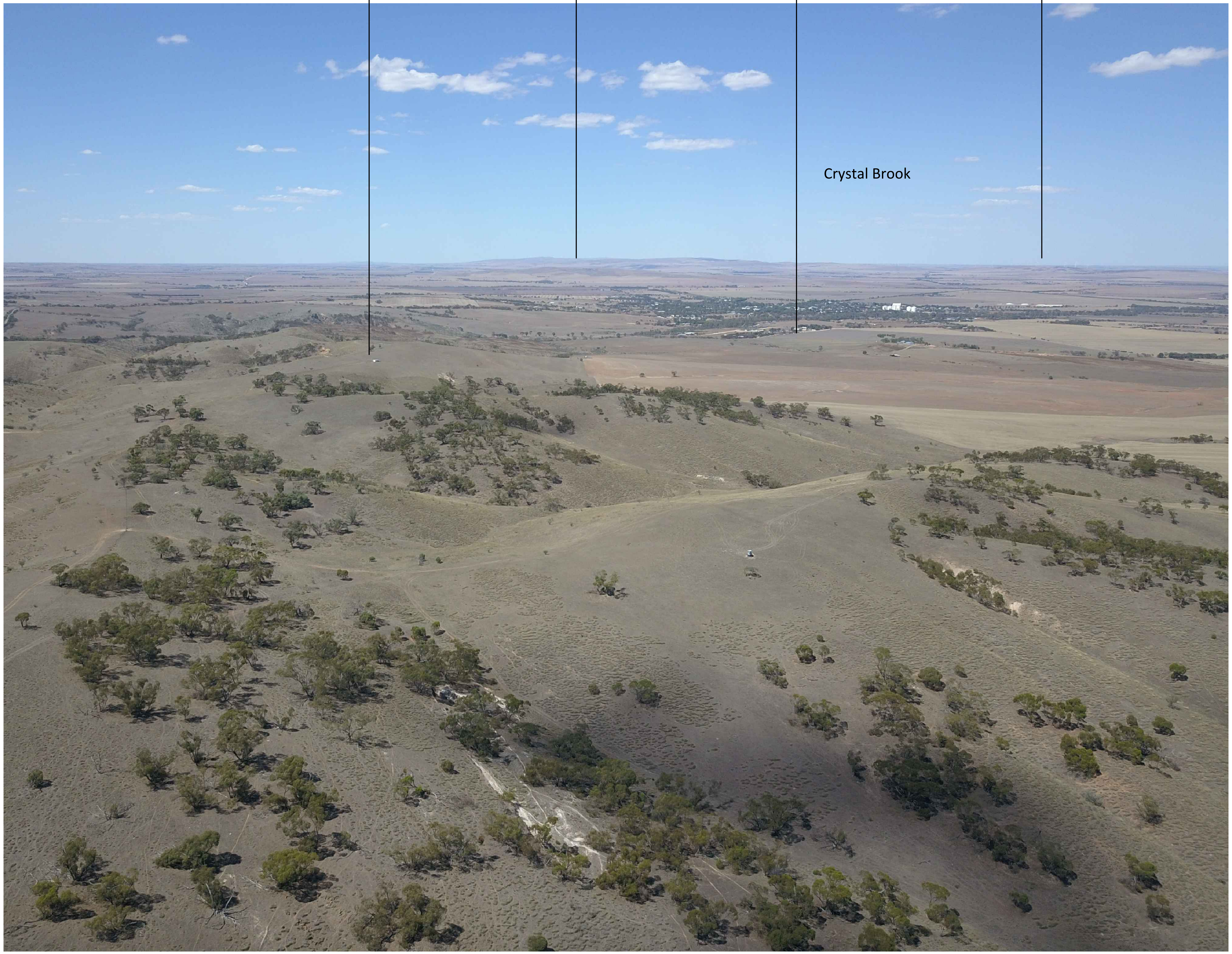

Aerial photo viewpoint A3 - Aerial view south from project site above wind turbine CB28

Wind turbine indicative extent

Figure 16 -
Crystal Brook Energy Park
Aerial photo location A3

Crystal Brook Energy Park

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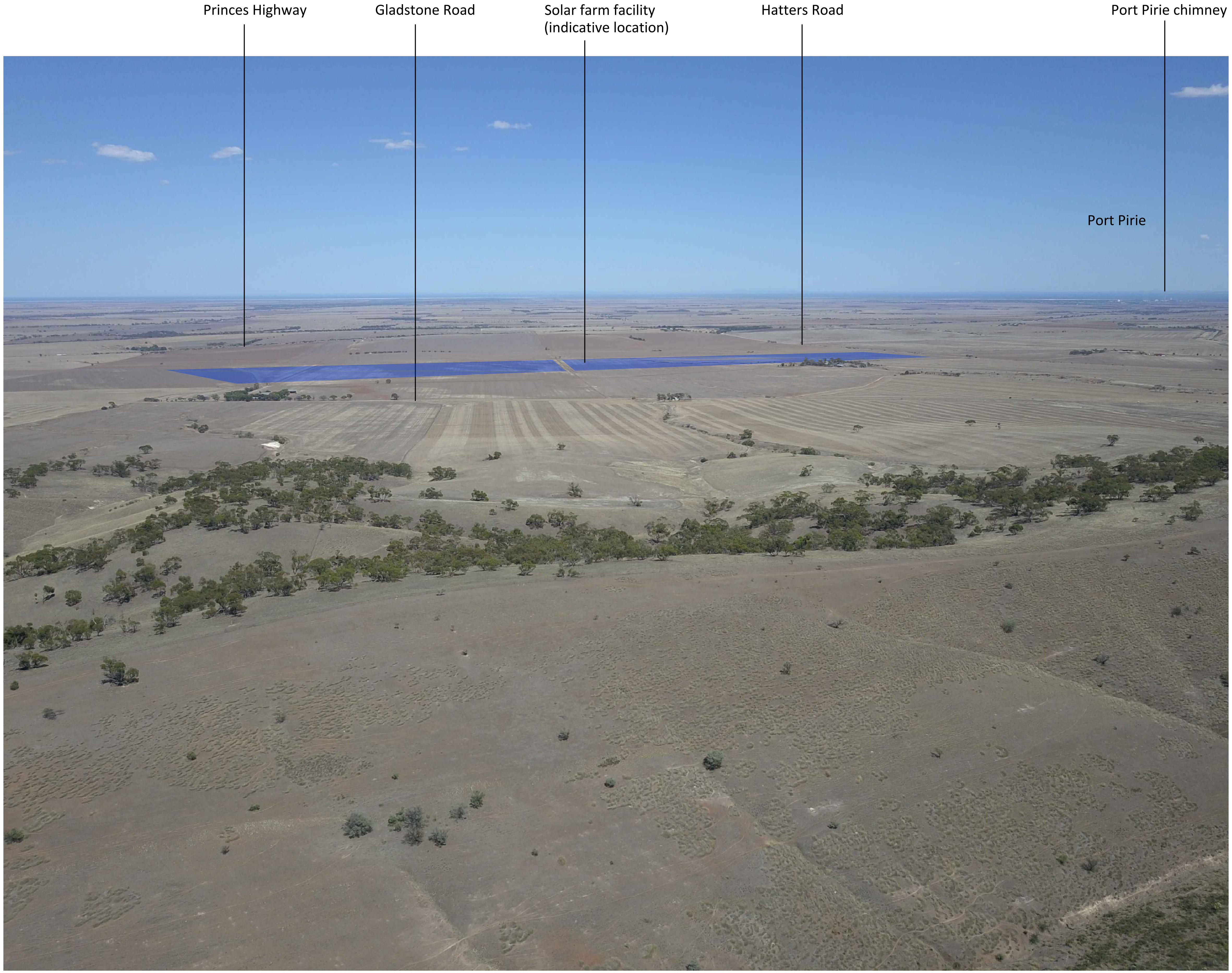

Aerial photo viewpoint A4 - Aerial view west from the project site toward and beyond the solar farm facility

Figure 17
Crystal Brook Energy Park
Aerial photo location A4

Crystal Brook Energy Park

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Aerial photo viewpoint A5 - Aerial view north from above Youngs Road toward the Beetaloo Valley

Figure 18
Crystal Brook Energy Park
Aerial photo location A5

Landscape character assessment

6.1 Landscape character area

As part of the LVIA process it is important to understand the nature and sensitivity of different components of landscape character, and to assess them in a clear and consistent process. For the purpose of this LVIA, landscape character is defined as '*the distinct and recognisable pattern of elements that occur consistently in a particular type of landscape'* (The Countryside Agency and Scottish Natural Heritage 2002). The pattern of elements includes characteristics such as landform, vegetation, land use and settlement.

For the purpose of this LVIA, the landscape character surrounding the Project has been determined as a singular landscape unit which generally occurs within the 3km viewshed of the Project Site. The landscape unit represents an area that is relatively recognisable in terms of its key landscape elements and physical attributes; which include a combination of topography/landform, vegetation/landcover, land use and built structures (including rural dwellings and local road corridors).

For the purpose of this LVIA the predominant landscape unit within and surrounding the Project Site has been identified as low undulating hills and ridgeline areas combining cultivated and modified agricultural lands interspersed with scattered tree cover.

6.2 Landscape character assessment

An understanding of a particular landscape's key characteristics and principal visual features is important in defining a distinctiveness and sense of place and to determine its 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 good practice employed in the assessment of wind farm developments and have been adopted for numerous wind farm assessments across Australia. The criteria are 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.

Landscape sensitivity is a relative concept, and landscape values of the surrounding environment may be considered of a higher or lower sensitivity than other areas in the region. Whilst landscape character assessment is largely based on a systematic description and analysis of landscape characteristics, this LVIA acknowledges that some individuals and other members of the local community may place higher values on the local landscape. These values may transcend preferences (likes and dislikes) and include personal and cultural influences.

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

The landscape sensitivity assessment criteria set out in **Table 3** have been evaluated for the landscape character area by applying a professionally determined judgement on a sliding scale between 1 and 5.

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

The scale of sensitivity for the landscape character area is outlined in **Table 4** and is set out against each characteristic identified in **Table 3**.

The overall landscape sensitivity for the landscape character area is a summation of the scale for each characteristic identified in **Tables 4**.

The overall scale is expressed as a total out of 30 (i.e. 6 characteristics for the landscape character area with a potential top scale of 5). Each characteristic is assessed separately and the criteria set out in **Table 3** are not ranked in equal significance. The overall landscape sensitivity for the landscape character area has been determined as either:

High (Scale of 23 to **30)** – key characteristics of the landscape character area will be impacted by the Project, and will 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 a number of perceived uncharacteristic and significant changes.

Medium (Scale 15 to 22) – 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, but may be accommodated to some degree.

Low Rating (Scale of 7 to **14)** – the majority 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.

Negligible Rating (Up to 6) the characteristics of the landscape character area will not be impacted or visibly altered by the Project.

Table 4 – Landscape character area

	Lower Sensitivity		↔		Higher Sensitivity
	Low	Low to Med	Medium	Med to High	High
Rating	1	2	3	4	5
Landform and Scale				4	
	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 as a result of extensive forested areas within surrounding State Reserves and National Parks.				

Table 4 – Landscape character area

	Lower Sensitivity		↔		Higher Sensitivity
	Low	Low to Med	Medium	Med to High	High
Rating	1	2	3	4	5
Landcover			3		
	Within the Project Site landcover is relatively simple and predictable, together with that of the immediate and surrounding landscape. Tree cover is generally limited within the 3km viewshed, occurring within steeper gullies across 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.				
Settlement and human influence			3		
	Settlement is generally dispersed immediately beyond the Project Site and surrounding landscape and consists largely of farmsteads and individual dwellings. There are some examples of small scale, historic or vernacular structures within the landscape. The Crystal Brook township is located to the south west of the Project Site.				
Movement				4	
	Movement within and immediately adjacent to the Project Site is limited to a generally low frequency of vehicular movements and more notably along the Wilkins Highway to the north of the wind farm site.				
Rarity		2			
	The Project Site and adjoining landscape are considered to be a relatively common landscape type within a regional context and do not tend to exhibit landscape features or elements which would only occur within the Project Site.				
Intervisibility			3		
	Areas of landscape surrounding the Project Site can allow for far distant and regional scale views. Views from Youngs Road (to the north of Tank Hill) offer elevated viewpoints that are publicly accessible. 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				

Table 4 – Landscape character area

	Lower Sensitivity		↔		Higher Sensitivity
	Low	Low to Med	Medium	Med to High	High
Rating	1	2	3	4	5
	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	**Score 19 out of 30** In consideration of the existing landscape characteristics, the 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, but may be accommodated to some degree.				

Zone of Theoretical Visibility

7.1 Zone of Theoretical Visibility (ZTV)

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

7.2 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), and hub height (essentially a view between the nacelle and tip of blade).

The ZTV assessment methodology is considered to be 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 some locations indicated on the ZTV diagrams due to the local presence of trees 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 surrounding viewshed.

A diagram illustrating the tip of blade and hub height visibility is illustrated in **Figure 19** and the ZTV diagrams are shown in **Figures 20** and **21**.

Both tip of blade and hub height ZTV diagrams illustrate similar areas of potential visibility and highlight the extent and influence of the Flinders Ranges hill and ridgeline landforms to the north of the Project Site.

The ZTV Diagrams illustrate the visual effect influenced by the topography and landscape features surrounding the Project Site. There is a greater proportional number of wind turbines potentially visible to the east and west of the Project Site, across gently undulating and relatively level rural/agricultural and generally sparsely populated landscape areas, with fewer wind turbines potentially visible from areas within 5 km the north of the Project Site. There are various pockets of land within and beyond 5km of the wind turbines, and more extensive areas between 5km and beyond 10 km of the wind turbines, where wind turbines will become less visible due to screening landform.

7.3 Visibility

The level of wind turbine and solar farm visibility within the Project viewshed can result from a number of factors including, but not limited to:

Distance

With an increase in distance the proportion of a person's horizontal and vertical view cone occupied by a visible turbine structure, group of turbine structures or solar panels would decline.

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

Whilst the distance between a view location and the wind turbines or solar panels is a primary factor to consider when determining potential visibility, there are other issues which may also affect the degree of visibility. The influence of distance on visibility and proportional representation with regard to wind turbines is illustrated in **Figure 22** and for the photo voltaic panels in **Figure 23**.

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 can be partially constrained by the available view from within a vehicle at proximate distances.

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 located 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.

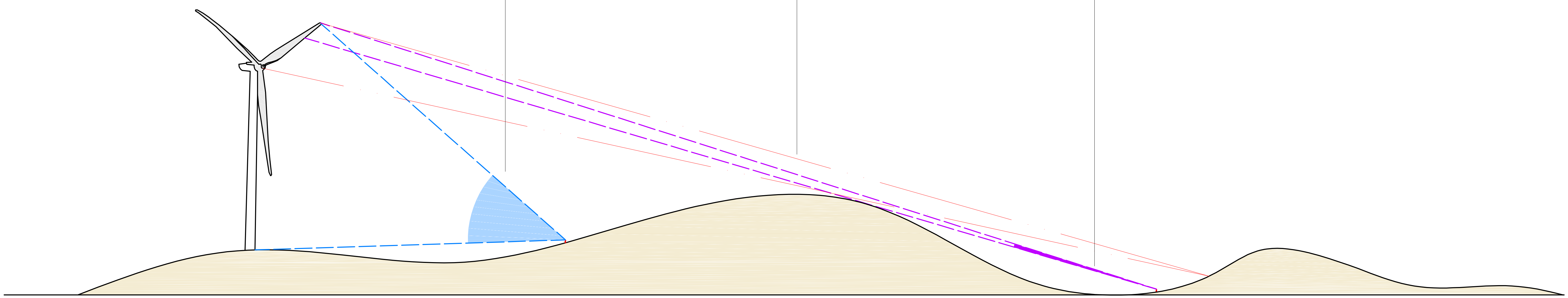
7.4 Climatic and Atmospheric Conditions

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



'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.

'Hub height'

View toward 'hub height' - where views extend toward the wind turbine hub (nacelle) and the tip of blades.

Figure 19
Zone of Theoretical Visibility

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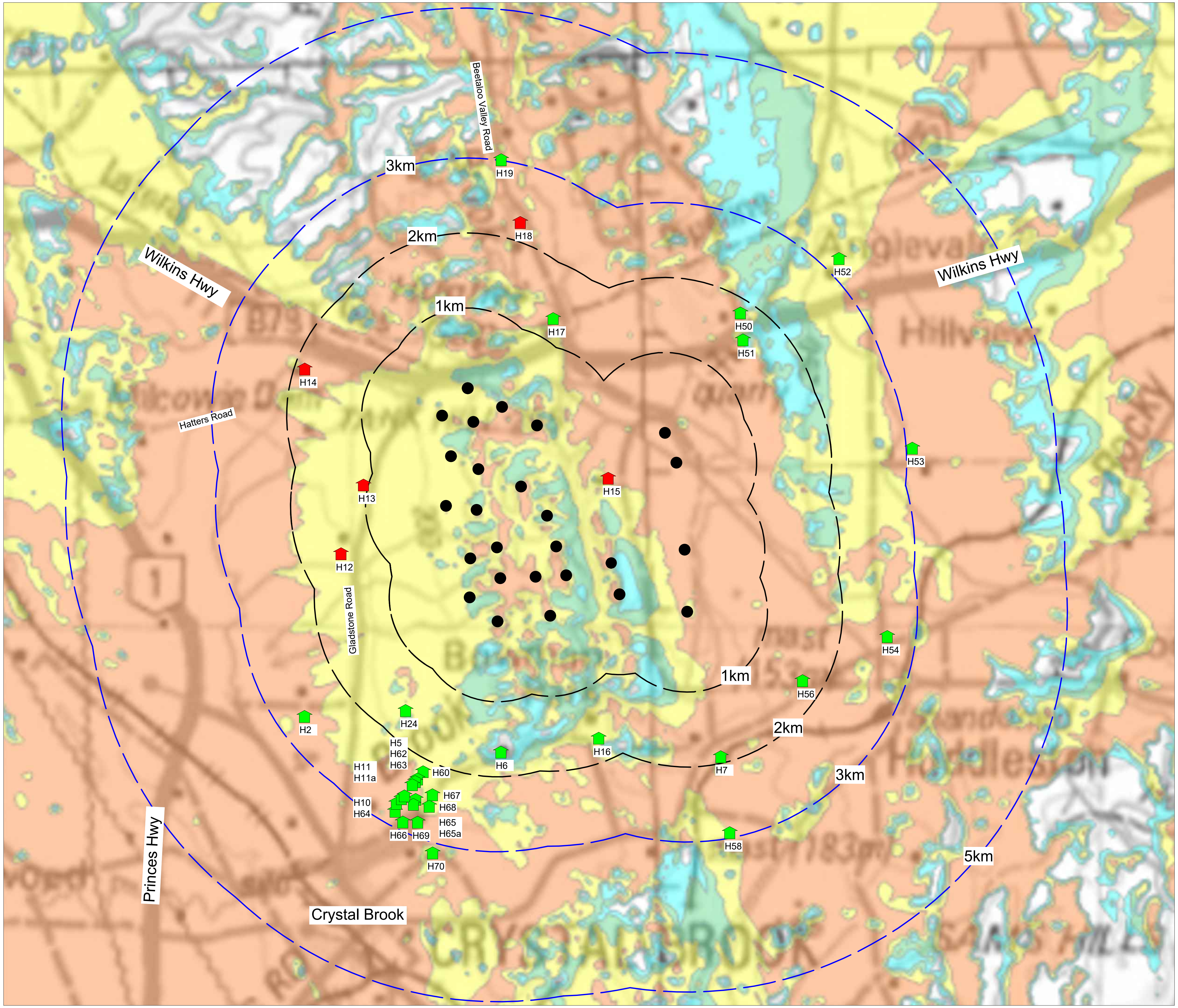

NOTES:

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

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

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

LEGEND:

Number of wind turbine hubs visible

0 1 9 17 25

Non host dwelling

Host dwelling

Proposed wind turbine (indicative location)

0km 1km

Figure 20
Zone of Theoretical Visibility
Wind turbine hub height

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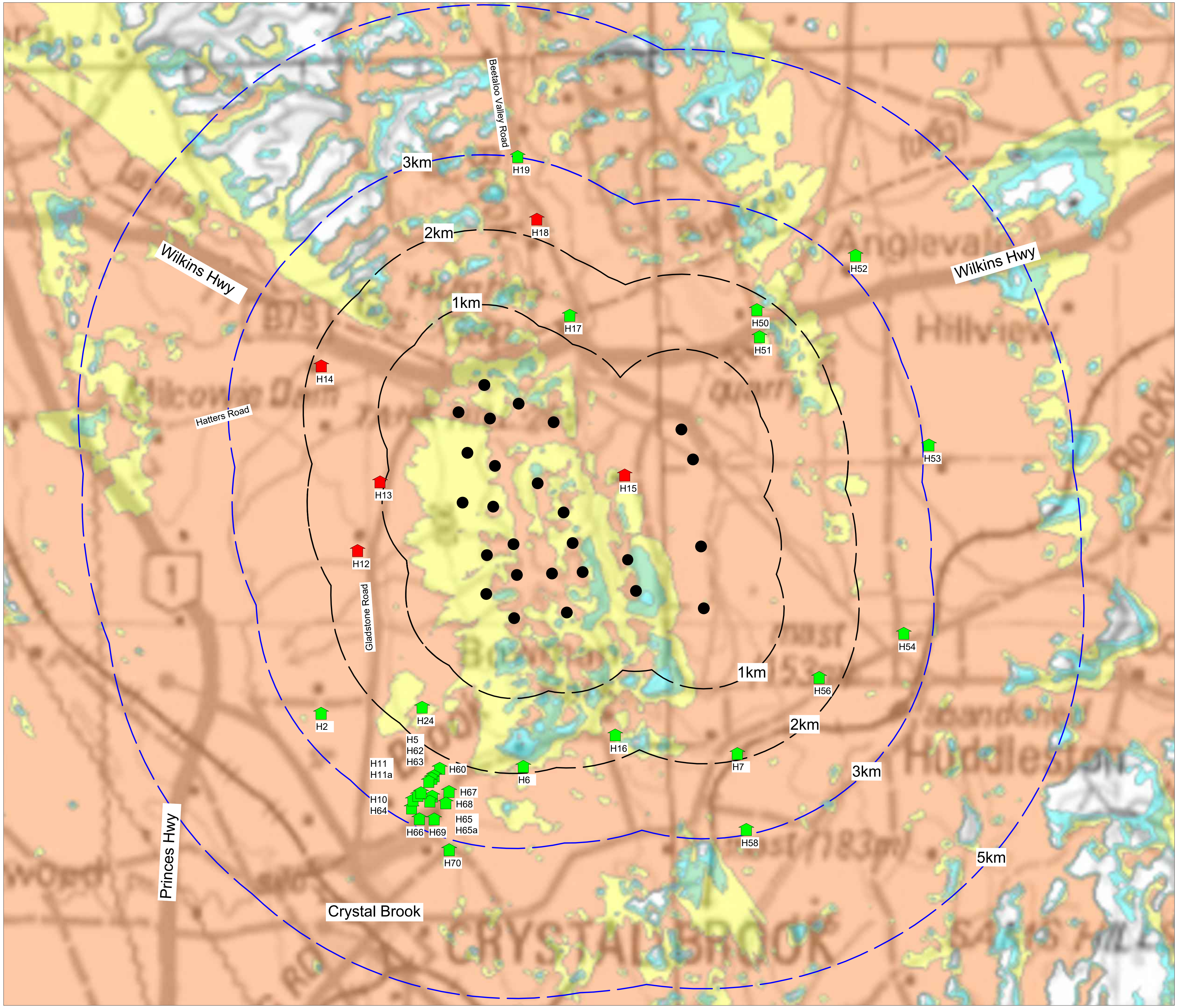

NOTES:

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

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

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

LEGEND:

Number of wind turbine tips visible

0 1 9 17 25

Non host dwelling

Host dwelling

Proposed wind turbine (indicative location)

0km 1km

Figure 21
Zone of Theoretical Visibility
Wind turbine tip height

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Maroona Wind Farm - View distance 2 km

Maroona Wind Farm - View distance 3 km

Maroona Wind Farm - View distance 4 km

Maroona Wind Farm - View distance 5 km

Maroona Wind Farm turbines: Vestas V126, 150 m tip height
Photographs: Nikon D700, 50mm prime lens

Approximate wind turbine swept area

2km 3km 4km 5km

Figure 22
Wind turbine visibility

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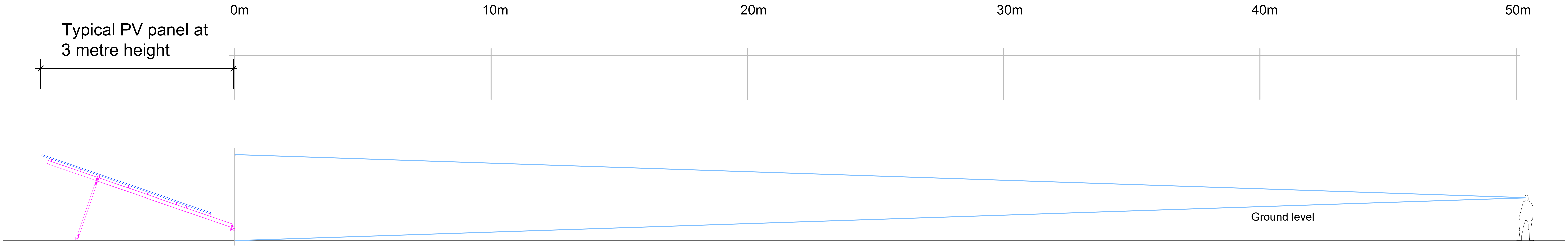
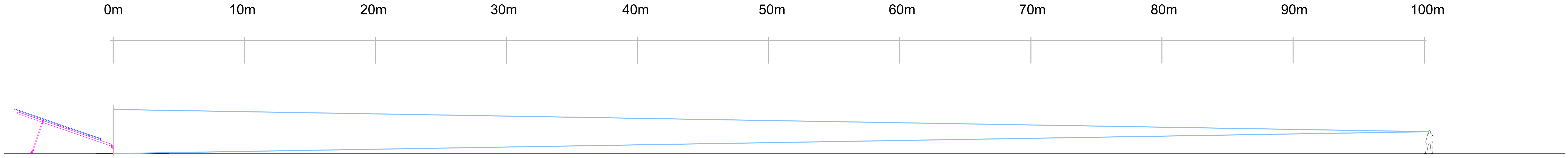
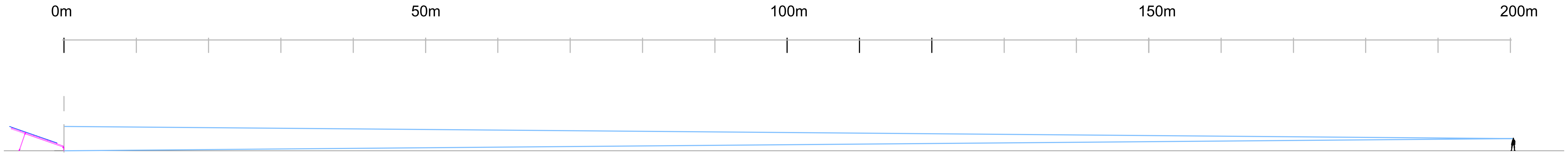


The PV panels viewed from a 50 metre distance would occupy less than 4% of the vertical human view cone



The PV panels viewed from a 100 metre distance would occupy less than 2% of the vertical human view cone



The PV panels viewed from a 200 metre distance would occupy less than 1% of the vertical human view cone

Figure 23
Photo voltaic panels - distance and visual effect

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Key views and visual effects

Section 8

8.1 Introduction

The overall determination of visual effects resulting from the construction and operation of the Project would result primarily from a combination of receiver sensitivity and the magnitude of visual effects.

A determination of visual effects from the combination of receiver sensitivity and the magnitude of visual effect is a well-established methodology and has been applied extensively on wind farm LVIA 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.

8.2 Sensitivity of visual receivers

Judging the sensitivity of visual receivers needs to take account of 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 within and surrounding the Project Site.

8.3 Magnitude of visual effects

Judging the magnitude of the visual effects needs to take account of:

- the scale of the change in the view with respect to the loss or addition of features in the view and changes in its composition, including the proportion of the view occupied by the proposed development
- the 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
- the nature of the view of the proposed development, in terms of the relative amount of time over which it will be experienced and whether views will be full, partial or glimpses.

Tables 5 and **6** set out definitions and criteria for sensitivity and magnitude.

The combination of sensitivity and magnitude will provide the rating of visual effect for viewpoints. **Table 7** sets out the relative visual impact grading values which combines issues of sensitivity and magnitude for the Project.

Table 5 – Receiver location sensitivity

View Category	Sensitivity
Residential Properties	***Highest Sensitivity***
Areas of high scenic value (National Parks or designated landscapes)	▽
Public recreational areas	▽
Rural employment/farming	▽
Motorists	▽
Business (commercial)	▽
Industrial areas	*Lower Sensitivity*

Table 6 – Magnitude assessment criteria

Criteria	Definition
Distance (wind)	
Very short	<1 km
Short	1 – 3 km
Moderate	3 km – 5 km
Long	+5 km
Distance (solar)	
Very short	> 500 metres
Short	500 metres – 1,000 metres
Medium	1,000 metres – 2,000 metres
Long	>2,000 metres
Duration of effect	
High	> 2 hours
Moderate	30 - 120 minutes
Low	10 – 30 minutes
Very low	< 10 minutes
Degree of screening	
High	Screening effectively blocks views toward Project
Moderate	Screening partially screens views toward Project

Table 6 – Magnitude assessment criteria

Criteria	Definition
Low	Screening filters some views toward Project
Very low	Limited or no screening toward Project
Wind turbine visibility	
High	20-26
Moderate	12-19
Low	6-11
Very low	1-5

An overall determination of visual effect at each receiver location has also been assessed and determined against the visual impact grading matrix in **Table 7** below. The levels of sensitivity and magnitude outlined in **Table 7** are **used as a guide** to determine levels of visual effect and are not absolute as the determination of visual effect also incorporates a degree of professional judgement.

Whist a residential dwelling location may have an overall high magnitude (resulting from high sensitivity, short view distance and high wind turbine or solar farm visibility), which results in a high visual impact; the visual impact may be offset and mitigated through tree cover or intervening landform which partially or completely screens the Project Site.

The location of the non-associated residential dwellings is illustrated in **Figure 24**. Host landowner residential dwellings and non-residential structures, such as agricultural sheds, within 3 km of the Project have not been assessed. The visibility of wind turbines is used as an effective method to determine the impact of the entire Project as they are the largest elements of the project.

Table 7 Visual impact grading matrix (**for guidance only**)

			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 will 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 medium distance views over a medium duration of time. A moderate extent of wind turbine visibility will 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.	Medium to long distance views over a low to medium duration of time. Wind turbines in views, at long distances or visible for a short duration not expected to be significantly distinct in the existing view. 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 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**

8.4 Views from townships and localities

Townships and localities within the landscape surrounding the Project include:

- Crystal Brook
- Gladstone and
- Beetaloo Valley.

Whilst wind turbines would be visible over the distances between the localities and the Project, views toward the wind turbines would be partially restricted by development and built structures within urban areas, as well as tree cover and landform within and surrounding the Beetaloo Valley. Views from locations within the majority of the Crystal Brook township would be screened by buildings and urban infrastructure; however, some residential dwellings within Crystal Brook, and those toward the fringe of the township may have greater visual exposure toward the Project Site resulting in Moderate visual effects. Similarly, residential dwellings within the northern and mid sections of the Beetaloo Valley are likely to have distant views toward the Project Site (and wind turbines) screened by both landform as well as dense areas of tree cover as illustrated in **Figures 15** and **18**. The visual effect of the Project (and wind turbines) will tend to Moderate from residential dwelling locations within the southern portion of the Beetaloo Valley where views may extend toward wind turbines within the northern portion of the Project Site as illustrated in **Figure 28**. Available views from localities within Gladstone (around 10km to the east of the Project Site) would tend to experience a low to negligible visual effect due to both distance and extensive areas of tree cover to the west of the township.

Table 8 Visual impact grading

	Wind	**Solar**
Sensitivity of visual receiver	High	High
Magnitude of visual effects	Low to Moderate	Negligible
Visual Impact	**Moderate**	**Negligible**

8.5 Views from Reserve and National Parks

There are a small number of State Reserves and a National Park generally to the north the Project Site. These include:

- Wirrabara Forest Reserve and
- Mount Remarkable National Park.

Views from within, as well as views out from Reserves and the National Park toward wind turbines within the Project Site, are likely to be partially screened or blocked by a combination of landform and tree cover. There are unlikely to be any significant views toward the wind turbines from these areas, and they would not be unduly impacted by the Project.

The solar farm would generally not be visible from view locations within or surrounding Reserves and the National Park.

Table 9 Visual impact grading

	Wind	**Solar**
Sensitivity of visual receiver	High	High
Magnitude of visual effects	Negligible to Low	Negligible
Visual Impact	**Negligible**	**Negligible**

8.6 Views from transport corridors (highways and local roads)

Wind turbines would be visible in medium to long distant and largely indirect views whilst travelling in both approximate east and west directions from some small portions of the Princes and Wilkins Highway corridors; however, existing tree planting and embankments adjacent to some sections of each highway corridor would largely screen and/or filter views toward the Project Site. The potential for direct views from the Wilkins Highway would be mitigated by the short duration and transitory nature of views.

Wind turbines would also be visible from a number of local roads, including the Gladstone Road, which extends south west to north east on the western side of the Project Site. The dynamic and constantly changing nature of views from vehicles travelling along local roads will tend to be transitory in nature and generally short term; however, views from local roads are likely to offer moderate to short distance and direct views toward the wind turbines from vehicles making regular trips to and from surrounding dwellings. As the sensitivity of receivers travelling along highways and local roads tends to be low, in combination with the generally short duration of views, the overall visual impact from roads is likely to be low.

The solar farm would be visible from short sections of the Princes and Wilkins Highway, as well as local roads including Hatters Road and Gladstone Road. The potential for direct views from these roads would be mitigated by the short duration and transitory nature of views.

Table 10 Visual impact grading (highways)

	Wind	Solar
Sensitivity of visual receiver	Low	Low
Magnitude of visual effects	Low to Moderate	Negligible to Low
Visual Impact	**Moderate**	**Low**

Table 11 Visual impact grading (local roads)

	Wind	Solar
Sensitivity of visual receiver	Low	Low
Magnitude of visual effects	Low to Moderate	Low
Visual Impact	**Moderate**	**Low**

8.7 Views from agricultural land

It is acknowledged that the Project may have the potential to impact people engaged in farming or rural based activities, where views toward wind turbines occur from surrounding and non-associated agricultural areas. Ultimately the level of impact 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 individual properties. Whilst views toward the turbines will occur from a wide area of surrounding rural agricultural land, this LVIA has determined that the sensitivity of visual impacts is less for those employed or carrying out work in rural areas compared to potential views from residential dwellings; however, the sensitivity of individual view locations will also depend on the perception of the viewer.

Table 12 Visual impact grading

	Wind	Solar
Sensitivity of visual receiver	Low	Low
Magnitude of visual effects	Moderate	Moderate
Visual Impact	**Moderate-low**	**Moderate-low**

8.8 View from publicly accessible locations

Publicly accessible locations, other than road corridors, include various public open spaces (including Bowman Park, Crystal Brook and the Heysen Trail), recreational areas, reserves or public meeting places. The majority of public open spaces and recreational areas are those associated and located within surrounding urban localities, where the influence of both distance and existing vegetative cover is likely to screen any potential views toward the Project Site.

Table 13 Visual impact grading

	Wind	Solar
Sensitivity of visual receiver	High	Moderate
Magnitude of visual effects	Low	Low
Visual Impact	**Moderate**	**Low**

8.9 Views from residential dwellings

Existing residential dwellings illustrated in **Figure 24** include dwellings on lots that are not associated with the Project as well as those that are.

The site inspection noted that some residential dwellings within the landscape surrounding the wind farm were screened by tree and/or windbreak shelter planting. It is possible that not all residential dwellings will have direct or significant views toward the wind turbines.

For the purpose of this LVIA only non-associated (non-host) dwellings have been incorporated into the Residential Visual Effect Matrix in **Table 14**.

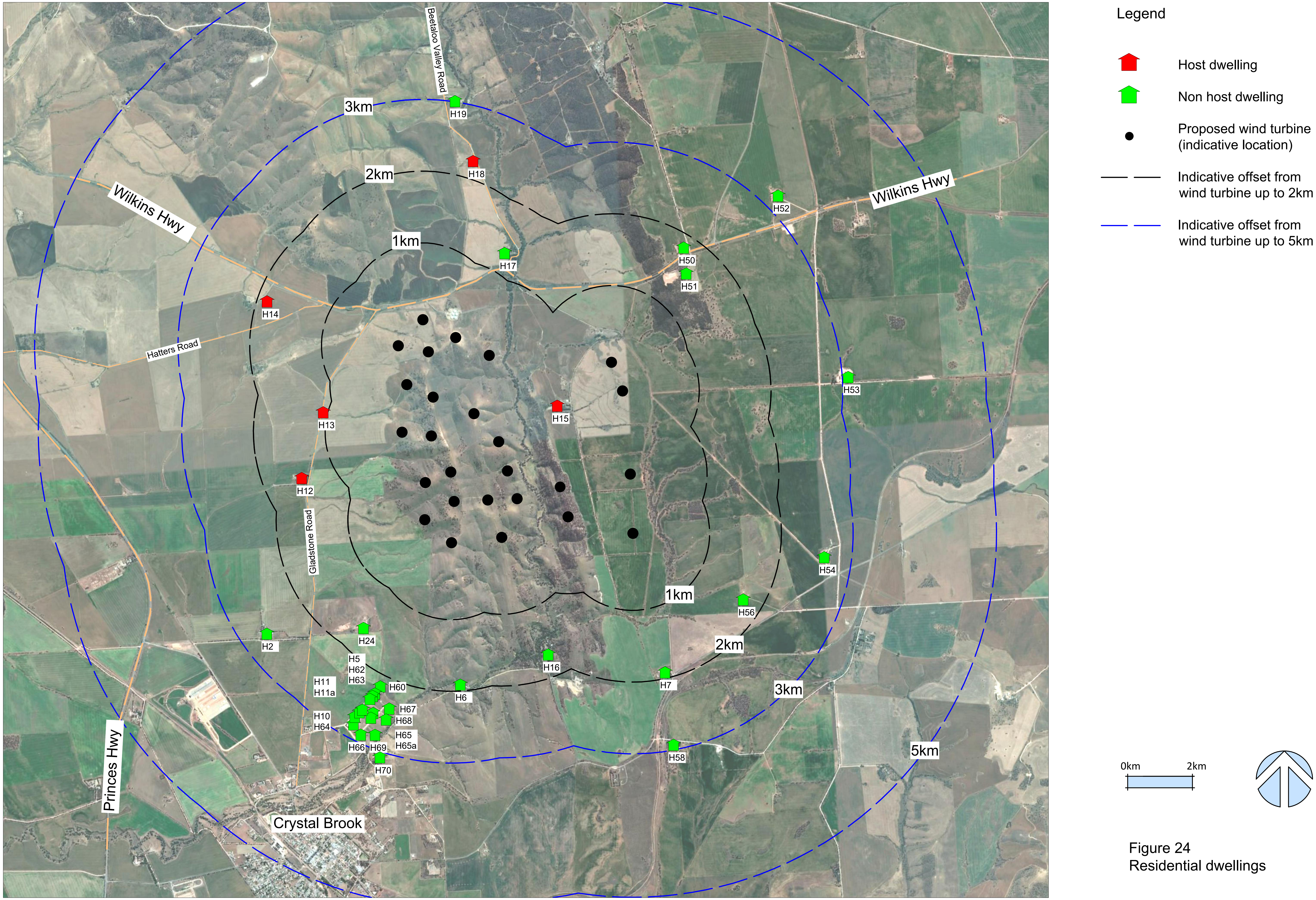

Figure 24
Residential dwellings

Crystal Brook Energy Park

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Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
Non-associated residential dwellings within 3km of a wind turbine							
H2	**Non-host landowner** Residential dwelling Sensitivity: High	Short 2.49 km	High	High	High	Short distance and direct views would potentially extend from the dwelling and curtilage in an east to north-east direction toward wind turbines within the Project Site. Views toward wind turbines within the east portion of the Project Site are likely to be partially restricted to upper portions of the turbine structures (nacelle and blades) by undulating hills beyond the dwelling. Views from the residential dwelling toward the solar facility would be partially screened by sheds and scattered tree cover beyond the dwelling and mitigated to some degree by the distance (around 1.5km) between the dwelling and solar facility. The photo voltaic panels would be orientated perpendicular to the dwelling.	Moderate to High

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
						Views generally in excess of 8km toward the substation and battery storage facility would be effectively mitigated by the view distance. Degree of existing screening at dwelling: low	
H6	**Non-host landowner** Residential dwelling Sensitivity: High	Short 1.85 km	High	Low	High	Short distance and direct views from the dwelling and curtilage toward the Project Site are likely to be partially (or completely) restricted by landform and partial tree cover beyond the dwelling. Views toward the solar facility, substation and battery storage facility would be effectively screened by landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	Negligible to Low
H7	**Non-host landowner** Residential dwelling	Short 1.87 km	High	High	High	Short distance and direct views would extend from the dwelling and curtilage in a north to north west direction toward wind turbines within the Project Site. Views toward some wind turbines are likely	Moderate

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
	Sensitivity: High					to be partially restricted by tree cover beyond the dwelling. Views toward the solar farm facility, substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Low to Moderate	
H16	**Non-host landowner** Residential dwelling Sensitivity: High	Short 1.52 km	High	Moderate	High	Short distance views would potentially extend from the dwelling and curtilage in a northerly direction toward wind turbines within the Project Site. Views toward the majority of wind turbines are likely to be partially restricted to upper portions of the turbine structures (nacelle and blades) and/or completely screened by tree cover beyond the dwelling. Views toward the solar farm facility, substation and battery storage facility would be effectively	Low

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
						screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	
H17	**Non-host landowner** Residential dwelling Sensitivity: High	Short 1.30 km	High	High	High	Short distance views would potentially extend from the dwelling and curtilage in a southerly direction toward wind turbines within the northern portion of the Project Site; however, views toward the majority of wind turbines are likely to be restricted and/or completely screened by tree cover beyond the dwelling. Views toward the solar facility, substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	Low

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
H19	**Non-host landowner** Residential dwelling Sensitivity: High	Short 2.96 km	High	High	High	Short distance views are likely to be partially restricted to upper portions of the turbine structures (nacelle and blades) by tree and shrub cover beyond the dwelling. Views toward the solar facility, substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	Low to Moderate
H24	**Non-host landowner** Residential dwelling Sensitivity: High	Short 1.56 km	High	Moderate	High	Short distance views would potentially extend from the dwelling and curtilage in an east to north east direction toward wind turbines within the western portion of the Project Site. Views toward wind turbines within the eastern portion of the Project Site are likely to be partially restricted to upper portions of the turbine structures (nacelle	Moderate to High

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
						and blades) and/or completely screened by scattered tree cover beyond the dwelling. Long distance views from the residential dwelling toward the solar facility would be partially screened by scattered tree cover beyond the dwelling and mitigated to some degree by the distance (around 2km) between the dwelling and solar facility. Views toward the terminal substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate	
H50	**Non-host landowner** Residential dwelling Sensitivity: High	Short 1.83 km	High	High	High	Short distance views would potentially extend from the dwelling and curtilage in a west to south westerly direction toward wind turbines within the Project Site; however, views toward the majority of wind turbines are likely to be restricted	Low

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
						and/or completely screened by tree cover beyond the dwelling. Views toward the solar facility, substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	
H51	**Non-host landowner** Residential dwelling Sensitivity: High	Short 1.48 km	High	Moderate	High	Short distance views would potentially extend from the dwelling and curtilage in a west to south westerly direction toward wind turbines within the Project Site; however, views toward the majority of wind turbines are likely to be partially restricted by tree cover beyond the dwelling. Views toward the solar facility, substation and battery storage facility would be effectively	Low to Moderate

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
						screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	
H52	**Non-host landowner** Residential dwelling Sensitivity: High	Moderate 3.10 km	High	Moderate	High to low	Moderate distance views would potentially extend from the dwelling and curtilage in a south westerly direction toward wind turbines within the Project Site; however, views toward the majority of wind turbines are likely to be partially restricted by tree cover beyond the dwelling. Views toward the solar facility, substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	Low

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
H53	**Non-host landowner** Residential dwelling Sensitivity: High	Short 2.87 km	High	High	High	Short distance views would potentially extend from the dwelling and curtilage in a westerly direction toward wind turbines within the Project Site; however, views toward the majority of wind turbines are likely to be partially and/or screened and restricted by tree cover beyond the dwelling. Views toward the solar facility, terminal substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	Negligible to Low
H54	**Non-host landowner** Residential dwelling (currently unoccupied)	Short 2.51 km	High	High	High	Short distance views would potentially extend from the dwelling and curtilage in a west to north west direction toward wind turbines within the Project Site; however, views toward some of the wind turbines are likely to be partially and/or	Low to Moderate

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
	Sensitivity: High					screened and restricted by scattered tree cover beyond the dwelling. Views toward the solar facility, terminal substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate	
H56	**Non-host landowner** Residential dwelling (currently unoccupied) Sensitivity: High	Short 1.67 km	High	High	High to low	Short distance views would potentially extend from the dwelling and curtilage in a north west direction toward wind turbines within the Project Site; however, views toward some of the wind turbines are likely to be partially and/or screened and restricted by scattered tree cover beyond the dwelling. Views toward the solar facility, terminal substation and battery storage facility would be effectively	Low to Moderate

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
						screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate	
H4, H5, H10, H11, H11a, H60, H62, H63, H64, H65, H65a, H66, H67, H68 and H69	**Non-host landowners** Residential dwellings located between Talbots Road and Crystal Brook Valley Road. Sensitivity: High	Short Closest dwelling (H60) at 2.08km	High	Moderate to High	High	Short distance views would potentially extend from the dwellings and curtilages in a north to north east direction toward wind turbines within the Project Site; however, views toward some of the wind turbines within the eastern portion of the Project Site are likely to be partially and/or screened and restricted by scattered tree cover beyond the dwellings. Views toward the solar facility, terminal substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling.	Moderate to High

Table 14 – Residential visual effect matrix (Refer **Figure 24** for residential receiver locations)

	SENSITIVITY	MAGNITUDE					
Receiver location	Category of receiver location and sensitivity grading	Approximate distance to closest turbine	Potential duration of effect	Extent of visibility (ZTV hub height)	Overall magnitude grading	Degree of visibility and screening	Visual effect
						Degree of existing screening at dwelling: Low to Moderate	
H70	**Non-host landowner** Residential dwelling Sensitivity: High	Short 2.95 km	High	High	High to low	Short distance views would potentially extend from the dwelling and curtilage in a north east direction toward wind turbines within the Project Site; however, views toward some of the wind turbines are likely to be partially and/or screened and restricted by scattered tree cover beyond the dwelling. Views toward the solar facility, terminal substation and battery storage facility would be effectively screened by tree cover and landform beyond the dwelling. Degree of existing screening at dwelling: Moderate to High	Low

8.10 Summary of residential visual effect (within 3km of wind turbines)

This LVIA identified a combined total of 14 non-host residential dwellings (2 of which are currently unoccupied), and a group of 15 dwellings between Talbots Road and Crystal Brook Valley Road (to the north of the Crystal Brook urban area), within the Project's 3km viewshed.

An assessment of non-host residential dwellings determined:

- 2 of the 14 residential dwelling locations would have a Moderate to High visual effect.
- 1 of the 14 residential dwelling locations would have a Moderate visual effect and
- 4 of the 14 residential dwelling locations would have a Low to Moderate visual effect
- 5 of the 14 residential dwelling locations would have a Low visual effect and
- 2 of the 14 residential dwelling locations would have a Negligible to Low visual effect.

The 15 residential dwellings located between Talbots Road and Crystal Brook Valley Road include dwellings constructed over recent years. There are also a small number of land plots that may be developed for residential dwellings in the future. Some of the more recently constructed dwellings also include landscape works (tree and shrub planting) which would be expected to provide some level of screening toward the wind turbines as the plants mature.

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

8.11 Summary of residential visual significance (beyond 3km of wind turbines)

The majority of residential dwellings located beyond 3km of the wind turbines are unlikely to be significantly impacted by the Project. The localised influence of topography, as illustrated in the ZTV diagrams, and influence of distance, has some impact on the extent and nature of views beyond 3km of the wind farm site. As noted for residential dwellings within 3km of wind turbines, a number of residential dwellings beyond 3km of the wind turbines also maintain planting for privacy or wind break purposes around their dwellings. Where present, planting around or beyond residential dwellings would tend to filter and/or screen views toward wind turbines, and the effectiveness of existing tree and shrub planting heights will increase in proportion with the distance of a dwelling from the wind turbines.

Cumulative assessment

Section 9

9.1 What is Cumulative Impact Assessment?

A cumulative landscape and visual impact 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 established viewshed of the proposed wind farm or may be located within a regional context where visibility is dependent on a journey between each site or project viewshed.

'Direct' cumulative visual impacts 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 impacts 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 has to turn their head in order to view both wind farms).

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

An assessment and determination of cumulative visual impact notes other wind farm developments within the broader viewshed, or regional locality, which may result in cumulative impacts. These include the operational Clements Gap Wind Farm around 24km south west of the Project Site, the operational Snowtown Wind Farm around 40km south west of the Project Site, as well as the Hornsdale and Hallet group of wind farms between 35km to in excess of 50km from the Project Site.

There would be no significant direct visual link between other regional wind farms and Project Site; however, very long distant views toward one or more wind farms would be visible from some elevated, but generally unpopulated areas including portions of Youngs Road to the north of the Project Site.

The potential for views toward wind turbines within the Project Site as well as other existing wind farms from residential dwellings and local roads/highways are generally restricted by tree cover and landform and the overall potential for any significant 'indirect' and 'sequential' cumulative impacts are considered to be low.

Solar panel sun glint, glare and lighting

Section 10

10.1 Introduction

This LVIA has considered a number of issues concerned with the potential for reflectivity of sunlight from the PV panels. Sunlight reflection is often perceived as a significant issue in relation to solar facilities; however, a primary function for the PV panels is to absorb sunlight energy rather than reflect it. The technical process in manufacturing PV panels includes an anti-reflection coating to the solar cell wafers within each panel that minimises potential for sunlight reflection. The proposed PV panels utilise high transmission, low iron glass, which absorbs greater amounts of light and produces less reflectance than standard glass. Primarily sunlight reflection would be visible as either 'sun glint' or 'glare'.

10.2 Sun glint

Sun 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 PV panels at the same angle that a person is viewing the PV panel surface.

10.3 Glare

Sunlight reflection from the polycrystalline structure of the individual PV panels may also result in glare (also known as diffuse reflection). Glare from a reflective surface occurs where sunlight is reflected at many angles rather than a single angle observed as sun glint.

There are a number of factors that determine both intensity and extent of sun glint and glare and include:

- the distance and orientation of the PV panels relative to surrounding view locations;
- the offset horizontal angle of the PV panels;
- time of day and seasonal variations defining position and angle of sunlight;
- the occurrence of cloud cover;
- the amount of particulate matter in the atmosphere (moisture, dust, smoke etc…) which may diffuse sunlight; and
- the presence of screening vegetation relative to view locations.

10.4 Assessment

The measure of how strongly various materials can reflect light from sources such as the sun (the 'albedo') has been measured (Power Engineers 2010 and Sunpower Corporation 200) and determined as a reflected energy percentage. These studies have shown that common materials utilised within rural/agricultural environments, including steel, standard glass and plexiglass can have higher reflected energy percentages than materials employed for PV glass panels.

Based on the results of previous assessments for PV solar power projects and studies carried out in a number of countries, the potential for sun glint and glare would not be expected to have a significant impact on residential dwellings surrounding the proposed solar facility, or upon motorists or people travelling through or over the surrounding landscape.

This LVIA has noted the relatively significant amount of vegetation in the landscape surrounding the proposed Project Site, as well as the screening influence of local topography. Given the vast majority of residential dwellings will not have a line of sight toward the proposed solar panels, the potential for sun glint to create a significant visual impact is considered to be low.

10.5 Lighting

The proposed solar farm will not incorporate permanent night time lighting into the Project Site, therefore permanent night time lighting will not give rise to potential visual impacts. However, it can be necessary to undertake maintenance on solar panels or Power Conversion Blocks at night time when the solar farm is not generating. In such cases, localised temporary lighting may be needed to ensure safe conduct of the maintenance work. Such lighting should be managed to ensure that in is focused inward to the work area and does not impact surrounding area. Given the locations of neighbouring residences there is low potential for impact on the residences.

Wind turbine shadow flicker & blade glint assessment summary Section 11

11.1 Introduction

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

A shadow flicker and blade glint assessment has been prepared by DNV-GL to determine and illustrate the potential impact of shadow flicker and blade glint on surrounding view locations. The detailed Shadow Flicker and Blade Glint assessment for the proposed project is included at LVIA **Appendix A**.

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

11.2 Residents

The results of the shadow flicker assessment for the proposed project determined that 5 residential view locations, four of which are host residential dwellings and one non-host residential dwelling, may be subject to some levels of shadow flicker. These residential view locations are:

- House ID H12 (Host Dwelling)
- House ID H13 (Host Dwelling)
- House ID H14 (Host Dwelling)
- House ID H15 (Host Dwelling) and
- House ID H24 (Non-Host Dwelling).

The non-host dwelling H24 is predicted to experience theoretical and actual shadow flicker duration that is below limits recommended by the Draft National Guidelines.

11.3 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 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.

The DNV-GL Shadow Flicker and Blade Glint assessment results are detailed in the LVIA **Appendix A**.

Photomontages

Section 12

12.1 Photomontages

Photomontages have been prepared to illustrate the general appearance of the wind turbines following construction. Four photomontages locations were selected to illustrate the Project. The photomontages have been located to illustrate views from areas close to residential dwellings or to illustrate cumulative impacts where possible.

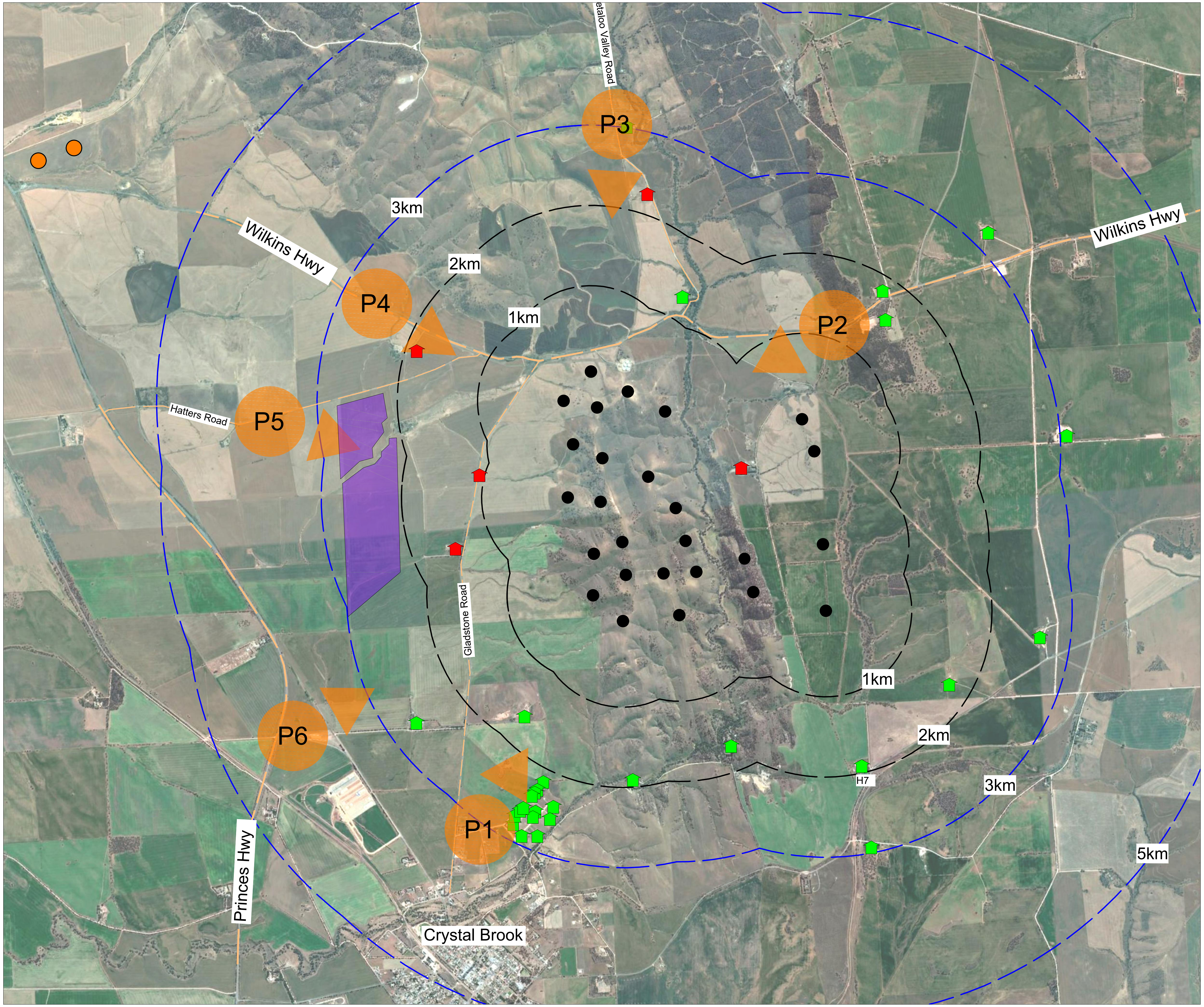
The photomontage locations were selected following a review of ZTV maps, together with a site inspection to identify potential representative viewpoints. The photomontage locations were selected from surrounding road corridors and at a range of distances between the viewpoint and wind turbine to illustrate the potential influence of distance on visibility. The photomontages locations are illustrated in **Figure 25** and photomontages presented in **Figures 26** to **31**.

Each photomontage was generated through the following steps:

- A digital terrain model (DTM) of the Project Site was created from a terrain model of the surrounding area using digital contours
- The site DTM was loaded in the 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 240m and a hub height of 161m and blade length of 79m
- 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.

The horizontal and vertical field of view within the majority of the photomontages exceeds the parameters of normal human vision. However, in reality the eyes, head and body can all move and under normal conditions a person would sample a broad area of landscape within a panorama view. Rather than restricting the extent of each photomontage to a single photographic image, a broader field of view is presented to more fully illustrate the extent of the wind turbines.

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



Legend

- ● Proposed wind turbine (indicative location)
- Proposed solar facility (indicative location)
- Battery storage and Hydrogen plant (indicative location)
- P1 Photomontage location
- Host dwelling
- Non host dwelling
- Indicative offset from wind turbine up to 2km
- Indicative offset from wind turbine up to 5km

0km 2km

Figure 25
Photomontage locations

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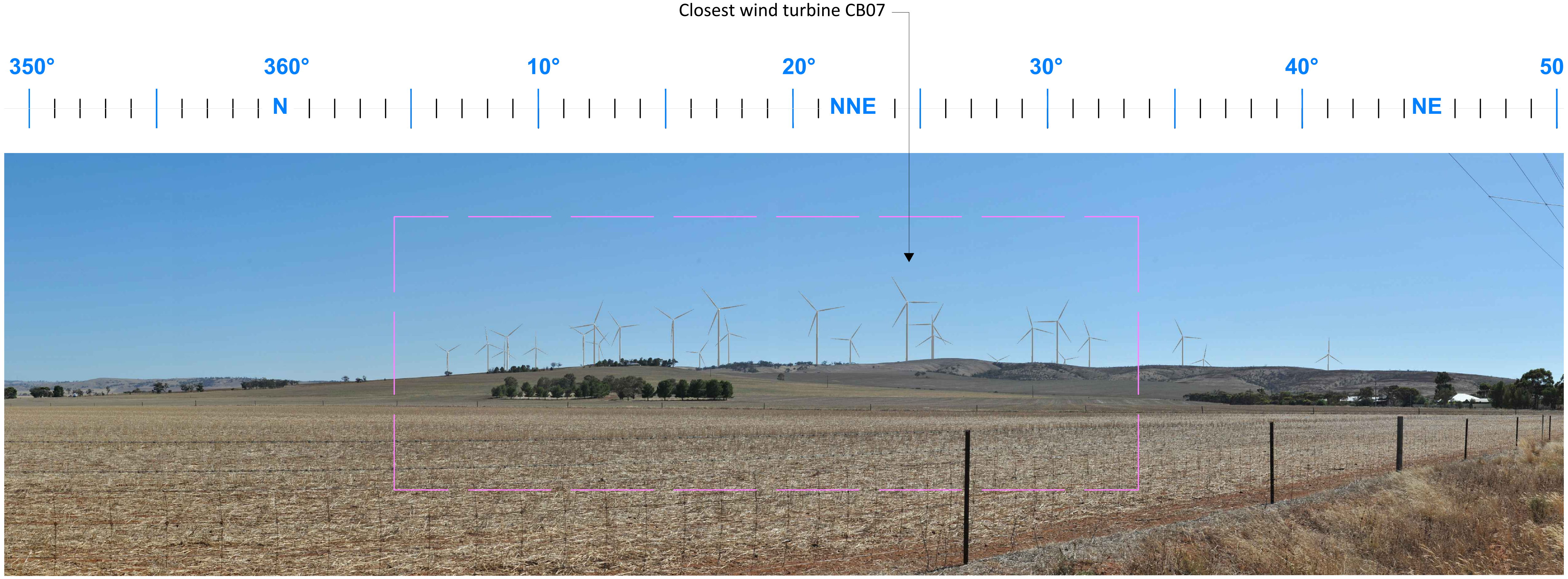
landscape architects

Crystal Brook Energy Park



Photomontage P1 - Proposed view north to north east from the Talbots Road. Approximate distance to closest visible wind turbine 3km

Photomontage P1 - Detail view through 30 degrees

Crystal Brook Energy Park

Extent of detail view

General Notes:

Coordinates:
Easting 240315, Northing 6307803

Photo date:
3rd February 2018, 11.00am

Elevation:
130m Australian Height Datum

Camera:
Nikon D700, 50mm 1:1.4D Lens

Original Page Format - A3 Landscape

Photomontage P1 is illustrated at a view angle of around 60 degrees which is within the central, binocular field, of human vision.

Photomontage limitations

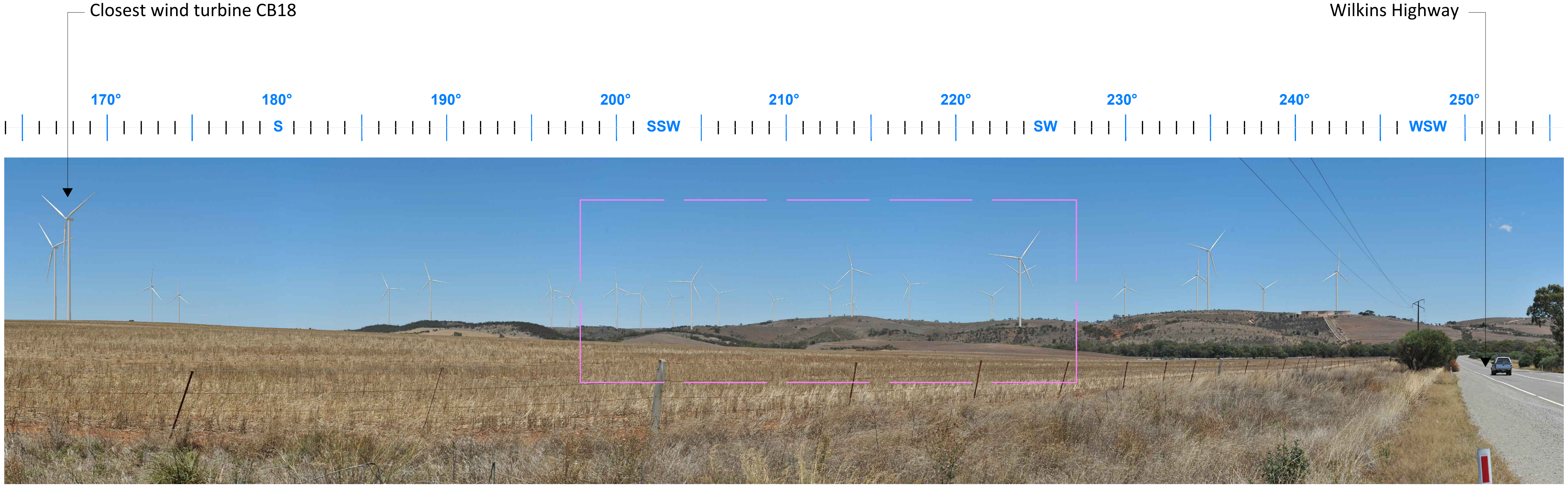
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

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.

Figure 26
Photomontage P1
Talbots Road

GREEN BEAN DESIGN
landscape architects



Photomontage P2 - Proposed view south south east to west south west from the Wilkins Highway. Approximate distance to closest visible wind turbine 1.16km

Photomontage P2 - Detail view through 30 degrees

Crystal Brook Energy Park

Extent of detail view

General Notes:

Coordinates:
Easting 243953, Northing 6313520

Photo date:
3rd February 2018, 1.41pm

Elevation:
244m Australian Height Datum

Camera:
Nikon D700, 50mm 1:1.4D Lens

Original Page Format - A3 Landscape

Photomontage P2 is illustrated at a view angle of around 90 degrees which is within the central, binocular field, of human vision.

Photomontage limitations

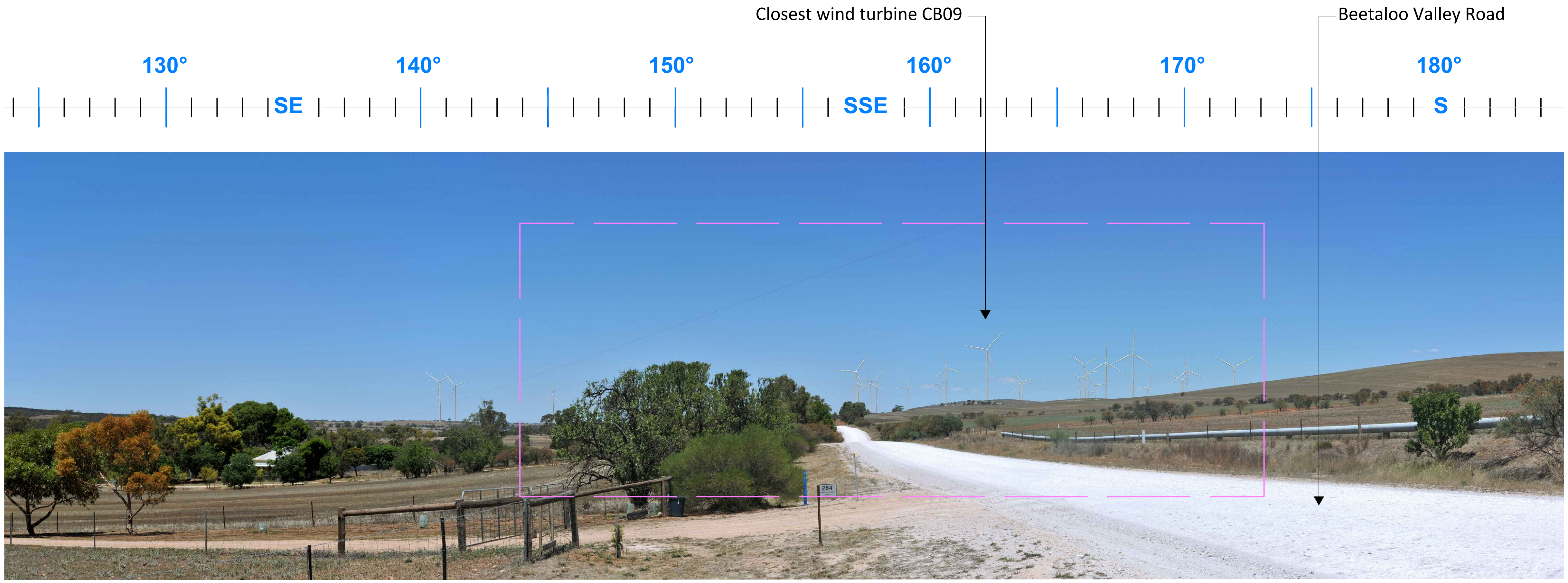
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

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.

Figure 27
Photomontage P2
Wilkins Highway

GREEN BEAN DESIGN
landscape architects



Photomontage P3 - Proposed view south east to south from Beetaloo Valley Road. Approximate distance to closest visible wind turbine 3.12km

Photomontage P3 - Detail view through 30 degrees

Crystal Brook Energy Park

Extent of detail view

General Notes:

Coordinates:
Easting 242027, Northing 6316277

Photo date:
3rd February 2018, 2.01pm

Elevation:
246m Australian Height Datum

Camera:
Nikon D700, 50mm 1:1.4D Lens

Original Page Format - A3 Landscape

Photomontage P3 is illustrated at a view angle of around 60 degrees which is within the central, binocular field, of human vision.

Photomontage limitations

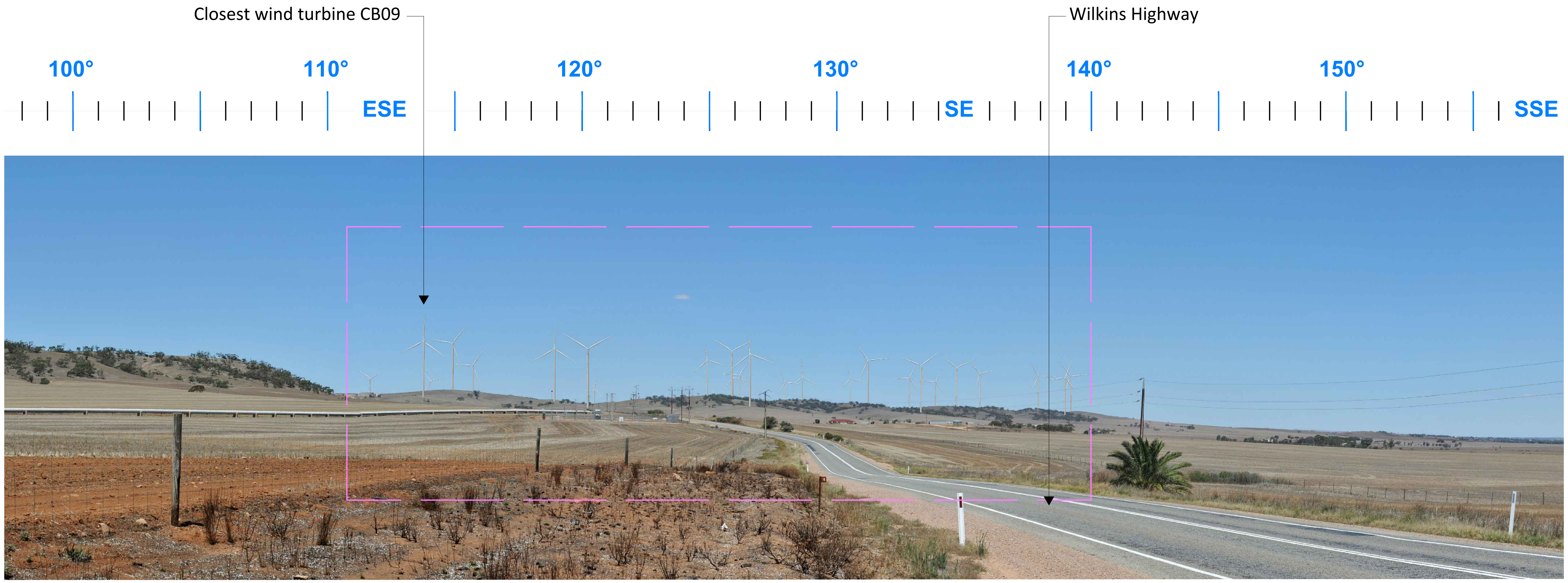
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

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.

Figure 28
Photomontage P3
Beetaloo Valley Road

GREEN BEAN DESIGN
landscape architects



Photomontage P4 - Proposed view east to south south east from Wilkins Highway. Approximate distance to closest visible wind turbine 3.5km

Photomontage P4 - Detail view through 30 degrees

General Notes:

Coordinates:
Easting 238512, Northing 6314440

Photo date:
3rd February 2018, 3.12pm

Elevation:
191m Australian Height Datum

Camera:
Nikon D700, 50mm 1:1.4D Lens

Original Page Format - A3 Landscape

Photomontage P4 is illustrated at a view angle of around 60 degrees which is within the central, binocular field, of human vision.

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.

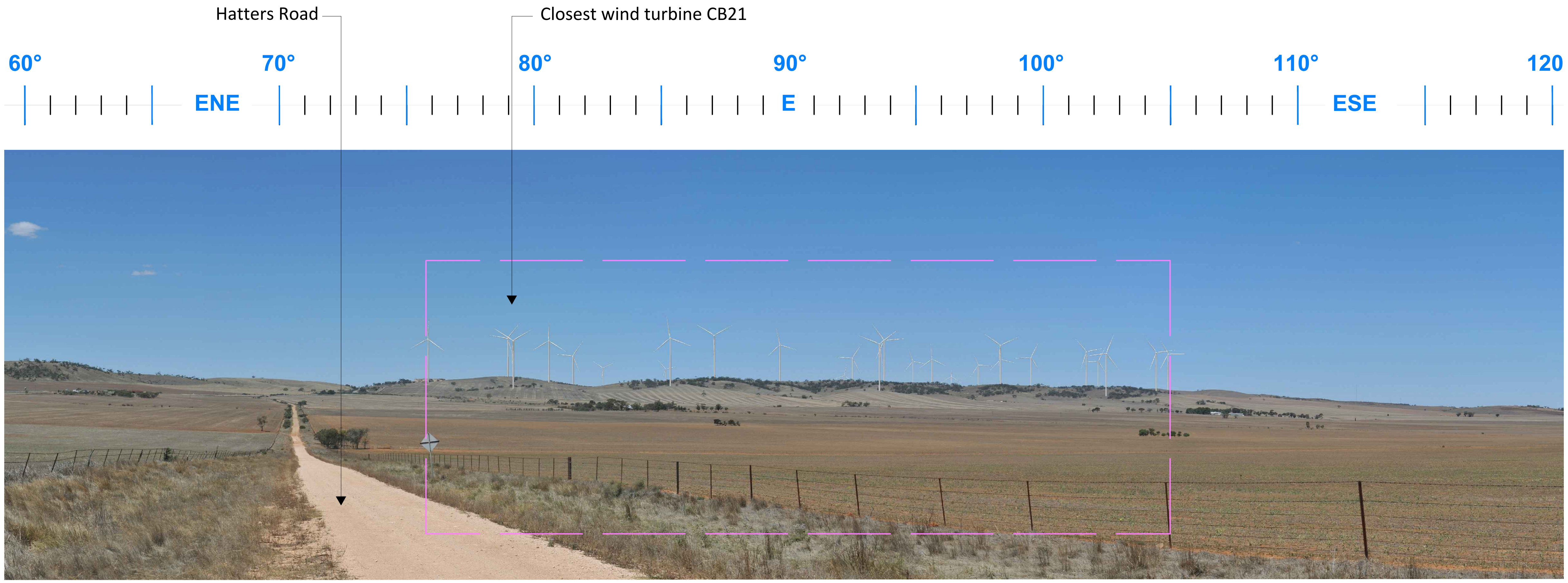
The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.

Figure 29
Photomontage P4
Wilkins Highway

Extent of detail view

Crystal Brook Energy Park

GREEN BEAN DESIGN
landscape architects



Photomontage P5 - Proposed view east north east to east south east from Hatters Road. Approximate distance to closest visible wind turbine 4km

Photomontage P5 - Detail view through 30 degrees

Crystal Brook Energy Park

Extent of detail view

General Notes:

Coordinates:
Easting 237578, Northing 6312660

Photo date:
3rd February 2018, 3.37pm

Elevation:
159m Australian Height Datum

Camera:
Nikon D700, 50mm 1:1.4D Lens

Original Page Format - A3 Landscape

Photomontage P5 is illustrated at a view angle of around 60 degrees which is within the central, binocular field, of human vision.

Photomontage limitations

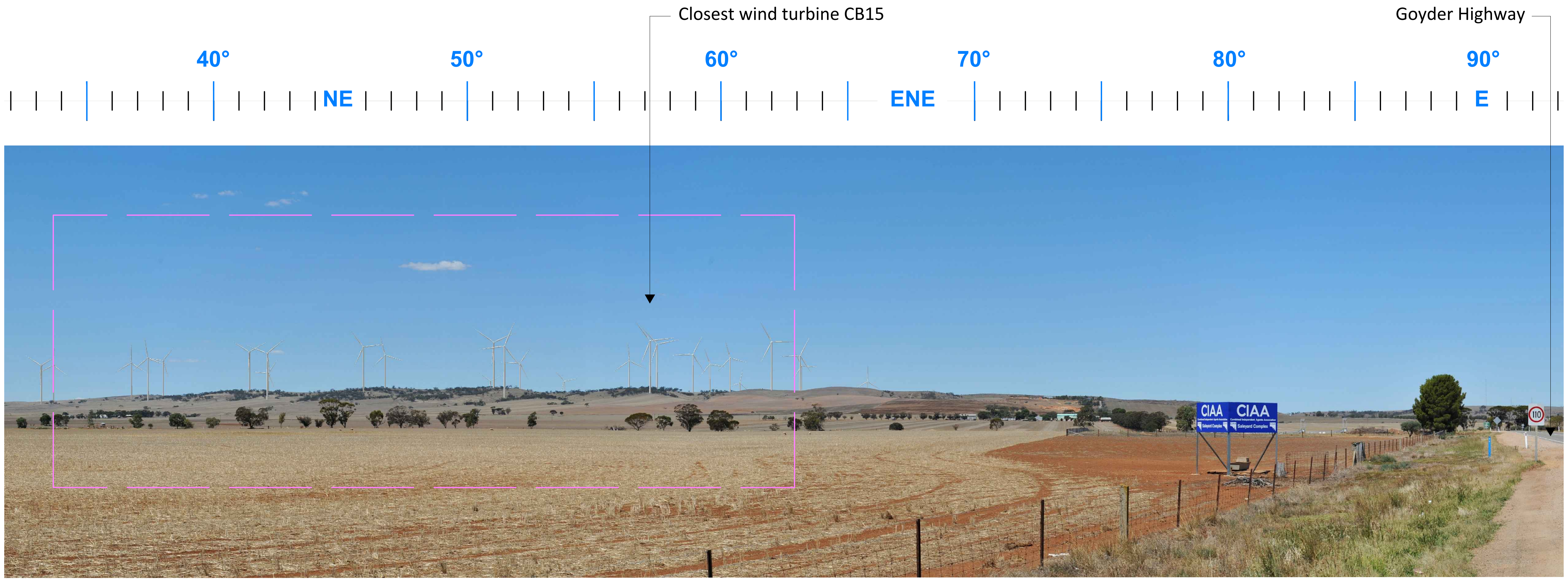
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

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.

Figure 30
Photomontage P5
Hatters Road

GREEN BEAN DESIGN
landscape architects



Photomontage P6 - Proposed view north east to east from Princes and Goyder Highway intersection. Approximate distance to closest visible wind turbine 4km

Photomontage P6 - Detail view through 30 degrees

Crystal Brook Energy Park

Extent of detail view

General Notes:

Coordinates:
Easting 237942, Northing 6308998

Photo date:
3rd February 2018, 3.57pm

Elevation:
114m Australian Height Datum

Camera:
Nikon D700, 50mm 1:1.4D Lens

Original Page Format - A3 Landscape

Photomontage P6 is illustrated at a view angle of around 90 degrees which is within the central, binocular field, of human vision.

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.

Figure 31
Photomontage P6
Goyder Highway

GREEN BEAN DESIGN
landscape architects

Pre-construction and construction

Section 13

13.1 Potential visual impacts

There are potential visual impacts that could occur during both pre-construction and construction phases of the Project. The key pre-construction and construction activities that would be visible from areas surrounding the Project include:

- ongoing detailed site assessment including wind monitoring towers and sub surface geotechnical investigations
- various civil works to upgrade local roads and access point
- 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 plant (if required)
- excavation and earthworks and
- various construction activities including erection of wind turbines, monitoring masts and terminal substation with associated electrical infrastructure works.

The majority of pre-construction and construction activities, some of which would result in physical changes to the landscape (which have been assessed in this LVIA report), are generally temporary in nature and for the most restricted to various discrete areas within or beyond the immediate Project Site. The majority of pre-construction and construction activities would be unlikely to result in an unacceptable level of visual impact for their duration and temporary nature. The following images illustrate typical construction activities during preparation and installation of wind turbines:

(Image source: CWP Pty Ltd)

Mitigation measures

14.1 Mitigation measures

The British Landscape Institute states '*the purpose of mitigation is to avoid, reduce, or where possible remedy or offset any significant negative (adverse) effects on the environment arising from the proposed development'* (2012). In general mitigation measures would reduce the potential visual impact of the Project by reducing the visual prominence of the wind turbines and associated structures by minimising the visual contrast between the wind turbines and the landscape in which they are viewed.

The following mitigation measures are also supported by the management of visual impacts through:

- the regularly spaced layout of the wind turbines which generally avoid resultant visual complexity
- the proposed application of uniform colours, size and shape across the Projects principal assets and
- the utilisation of solid tubular wind turbine towers (as opposed to lattice structures).

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.

14.2 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.

14.3 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.

14.4 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.

14.5 On-site and off-site landscape mitigation

Subject to the requirements and conditions of the Development Application, the Proponent will seek to consult and undertake reasonable and feasible landscape mitigation works at residential properties surrounding the Project Site to mitigate views toward the Projects principal assets. The Proponent will also investigate the feasibility for 'on-site' landscape works to screen smaller scale elements within the Project Site such as those associated with the solar farm, battery storage facility and terminal substation.

Conclusion

15.1 Conclusion

The key findings of this LVIA are summarised below:

- The landscape character type, identified and described in this LVIA, is generally well represented throughout the rural areas and more generally within the broader portions of the landscape area surrounding the Project Site.
- The distinguishable characteristics of the landscape character area may be altered by the Project, although the landscape character area would 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, but these may be accommodated to some degree.
- Views toward the Project from local roads will offer a range of transitory views which will be subject to direction of travel and potential screening influence of vegetation alongside road corridors. Views from highways and some local roads would be partially screened and/or filtered by local topography and roadside tree planting.
- Given separation distances, the Project is unlikely to have a significant visual effect on the character of surrounding residential localities and the Crystal Brook township, where views toward the Project from the majority of residential and/or commercial view locations would be screened by adjoining buildings or structures and/ or surrounding tree cover and landform.
- Some residential dwellings surrounding the Project Site maintain privacy and/or shelter planting around dwellings. The extent of planting reduces the potential visibility of the Project from a number of residential view locations within the surrounding viewshed.
- This LVIA identified 14 non-host residential dwellings within 3km of the wind turbines and determined that the majority of these would not experience a significant (high) visual effect as a result of the Project.
- Given separation distances between sensitive view locations and the Project Site, it is unlikely that electrical infrastructure including the solar facility, terminal substation and battery storage facility, would form prominent elements within existing views.
- Proposed mitigation works, including landscape screening, is considered likely to mitigate views toward the majority of the Projects principal assets.
- Overall this LVIA concludes that the Project would not have an unreasonable impact on the landscape character, or the visual amenity of people living, working, or travelling through the landscape surrounding the Project Site.

Limitations

GBD has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Neoen Australia Pty Ltd. 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 November 2016.

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 report was completed between December 2017 and March 2018 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.

Appendix A

DNV-GL Shadow Flicker and Blade Glint Assessment 28 March 2018

Noise Impact Assessment

Crystal Brook Energy Park

Environmental Noise Assessment

March 2018

sonus.

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Document Title Crystal Brook Energy Park – Environmental Noise Assessment

Document Number S5089C6

Date March 2018

Author Jason Turner, MAAS

Reviewer Mathew Ward

TABLE OF CONTENTS

GLOSSARY

A-weighting	Frequency adjustment applied to measured noise levels to replicate the frequency response of the human ear.
Ambient noise level	The noise level of all existing noise sources in the environment (in the absence of the wind farm).
Background noise level	The ambient noise level which excludes intermittent noise sources.
Beneficiary	Landowner with a commercial agreement with the wind farm developer
CONCAWE	The oil companies' international study group for conservation of clean air and water - Europe, *The propagation of noise from petrochemical complexes to neighbouring communities* (May 1981).
CNVMP	Construction noise and vibration management plan
Day	The period between 7am and 10pm.
dB(A)	A-weighted noise or sound power level in decibels.
EPA	Environment Protection Authority
Policy	*Environment Protection (Noise) Policy 2007*
Equivalent noise level	Energy averaged noise level.
$L_{A90,10}$	A-weighted noise level exceeded for 90% of a 10 minute time period. Represents the background noise level.
Neighbour	Landowner without a commercial agreement
Night	The period between 10pm and 7am.
2009 Guidelines	*Wind Farms Environmental Noise Guidelines 2009*
Sound power level	A measure of the sound energy emitted from a source of noise.
Weather category 6	The CONCAWE weather conditions which is most conducive for the propagation of noise, resulting in highest predicted noise levels.
WHO	World Health Organisation
WHO Guidelines	*WHO Guidelines for Community Noise*
Worst-case	Conditions resulting in the highest noise level at residences.
WTG	Wind turbine generator

1 INTRODUCTION

Sonus has conducted an environmental noise assessment of the proposed Neoen Crystal Brook Energy Park (the Project) located to the north of Crystal Brook.

The Project comprises solar photovoltaic arrays, wind turbine generators (WTGs) and battery storage.

This report assesses the environmental noise from the Project by predicting the noise levels at beneficiaries and neighbours and comparing them with criteria provided by the *Wind farms environmental noise guidelines 2009*, and the *Environment Protection (Noise) Policy 2007* as relevant.

2 PROJECT DESCRIPTION

The Project is proposed to comprise up to 150MW of solar photovoltaic arrays, up to 125MW of wind generation and up to 130MW/400MWh of battery storage, dispatched via one or more high voltage substations (pending detailed electrical design).

Sonus understands that a hydrogen production facility is also under investigation by Neoen, but that the technology has not yet been selected and the proposal is insufficiently advanced to determine noise impacts. Consequently, this component is not included within this Environmental Noise Assessment.

The noise from the Project will be associated with

- Solar inverters and transformers distributed at up to 50 locations across the solar photovoltaic site;
- Up to 26 WTGs distributed throughout the proposed wind farm;
- Battery inverters and cooling systems required for the battery storage located at the substation and battery storage site; and
- One or more transformers with a capacity of 320MVA located at the substation and battery storage site.

The general layout of the Project site and surrounding dwellings is provided as Appendix A.

3 DEVELOPMENT PLAN

The project site is proposed to be located on land which spans Primary Production and Rural Landscape Protection Zones within the Port Pirie Regional Council Development Plan.

The closest dwellings to the project are located in the above zones and in addition in the:

- Port Pirie Regional Council Development Plan: Rural Living Zone; and,
- Northern Areas Council Development Plan: Rural Landscape Protection Zone.

The Development Plan has been reviewed and particular regard has been given to the following provisions:

3.1 Port Pirie Regional Council Development Plan

General Section - Interface between Land Uses

OBJECTIVES

1. *Development located and designed to minimise adverse impact and conflict between land uses.*
2. *Protect community health and amenity from adverse impacts of development.*

PRINCIPLES OF DEVELOPMENT CONTROL

1. *Development should not detrimentally affect the amenity of the locality or cause unreasonable interference through any of the following:*

   …

   a) Noise

   …
2. *Development should be sited and designed to minimise negative impacts on existing and potential future land uses desired in the locality.*

Noise Generating Activities

7. *Development that emits noise (other than music noise) should include noise attenuation measures that achieve the relevant Environment Protection (Noise) Policy criteria when assessed at the nearest existing noise sensitive premises.*

Renewable Energy Facilities

OBJECTIVES

3. *Location, siting, design and operation of renewable energy facilities to avoid or minimise adverse impacts on the natural environment and other land uses.*

PRINCIPLES OF DEVELOPMENT CONTROL

Wind Farms and Ancillary Development

3. *Wind farms and ancillary development should avoid or minimise the following impacts on nearby property owners / occupiers, road users and wildlife:*

   …

   b) *excessive noise*

   …

4 ASSESSMENT APPROACH

The General Section Interface between Land Uses Council Wide Principle of Development Control 7 of the Port Pirie Regional Council Development Plan makes reference to the *Environment Protection (Noise) Policy 2007* (the Policy).

4.1 Solar, Battery and Substation Noise

The Policy provides appropriate objective criteria for the assessment of noise from the solar, battery and transformer components of the Project. The Policy is based on the World Health Organisation Guidelines to prevent annoyance, sleep disturbance and unreasonable interference with the amenity of a locality. Therefore, compliance with the Policy is considered to satisfy the relevant provisions of the Development Plan related to environmental noise.

4.2 Wind Farm Noise

The Policy refers to the EPA's *Wind farms environmental noise guidelines 2003* (the 2003 Guidelines) for the assessment of wind farm noise in South Australia. The *Wind farms environmental noise guidelines 2009* (the 2009 Guidelines) replaced the 2003 Guidelines.

Compliance with the contemporary 2009 Guidelines is considered to satisfy the relevant provisions of the Development Plan that relate to wind farm noise.

4.3 Construction Noise

The appropriate assessment methodology for noise from construction activities is provided by the Policy. The Policy provides an emphasis on implementing reasonable and practicable noise reduction measures during typical day time construction hours. The Policy also establishes objective requirements for night time activity.

5 ASSESSMENT METHODOLOGY

The final make and model of the equipment used for the Project will be selected through a competitive procurement process and therefore is not available at the development application stage.

The sound power levels in this assessment are provided for indicative purposes to show that suitable contemporary selections can achieve the relevant objective requirements.

A final assessment will be made following detailed design to confirm that the final solar, battery and WTG arrangement and selections will comply with the project criteria. In addition, a compliance test procedure will be developed to ensure the wind farm achieves all of the relevant noise requirements.

6 NOISE PROPAGATION MODEL

The predictions of environmental noise from the proposed Project utilise the CONCAWE[1] noise propagation model and SoundPLAN noise modelling software. The sound propagation model considers the following influences:

- sound power levels (acoustic energy) produced by each individual noise source;
- the locations of noise sources;
- separation distances between noise sources and dwellings;
- local topography;
- influence of the ground;
- air absorption; and,
- meteorological conditions.

The CONCAWE system divides meteorological conditions into six separate “weather categories”, depending on wind speed, wind direction, time of day and level of cloud cover. Weather Category 1 provides the weather conditions associated with the “lowest” propagation of noise, whilst Weather Category 6 provides “worst-case” (i.e. highest noise level) conditions. Weather Category 4 provides “neutral” weather conditions for noise propagation (that is, conditions which do not account for the effects of temperature inversion or wind on propagation).

For a conservative assessment, the noise model has considered meteorological conditions corresponding to Weather Category 6, resulting in the highest predicted noise level at the residences.

[1] CONCAWE - The oil companies’ international study group for conservation of clean air and water – Europe, ‘The propagation of noise from petrochemical complexes to neighbouring communities’, May 1981.

7 SOLAR, BATTERY AND SUBSTATION ASSESSMENT

7.1 Noise Criteria

The Policy establishes goal noise levels (L_{eq}) to be achieved at neighbouring residences based on the Development Plan zoning and the land use/s principally promoted.

Based on the above, the most onerous application of the Policy for a new development results in the following goal noise levels at the nearest neighbours:

- an average noise level ($L_{eq,15min}$) of 47 dB(A) during the day (7am until 10pm); and,
- an average noise level ($L_{eq,15min}$) of 40 dB(A) during the night (10pm until 7am).

The “night” goal noise level is the most relevant criteria for the combined noise from the operation of the solar, battery and substation components, even though the solar component might only operate for a limited duration during the night time period.

In addition to the above, when measuring or predicting noise levels for comparison with the goal noise levels of the Policy, adjustments are made for any dominant characteristic of tone, low frequency, modulation or impulsiveness. A 5 dB(A) penalty is added if one characteristic is present, 8 dB(A) is added for two characteristics and 10 dB(A) is added for three or four characteristics. In order to apply a penalty, the characteristic must be dominant when considered within the context of the existing acoustic environment at the noise receivers.

7.2 Noise Sources

The environmental noise from solar photovoltaic arrays and battery storage is associated with the ancillary inverters, transformers and cooling systems.

As with the WTGs, the final make and model of the equipment used for the Project will be selected through a competitive procurement process and therefore is not available at the development application stage. The sound power levels used in this assessment are provided for indicative purposes to show that suitable contemporary selections can achieve compliance with the Policy.

A final assessment will be made during the detailed design stage of the Project to confirm that the final equipment selections will comply with the project criteria.

The following noise sources have been included in this assessment to provide an indication of the noise from the solar photovoltaic sites (1 and 2), battery storage site (3 and 4) and the substation (5):

1. 60 x 2.5MW solar inverters distributed across the solar photovoltaic sites;
2. 60 x 3MVA[2] transformers distributed across the solar photovoltaic sites;
3. Battery inverters with a capacity of up to 130MW;
4. Air-conditioning condensing units (in the circumstance where the batteries are required to be maintained at a conditioned air temperature within a building, which will be dependent on technology selection); and
5. High-voltage transformer(s) with an overall capacity of 320MVA.

The following input data have been used:

1. Each of the solar inverters will be acoustically similar to the *SMA Sunny Central 2500-EV inverter* with the one third octave sound power level data as summarised in Table 1.

Table 1: Solar inverter sound power levels.

One Third Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 pW)
25 Hz	43
31.5 Hz	46
40 Hz	49
50 Hz	52
63 Hz	56
80 Hz	60
100 Hz	64
125 Hz	65
160 Hz	65
200 Hz	68
250 Hz	72
315 Hz	80
400 Hz	77
500 Hz	72
630 Hz	74
800 Hz	77
1,000 Hz	76
1,250 Hz	72
1,600 Hz	70
2,000 Hz	70
2,500 Hz	81
3,150 Hz	91
4,000 Hz	70
5,000 Hz	69
6,300 Hz	78
8,000 Hz	69
10,000 Hz	66
Total	**92**

[2] The inverters and transformers might be combined into a single unit depending on the technology employed.

2. Each of the 3MVA transformers at the solar site will have total sound power levels equivalent to the level derived from the Australian/New Zealand Standard AS/NZS60076.10:2009, *Power transformers - Determination of sound levels (IEC 60076-10, Ed. 1(2001) MOD)* as summarised in Table 2.

Table 2: 3MVA Transformer sound power levels.

Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 ρW)
63 Hz	52
125 Hz	60
250 Hz	67
500 Hz	70
1,000 Hz	62
2,000 Hz	59
4,000 Hz	52
Total	**73**

3. For every 2.5MW of battery inverter required for the battery storage, the one third octave sound power level data as per Table 1: Solar inverter sound power levels. It has been assumed that the batteries themselves will not increase the noise levels above that of the inverters.

4. The octave band sound power levels as summarised in Table 3 for the total of all air-conditioning condensing units.

Table 3: Total of all air-conditioning condensing units sound power levels.

Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 ρW)
63 Hz	89
125 Hz	90
250 Hz	94
500 Hz	98
1,000 Hz	99
2,000 Hz	96
4,000 Hz	92
8,000 Hz	84
Total	**104**

5. One or more transformers with an overall capacity of 320MVA at the substation with total sound power levels equivalent to the level derived from the Australian/New Zealand Standard AS/NZS60076.10:2009, *Power transformers - Determination of sound levels (IEC 60076-10, Ed. 1(2001) MOD)* as summarised in Table 4.

Table 4: 320 MVA rated transformer sound power levels.

Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 pW)
63 Hz	80
125 Hz	88
250 Hz	96
500 Hz	98
1,000 Hz	90
2,000 Hz	88
4,000 Hz	80
Total	**101**

7.3 Predicted Noise Level

The noise level at neighbouring residences has been predicted based on the inputs and noise model detailed above.

Predicted noise levels are less than 40 dB(A) at all neighbouring residences therefore satisfying the requirements of the Policy and Development Plan. A summary of the predicted noise levels at the nearest neighbours is provided in Table 5.

Table 5: Solar Battery and Substation Noise Predictions.

House ID	Criterion (dB(A))	Predicted Noise Level (dB(A))	Compliance
Residences Surrounding the Solar Arrays			
H2	40	20	Yes
H12	40	32	Yes
H13	40	29	Yes
H14	40	30	Yes
H49	40	23	Yes
H80	40	24	Yes
Residences Surrounding the Substation and Battery Storage			
H22	40	24	Yes
H23	40	27	Yes
H78	40	30	Yes
H79	40	29	Yes
H81	40	27	Yes

Some of the equipment proposed for the Project will have audible tonality in close proximity, although the potential for it to be a dominant characteristic at the residences is diminished by the masking effect of the (broadband) cooling fan systems used in the inverters and condensing units. Notwithstanding, even if a correction of 5 dB(A) is added to the predicted level for tonality, the Policy would still be achieved.

A final assessment will be made during the detailed design stage to confirm that the final equipment selections comply with the noise criteria for the project.

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8 WIND FARM ASSESSMENT

8.1 Noise Monitoring

To determine the background noise levels at various wind speeds, background noise monitoring was conducted at 5 locations in the vicinity of the proposed wind farm between 7 December 2017 and 24 January 2018. The background noise monitoring was conducted in accordance with the 2009 Guidelines.

Monitoring Location

The monitoring locations are summarised in Table 6.

Table 6: Monitoring locations and periods.

Monitoring Location ID	Co-ordinates (UTM WGS84 54H)	
	Easting	Southing
H15	243428	6311908
H16	243232	6308581
H18	242357	6315237
H53	247318	6312198
H60	240991	6308333

The noise monitoring equipment was located such that the measured background noise levels are representative of the background noise environment experienced at the dwellings.

Photographs of the monitoring equipment at each location are provided in Appendix B.

Equipment

The background noise was measured using *Rion* "NL-21" (Type 2) sound level meters, all of which have a noise floor less than 20 dB(A). The sound level meters were calibrated at the beginning and end of the measurement period with a *Rion* "NC74" Calibrator. All microphones were fitted with weather proof windshields, with the microphone positioned approximately 1.5 m above ground level.

The wind speed was also measured at a height of 1.5m at each of the noise measurement locations using *Rainwise* "WindLog" anemometers to determine periods when wind directly on the microphone may have influenced the measured background noise levels.

Collected Data

The background noise level (L_{A90}) was measured continuously, in 10 minute intervals, at each monitoring location over the monitoring periods.

During the background noise monitoring period, Neoen measured the average wind speed, in 10 minute intervals, at a range of heights between 40m and 200m above ground level using a *SODAR* Triton device to provide an indication of the hub height wind speed. The location of the *SODAR* is provided in Table 7.

Table 7: SODAR location.

Co-ordinates (UTM WGS84 Z54)	
Easting	**Southing**
241795	6311078

The 2009 Guidelines specify that the background noise should be correlated with wind speeds at the WTG hub height. The wind speeds at a hub height of 160m above ground level have been provided by Neoen based on the *SODAR* measurement data.

Data Analysis

Prior to correlation and regression analysis of the noise and wind data, the data points corresponding to any of the following periods were removed:

- periods of measured rainfall (including the 10 minute periods before and after the recorded period) based on Bureau of Meteorology rain observations;
- periods of measured wind speed exceeding 5 m/s at the microphone height for more than 90% of the measurement period based the data collected using the *Rainwise* "WindLog" anemometers;
- hub height wind speeds below the cut-in (4 m/s) and above the cut-out (15 m/s); and,
- data points clearly influenced by extraneous noise sources.

Table 8 summarises the number of data points at each monitoring location following data removal.

Table 8: Data points.

Monitoring Location ID	Number of Data Points
H15	5605
H16	5598
H18	5606
H53	5471
H60	5579

The resultant background noise data for each monitoring location were correlated with the hub height wind speed data to produce a least squares regression analysis and line of best fit in accordance with the 2009 Guidelines. The data and the regression curves[3] are shown in Appendix C.

8.2 Noise Criteria - Neighbours

To protect the neighbours to the wind farm, the 2009 Guidelines require:

The predicted equivalent noise level ($L_{Aeq,10}$), adjusted for tonality in accordance with these guidelines, should not exceed:

- *35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or*
- *40 dB(A) at relevant receivers in localities in other zones, or*
- *the background noise ($L_{A90,10}$) by more than 5 dB(A)*

whichever is greater, at all relevant receivers for wind speed[4] from cut-in to rated power of the WTG and each integer wind speed in between.

Where the wind farm exhibits a tonal characteristic, a 5 dB(A) penalty is to be applied to the criteria.

In addition, the 2009 Guidelines note that:

The criteria have been developed to minimise the impact on the amenity of premises that do not have an agreement with the wind farm developers.

[3] The correlation coefficient for each regression curve indicates the relationship between the background noise at the dwelling and the wind speed at the wind farm site. A low correlation coefficient indicates a limited relationship, as will naturally occur in many circumstances including locations that are shielded from the winds across the wind farm site, rather than indicating any deficiency in the data or its analysis.

[4] Where wind speed is referenced in this report, it is taken to be at the hub height, in accordance with the SA Guidelines, unless specifically noted otherwise.

8.3 Noise Criteria – Beneficiaries

The 2009 Guidelines note that:

> *The criteria have been developed to minimise the impact on the amenity of premises that do not have an agreement with the wind farm developers.*

Where a landowner has formed a commercial agreement with the developer, becoming a 'beneficiary' or 'involved landowner', the 2009 Guidelines enable different (less onerous) criteria for noise levels at their residences.

The criteria are based on the World Health Organisation (WHO) *Guidelines for Community Noise* (WHO Guidelines). The WHO guidelines provide recommendations with regard to protecting against:

- sleep disturbance within habitable rooms of residences, and;
- annoyance during the daytime for outdoor areas.

The recommendations of the WHO Guidelines are repeated below:

> *"For a good night's sleep, the equivalent sound level should not exceed 30 dB(A) for continuous background noise"*
>
> and
>
> *"To protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB L_{Aeq}."*

The indoor level of 30 dB(A) equates to an outdoor level of 45 dB(A) with windows open or 52 dB(A) with windows closed.

8.4 Criteria Summary

The co-ordinates of the neighbours and beneficiaries, the land use zoning and the resultant noise criteria determined from the 2009 Guidelines and WHO Guidelines are provided in Appendix D.

8.5 Noise Predictions

WTG Locations and Sound Power Levels

The proposed wind farm layout comprises up to 26 WTGs, with the co-ordinates of the WTGs provided in Appendix E. The closest WTG and direction from each dwelling is provided in Appendix F.

The preliminary assessment has been made based on a representative WTG selection with a hub height of 160m above ground level. The sound power levels used for the assessment are based on Table 9 for the *GE 4.8-158* WTG:

Table 9: Maximum WTG Sound Power Level at any Wind Speed.

Octave Band Centre Frequency (Hz)	Sound Power Level (dB(A) re 1 pW)
16 Hz	67
31.5 Hz	78
63 Hz	87
125 Hz	93
250 Hz	96
500 Hz	98
1,000 Hz	101
2,000 Hz	97
4,000 Hz	86
8,000 Hz	70
Total	**105**

The above sound power level data are provided for indicative purposes to show that a contemporary WTG selection can comply with the Project criteria. An assessment will be made during the detailed design phase to confirm that the final WTG selection will comply with the project criteria. In addition, a guarantee will also be obtained from the manufacturer to ensure that the WTG will be free of tonality at all surrounding dwellings.

Predicted Noise Levels

The noise level at dwellings has been predicted based on the above WTG sound power levels and compared with the relevant criteria. The maximum noise levels from the wind farm are compared with the corresponding noise criterion at each residence in Table 10.

Table 10: Noise Predictions.

House ID	Criterion (dB(A))	Max Predicted Noise Level (dB(A))	Compliance
H2	40	32	Yes
H3	35	27	Yes
H4	35	30	Yes
H5	35	33	Yes
H6	40	34	Yes
H7	40	33	Yes
H8	40	29	Yes
H9	35	29	Yes
H10	35	31	Yes
H11	35	32	Yes
H12	45	39	Yes
H13	45	41	Yes
H14	45	34	Yes
H15	45[5]	44	Yes
H16	40	36	Yes
H17	40	38	Yes
H18	45	32	Yes
H19	40	28	Yes
H19B	40	27	Yes
H20	40	26	Yes
H21	40	24	Yes
H22	45	<20	Yes
H23	40	<20	Yes
H24	40	37	Yes
H25	40	22	Yes
H26	40	<20	Yes
H27	40	<20	Yes
H28	40	<20	Yes
H29	40	<20	Yes
H30	40	<20	Yes
H31	40	<20	Yes
H32	40	<20	Yes
H33	45	<20	Yes
H34	40	<20	Yes
H35	40	<20	Yes
H36	40	<20	Yes
H37	40	<20	Yes
H38	40	<20	Yes
H39	40	<20	Yes
H40	40	<20	Yes
H41	40	<20	Yes
H42	40	<20	Yes
H43	40	<20	Yes
H44	40	<20	Yes
H45	40	<20	Yes
H46	40	<20	Yes
H47	40	<20	Yes
H48	40	<20	Yes
H49	40	26	Yes
H50	40	32	Yes
H51	40	34	Yes
H52	40	26	Yes
H53	40	28	Yes
H54	45	29	Yes
H55	40	25	Yes
H56	45	33	Yes
H57	40	25	Yes
H58	40	28	Yes
H59	40	28	Yes
H60	40	34	Yes
H61	40	33	Yes
H62	35	32	Yes
H63	35	32	Yes
H64	35	31	Yes
H65	35	32	Yes
H66	40	30	Yes
H67	40	32	Yes
H68	40	32	Yes
H69	40	30	Yes
H70	40	29	Yes
H71	35	28	Yes
H72	35	27	Yes
H73	35	27	Yes
H74	35	27	Yes
H75	45	25	Yes
H76	40	25	Yes
H77	40	<20	Yes
H78	40	<20	Yes
H79	40	<20	Yes
H80	40	25	Yes
H81	40	<20	Yes
H82	40	<20	Yes

[5] Higher external noise levels at H15, the residence of an involved landholder with numerous turbines on his land, are being sought and is the subject of separate correspondence and testing at this beneficiary.

The predicted noise level contours for the WTG maximum sound power levels are provided in Appendix G.

Appendix G also shows:

- the locations of neighbours;
- the locations of beneficiaries;
- the land use zoning;
- the noise monitoring locations; and,
- the WTG locations.

Table 10 and Appendix G indicate that the wind farm complies with the 2009 Guidelines and therefore satisfies the Development Plan at all dwellings.

9 CONSTRUCTION NOISE

9.1 Noise Criteria

The Policy provides an emphasis on implementing reasonable and practicable noise reduction measures and does not set mandatory standards or objective criteria for activity which is conducted during typical day time construction hours.

The Policy establishes a more stringent objective approach for night-time activity, requiring an average goal noise level of 45 dB(A) and a maximum goal noise level of 60 dB(A) to be met for night time construction works. The objective approach does not apply “if other grounds exist that the Authority…….determines to be sufficient”.

9.2 Construction Noise and Vibration Management Plan

A Construction Noise and Vibration Management Plan (CNVMP) will be prepared once construction activity is finalised to ensure compliance with the Policy. The CNVMP will also provide the community consultation and complaint assessment processes for the construction phase of the project.

As construction traffic and activity will typically be limited to the hours between 7am and 7pm on any day other than a Sunday or public holidays, the CNVMP will predominantly address the adoption of “all reasonable and practicable” noise mitigation measures.

These measures will include the following subject to detailed information on the actual construction processes used:

- construction of temporary acoustic barriers where required;
- proprietary enclosures around machines if necessary;
- exhaust silencers on equipment;
- substituting construction methods with alternative processes that produce less noise where cost effective to do so;
- the fitting of broadband reversing signals to vehicles which remain on the site; and,
- administrative measures such as inspections, scheduling and providing training to establish a noise minimisation culture for the works.

The CNVMP will also address specific activities (such as blasting, concrete batching, percussion drilling rigs, etc.) when the construction processes are refined and finalised. The CNVMP will address any activity that is required to occur outside of the typical construction hours (such as concrete pouring before 7am on days of extreme heat) and construction vibration impacts.

10 CONCLUSION

An environmental noise assessment has been made of the proposed Crystal Brook Energy Park Project.

The assessment considers noise at the closest residences from up to 150MW of solar photovoltaic arrays, up to 130MW/400MWh of battery storage, one or more high-voltage substations and up to 26 wind turbine generators with a total capacity of up to 125MW.

Noise predictions from the solar, battery and substation have been made and assessed against criteria developed in accordance with the *Environment Protection (Noise) Policy 2007*.

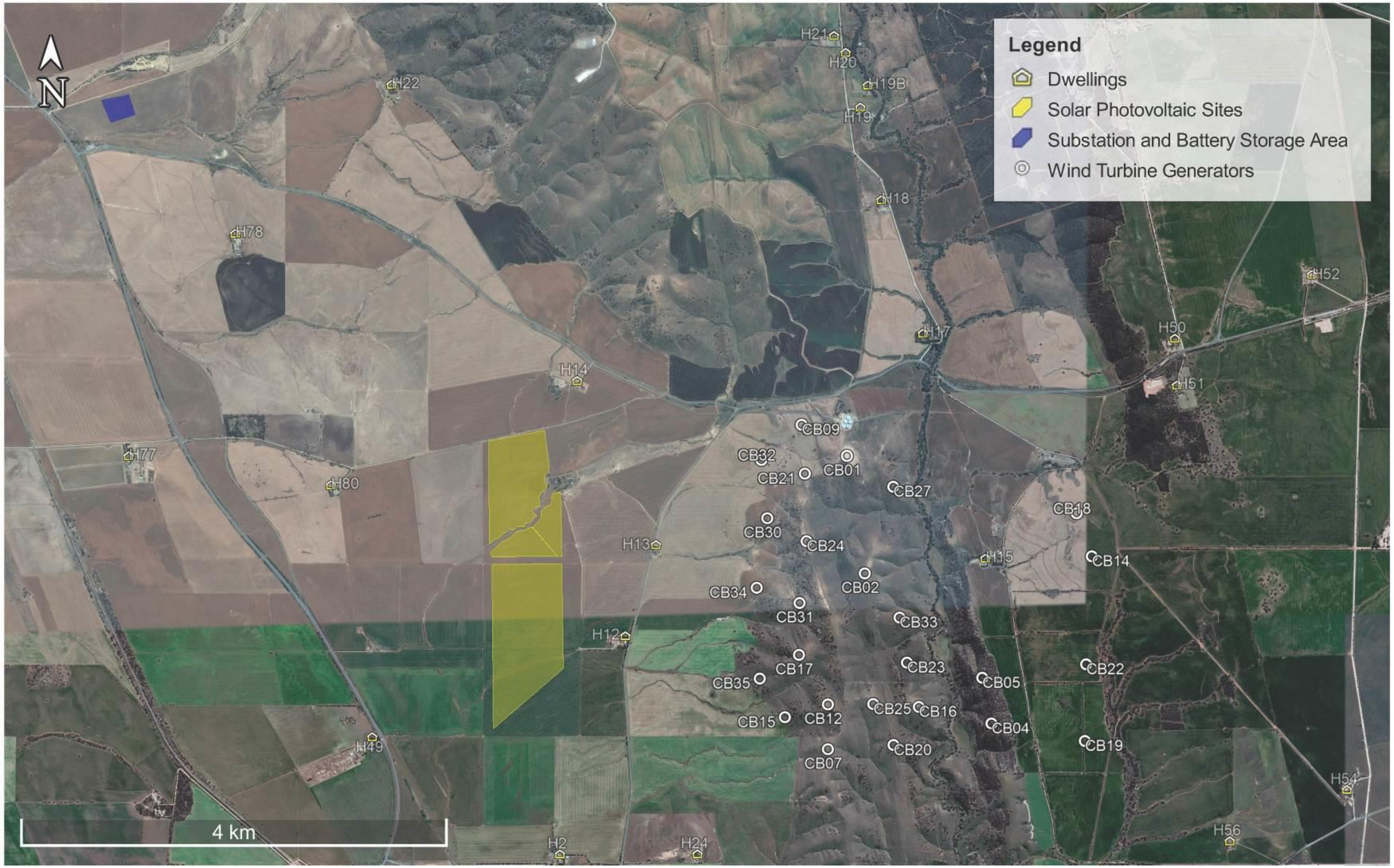
Noise predictions from the wind farm have been made and assessed against criteria developed in accordance with the *Wind Farms Environmental Noise Guidelines 2009.*

Based on the predictions, the requirements of the *Environment Protection (Noise) Policy 2007* and *Wind Farms Environmental Noise Guidelines 2009* can be achieved at all surrounding dwellings

A final assessment will be made during the detailed design stage of the project to confirm that the final equipment selections will comply with the project criteria.

Based on the above it is considered that the proposal is *located and designed to minimise adverse impact* and *does not detrimentally affect the amenity of the locality*, satisfying the relevant provisions of the Port Pirie Regional Council Development Plan.

Appendix A: General Site Layout



Appendix B: Photographs of Monitoring Equipment

H15

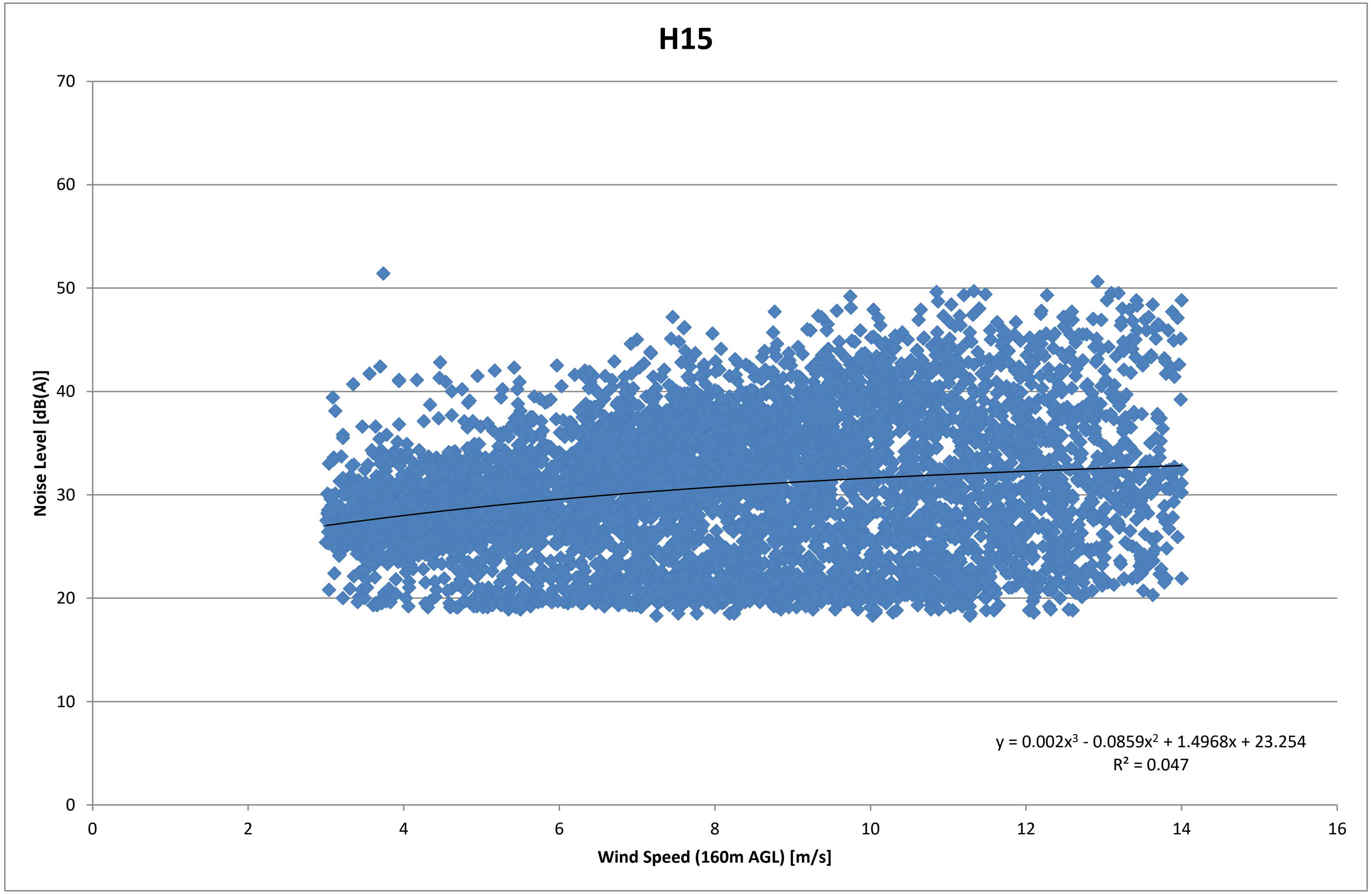
H16

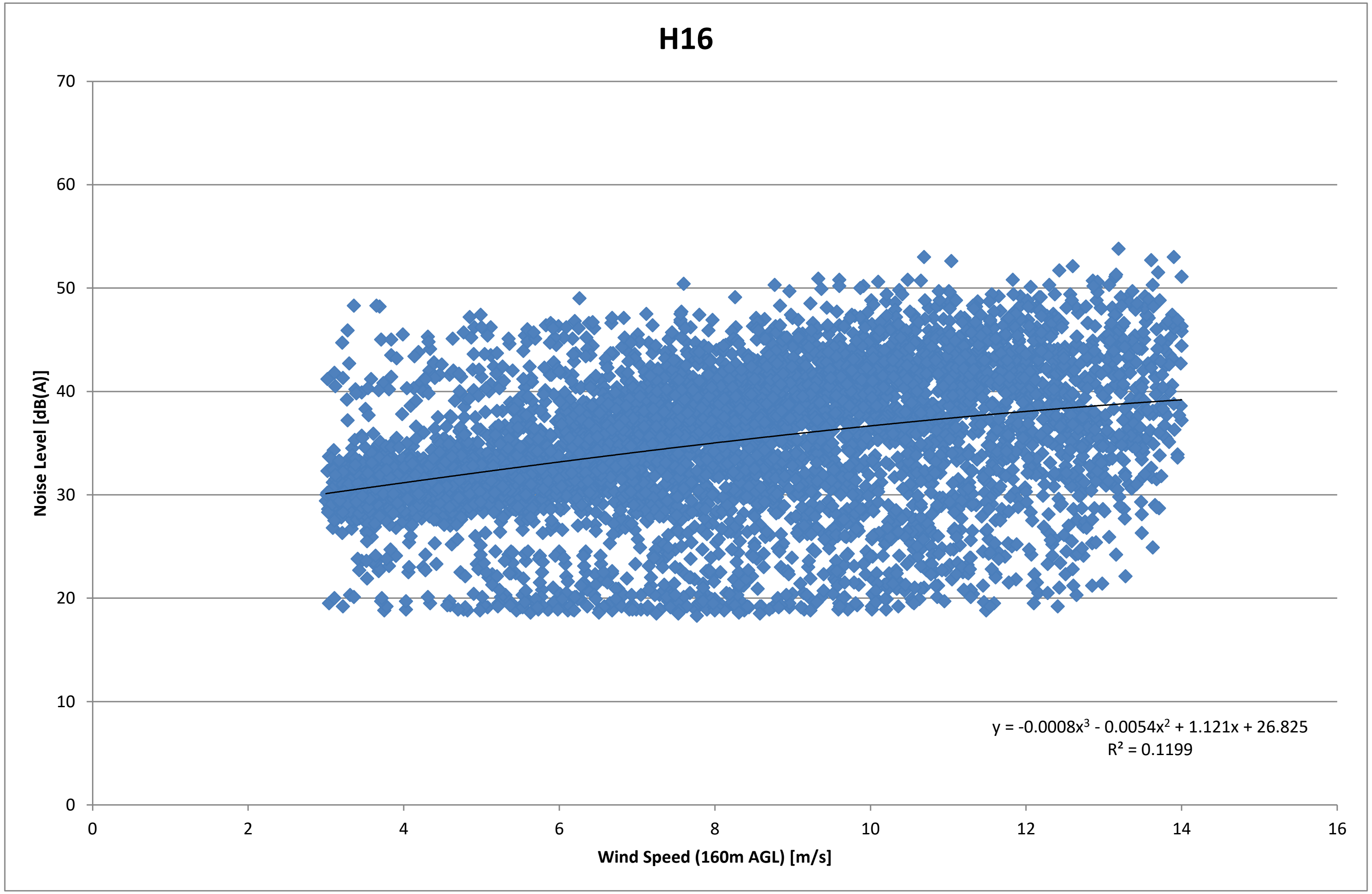
H18

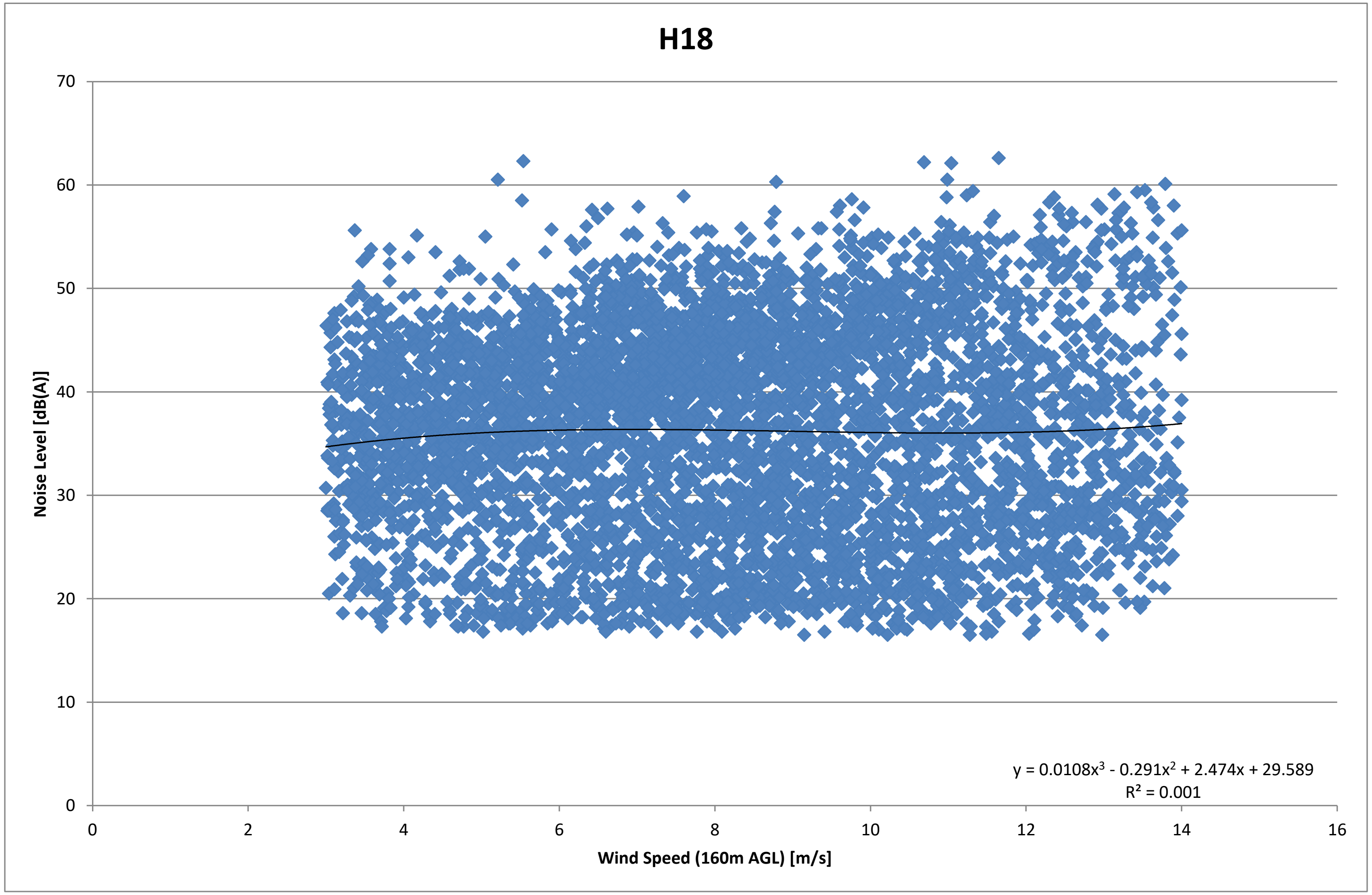
H53

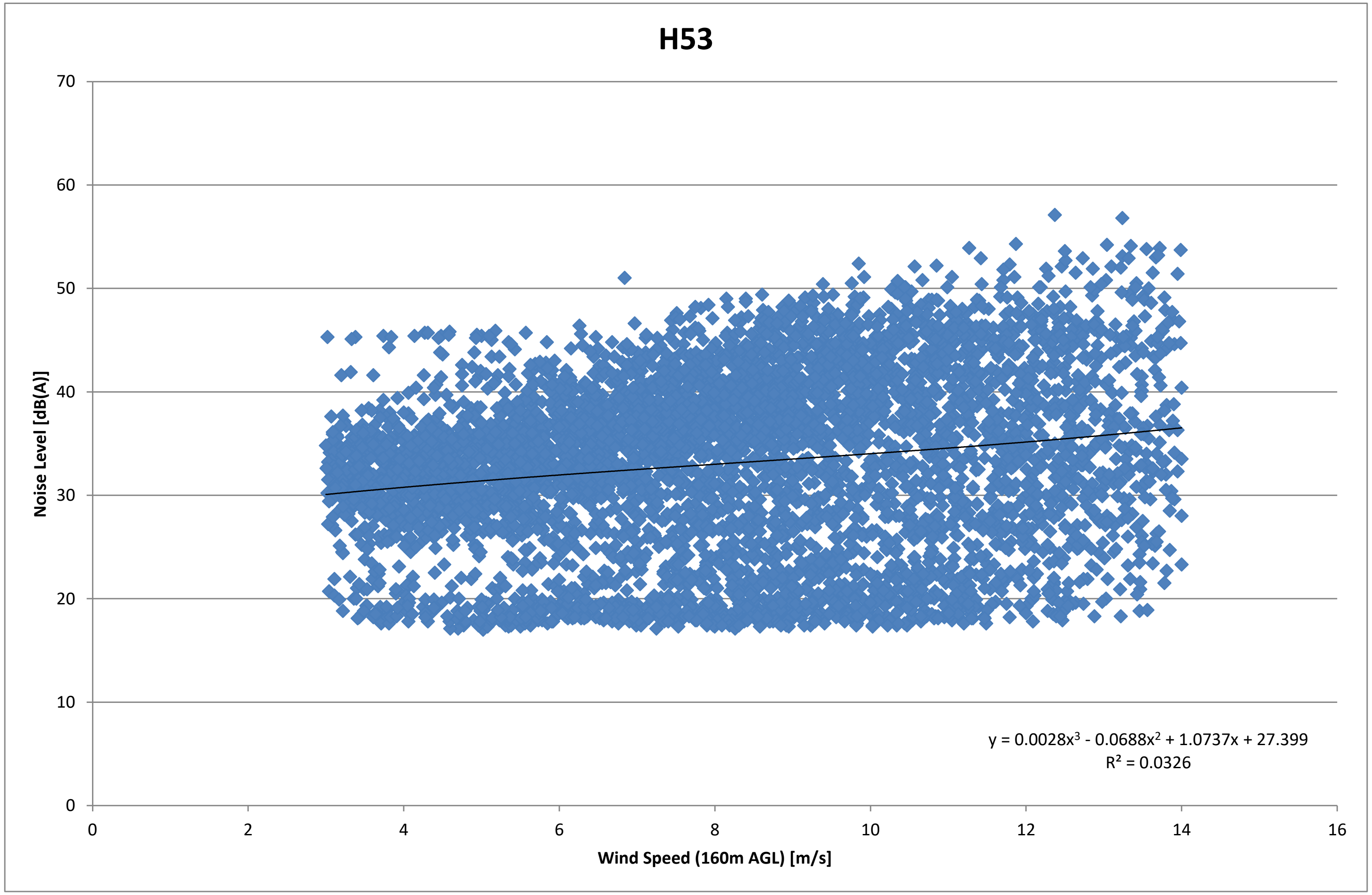
H60

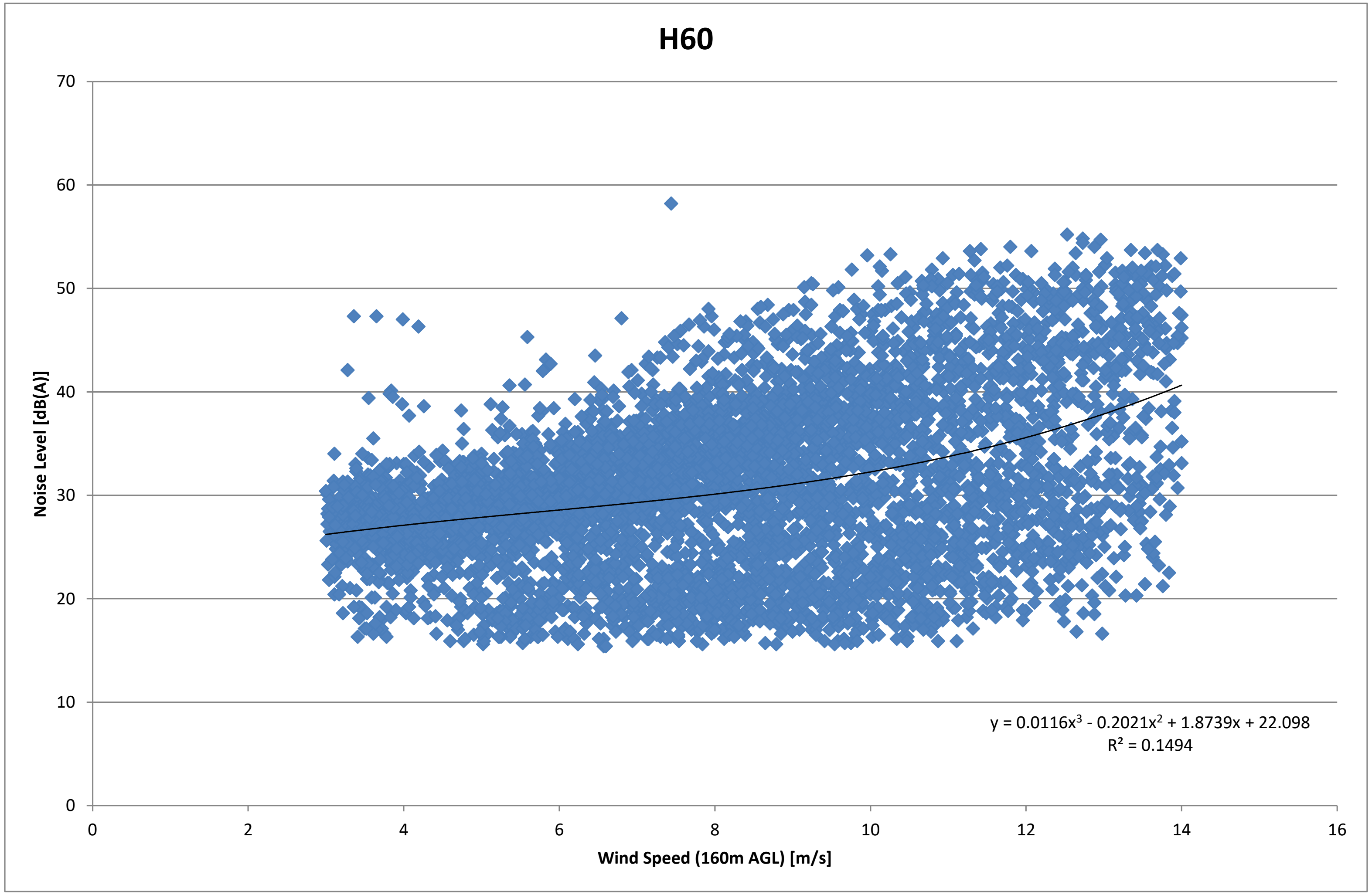
Appendix C: Background Noise Regression Curves




H16
Noise Level [dB(A)]
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
Wind Speed (160m AGL) [m/s]
y = -0.0008x³ - 0.0054x² + 1.121x + 26.825
R² = 0.1199


H18
70
60
50
40
30
20
10
0
Noise Level [dB(A)]
0
2
4
6
8
10
12
14
16
Wind Speed (160m AGL) [m/s]
y = 0.0108x³ - 0.291x² + 2.474x + 29.589
R² = 0.001


H53
70
60
50
40
30
20
10
0
Noise Level [dB(A)]
0
2
4
6
8
10
12
14
16
Wind Speed (160m AGL) [m/s]
y = 0.0028x³ - 0.0688x² + 1.0737x + 27.399
R² = 0.0326


H60
70
60
50
40
30
20
10
0
Noise Level [dB(A)]
0
2
4
6
8
10
12
14
16
Wind Speed (160m AGL) [m/s]
y = 0.0116x³ - 0.2021x² + 1.8739x + 22.098
R² = 0.1494

Appendix D: House Location, Status and Noise Criteria

House ID	Co-ordinates (UTM WGS84 54H		Beneficiary	Rural Living	Base Limit Criterion (dB(A))
	Easting	Southing			
H2	239529	6309044			40
H3	239969	6307334		Yes	35
H4	240449	6307780		Yes	35
H5	240889	6308157		Yes	35
H6	242167	6308295			40
H7	244759	6308437			40
H8	240021	6307806			40
H9	240303	6307652		Yes	35
H10	240651	6307913		Yes	35
H11	240769	6308018		Yes	35
H12	240088	6311098	Yes		45
H13	240352	6311957	Yes		45
H14	239573	6313468	Yes		45
H15	243449	6311913	Yes		45[5]
H16	243225	6308568			40
H17	242807	6313995			40
H18	242384	6315232	Yes		45
H19	242163	6316091			40
H19B	242228	6316298			40
H20	242009	6316598			40
H21	241897	6316753			40
H22	237757	6316186	Yes		45
H23	236769	6317380			40
H24	240819	6309079			40
H25	241753	6317644			40
H26	241314	6318064			40
H27	241791	6318208			40

House ID	Co-ordinates (UTM WGS84 54H		Beneficiary	Rural Living	Base Limit Criterion (dB(A))
	Easting	Southing			
H28	241708	6318437			40
H29	241926	6318501			40
H30	241877	6318997			40
H31	241757	6319472			40
H32	241619	6319468			40
H33	240720	6319723	Yes		45
H34	242399	6319734			40
H35	241789	6320255			40
H36	241349	6320030			40
H37	239941	6321732			40
H38	239321	6321661			40
H39	238437	6323654			40
H40	238954	6322047			40
H41	238193	6321698			40
H42	240925	6323068			40
H43	240915	6323282			40
H44	240756	6323502			40
H45	238805	6320972			40
H46	238697	6317688			40
H47	237905	6317234			40
H48	245745	6318009			40
H49	237737	6310091			40
H50	245172	6314012			40
H51	245204	6313575			40
H52	246443	6314645			40
H53	247316	6312213			40
H54	246901	6309843			45

House ID	Co-ordinates (UTM WGS84 54H		Beneficiary	Rural Living	Base Limit Criterion (dB(A))
	Easting	Southing			
H55	247432	6308811			40
H56	245814	6309334			45
H57	246914	6308148			40
H58	244844	6307430			40
H59	244075	6307035			40
H60	241011	6308319			40
H61	241010	6308257			40
H62	240853	6308122		Yes	35
H63	240824	6308097		Yes	35
H64	240600	6307877		Yes	35
H65	240897	6307967		Yes	35
H66	240748	6307704			40
H67	241107	6308030			40
H68	241077	6307896			40
H69	240907	6307687			40
H70	240970	6307379			40
H71	241578	6306992		Yes	35
H72	241503	6306846		Yes	35
H73	241533	6306807		Yes	35
H74	241600	6306717		Yes	35
H75	241667	6306352	Yes	Yes	45
H76	242341	6306161			40
H77	235379	6312652			40
H78	236325	6314757			40
H79	233760	6314867			40
H80	237286	6312432			40
H81	234268	6317867			40
H82	234511	6318636			40

Appendix E: WTG Locations

WTG ID	Co-ordinates (UTM WGS84 54H	
	Easting	Southing
CB01	242122	6312882
CB02	242321	6311791
CB04	243547	6310423
CB05	243449	6310846
CB07	242017	6310140
CB09	241690	6313160
CB12	242005	6310560
CB14	244447	6312007
CB15	241605	6310430
CB16	242861	6310559
CB17	241722	6311013
CB18	244294	6312405
CB19	244428	6310281
CB20	242633	6310196
CB21	241732	6312707
CB22	244421	6310997
CB23	242739	6310968
CB24	241765	6312077
CB25	242433	6310575
CB27	242567	6312607
CB30	241390	6312282
CB31	241714	6311498
CB32	241321	6312824
CB33	242658	6311387
CB34	241308	6311629
CB35	241360	6310783

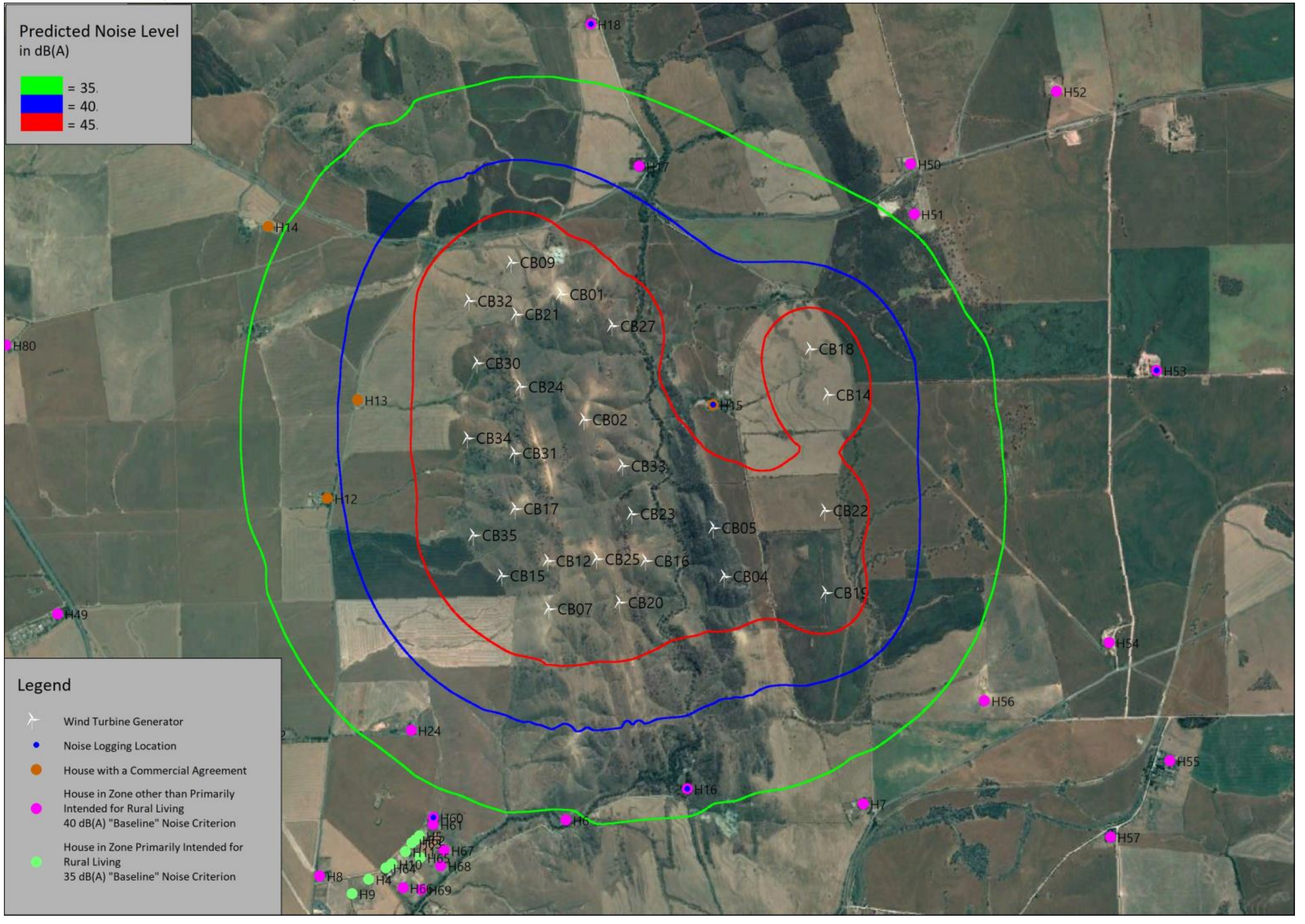
Appendix F: Closest WTG to each dwelling with distance and angle in relation to the dwellings (beneficiaries highlighted)

House ID	Closest WTG to Dwelling	Distance to closest WTG (m)	Angle (degrees)
H2	CB15	2496	56
H3	CB07	3473	36
H4	CB07	2833	34
H5	CB07	2281	30
H6	CB07	1851	355
H7	CB19	1873	350
H8	CB15	3065	31
H9	CB07	3021	35
H10	CB07	2612	32
H11	CB07	2461	30
H12	CB35	1310	104
H13	CB34	1011	109
H14	CB32	1862	110
H15	CB33	950	236
H16	CB20	1732	340
H17	CB01	1307	212
H18	CB09	2185	199
H19	CB09	2969	189
H19B	CB09	3184	190
H20	CB09	3453	185
H21	CB09	3599	183
H22	CB32	4899	133
H23	CB32	6440	135
H24	CB15	1563	30
H25	CB09	4484	181
H26	CB09	4918	176
H27	CB09	5049	181
H28	CB09	5277	180

House ID	Closest WTG to Dwelling	Distance to closest WTG (m)	Angle (degrees)
H29	CB09	5346	183
H30	CB09	5840	182
H31	CB09	6312	181
H32	CB09	6308	179
H33	CB09	6634	172
H34	CB09	6612	186
H35	CB09	7096	181
H36	CB09	6878	177
H37	CB09	8748	168
H38	CB09	8825	164
H39	CB09	10986	163
H40	CB09	9298	163
H41	CB09	9226	158
H42	CB09	9937	176
H43	CB09	10151	176
H44	CB09	10384	175
H45	CB09	8327	160
H46	CB09	5427	147
H47	CB09	5560	137
H48	CB18	5789	195
H49	CB35	3688	79
H50	CB18	1831	209
H51	CB18	1482	218
H52	CB18	3104	224
H53	CB14	2876	266
H54	CB19	2511	280
H55	CB19	3344	296
H56	CB19	1679	304

House ID	Closest WTG to Dwelling	Distance to closest WTG (m)	Angle (degrees)
H57	CB19	3276	311
H58	CB19	2881	352
H59	CB19	3265	6
H60	CB07	2080	29
H61	CB07	2135	28
H62	CB07	2329	30
H63	CB07	2365	30
H64	CB07	2670	32
H65	CB07	2444	27
H66	CB07	2746	28
H67	CB07	2297	23
H68	CB07	2433	23
H69	CB07	2692	24
H70	CB07	2952	21
H71	CB07	3178	8
H72	CB07	3334	9
H73	CB07	3368	8
H74	CB07	3448	7
H75	CB07	3804	5
H76	CB07	3992	355
H77	CB32	5944	88
H78	CB32	5357	111
H79	CB32	7832	105
H80	CB32	4054	84
H81	CB32	8670	126
H82	CB32	8953	130

Appendix G: Predicted WTG Noise (maximum sound power level)



22 March, 2018

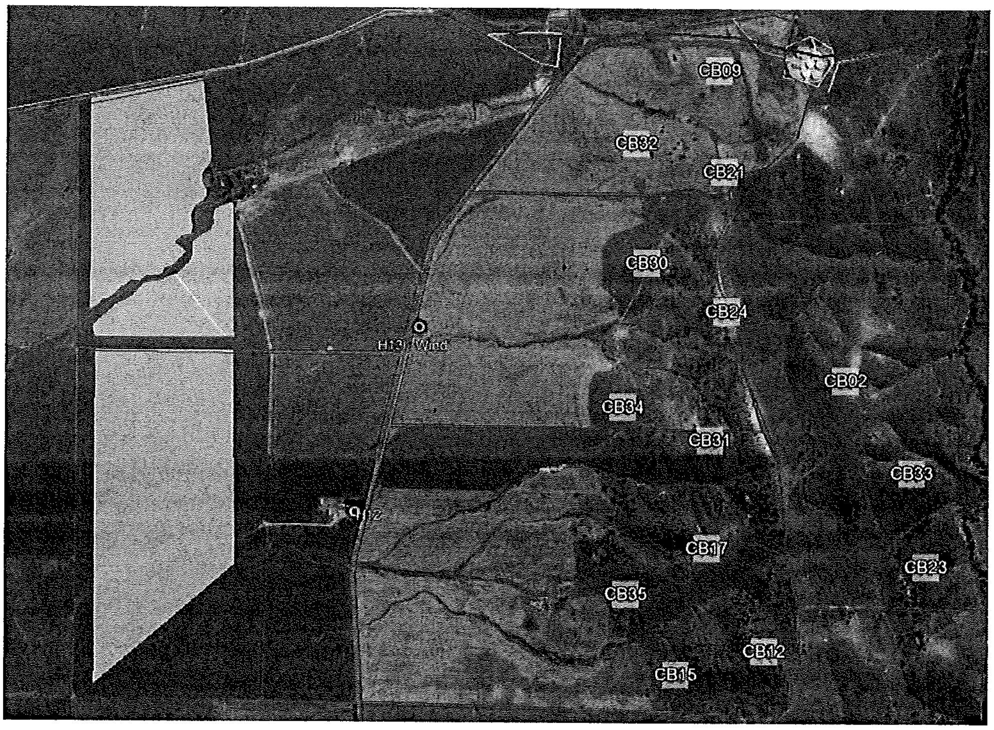
To Whom it May Concern;

Noise levels and turbine setback at residence located on Hughes Gap Road, Crystal Brook, Section 9 Hundred of Napperby

1 I, Charles Richards, along with my sons Benjamin and Luke Richards have for several years been part of a group of local landholders in the Crystal Brook area, South Australia. This group of landholders were originally approached by Origin Energy in 2009 to host turbines on our land. After Origin abandoned the project in 2012, I led the group in seeking expressions of interest from renewable developers. We selected Neoen Australia (**Neoen**) to take over the project based on the company's excellent record in South Australia.

2 In December 2016, I signed an Option to Lease with Neoen, the effect of which was to give Neoen the right to place wind turbines and solar panels, plus associated infrastructure on my land, and to execute a lease in their favour once the Option is called upon. Under the lease, Neoen will pay me an annual fee of $5500 per MW of wind generation and $2,250 per hectare of solar generation installed on the land (CPI-adjusted), plus a Construction Disruption Payment at the commencement of construction, comprising $5500 per MW of wind generation and $2,250 per hectare of solar generation to be installed.

3 Neoen, in consultation with myself, has subsequently developed a turbine layout (**Proposed Layout**) as per the map below, according to which (subject to Development Approval) up to 14 turbines of between 4-5 MW in capacity and up to 240m in height are proposed to be located on my land, along with approximately 150MW of solar generation.



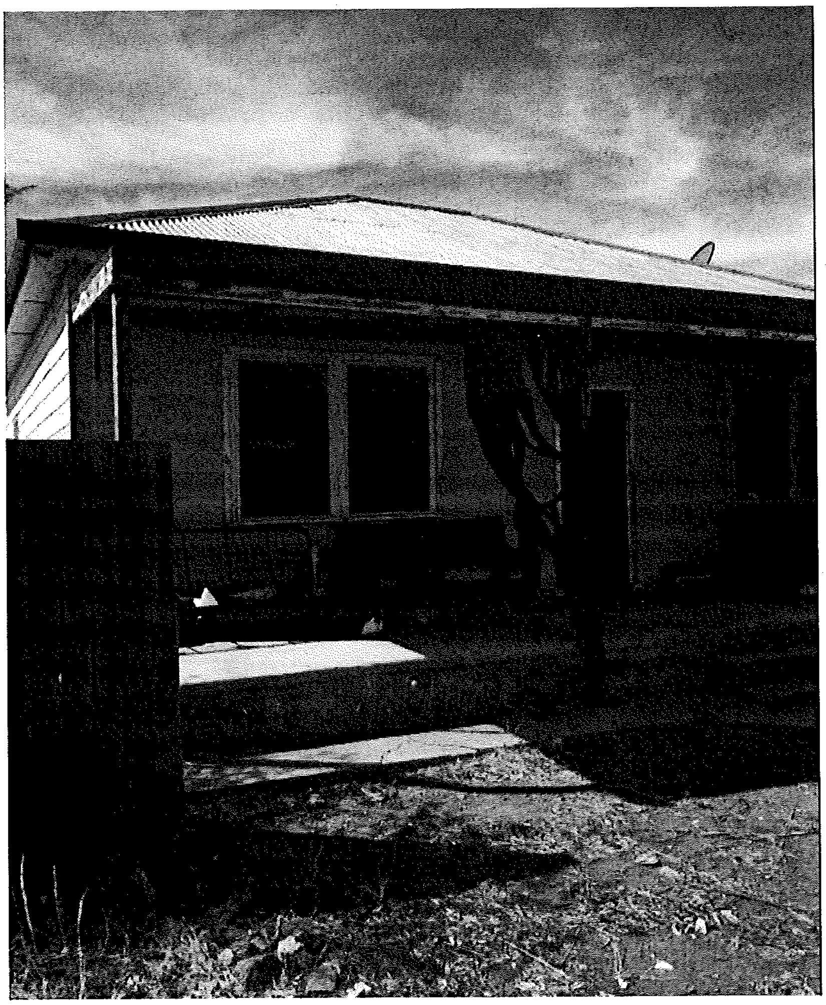
4 The closest of these proposed turbines is around 1300m from my residence (H12). The predicted noise impact at this residence as explained to me by Neoen is well within EPA guidelines for involved landholders. However, there is also another dwelling to the north, located on another land parcel owned by myself (H13), and the closest proposed turbines to this dwelling are approximately 1km away.

5 Previously, Neoen had retained a 1300m buffer between the nearest turbines and H13. However, with the removal of the northern half of the project to take into account community and Council preferences, it became necessary for Neoen to explore additional turbine locations in the southern part of the project, so I approached Neoen regarding the possibility of placing turbines closer to H13. Neoen informed me that this would not be possible as H13 was a 'dwelling' for the purposes of the *Development Act 1993* (SA), and thus subject to a 1km setback rule under state wind farm planning policy. Neoen also informed me that although owned by myself, H13 was still a 'residence' for the purposes of the EPA's *South Australia Wind Farm Noise Guidelines*, and that as the occupiers will not be 'beneficiaries' of the project it will be subject to section 2.2 of the Guidelines:

> *The predicted equivalent noise level (LAeq,10), adjusted for tonality in accordance with these guidelines, should not exceed:*
>
> ...
>
> • *40dB(A) at relevant receivers in localities1 in other zones, or*
> • *the background noise (LA90,10) by more than 5dB(A)*

6 Neoen informed me that advice from its acoustic consultants, Sonus, was that these limits would likely be exceeded if turbines were located closer.

7 Currently, I rent this dwelling to a tenant on a month-by-month basis. However, the house has fallen into significant disrepair and has been severely damaged by white ants. Furthermore, its construction is not of a sufficiently high quality to justify the substantial structural renovations which would be needed – nor is the rental return ($60/week) liable to be sufficiently increased by these renovations to recoup their cost. Please see the photo below:



For these reasons, my intention has been to cease to rent the dwelling and to instead demolish it. Based on the availability of housing in the Crystal Brook area, I do not believe the current tenants will have any difficulty securing equivalent or better accommodation for a similar cost. Thus, I have suggested to Neoen that at financial close, the house be demolished and the 1300m buffer removed from the layout. The additional turbines which are enabled by this will far outweigh the loss of the rental return.

8 I understand that Neoen has accordingly removed the 1300m buffer on the condition that the house be demolished. This letter is intended to certify that at or immediately after financial close of the Crystal Brook Energy Park:

- I will give notice in full accordance with law to the tenants to terminate the lease;
- The house will be demolished; and
- It will not be rebuilt during the life of the project;

thus ceasing to be a 'dwelling' for the purposes of the *Development Act 1993* (SA) or a residence for the purposes of the *Guidelines*, and negating any issue associated with noise or proximity of turbines.

9 If any person from the relevant authority would like to discuss the above, please contact me on 0412 743 481.

Kind regards,

....

Charles Richards

18 March, 2018

To Whom it May Concern;

NOISE LEVELS AT 296 HEAD ROAD, CRYSTAL BROOK

1 I, Phillip Head, am one of two directors of Rochleigh Partners Pty Ltd **(Rochleigh)** (ABN 35008161466), the other director being my brother, Lawrence Head. Rochleigh owns the property on which I live **(the Land)**, the address of which is 296 Head Road, Crystal Brook. The exact location of my residence is:

UTM WGS84 54H
Easting: 243428
Southing: 6311908

My brother Laurence resides elsewhere. No other persons currently reside at my address.

2 In my capacity as director of Rochleigh, I have for several years been part of a group of local landholders in the Crystal Brook area, South Australia. This group of landholders were originally approached by Origin Energy around 2009 to host turbines on our land. After Origin abandoned the project in 2012, the group (led by involved landholder Charles Richards) sought expressions of interest from renewable developers, and ultimately selected Neoen Australia (**Neoen**) to take over the project.

3 In late 2017, Rochleigh signed an Option to Lease with Neoen, the effect of which was to give Neoen the right to place wind turbines and associated infrastructure on the Land, and ultimately to execute a lease with Rochleigh. Under the lease, Neoen will pay Rochleigh an annual fee of $3300 per MW of wind generation installed on the Land (scaling with CPI), plus a Construction Disruption Payment of $3300 per MW at the commencement of construction.

4 Neoen, in consultation with myself, has subsequently developed a turbine layout (**Proposed Layout**) as per Attachment A, according to which (subject to Development Approval) up to 8 turbines of between 4.2MW and 4.8MW

in capacity and up to 240m in height are proposed to be located on the Land. The proposed locations of these turbines range from around 950m to 1800m distance from my residence at the following locations, and as per the map below:

Turbine ID	Latitude	Longitude
CB01	-33.292329	138.230722
CB04	-33.314825	138.245314
CB05	-33.310991	138.244382
CB14	-33.300768	138.255419
CB18	-33.297146	138.25389
CB19	-33.316314	138.254728
CB22	-33.309862	138.254855
CB27	-33.294918	138.235414

5 This letter is intended to certify to the South Australian Environmental Protection Authority (**EPA**) the following:

a. Neoen has provided me with a copy of the EPA's *Wind Farms Environmental Noise Guidelines*, and explained the relevant recommended limit of 45dB(A) outside noise and 30dB(A) inside noise at the residences of involved landholders;

b. Neoen has engaged acoustic consulting firm Sonus to conduct six weeks of noise monitoring at my residence to establish background noise, and also to conduct full testing of the noise attenuation qualities of my residence, at Neoen's cost.

6 In the context of the above, I am fully aware that the construction and operation of the Crystal Brook project according to the Proposed Layout is likely to result in the following:

a. **Outside** noise levels at my residence up to 48 dB(A), comparable to an air-conditioning unit at a neighbouring property in a suburban environment in terms of perceived noise, being "just noticeably" louder than the recommended level of 45 dB(A);

b. **Inside** noise levels of no greater than 30 dB(A) (based on results from Sonus' on-site testing of the house), being consistent with the World Health Organisation *"Guidelines for Community Noise"*, 1999, that provide recommendations to protect against sleep disturbance; and

c. **A change in the acoustic amenity at** my residence.

7 If the EPA would prefer to discuss the above further, I (and Neoen) am at the EPA's disposal.

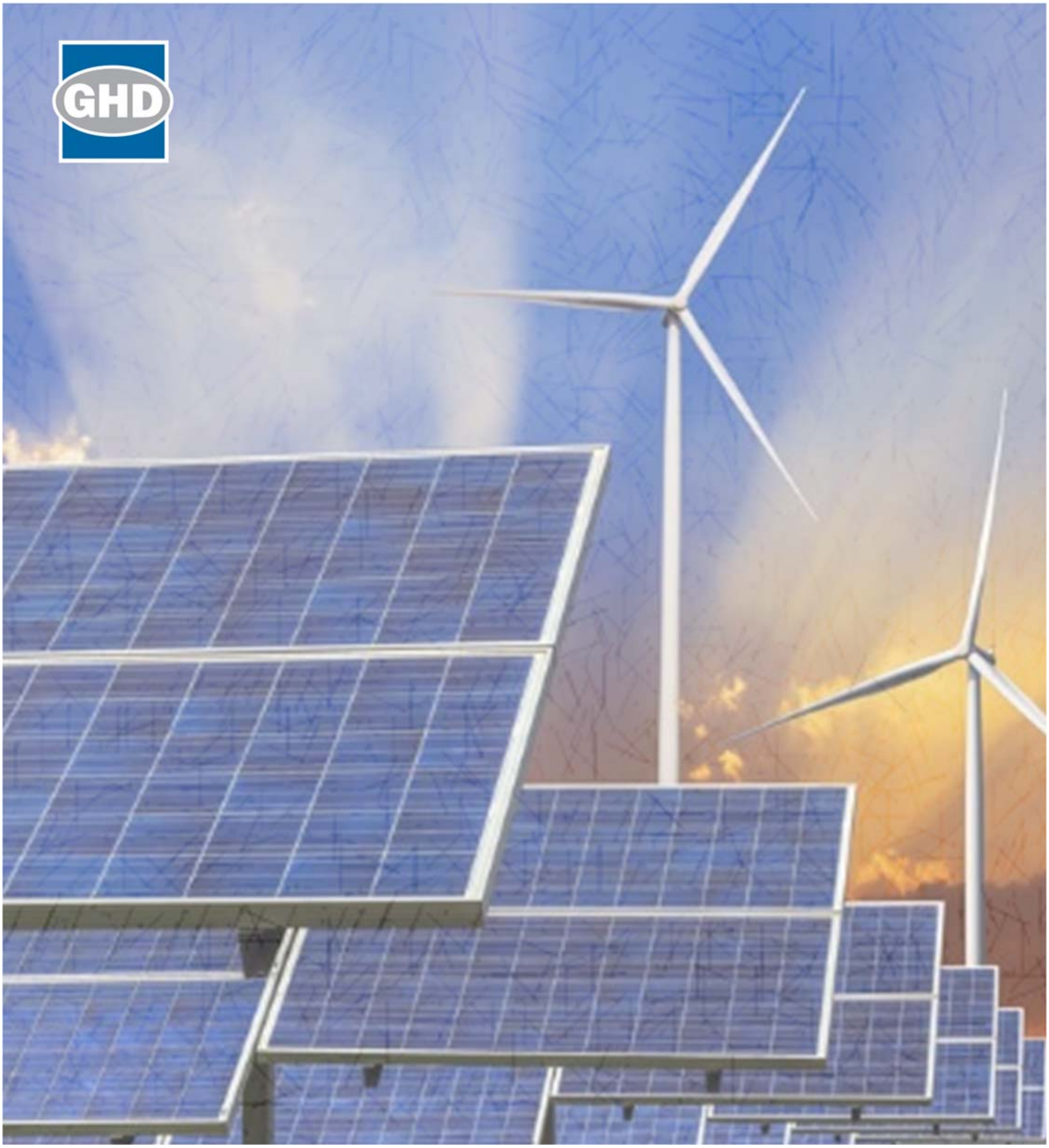
Kind regards,

....

Phillip Head

Director, Rochleigh Partners Pty Ltd

Traffic Impact Assessment



Neoen Australia Pty Ltd

Crystal Brook Energy Park Pro ect

Traffic Impact Assessment Report

March 2018

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1. Introduction

1.1 Background

GHD Pty Ltd have been engaged by Neoen Australia Pty Ltd to provide environmental, ecological assessments and planning services including a Traffic Impact Assessment (TIA) associated with the proposed construction of the Crystal Brook Energy Park.

1.2 Project Description

Neoen Australia Pty Ltd is proposing to construct the “Crystal Brook Energy Park” inclusive of wind and solar infrastructure within the Mid North Region, part of the Port Pirie Regional Council area, just north of Crystal Brook approximately 200 km north of Adelaide, South Australia.

The project locality has been subject to assessment over the last decade, originally referred to as the *Collaby Hill Wind Farm* proposal, with the general layout of the project area running along a low range in a generally north south alignment, which forms part of the Southern Flinders Rangers.

The proposed Crystal Brook Energy Park traffic management implications are the subject of this TIAR. During the construction phase (which is estimated to be a minimum of 12 months), particular consideration has been given to the transportation of components to be installed at the site.

This could comprise of, but not limited to the following; turbines, wind monitoring masts, nacelles, hubs, blades, modularised tower sections, internal underground cabling, new 275kV transmission line, substation, transformers, access roads / tracks, permanent control / maintenance facility and a temporary site office, during construction phase only

Advice obtained by Neoen Australia Pty Ltd that the componentry is likely to be imported from overseas or manufactured locally in Australia. Components will be transported and arrive via either a port or road, or via road only, particularly for components manufactured in South Australia and/or Interstate.

1.3 Purpose of this report

The purpose of this report is to seek an appreciation of the transportation logistics, to bring about the plant, labour and materials to the intended development site. Thereby, understanding the capacity required from the existing road infrastructure and highlighting what potential improvements will be required in order to ensure the road network is capable of accommodating the vehicle fleet generated by this development.

1.4 Scope and limitations

This report, having been prepared by GHD Pty Ltd for Neoen Australia Pty Ltd and may only be used and relied on by Neoen Australia Pty Ltd for the purpose agreed between GHD Pty Ltd and the Neoen Australia Pty Ltd as set out in section **Error Reference source not found.** of this report.

GHD Pty Ltd otherwise disclaims responsibility to any person other than Neoen Australia Pty Ltd arising in connection with this report. GHD Pty Ltd also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD Pty Ltd in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD Pty Ltd has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD Pty Ltd described in this report. GHD Pty Ltd disclaims liability arising from any of the assumptions being incorrect.

GHD Pty Ltd has prepared this report on the basis of information provided by Neoen Australia Pty Ltd and others who provided information to GHD Pty Ltd (including Government authorities)], which GHD Pty Ltd has not independently verified or checked beyond the agreed scope of work. GHD Pty Ltd does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD Pty Ltd does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD Pty Ltd is also not responsible for updating this report if the site conditions change.

1.5 Assumptions

The construction project delivery method provided by Neoen Australia Pty Ltd is accurate in terms of staging, plant requirements and scheduled timeframes for the movement of this plant on and off the development site at the time of receiving this information.

Due diligence has been undertaken in terms of inclement weather affecting the construction program provided by Neoen Australia Pty Ltd.

Advice received from the Department of Planning, Transport and Infrastructure (DPTI) related to favoured Over-dimensional / Over-Mass vehicle routes and associated terms and conditions of use are accurate and current at time of writing this report.

2. Methodology

The methodology carried out to assess the traffic and transport impacts associated with the proposed Crystal Brook Energy Park project and accordingly the structure of this report have been described in Error! Reference source not found.**1** below.

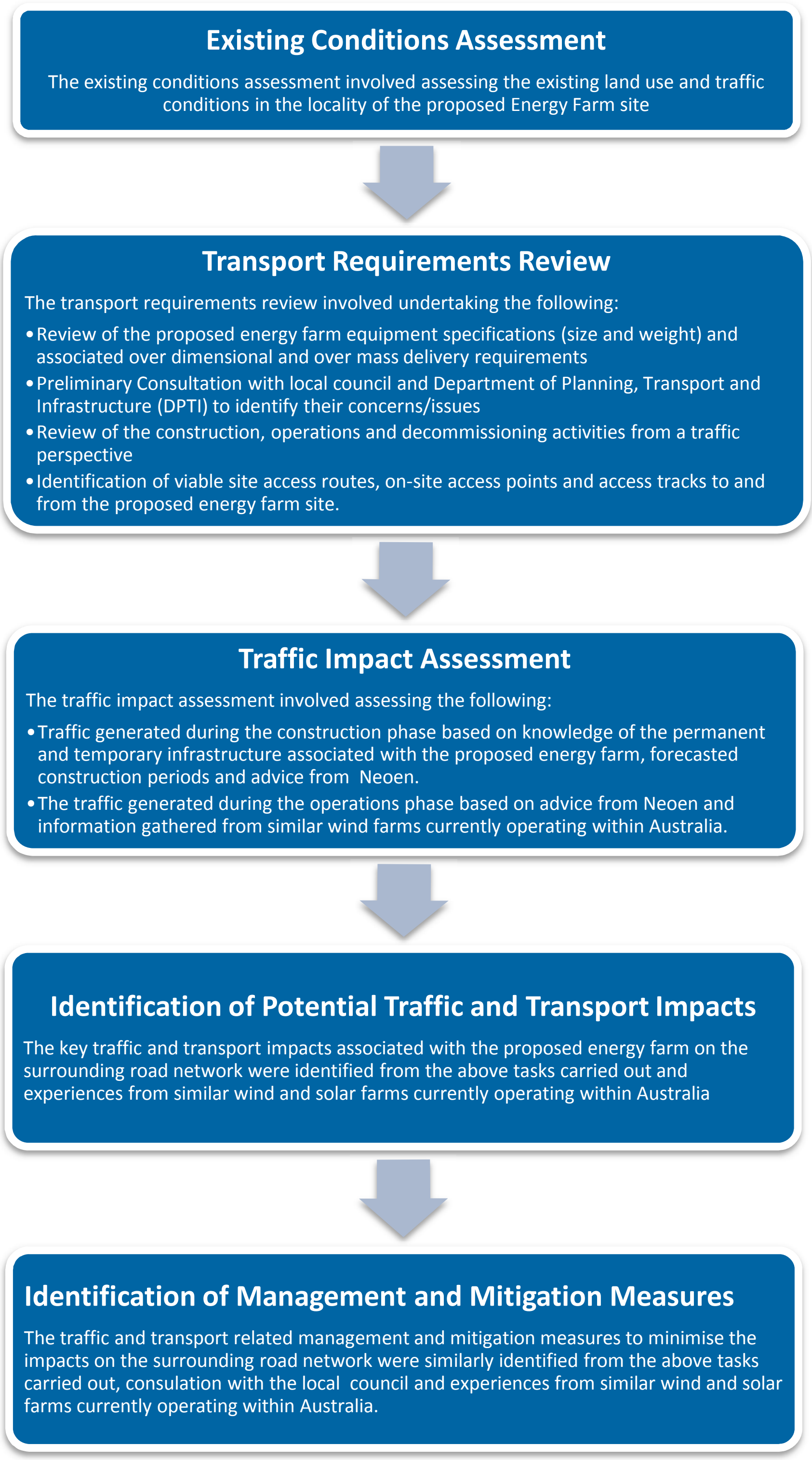


Figure 1 Summary of TIA methodology

3. Existing Conditions

3.1 Proposed Site Location

Crystal Brook is a town in South Australia's mid north region, within the Port Pirie Regional Council area with a population of approximately 1,324 people according to the recent 2016 census.

The township offers a number of facilities, including a small primary school and kindergarten, main street shopping experiences and other necessities. The local farming community actively supports many small businesses in the town. Therefore, to minimise the impacts to this small community, it is proposed for the majority of the construction traffic (heavy vehicles) to bypass the township.

The proposed Crystal Brook Energy Park situated approximately 200 km, or 2 hours and 23 minutes north of Adelaide's CBD via Port Wakefield Road and Augusta Highway (A1) as shown in Error! Reference source not found.**2** below.

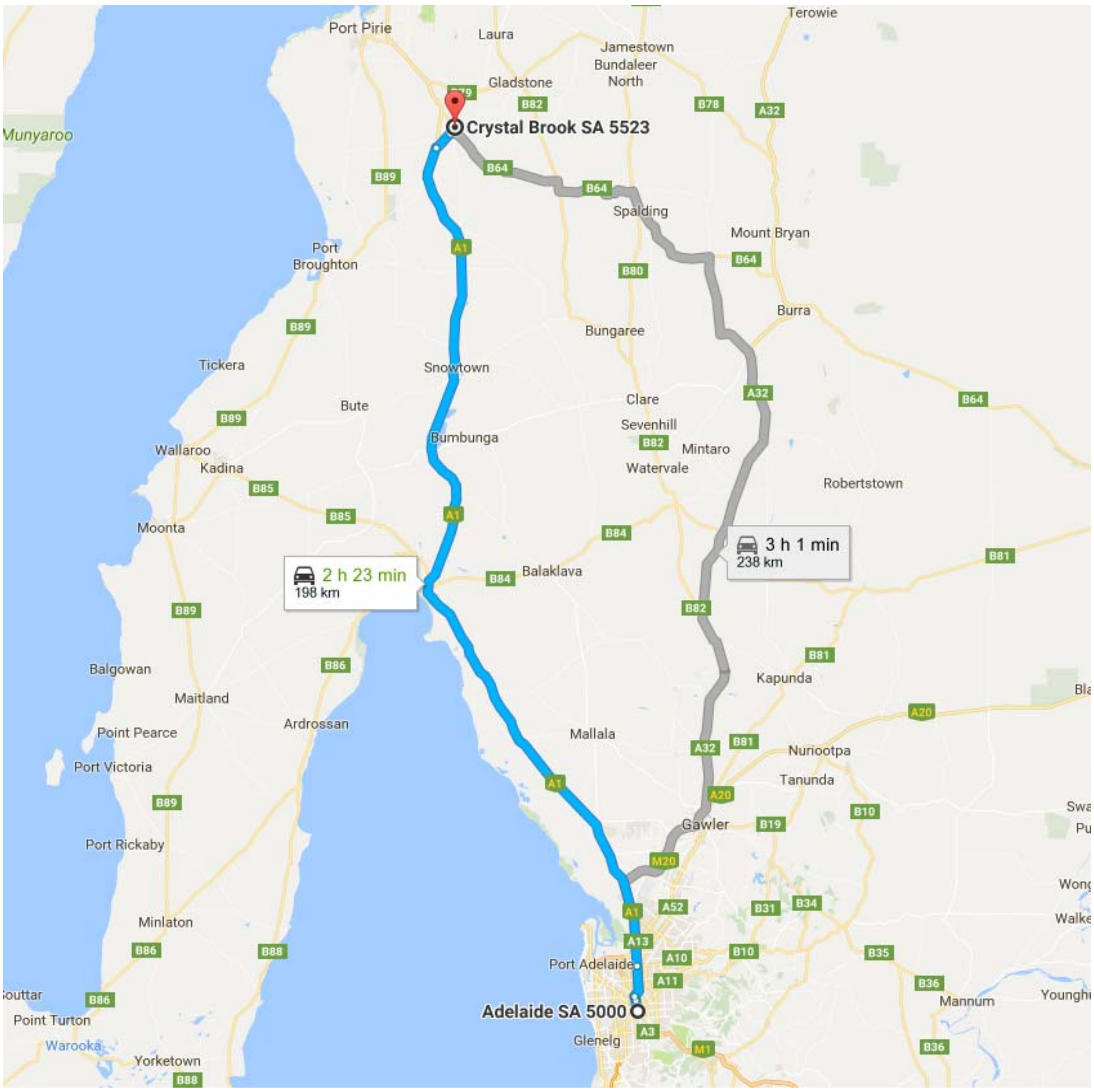


Figure 2 **Location plan of proposed site**

3.2 Land Use

The project area for the Crystal Brook Energy Park spans approximately 18.0 km in a north to south direction and has an average width of 3.0 km, which compromises of a variety of agricultural pursuits. The topographic structure is relatively steep on the primary ranges western facing slopes with the landscape continuing eastwards with a similar low range profile.

The project areas area separated into a north and south section by the Wilkins Highway (B79), which travels through “Hughes Gap” with steep topography on both sides. The area of land off the Wilkins Highway between Hughes Gap Roads (Gladstone – Laura Road), Hatters Road and Robinson Road, before the Goyder Highway (B64) to the south, is proposed to accommodate the solar infrastructure portion of the project to be positioned on farming/pastoral land.

Further north off the Augusta Highway, Collaby Hill Road is the location for the substation and battery storage area that includes the hydrogen production facility. The most up to date provisional Crystal Brook Energy Park layout comprises of 29 wind turbines as shown in Error! Reference source not found.**3**.

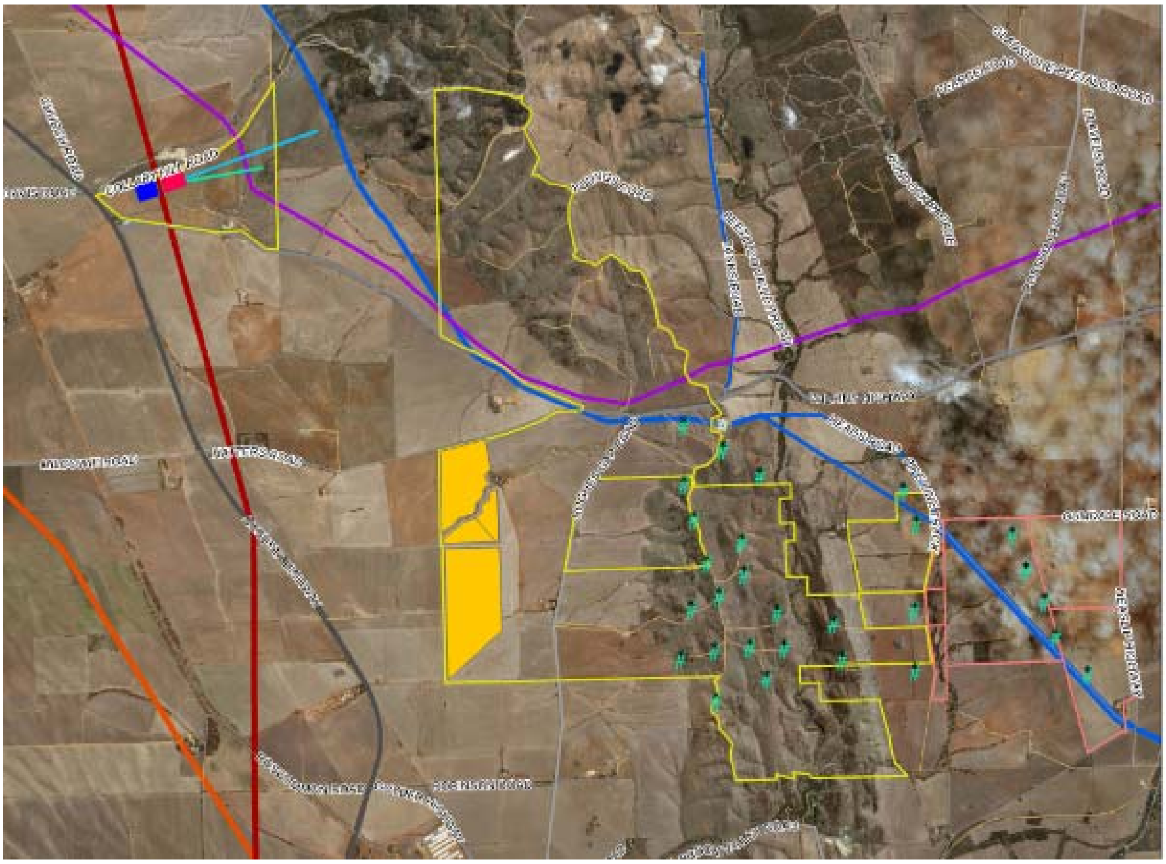


Figure 3 Location plan of Crystal Brook Energy Park

3.3 Surrounding Road Network

3.3.1 Minor Roads

The current layout has two distinct integrated components; a PV Solar Scheme to be established between Hatters Road and Robinson Road, both local access roads, adjacent to Hughes Gap Road (Gladstone – Laura Road) to the east and the Augusta Highway to the west. The Wind Farm positioned midblock with the intention that both will be provided access via the Wilkins Highway, locally known as the Warnertown – Jamestown Road.

Hatters Road is an unsealed gravel road with a cross-section width of approximately 5.0 m. **Figure 7** Configuration of Collaby Hill Road shows a typical configuration of this link road, which forms the western boundary of the proposed development site.

This local access route comes under the care, control and management of the Port Pirie Regional Council, which presently, grades the existing Hatters Road every second year based upon its current demand.

Figure 4 **Local Access Road – Hatters Road, ad acent to solar site**

Figure 5 Local Access Road – Hatters Road

Figure 6 Typical Configuration of a Minor Access Road

Figure 7 **Configuration of Collaby Hill Road north of the Energy Park, ust off the Augusta Highway and connects to Beetaloo Valley Road**

The majority of this local access road is suitable for two-way heavy vehicle traffic; and it is proposed that roads accessing the proposed turbine locations will be locally widened up to approximately 6.0 m where required at site entry gateways.

The existing traffic volumes along this road is typically very low and generally is only used by a small number of properties and occasional transportation of agricultural equipment and livestock.

The Crystal Brook Township located on the eastern side of the Augusta Highway (A1) offers road connection to a variety of services. There are informal tracks connecting the A1 in a number of locations near the site.

3.3.2 Regional Distributor or Collector Roads

The nearest regional / collector road that will provide access between the Township facilities and the proposed development site is Hughes Gap Road (Gladstone – Laura Road) which connects from the Wilkins Highway at the north of the site and Goyder Highway to the south, as shown in **Figure 7** Configuration of Collaby Hill Road.

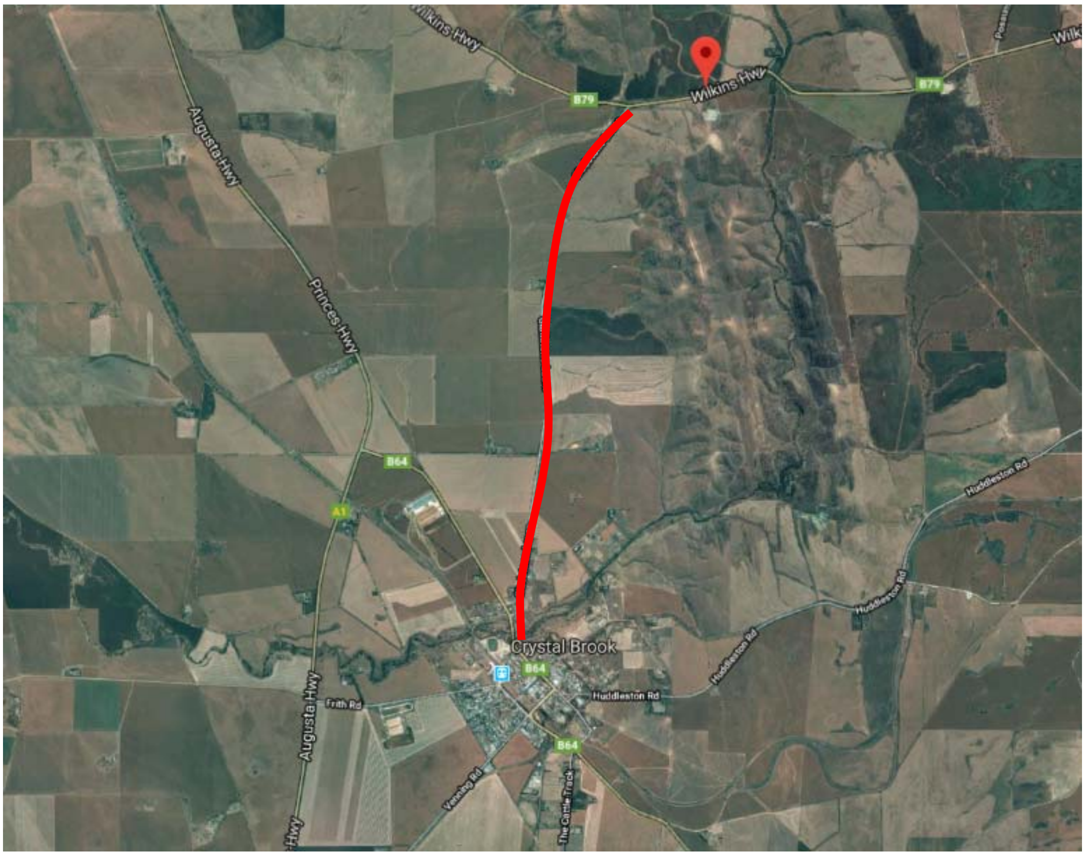


Figure 8 Regional Distributor or Connector Road – Hughes Gap Road, locally known as the Gladstone – Laura Road

3.4 DPTI Approved Freight Routes

Performance Based Standards (PBS) set minimum heavy vehicle *'performance'* standards to ensure trucks are stable on the road and can turn and stop safely. PBS vehicles are generally referred to as SMART trucks - because they work smarter.

The Standards are a national program that focuses on how the vehicle behaves on the road, rather than how big and heavy it is. With this, the Standards have been approved through the *Council of Australian Governments* and the *Australian Transport Commission*.

PBS vehicle routes are classified into four (4) national networks levels, i.e. Levels 1 to 4 as shown in Error! Reference source not found. **1**. These network levels include a Class A and Class B category for the vehicle lengths.

Both Class A and Class B categories cover General Mass Limits (GML), Concessional Mass Limits (CML) and Higher Mass Limits (HML). PBS Classification Level 2A is approximately equivalent to a GML B-Double Route as shown in below in Error! Reference source not found.**9**.

Table 1 PBS Route network classifications

Vehicle Performance Level	Network Access by Vehicle Length (m)	
	Access Class "A Existing Networks	Access Class "B Classified PBS Networks
Level 1	L≤20 m	Not Applicable
Level 2	L≤26 m	L≤30 m
Level 3	L≤36.5 m	L≤42 m
Level 4	L≤53.5 m	L≤60 m

DPTI RAVnet provides up to date information on PBS route network classification of DPTI owned roads in SA. A RAVnet route assessment is only required for B-Double and Road Train access when a route is to be gazetted as part of the approved route network.

However, the above routes provide a good guide to the existing condition of major roads, and should be utilised as part of the proposed route where possible.

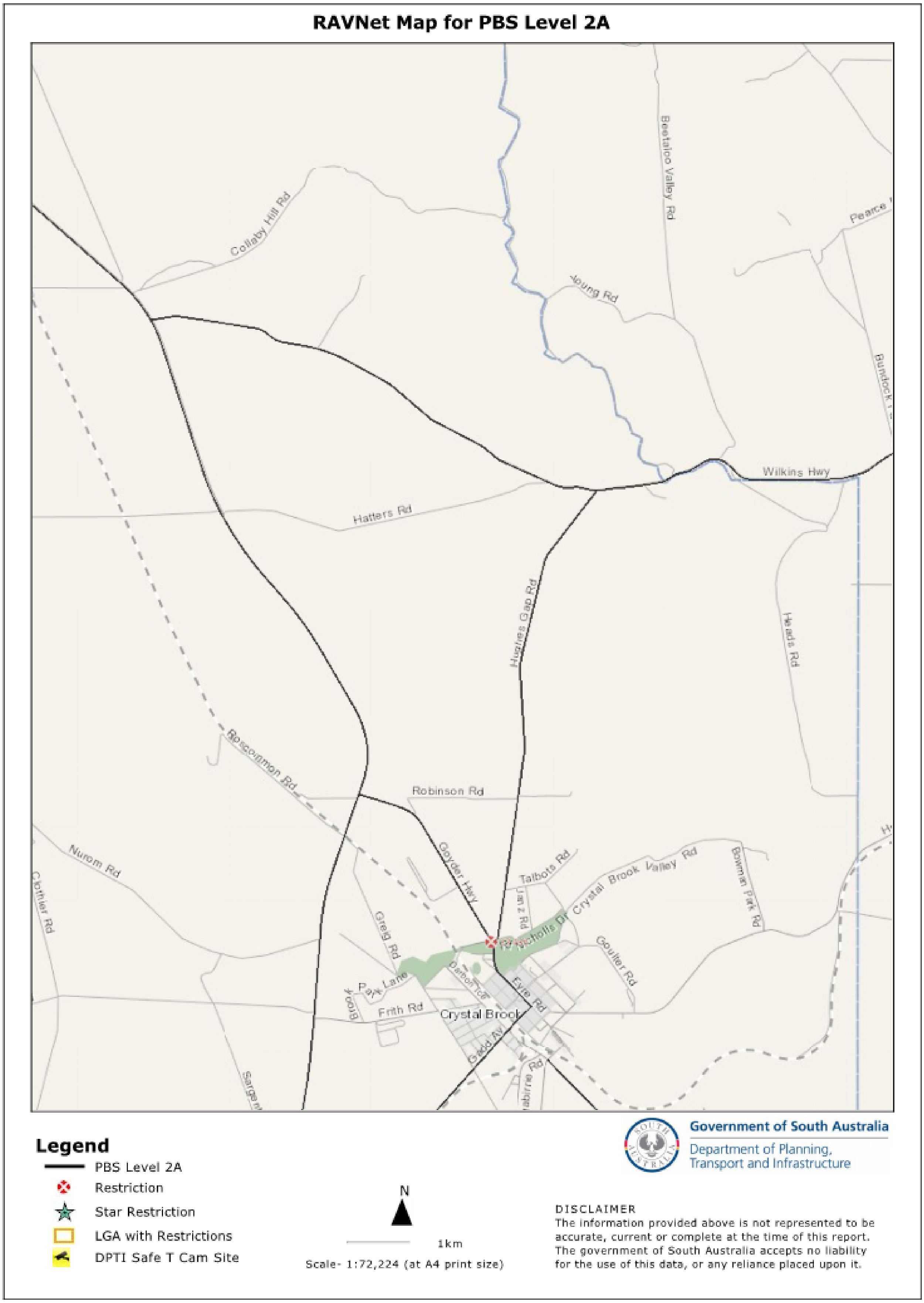


Figure 9 **PBS Route Network Level 2A – Crystal Brook Area**

3.5 Permits

Permits are approved and issued by the relevant Road Authority for “special” requirements. This then negates the requirement for any formal gazettal for this project. All roads, described below in *Section 46*, have been identified as being used for the transportation of the components, materials and equipment required for the Crystal Brook Energy Park, which currently have gazette notices allowing Restricted Access Vehicles up to the following:

- 36.5 m Road Train (General Mass Limit) GML
- 36.5 m Road Train (Higher Mass Limit) HML
- 25.0 m 59.5 t Low Loader (Over size/Over mass) OSM

For all vehicles outside of these dimensions / mass limits, permits must be obtained through the NHVR and DPTI.

3.6 Existing Traffic Volumes

3.6.1 Annual Average Daily Traffic Volumes

The Annual Average Daily Traffic (AADT) estimate represents the total bi-directional traffic volume passing a roadside observation point over a period of one (1) year and divided by the number of days in a year.

Details of traffic volumes have been obtained from the Rural Traffic Estimate Maps produced by the Road Asset Management System, DPTI. These traffic counts identify the two-way AADT volumes and percentage of Heavy Vehicles (%HV).

For example, Augusta Highway is gazetted for Level 3A access under the PBS classification system with an AADT of 14,200 vehicles between Venning Road, Crystal Brook and Quarry Road, Warnertown with 53.5% or 7,957 of these being heavy vehicles and governed by a posted speed limit of 110 km/h.

Further traffic volumes shown below in Error! Reference source not found. **2**. The preferred transportation route from Port Adelaide to the Crystal Brook Energy Park during the construction phase is shown below in Error! Reference source not found.**10, 11, 12 13**.

Table 2 Existing Traffic Volumes

Road	Section	Road Authority	AADT	CV
Port Wakefield Road	Between and Balaklava Road (B84) and intersection of Copper Coast Highway (B85) and Augusta Highway (A1)	DPTI	8,600	18.5
Augusta Highway	Between Port Wakefield Road and Copper Coast Highway Yorke and Copper Coast Highways (locally known as Federation Corner)	DPTI	6,300	20.5
Augusta Highway	Between Federation Corner and Blythe Road, Lochiel	DPTI	3,700	21.5
Augusta Highway	Between Blyth Road, Lochiel and Barunga Gap Road, Snowtown	DPTI	3,700	27

Augusta Highway	Between Barunga Gap Road, Snowtown and North Terrace, Snowtown	DPTI	3,800	21
Augusta Highway	Between North Terrace, Snowtown and Ellis Street West, Redhill	DPTI	3,500	21.5
Augusta Highway	Between Ellis Street West, Redhill and Clements Road, Merriton	DPTI	3,500	21.5
Augusta Highway	Between Clements Road, Merriton and Venning Road, Crystal Brook	DPTI	4,000	24
Augusta Highway	Between Venning Road, Crystal Brook and Goyder Highway (B64)	DPTI	3,500	21.5
Augusta Highway	Between Goyder Highway (B64) and Wilkins Highway (B79)	DPTI	5,000	18
Augusta Highway	Between Wilkins Highway and Quarry Road, Warnertown	DPTI	5,700	14
Wilkins Highway (known as the Warnertown–Jamestown Road)	Between Augusta Highway (A1) and Hughes Gap Road (Gladstone – Laura Road)	DPTI	1,200	15
Hughes Gap Road (Gladstone – Laura Road)	Between Goyder Highway (B64) and Wilkins Highway (B79)	DPTI	550	13.5

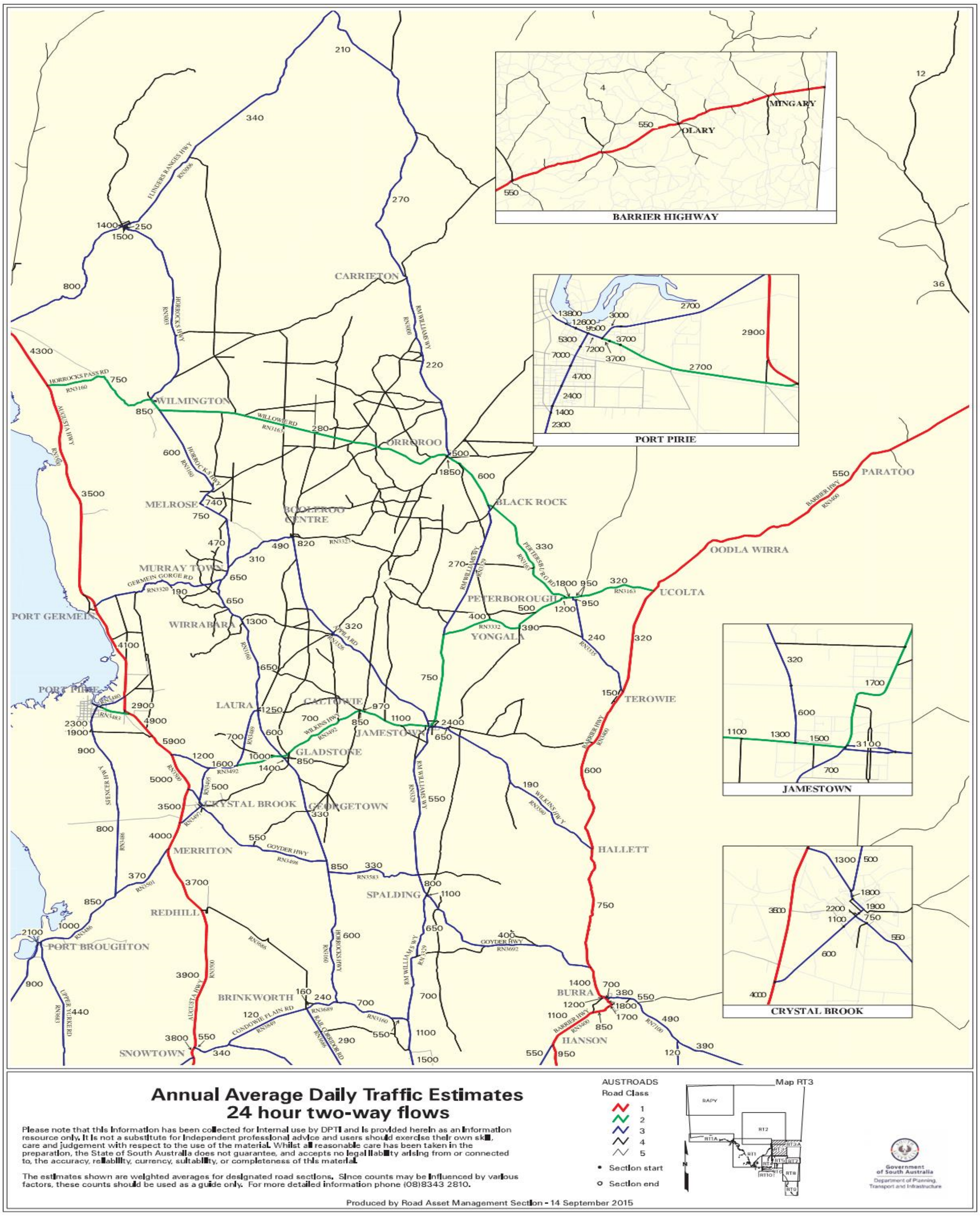


Figure 10 Augusta Highway AADT – Crystal Brook to Snowtown (DPTI Roads[1])

[1] Source: DPTI Annual Average Daily Traffic Estimates 24 Hour Two-Way Flow

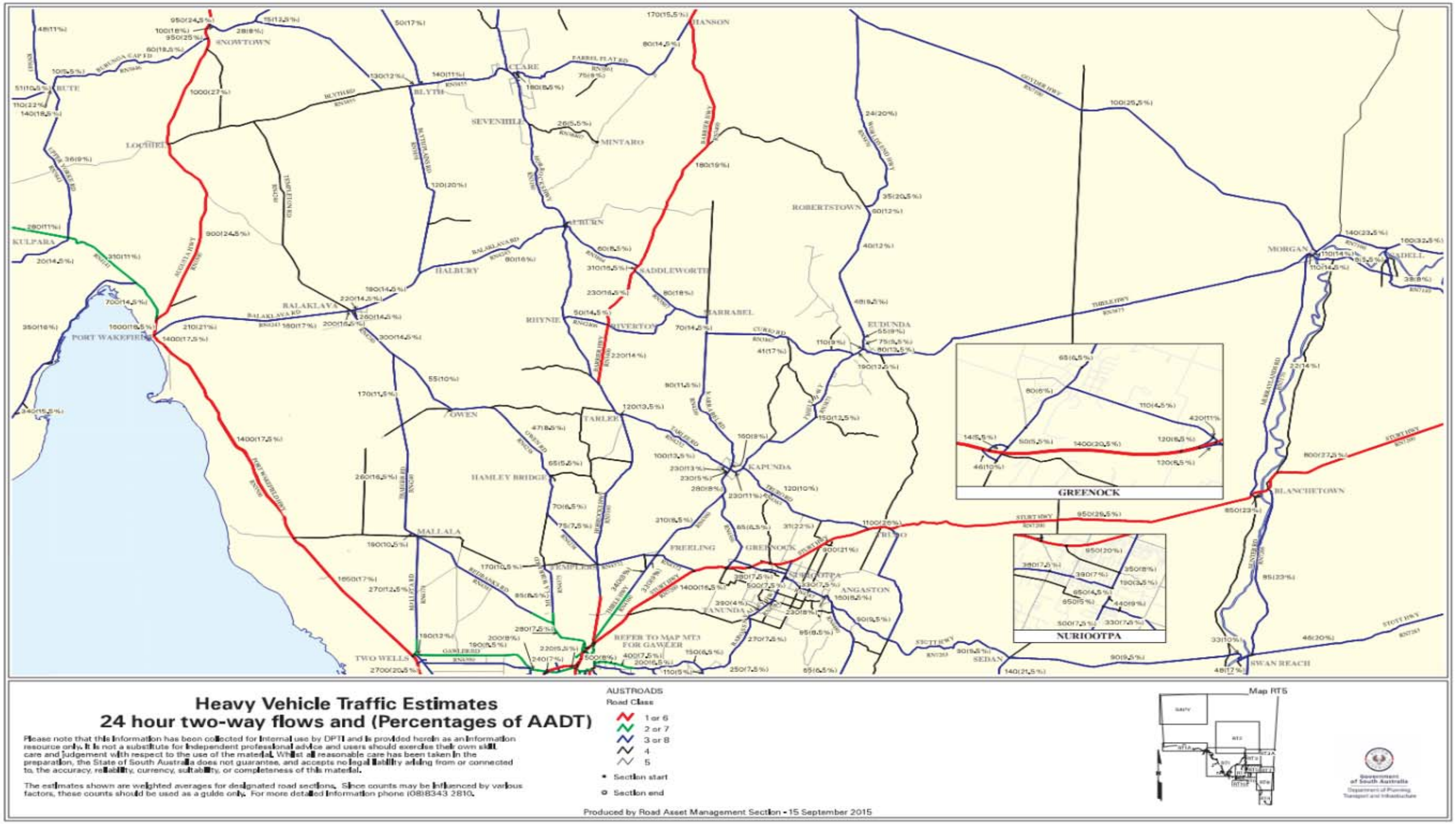


Figure 11 Augusta Highway Port Wakefield Road AADT – Snowtown (DPTI Roads[1])

[1] Source: DPTI Annual Average Daily Traffic Estimates 24 Hour Two-Way Flow

Figure 12 Port Wakefield Road AADT – Port Wakefield to St Kilda (DPTI Roads[1])

[1] Source: DPTI Annual Average Daily Traffic Estimates 24 Hour Two-Way Flow

Figure 13 Port Wakefield Road AADT – St Kilda to Port Adelaide (DPTI Roads[1])

[1] Source: DPTI Annual Average Daily Traffic Estimates 24 Hour Two-Way Flow

3.7 Crash History

3.7.1 Augusta Highway

A review of the crash data from Location SA Map Viewer (2015) indicates the span of the section of road between Collaby Hill Road and Goyder Highway recording 7 crashes, with 2 of these recorded as casualty crashes at major intersections as seen in Error! Reference source not found..

Table 3 Recorded crash data Augusta Highway

Number of Crashes	Reason	Additional Information (day night, fatality serious)
1 crash	Right angle	2 casualty injuries intersection of Wilkins Hwy
1 crash	Car rollover	Hit animal
1 crash	Hit fixed object	1 casualty injury
1 crash	Car rollover	Hit animal, daylight hours
1 crash	Head-on	Daylight hours
1 crash	Side swipe	Daylight hours
1 crash	Right angle	Intersection of Goyder Hwy

The main cause of the crashes along this section of the Augusta Highway includes car rollovers and right angle crashes at intersecting roads, which is represented in Error! Reference source not found. **14** below.

With such a vast, open span of land, it is hard to minimise some crashes from occurring that are typically due to either driver inattention, fatigue or other driver error.

Figure 14 Highlighted locations of crashes on Augusta Highway between Wilkins Highway and Goyder Highway

3.7.2 Wilkins Highway

A review of the crash data from Location SA Map Viewer (2015) indicates the span of the section of road between Collaby Hill Road and Goyder Highway recording 11 crashes, with 7 of these recorded as casualty crashes and 1 serious injury as seen in Error! Reference source not found..

The main cause of the crashes along this section of the Wilkins Highway includes hit fixed object, car rollovers and right angle crashes that is represented in Error! Reference source not found. **15** below.

With such a vast, open span of land, it is hard to minimise some crashes from occurring that are typically due to either driver inattention, fatigue or other driver error.

Table 4 **Recorded crash data Wilkins Highway**

Number of Crashes	Reason	Additional Information (day night, fatality serious)
1 crash	Hit animal	Daylight hours
1 crash	Hit fixed object	Daylight hours
1 crash	Hit fixed object	Daylight hours
1 crash	Hit fixed object	1 casualty injury, at Hughes Gap Road, night time
1 crash	Hit fixed object	Daylight hours
1 crash	Vehicle rollover	Daylight hours
1 crash	Head on	3 casualty injuries, daylight hours
1 crash	Vehicle rollover	1 casualty injury, night time hours
3 crashes	2 Right angle, 1 hit fixed object	2 casualty injuries, 1 serious injury, 1 night time hours

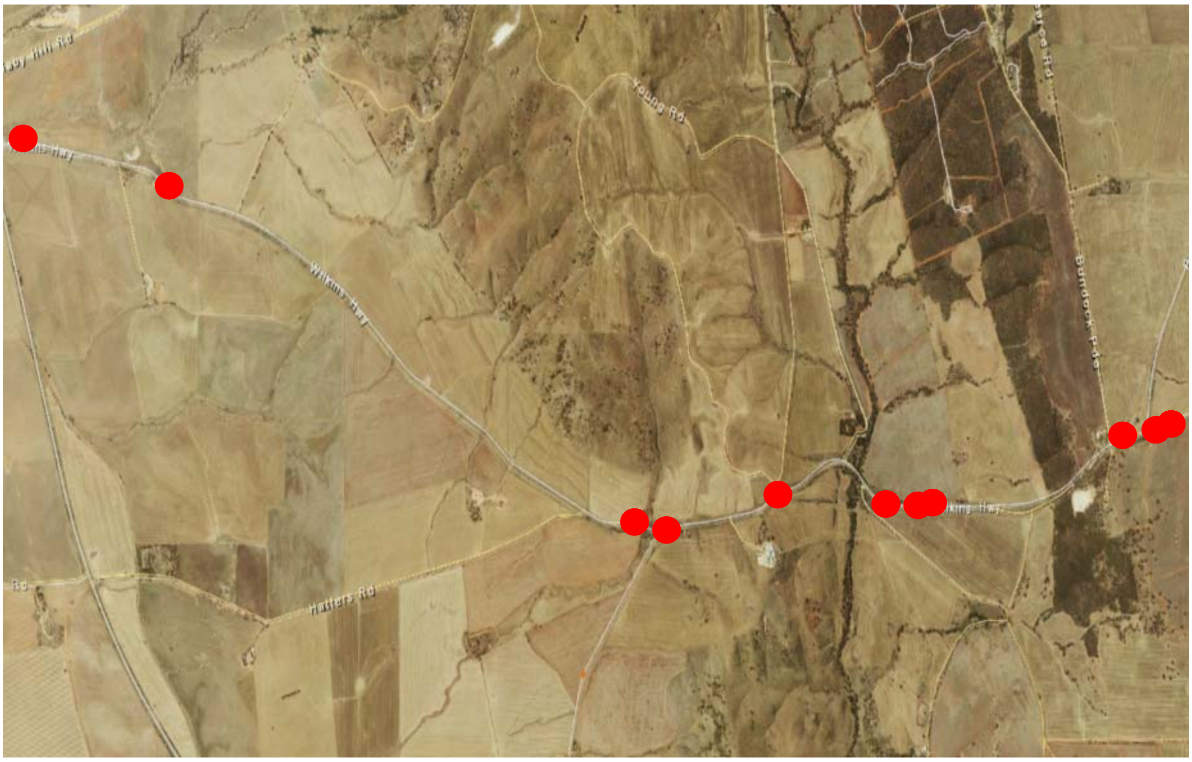


Figure 15 Highlighted locations of crashes on Wilkins Highway between Augusta Highway and Possum Park Road

3.8 Major Transport Routes (Motorways and Highways)

The Crystal Brook Energy Park incorporates wind and solar infrastructure components for construction materials that will be obtained from Adelaide will likely traverse the Port Wakefield and Augusta Highways.

However, if specific materials are required to be sourced from Victoria, vehicles will be able to use the Dukes Highway (A8) to connect to Murray Bridge and then deviate north to Route 20 via Mannum Road. These routes are shown in Error! Reference source not found..

Figure 16 Key Ma or Transport Routes proposed access route to Crystal Brook Energy Park from Melbourne, Victoria

The M1 and A1 section of the South Eastern Freeway is the major route from Adelaide to the east, carrying the National Highway to Tailem Bend and onto the Dukes Highway (A8).

The South Eastern Freeway is almost entirely freeway with only the single carriageway at Swanport Bridge breaking the dual carriageway conditions.

A constraint along the South Eastern Freeway for over dimensional / over mass loads is the height restrictions at the Heyson Tunnel. The height clearance for the Heysen Tunnels is 5.3 m (this is also the clearance height for the Mt Osmond and Crafers interchanges).

The Dukes Highway (A8) provides the main east-west route in southwestern Victoria, providing a strategic link between Melbourne and the South Australian border. It is primarily a single carriageway in each direction, but with frequent overtaking lanes along the route.

If loads are over 100 tonne or greater than 5.0m in height it may be prudent to seek connection to Crystal Brook via the Riverland to avoid issues with “heard room” clearance and bridge structures that may be fragile.

The South Eastern Freeway and Dukes Highway are all classified as PBS Classification Level 2A whereas the Augusta Highway is classified as Level 3A.

The principal heavy vehicle, over mass and over dimensional routes providing access east of the South Australian/Victorian border (as provided by VicRoads on-line heavy vehicle access maps database) are shown in

Figure 17 Principal Heavy Vehicle OMD Routes providing access to the proposed site, from east of the Victorian/South Australian Border

17.

Figure 17 Principal Heavy Vehicle OMD Routes providing access to the proposed site, from east of the Victorian South Australian Border

The routes used during the construction phase will be dependent on the delivery location of the turbine components and preferred supplier / manufacturer of construction materials and equipment. The principal site access routes identified to the proposed site are discussed further in *Section 6*.

4. Traffic Impact Assessment

4.1 Introduction

A Traffic Impact Assessment (TIA) is one of several key technical studies undertaken in the preparation of the Development Application (DA), which details the principal impacts of the traffic, and transport related activities associated with the Crystal Brook Energy Park project during the development construction and operational phases of the project.

Some of the key issue with regard to traffic and transport matters relate to the impacts likely to arise from the additional vehicles accessing the site both during its construction and operation phases. Therefore, the traffic management implications of the proposal are the subject of this report.

Specific consideration to the movement of traffic, specifically associated with heavy vehicle movements, has been considered with the transportation of components to be implemented at the site. This could comprise of, but not limited to the following; turbines, wind monitoring masts, nacelles, hubs, blades, modularised tower sections, internal underground cabling, new 275kV transmission line, substation, transformers, access roads / tracks, permanent control / maintenance facility and a temporary site office, during construction phase only.

Due to the size and weight of these components during the construction period, a large proportion of equipment associated with the proposed wind farm will exceed South Australia's (and the majority of states throughout Australia) over mass and over dimensional vehicle limits and will therefore require special permits for transportation from the Department of Planning, Energy and Infrastructure (DPTI).

The proposed renewable hybrid project development will generate extra traffic during the construction and operational phases. However, the traffic generated during the construction phase would vary greatly with that generated during the ongoing operational phase.

4.2 Road Network

4.2.1 Existing Conditions

It has been identified that due to the size and weight of the components associated with the implementation of the construction of the Crystal Brook Energy Park, its likely the components will be imported from overseas. Arriving at Outer Harbor and then transported through the City of Port Adelaide Enfield Council area and Greater Adelaide via the Port Wakefield Road and Augusta Highway (A1) just north of Crystal Brook to the proposed site.

As this will exceed South Australia's over mass and over dimensional heavy vehicle limits, special permits for the generation and distribution transportation models will be required through the NHVR and DPTI.

It should also be noted that DPTI are in the process of approving 53.5 m Road Train (A-Triple) GML and HML vehicles along Augusta Highway between Port Wakefield and Port Pirie.

4.2.2 Augusta Highway

The Augusta Highway is part of Australia's ring route (National Highway A1) or simply known as the A1, located between Port Wakefield and Port Augusta, the Augusta Highway's classification as a primary arterial road is due to the primary interstate transport route between South Australia and Northern Territory.

Augusta Highway comes under the care, control and management of DPTI in South Australia and it consists of a single carriageway with one lane of traffic in each direction of travel, a sealed pavement and divided by a painted centreline.

The Augusta Highway from Port Wakefield to Crystal Brook has been gazetted for Level 3A access under the Performance Based Standards (PBS) Scheme, through the NHVR classification system and carries approximately 5,000 vehicles per day (VPD).

The following approved Restricted Access Vehicles (RAV's) are:

- 36.5 m Road Train (General Mass Limit) GML
- 36.5 m Road Train (Higher Mass Limit) HML
- 25.0 m 59.5 t Low Loader (Over size/Over mass) OSM

4.2.3 Port Wakefield Road

Port Wakefield Road is classified as a major rural highway, serving as the primary route from Adelaide to the north, Yorke Peninsula, Port Augusta and northern and western South Australia, the Northern Territory and Western Australia.

Port Wakefield Road branches off at Main North Road at Gepps Cross with a posted speed limit of 110 km/h. It consists of a dual carriageway until Port Wakefield Township, through and past Port Wakefield the road becomes a single lane carriageway in each direction, with a sealed pavement width of approximately 7.0 m and an unsealed shoulder approximately 4.0 m wide on each side.

Port Wakefield Road is currently gazetted for Level 3A access under the Performance Based Standards (PBS) Scheme, through the NHVR classification system and carries on average between 4,000 and 5,000 vehicles per day (VPD).

The following approved Restricted Access Vehicles (RAV's) are:

- 36.5 m Road Train (General Mass Limit) GML

- 36.5 m Road Train (Higher Mass Limit) HML
- 25.0 m 59.5 t Low Loader (Over size/Over mass) OSM

Port Wakefield Road would be the primary approach route to the site from Adelaide for large construction components of the Crystal Brook Energy Park.

4.2.4 Wilkins Highway (known as the Warnertown – Jamestown Road)

The Wilkins Highway (B79) is an east-west route across South Australia's Mid North Region. It runs from the Augusta Highway, just south of Warnertown through to Jamestown, and is locally known as the Warnertown-Jamestown Road. Wilkins Highway then continues from Jamestown (B78) meeting up with the Barrier Highway (A32), at the town of Hallett.

Wilkins Highway is an Austroads class 3 arterial highway running east/west between Augusta Highway and Jamestown. It has a posted speed limit of 110 km/h and consists of a single carriageway with one lane in each direction, a sealed pavement width of approximately 7.0 m and an unsealed shoulder approximately 3.0 m wide on each side.

The Wilkins Highway is gazetted for Level 3A access under the Performance Based Standards (PBS) Scheme, through the NHVR classification system and carries between approximately 1,000 and 1,500 vehicles per day (VPD).

Although commercial traffic is unknown, it is expected to be less than the Port Wakefield and Augusta Highway. The following approved RAV's are:

- 36.5 m Road Train (General Mass Limit) GML
- 36.5 m Road Train (Higher Mass Limit) HML
- 25.0 m 59.5 t Low Loader (Over size/Over mass) OSM

4.2.5 Hughes Gap Road (known as the Gladstone – Laura Road)

Hughes Gap Road, referred as the Gladstone – Laura Road, is an Austroads class 3 rural connector running north/south from the Goyder Highway (B64) intersection north of Crystal Brook through to Wilkins Highway (B79) with a posted speed limit of 110 km/h.

It consists of a single carriageway with one lane in each direction, a sealed pavement width of approximately 6.2 m and an unsealed shoulder approximately 3.0 m wide on each side.

Hughes Gap Road is gazetted for Level 2A access under the Performance Based Standards (PBS) Scheme through the NHVR classification, system and carries on average approximately 550 VPD.

This road would be the link road for local trips from Crystal Brook to the Energy Park sites. The following approved RAV's are:

- 26.0 m B-Double (General Mass Limit) GML
- 26.0 m B-Double (Higher Mass Limit) HML

4.3 Key Intersections

The following intersections surrounding the Crystal Brook Energy Park site would likely to be utilised heavily during construction and operational activities:

- Augusta Highway / Wilkins Highway Intersection
- Wilkins Highway / Hughes Gap Road (Gladstone – Laura Road) Intersection

- Hughes Gap Road / Goyder Highway Intersection

4.3.1 Intersection of Augusta Highway / Wilkins Highway

The intersection between Augusta Highway and Wilkins Highway is priority controlled T-junction with Augusta Highway being the major approach. The intersections lighting is adequate and has defined traffic control, with full channelisation of left and right turn movements from Augusta Highway and a stand-up left turn slip lane from Wilkins Highway. Geometry at the intersection is generous, with large corner radii and pavement widths as shown in Error! Reference source not found.**18, 19 20**.

Figure 18 Wilkins Highway and Augusta Highway intersection looking west

Figure 19 Augusta Highway on approach to Wilkins Highway looking north

Figure 20 Augusta Highway and Wilkins Highway intersection looking south

4.3.2 Intersection of Wilkins Highway and Hughes Gap Road

The intersection between Wilkins Highway and Hughes Gap Road (Gladstone – Laura Road) is an unlit priority controlled T-junction with Wilkins Highway being the major approach. Traffic at the intersection is uncontrolled and unchannelised, with only an auxiliary left turn lane on Wilkins Highway, edge and centreline marking and a narrow concrete pavement bar median on Hughes Gap Road (Gladstone – Laura Road). Geometry at the intersection is good, with large corner radii and reasonable pavement width as shown in Error! Reference source not found.**21**

22.

Figure 21 Hughes Gap Road (Gladstone – Laura Road) intersection with Wilkins Highway looking east

Figure 22 **Hughes Gap Road (Gladstone – Laura Road) intersection with Wilkins Highway looking west**

4.3.3 Hughes Gap Road (Gladstone – Laura Road) and Goyder Highway

The intersection between Goyder Highway and Hughes Gap Road (Gladstone – Laura Road) is an unlit priority controlled T-junction with the Goyder Highway being the major approach. Traffic at the intersection is priority controlled with no channelisation, with only edge and centreline marking and a hazard sign indicating the termination of Hughes Gap Road (Gladstone – Laura Road). Geometry at the intersection is adequate, with large corner radii and reasonable pavement width as shown below in Error! Reference source not found.**23** **24**.

Figure 23 Goyder Highway and Hughes Gap Road (Gladstone – Laura Road) intersection looking north

Figure 24 Goyder Highway and Hughes Gap Road (Gladstone – Laura Road) intersection looking south

5. Traffic Generation & Distribution

5.1 Introduction

5.1.1 Projected Vehicle Movements

The estimated maximum trips for construction staff movements to and from the site are based on an estimated maximum workforce at any one time of 115 personnel at the area where the solar array and wind farm are planned, and assuming a vehicle occupancy rate of 1.5 persons per vehicle.

The principal deliveries of material and equipment to be delivered to the site and the types of vehicles expected to access the site and the estimated number of vehicle movements the activity is likely to occur over the construction period, which is summarised below in the following

Table 16 Level of Service (LoS) vs AADT for two lane, two way rural roads, assuming rolling terrain and K=0.10 (Austroads GTEP part 2, table 3.9, 199**9**.

The construction period is projected to take twelve (12) months at a minimum; however, the worst-case scenario in terms of traffic loading occurs during a core six (6) month period.

Table 5 Estimated Total Trips generated by the proposed Solar Storgae Facility

Solar – Pro ected Weekly Vehicle Movements									
Vehicle type	Weeks 1-4	Weeks 5-8	Weeks 9-12	Weeks 13-16	Weeks 17-20	Weeks 21-24	Weeks 25-28	Weeks 29-32	**Daily Average Range**
Utes	0	50	50	80	80	80	50	10	**Peak 12 per day for three months**
Trucks	0	5	5	5	1	1	1	0	**1 per day for three months**
Semi Trailers	0	1	5	5	5	1	0	0	**1 per day for three months**
Concrete Agitator	0	0	0	6	0	0	0	0	**1 per day for four weeks**
Crane	0	0	0	40T	40T	0	0	0	**Two separate trips**

Note: Transport of Solar Cells projected to be Five (5) semi-trailers per week for a three-month period.

Table 6 Estimated Total Trips generated by the proposed Wind Farm

Wind – Pro ected Weekly Vehicle Movements									
Vehicle type	Weeks 1-4	Weeks 5-8	Weeks 9-12	Weeks 13-16	Weeks 17-20	Weeks 21-24	Weeks 25-28	Weeks 29-32	**Daily Average Range**
Utes	50	50	0	0	0	0	0	0	**Peak 10 per day for two months**
Trucks	40	40	0	0	0	0	0	0	**8 per day for two months**
Semi Trailers	0	0	0	0	0	0	0	0	
Concrete Agitator	0	0	0	0	0	0	0	0	
Crane	0	0	0	0	0	0	0	0	

Note: Wind Turbine Blades delivery planned for weeks 13 -16 on up to twelve OD Truck combinations

Table 7 Estimated Total Trips generated by the development of the Power Connections

Power Line – Pro ected Weekly Vehicle Movements									
Vehicle type	Weeks 1-4	Weeks 5-8	Weeks 9-12	Weeks 13-16	Weeks 17-20	Weeks 21-24	Weeks 25-28	Weeks 29-32	**Daily Average Range**
Utes	0	0	0	30	0	0	0	0	**Peak 6 per day for eight months**
Trucks	0	0	0	10	0	0	0	0	**1 per day for three months**
Directional Driller	0	0	0	0	1 total	0	0	0	
Concrete Agitator	0	0	0	10 total	0	0	0	0	**2 per day**
Auger Truck	0	0	0	4	0	0	0	0	
Over Sized Trucks	0	0	0	0	0	0	0	0	

Table 8 Summary of Pro ected Weekly Traffic Movements

Summary of Pro ected Weekly Vehicle Movements to Development Site									
Vehicle type	Weeks 1-4	Weeks 5-8	Weeks 9-12	Weeks 13-16	Weeks 17-20	Weeks 21-24	Weeks 25-28	Weeks 29-32	**Daily Average Range**

Utes	50	130	130	170	140	150	120	50	**10 to 34**
Trucks	40	49	13	23	3	3	1	0	**0.2 to 9.8**
Semi Trailers	0	1	5	5	5	1	0	0	**0.2 to 1**
Concrete Agitator	0	10 total	0	16 total	60 total	0	0	0	
Crane	0	0	80T	40 / 80T	40 /80T	500 T	0	0	
Container Trucks	0	0	0	12 total	0	0	0	0	
Over Sized Trucks	0	0	0	12 Total	0	0	0	0	
Auger Truck	0	0	0	4	0	0	0	0	
Directional Driller	0	0	0	0	1 total	0	0	0	

Table 9 Summary of Total Pro ected Traffic Movements

Summary of Pro ected Total Vehicle Movements to Development Site									
Vehicle type	Weeks 1-4	Weeks 5-8	Weeks 9-12	Weeks 13-16	Weeks 17-20	Weeks 21-24	Weeks 25-28	Weeks 29-32	**TOTAL**
Utes	200	520	520	680	560	600	480	200	**3,760**
Trucks	200	245	65	115	15	15	5	0	**660**
Semi Trailers	0	4	20	20	20	5	0	0	**69**
Concrete Agitator	0	10 total	0	16 total	60 total	0	0	0	**86**
Crane	0	0	80T	40 / 80T	40 /80T	500 T	0	0	**6**
Container Trucks	0	0	0	12 total	0	0	0	0	**12**
Over Sized Trucks	0	0	0	12 total	0	0	0	0	**12**
Auger Truck	0	0	0	4 total	0	0	0	0	**4**
Directional Driller	0	0	0	0	1 total	0	0	0	**1**

5.2 Trip Distribution

The vehicle trips associated with the construction phase will access the site via the key transport routes as discussed in Section **Error Reference source not found.** and highlighted in Error! Reference source not found.**25**.

Figure 25 Estimated Trip Distribution for traffic generated by proposed Energy Park during Construction Phase

As far as practical, construction materials would be sourced locally, the majority likely to be sourced from Port Pirie. Materials transport from Port Pirie would follow the following route,

1. Warnertown Road
2. Port Wakefield Road
3. Warnertown Jamestown Road.

It is not intended to set up on-site accommodation for construction personnel for the project and as such there would be no single transport route for construction personnel. It is likely that the majority of personnel would travel from Crystal Brook, Port Pirie and Jamestown.

Within the development site, it is intended that all materials and equipment transportation would take place on newly constructed internal site roads and the use of external public roads will be minimal.

5.3 Impact Assessment

Based on the existing daily traffic volumes and levels of service for the roads surrounding the proposed development site, the estimated increase in daily trips during the construction period of the proposed Energy Park is considered to not impact significantly on the existing level of service.

A comparison of existing traffic volumes against the estimated traffic volumes during the construction period is shown in. **Table 100**.

Table 10 Comparison of Existing Traffic Volumes against Estimated Traffic Generated by the Energy Farm Pro ect

Impacted Road	Existing Traffic Volume (AADT)	Existing % HV	Estimated Traffic Volume during Construction Period (AADT)	Estimated % HV during Construction Period

5.4 Sight Distance

A primary road safety concern during construction is vehicle sight distance at key intersections and the site access point. Delivery vehicles will often be slow moving and take time to clear the carriageway, hence it is critical that approaching vehicles have enough time to reduce speed and avoid collision.

At a design speed of 120 km/hr (posted speed limit + 10 km/hr), the required stopping sight distance (SSD) under Austroads guidelines is 279 m for heavy vehicles and 241 m for passenger vehicles. See Appendix A for details.

Preliminary measurement at the likely site access point for the Energy Farm, shows sight distance from the intersection would be approximately:

- 300 m to the western approach.
- 250 m to the eastern approach.

The sight distance to both the eastern and western approach meets Austroads requirements for passenger vehicles. However, sight distance to the eastern approach fails to meets requirements for heavy vehicles, raising a substantial safety concern.

Preliminary measurement at the likely site access point for Crystal Brook South Wind Farm shows sight distance from the intersection would be in excess of 400 m, exceeding Austroads requirements for both heavy vehicles and passenger vehicles.

Figure 26 **Crystal Brook Energy Park proposed site access point looking west along Wilkins Highway**

Figure 27 Crystal Brook Energy Park proposed site access point looking east along Wilkins Highway

Preliminary inspection and measurement of each key intersection described in *Section 4.2,* revealed that in all cases, sight distance is in excess of Austroads requirements.

5.5 Construction

5.5.1 Construction Traffic Generation

Traffic generated during the construction stage for the site compound of Crystal Brook Energy Park would include the following:

- Over dimensional vehicles carrying turbine towers, nacelles, blades and end bed. These vehicles would be required to travel on permit.
- A heavy crane for erection of the turbine towers, required to travel on permit.
- Heavy vehicles carrying reinforcement steel for turbine foundations.
- Agitator trucks carrying concrete for turbine foundations.
- Heavy vehicles carrying earthmoving and construction equipment.
- Heavy vehicles carrying building materials for turbine associated infrastructure, including service roads and site buildings.
- Heavy vehicles carrying electrical distribution equipment, including substation transformers, transmission poles and transmission lines. Vehicles carrying the substation transformers may require a permit.
- Light vehicles carrying construction personnel.

Turbine and electrical distribution equipment would be transported form Adelaide while construction materials would be sourced locally. The estimated number of vehicles for each delivery load, based on 29 turbines, is summarised in

Table 16 Level of Service (LoS) vs AADT for two lane, two way rural roads, assuming rolling terrain and K=0.10 (Austroads GTEP part 2, table 3.9, 199

Table 11 Estimated Site Compound Vehicle Movement

Load Element	Vehicle Type	No. of truck movements
Concrete aggregates for footings	Truck Trailer	580
Reinforced steel for footings	Semi-Trailer	87
Other concrete supplies for footings (sand/cement)	Truck Trailer	387
High voltage cable rolls	Truck Trailer	58
Turbine Blades	OSM	87

Turbine Nacelles	OSM	29
Turbine Cooling Towers	OSM	29
Turbine Hubs	OSM	29
Tower Sections	OSM	145
Cranes / heavy equipment	Unspecified	58
Total		**1,489**

Table 12 Estimated Construction Materials

Load Element	Vehicle Type	No. of truck movements
Road Pavement	Truck Trailer	700
Road Subgrade	Truck Trailer	2,100
Substation Area Gravel	Truck Trailer	67
Laydown Area Gravel	Truck Trailer	500
Batch Plant Area Gravel	Truck Trailer	50
Construction Compound Area Gravel	Truck Trailer	200
Battery Storage & Solar Area Gravel	Truck Trailer	1,400
Operational and Maintenance Facility Area Gravel	Truck Trailer	133
Gravel Materials Sourced Onsite		**65 3,348**
Gravel Materials Imported		**35 1,803**

5.6 Driver Awareness

During construction of the Crystal Brook Energy Park, heavy vehicle volume on the surrounding roads would be substantially elevated from normal levels. For motorists not aware of the Energy Parks construction, it is possible that slow moving heavy vehicles may well be encountered unexpectedly.

While this is a safety issue in itself, there is also the possibility that the low speed of vehicles delivery heavy equipment would also frustrate following drivers into undertaking unsafe passing manoeuvres.

5.7 Operations Phase Traffic Impacts

5.7.1 Operations and Maintenance

The proposed Crystal Brook Energy Park is designed for stand-alone remote operation. It will generally, operate unattended for most of its operational life, and therefore the traffic associated with the long-term operation will be nominal. There are two phases of operation post the construction phase. These include:

- Commissioning and Testing;
- Operations and Maintenance, and
- Decommissioning and Rehabilitation.

During the initial commissioning and testing phase of the respective plants operation, the proposed Crystal Brook Energy Park sites will require attendance by a number of technical and maintenance staff (up to 25 staff) on a daily basis for a period of 3 months. Under normal conditions there will be a single station operator in attendance at site each day to undertake site inspections and maintenance (routine and unscheduled).

It is expected that the routine maintenance activities will require the site to be accessed approximately every 3 months by up to 2 to 3 staff for a period of a week. These people will be in addition to the regular maintenance staff. Any unscheduled maintenance or repairs may require attendance at site by additional specialist personnel and equipment.

Based on the above activities the operational traffic level will be low and primarily consist of light commercial vehicles such as light vehicles and four-wheel drives. Larger equipment may be required for major unscheduled maintenance events such as the replacement of a gearbox or turbine component (such as, blade or nacelle) that cannot be repaired on-site.

These would likely be sourced from either Port Adelaide / Adelaide or possibly Port Pirie. Vehicle movements associated with the delivery of equipment to and from Port Adelaide / Adelaide, will be dependent on the equipment being transported and will likely be via the routes discussed in *Section 3*.

Once construction is completed and the wind farm moves into operations phase, traffic generation would be greatly reduced. Traffic generated during operations would consist of the following:

- Operations personnel travelling to the wind farm on a daily basis
- Routine inspection and maintenance teams travelling to the wind farm on a fortnightly to monthly basis

- Heavy maintenance or repair deliveries arriving at a maximum once per year. Dependant on the type of maintenance or repair, this may result in heavy or over dimensional vehicles travelling to the wind farm site.

Given that traffic volume generated by the Crystal Brook North Wind Farm during operations would be greatly reduced compared to the construction phase, it is anticipated that operational traffic impacts would be minimal.

5.8 Decommissioning Phase Traffic Impacts

At the end of the operations phase (usually 30 years) a decision is made to either erect new turbines on the site or to formally decommission the property assets and remove the existing turbines and other plant and equipment and rehabilitate the site.

Whether new turbines are erected or the site decommissioned and rehabilitated both options will likely require the removal of the proposed wind turbine infrastructure. The traffic impacts would likely be similar or slightly less to the construction phase, as the need to construct the concrete foundations and access tracks will not be required.

The traffic generation and associated impacts will need to be assessed at the time of decommissioning, as the traffic conditions on the surrounding road network would likely be altered over a 30-year period.

6. Transportation Requirements

6.1 Introduction

The equipment transport requirements for the Crystal Brook Energy Park will vary during the different phases of the project. The construction phase will generate the most traffic, particularly heavy vehicles, in order to deliver the infrastructures components (equipment and materials) associated with the proposed development.

The operational phase will primarily consist of employee movements associated with the day-to-day operation of the site. The infrastructure components associated with the proposed Energy Park site includes the following below, but is not limited to:

- Wind turbines and associated equipment (nacelles, hubs, blades);
- Wind monitoring masts facility;
- Additional power station plant to enable hybrid operation (substation and transformers);
- Solar Panels;
- Transmission infrastructure (underground cabling, new 275kV transmission line); and
- Internal access tracks and roads;

It is likely that semi-trailer vehicles would be able to transport some of the construction materials and equipment to the site. Over-dimensional / over-mass permits will likely need to be obtained through the National Heavy Vehicle Regulator (NHVR) and DPTI for delivery of some of the wind turbine components.

Typically, restrictions would be enforced for over mass and / over dimensional loads, which may include:

- Travel during daylight only and preferably during off-peak times;
- The use of pilot vehicles for over dimensional and over mass loads to warn approaching road-users that an over dimension vehicle is on the road;
- The use of police escorts for over dimensional loads to ensure safe traffic control and movements in and around these large vehicles;
- The use of infrastructure authority escorts to lift overhead wires for high loads; and
- The implementation of speed restrictions for over mass loads while travelling along bridge structures.

Where Council owned roads are to be utilised for transportation of equipment, an agreement may need to reached between the Port Pirie Regional Council and Neoen Australia Pty Ltd to establish maintenance responsibilities of the road during the construction period.

It is anticipated that some personnel during construction and operation phases may well commute to/from the township of Crystal Brook.

6.2 Equipment Specifications

During the construction phase of the Energy Park, the delivery of the wind turbine components and substation transformers will have the most significant impact on the road network due to the size and weight of equipment. A large portion of equipment associated with the proposed wind farm will exceed South Australia's (and the majority of states throughout Australia) over mass and over dimensional vehicle limits as defined in **Table 13**.

Table 13 South Australia s Over Mass Over Dimensional Vehicle Limits

Over Mass Limit	Over dimensional Limits		
	Width (m)	Height (m)	Length (Prime mover trailer)
42.5 t	2.5 m	4.3 m	19 m

6.2.1 Wind Turbines

The turbines proposed will have a maximum height of up to 140 m (at the blade tip), comprising towers of approximately 85 m and blades of approximately 55 m. Each wind turbine comprises of the following (as indicatively shown in

Figure 17 Principal Heavy Vehicle OMD Routes providing access to the proposed site, from east of the Victorian/South Australian Border

28):

- 3 blades (55 m long);
- 1 nacelle (delivered in 2 sections);
- 4 tower sections; and
- 1 turbine hub.

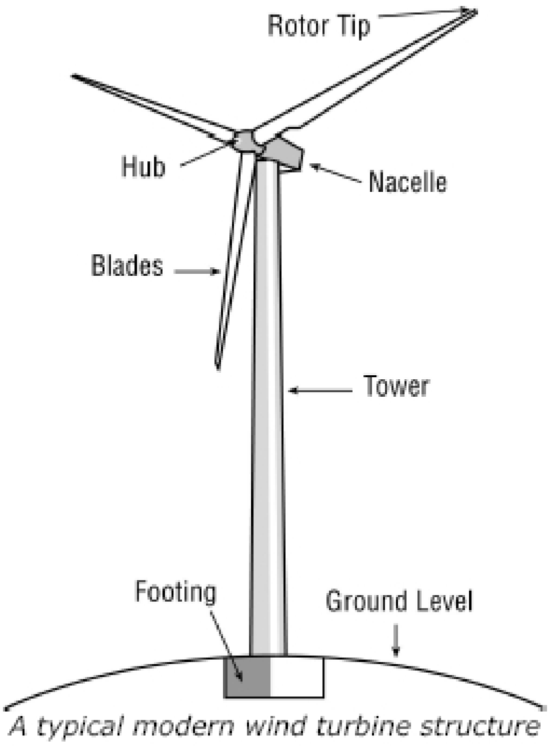


Figure 28 A Wind Turbine Structure

To facilitate transportation and ease of installation of these large items, each item will be delivered to the proposed wind farm as single packages.

The approximate weight and dimensions of the individual wind turbine components are summarised in **Tables 14 15**. Also, highlight that all components will need an over mass, either over dimensional or both permits to be obtained by the relevant road authorities prior to delivery.

Table 14 Pressumed approximate weight and dimensions of the wind turbine components

Component	Height (m)	Length (m)	Width (m)	Weight (Tonnes)	Over dimensional	Over Mass
Nacelle	3.4	12.8	4	70	✓	✓
Hub	3.74	5.42	3.75	70	✓	✓
Blades	4	62	-	5.5-6.5	✓	

Table 15 Pressuemd approximate weight and dimensions of the 100m tower components

Component	Min Diameter (m)	Max Diameter (m)	Length (m)	Weight (Tonnes)	Over dimensional	Over Mass
Top	2 - 2.5	3 - 3.5	25 - 35	30 - 35	✓	
Middle Upper	3 - 3.5	3.5 – 4	25 - 30	45 - 50	✓	✓
Middle Lower	3 - 3.5	3.5 – 4	25 - 30	45 - 50	✓	✓
Bottom	3.5 - 4	4.5 – 5	15 - 20	40 - 50	✓	✓

6.3 Wind Farm Development Phases

6.3.1 Construction Phase

As discussed previously, the construction phase of the project is anticipated to be a 12 month process, and will have the most significant impact, in relative terms, on the surrounding road network. The principal construction traffic and transport activities that will be carried out during the construction phase include the following:

- Delivery of the wind turbine components. The turbine towers may be produced locally in Australia (from Adelaide or Melbourne) but most likely imported and all other turbine components will likely be imported from overseas;
- Delivery of the substation equipment. The equipment may be sourced locally or imported from overseas depending on the supplier;
- Delivery of other construction equipment and materials. Where possible the construction equipment and materials will be sourced locally; and
- Transport of construction staff (interstate and intrastate).

6.3.2 Over Mass and Over Dimensional Permits

From the above listed transport activities, the main issue will be the delivery of the wind turbine components and on account of the size and weight. As highlighted in **Tables 14 15**, the delivery of this equipment will require either an over mass, over dimensional or both permit(s) to be obtained from the relevant road authorities being DPTI and/or VicRoads for travel on DPTI and/or VicRoads controlled, owned and managed roads.

Each state transport authority, as part of its permit approval process independently undertake an assessment of the adequacy of the road infrastructure on the routes proposed and includes sufficiency assessments of infrastructure such as bridge structures and culverts identified on the way.

This may be a factor if interstate transportation from Victoria with options for deviation via the Riverland to link into the Augusta Highway and then down to Crystal Brook via the Wilkins Highway.

It is the transport contractor's responsibility to conduct surveys of road conditions prior to applying for the necessary transport permits. It is usual for the authorities to specify any required precautionary works to be undertaken before carrying out the transport task.

Subsequent disputes on road damage are typically resolved between the transport contractor and the authorities and included in the service fee charges. The final choice of route will be dependent upon what is acceptable to the authorities.

Typical conditions employed for the transport of over mass and / or over dimensional loads include:

- Travel during daylight only and preferably during off-peak times;
- The use of pilot vehicles for over dimensional and over mass loads to warn approaching road-users that an over dimension vehicle is on the road;
- The use of police escorts for over dimensional loads to ensure safe traffic control and movements in and around these large vehicles;
- The use of infrastructure authority escorts to lift overhead wires for high loads; and
- The implementation of speed restrictions for over mass loads while travelling along bridge structures.

Where Council owned local collector roads are to be utilised for transportation of wind turbine equipment, it is recommended that a maintenance agreement be developed between the relevant Council and Neoen Australia Pty Ltd, outlining maintenance and rehabilitation responsibilities.

6.3.3 Delivery Vehicle Types

The type of vehicles accessing the site will be dependent upon the equipment and personnel being transported. The typical transport vehicles employed for erecting the turbines are likely to include the following:

- A low loader trailer system and prime mover for the transport of each tower section as shown in
- **Figure** 17 Principal Heavy Vehicle OMD Routes providing access to the proposed site, from east of the Victorian/South Australian Border
- **29**. With an approximate diameter of 4.5 m and an overall travel height approaching 5 m, attention to overhead clearance will be critical for the movement of the tower sections.

Figure 29 **An example of a low loader trailer system for the transportation of tower sections**

- An example of a typical low loader trailer system and prime mover used for the transport of the nacelles and hubs is shown in
- **Figure** 17 Principal Heavy Vehicle OMD Routes providing access to the proposed

site, from east of the Victorian/South Australian Border

- **30**. Overhead clearance will need to be checked and the significant mass will be a factor with regard to bridge limits and climb grades.

Figure 30 An example of a typical low loader trailer system for the transportation of the nacelle and hub sections

- A semi-trailer in conjunction with a rear wheel steering trailer for the transport of each blade as shown in
- **Figure** 17 Principal Heavy Vehicle OMD Routes providing access to the proposed site, from east of the Victorian/South Australian Border
- **31**. With blades of up to 55 m long, the semi-trailer will likely be approximately 68 m long.

A rear wheel steering trailer is required to facilitate in turning movements for the long load. When assessing the transport route for the blades consideration of allowable bend radius, changes in grade and road alignment on approach to bridges and rail crossings will be critical.

Figure 31 An example of a semi-trailer with rear wheel steering trailer for the transportation of the blades

- A boom truck for transporting the top controller, switch cabinet, transformers and fasteners.
- In addition to the wind turbine components, large cranes will also be required on site to lift the nacelle, hub, blades and tower sections as shown in
- **Figure** 17 Principal Heavy Vehicle OMD Routes providing access to the proposed site, from east of the Victorian/South Australian Border
- **32**. These may require over mass and over dimensional vehicles in order to initially access the site.

Figure 32 An example of a cranes employed to erect a wind turbine

- The substation transformers, weighing approximately 132 tonnes each, will also require the use of a prime mover and large multi-axle low loader trailer for delivery.

6.3.4 Operations Phase

The proposed wind farm is designed to operate without intervention, with each turbine capable of operating independently of all other wind turbines. The operations phase of the proposed wind farm is forecast to be up to 30 years.

A 24 hour monitoring and fault response will be maintained during the operations phase. The vast majority of maintenance during the operations phase will be preventative maintenance that will be undertaken through a schedule that will cycle through all the wind turbines to ensure service intervals are met. In addition to preventative maintenance, some repair work will be required should breakdowns occur.

The principal traffic and transport activities that will occur during the operations phase include the following:

- General staff travel to the proposed wind farm site for regular inspections;
- Routine servicing of wind turbine components;
- Corrective maintenance of wind turbine components;
- Replacement of major wind turbine components
- Parts delivery to and from the proposed wind farm site; and
- Maintenance of roads and access tracks.

6.3.5 Decommissioning Phase

At the end of the operations phase of the proposed wind farm a decision will be made whether to erect new turbines on the site or to formally decommission the proposed wind farm, remove the existing turbines and rehabilitate the site. Decommissioning will be undertaken in accordance with legal requirements, conditions of approval and landowner requirements.

6.4 Port Review

The wind turbine components are proposed to be imported from overseas to Outer Harbour at Port Adelaide on account of its proximity to the proposed Energy Park site. The Outer Harbour port facilities have facilities to handle non-standard containers, such as those associated with the wind turbine equipment. This facility has previously processed wind farm equipment imported from Denmark for the Wattle Point 59-turbine plant on the Yorke Peninsula and the arrival of equipment for the Snowtown 47-turbine plant and Snowtown 2 turbine components) as shown in

To assist with storage of the 45 m blades prior to delivery, Port Adelaide prepared an additional port area of 20,000 m^2 behind number 20 berth.

Wind farm equipment discharged at Port Adelaide.

Figure 17 Principal Heavy Vehicle OMD Routes providing access to the proposed site, from east of the Victorian/South Australian Border

33 below.

Figure 33 Previous Wind Farm equipment delivery to Port Adelaide

6.5 General

All road routes from Adelaide and/or Melbourne are primarily either National Highways or State Roads and, subject to statutory permit conditions, can accommodate the proposed wind farm related over dimensional and over mass vehicles.

A traffic management plan (TMP) detailing the specific route, time of travel, load type and proposed vehicles will need to be prepared in advance of each stage of site construction and will need to be submitted to the NHVR, State and Local Road Authorities, as follows:

- DPTI in South Australia
- VicRoads in Victoria

Local Government jurisdictions will also require notification, i.e. Port Pirie Regional Council in South Australia, before an over dimensional and/or over mass permit can be considered for approval or be issued.

While this study gives consideration to feasible road transport routes, the final choice of route is dependent upon the final delivery location of the wind turbine equipment, the transport contractor selected, the availability and type of vehicles at the contractor's disposal, recommendations in the TMP and the route that is acceptable to authorities.

Neoen Australia Pty Ltd, together with the transport contractor(s), will need to develop alternate transport strategies dependent on the item being delivered and where it is being sourced.

Access to the proposed site will primarily be via the following main transportation routes depending on the location where personnel, equipment, materials are going to and from and include:

- Adelaide to Crystal Brook via Port Wakefield Road and Augusta Highway
- Port Adelaide to Crystal Brook via Port Expressway, Port Wakefield Road and Augusta Highway
- Melbourne to Crystal Brook via Port Augusta (Dukes, Mallee, Sturt, Goyder, Wilkins, Augusta and Stuart Highways)

A site visit was undertaken by GHD on the 12 December 2017, to identify any potential constraints to the preferred site access route(s). Road constraints associated with transporting over dimensional and/or over mass loads include:

- Sharp bends, curved sections and steep grades; and
- Height constraints such as tunnels and bridges; however, none exist in this case, except as mentioned the Heysen Tunnels, Mt Osmond and Crafers interchanges if coming from Victoria.

Where possible, the identified site access route(s) to the proposed Energy Park utilise existing over dimensional and over mass networks for South Australian and Victorian road networks.

6.6 Road Capacity Impact

Shown in

Table 16 Level of Service (LoS) vs AADT for two lane, two way rural roads, assuming rolling terrain and K=0.10 (Austroads GTEP part 2, table 3.9, 199**6** is an extract from the Austroads Guide to Traffic Engineering Practice, part 2 (Austroads, 1999), which provides planning level guidance on the capacity of a two way, two lane rural highway.

Table 16 Level of Service (LoS) vs AADT for two lane, two way rural roads, assuming rolling terrain and K 0.10 (Austroads GTEP part 2, table 3.9, 1999)

Level of Service	A	B	C	D	E
Maximum two-way traffic volume (AADT)	1,100	2,800	5,200	8,000	14,800

Construction traffic would likely peak during pouring of the turbine foundations, with each foundation requiring approximately 80 concrete deliveries at 6 minute headways. Allowing for additional general site activity, it is likely that construction traffic would peak at no more than 100 to 200 vehicles per day.

Existing traffic volumes on each of the roads used to access the Energy Park site are relatively low as shown in Section. Based on the rural highway capacity estimates, traffic volumes on each of the roads would need to grow in the order of thousands of vehicle per day before level of service would be substantially degraded.

As such, the combined traffic generation from the Crystal Brook Energy Park site is not considered that construction traffic generation would have a substantial impact on traffic capacity.

Level of Service (LoS) on the Wilkins Highway (Warnertown – Jamestown Road) Hughes Gap Road (Gladstone – Laura Road) would remain at LoS A. However, slow moving over mass and over dimensional deliveries could potentially result in significant short-term disruptions to local traffic operations, especially at intersections.

Turning volumes were not available for the key intersections which will be used to access Crystal Brook Energy Park. As such, a quantitative assessment of the capacity impact due to additional traffic generation could not be undertaken.

However, because existing two-way volumes on each road are relatively low, it is expected that intersection sufficient absorption capacity will be available to easily accommodate additional traffic generated by the Energy Park.

6.7 Road Pavement Impact

Impact on road pavement due increased heavy vehicle traffic is dependent on the existing road condition and design of the road pavement. Given that construction of the Crystal Brook Energy Park would result in a relatively large and sustained increase in heavy vehicle traffic on the surrounding roads and highways, including the Hughes Gap Road (Gladstone – Laura Road) and Wilkins Highway (B79), especially through “Hughes Gap”.

Therefore, it is possible that some pavement damage will result, particularly on minor, local roads such as Hatters Road and Collaby Hill Road, which will be required to traverse around to and from the Crystal Brook Energy Park site.

7. Management / Mitigation Measures

7.1 Introduction

The principal issues associated with traffic and transport will be during the construction phase of the proposed energy farm, in particular with the delivery of the large items of equipment including the wind turbine components and the movement of construction vehicles and the associated material deliveries.

The potential traffic generated during the operations phase will be nominal compared with existing traffic flows on the surrounding road network.

The following sections discuss the proposed management and mitigation measures for the three key types of traffic generated over the life cycle of the proposed energy farm including:

- Construction traffic;
- Operations traffic, and
- Decommissioning traffic.

7.2 Construction Traffic

The Neoen selected transport contractor will develop the specific traffic management measures as part of the process of obtaining approvals from the relevant state and local road authorities including DPTI, VicRoads and councils located along the defined transport route(s) for the transportation of the necessary equipment, construction vehicles and materials. The proposed management measures would likely include the following:

- **Engaging licensed and experienced transport contractor(s)** who have the required equipment and experience in transport of over dimensional and over mass loads, and have established knowledge and contacts with the relevant road authorities. The transport contractors will generally be responsible, in conjunction with Neoen Australia Pty Ltd, for:

– Obtaining all the required permits for undertaking the transport task, from the responsible authorities;
– Selecting final route, mode of operation and timetable and identifying any modifications required to existing road infrastructure (such as, temporary removal of street furniture, temporary modifications to roundabouts, intersections and access points) as part of obtaining the required permits;
– Complying with over dimensional and over mass permit conditions stated by authorities, including measures such as pilot cars and police escorts and staging of deliveries to meet restrictions on travel times along different routes;
– Phasing of delivery schedules to meet construction requirements, and to ensure deliveries will not overwhelm transport infrastructure, based on the permits obtained from authorities;
– Conducting any surveys and arranging for any pavement and infrastructure inspections prior to carrying out the transport tasks to ensure all roads along the proposed route are suitable; and
– Installing of suitable warning signs and signage at appropriate locations along the route, to alert other transport users of the transportation activities.

- **Developing of a specific Traffic Management Plan (TMP)** to coordinate between the transport contractor programs and ensure that equipment is delivered to the required turbine locations on site with minimal impact on the surrounding road network, adjacent town centre and the local farmers. The TMP would be developed in further consultation with the relevant state and local road authorities to ensure all road safety and traffic issues are addressed and the impacts to the local communities and road users are minimised. The TMP will include:

  – Designated delivery periods, delivery routes and access points to the site for all materials and equipment supplied for different locations around the site;
  – Designated speed limits and load limits specified for heavy vehicle routes;
  – Directional and warning signage on the designated access routes to the site;
  – Designated reserve areas on the construction site for parking, turning, loading and unloading;
  – Appropriate traffic controls and management on site to ensure that vehicles use the designated site access tracks and do not travel off these tracks;
  – Appropriate traffic controls and management on site to ensure that vehicles use the designated wash down areas if applicable;
  – An inspection and maintenance program for the selected access routes and site tracks, to ensure these are kept in an adequate and safe condition; and
  – Controls and management measures to ensure farm stock (sheep and cattle) are not able to escape form the site through access points during construction operations.
- **Developing of a specific Environmental Management Plan (EMP)** to mitigate the impact of transport related activities on-site. The development of the plan would involve close consultation with landowners to ensure their interests are protected. Within the environmental management plan the following key issues would be addressed. These include (but not limited to):

  – Site security;

- Minimisation of seed and weed transport;
- Control of stock; and
- Erosion and sediment control.

- **Designing and constructing the on-site access tracks (new and upgraded)** to ensure that they are safe and suitable for the selected transportation vehicles.
- **Developing and implementing a suitable community information and awareness program** to ensure that residents along the preferred routes are fully aware of the proposed transportation plans, timings and activities.

7.3 Operations Traffic

As mentioned above, during the normal energy farm operation the potential traffic generated by site staff on account of general operational activities (such as, site inspections and maintenance (routine and unscheduled)) would be nominal in comparison with existing traffic flows and therefore it is not considered that specific traffic management measures are required.

7.4 Decommissioning Traffic

The traffic associated with decommissioning the proposed energy farm will be similar to the construction phase and therefore the majority of mitigation and management measures listed in Section 7.5 will apply to the decommissioning phase as appropriate.

7.5 Summary

The traffic and transport management and mitigation measures that would be implemented during the design, construction and operation phases of the proposed wind farm are summarised in **Table 17**.

Table 17 Summary of the traffic and transport management and mitigation measures

Project Stage	Potential Impacts	Management / Mitigation Measures
1. Design		
1.1	Inadequate design of the access tracks and local road network upgrades to accommodate heavy vehicle access, in particular over mass and over dimensional loads.	The condition of the local roads and existing access tracks will need to be assessed prior to start of works. The on-site access tracks and any local road upgrades will need to be designed to accommodate for safe and stable transport activities.
1.2	There may be issues in obtaining pre approval for over mass and over dimensional permits for delivery of the proposed wind farm components from the relevant local and state road authorities.	A specific TMP will be developed for management of all traffic issues during the construction phase. The selected transport contractor(s) and Neoen will need to be consult closely with the relevant local and state road authorities during the development of the TMP and route assessment for obtaining over dimensional and / or over mass permits.
2. Construction		
2.1	The proposed transport routes for heavy vehicle movements, in particular for over dimensional and over mass loads associated with the wind farm equipment deliveries may not be suitable.	Neoen to engage an experienced transport contractor(s) who will be responsible for all aspects of equipment transportation to the site. A detailed desktop analysis of the proposed route and consultation with relevant authorities will be undertaken prior to construction to mitigate risk.

Project Stage	Potential Impacts	Management / Mitigation Measures
2.2	Road deterioration of the access tracks and local roads surrounding the proposed wind farm site may occur due to the large number of heavy vehicle movements, in particular for over dimensional and over mass loads.	Construction contractor to ensure the construction of the on-site access tracks and any local road upgrades are able to accommodate the transport activities during the construction phase. Regular monitoring of road conditions during construction activities will need to be carried out to ensure access roads and access tracks are maintained in safe and adequate condition, with prior agreements achieved with authorities on relevant responsibilities. Regular monitoring of local roads will need to be carried out in conjunction with the local council to ensure they are kept in a safe condition.
2.3	Impacts on the local community and surrounding town centre due to the increased movement of traffic along the proposed development site access routes.	A community consultation program will need to be carried out advising of the transport activities to ensure local residents and businesses are informed on program, timing and management.
2.4	Delays and increased safety issues to road users (including cars, pedestrians and cyclists) may occur with the increased number of heavy vehicle movements, in particular for over dimensional and over mass loads.	Implementation of traffic controls specified in TMP to manage traffic on and off-site to minimise impacts on local traffic flows, pedestrian movements and impacts on site. A safe and secure delivery area within the construction compound will need to be provided for the purpose of facilitating the delivery management and coordination of heavy vehicle movements and accordingly minimise the impacts on the surrounding road network. Delivery of over dimensional and / or over mass loads will need to be scheduled to off-peak times, as far as practicable.
2.5	The following on-site issues may occur due to transport related activities including: • Transport of seeds and weeds; • Erosion and sediment.	Implementation of the site management controls specified in the EMP to address the potential on-site transport related issues. For example, to minimise the impact on vegetation and habitat, as well as weed transport, construction traffic and materials will be restricted to the allocated tracks, set down areas and hardstands, using only wide sections or specific passing areas to manoeuvre around materials and other traffic. Where weed transfer may be of critical concern vehicle wash-down stations can be set up.
3. Operation		
3.1	Unscheduled wind turbine and solar breakdowns and associated maintenance activities may involve the transport of over dimensional and / or over mass loads.	Develop a pre- prepared and approved TMP for maintenance activities (routine and unscheduled). Implementation of the traffic controls specified in the TMP to manage traffic during maintenance activities.
3.2	Road deterioration may occur along the access tracks and local roads due to operational and maintenance activities.	On-going road monitoring during operations to be undertaken, to ensure access roads and site tracks are maintained in safe and adequate condition, with prior agreements with authorities on relevant responsibilities.

8. Summary and Conclusion

The traffic and transport issues arising from the proposed Crystal Brook Energy Park development will have an effect on the daily activities of the local community surrounding the proposed site due to potentially increased traffic delays and noise. This will primarily be on the adjacent landowners and to a lesser extent the township of Crystal Brook.

The primary impact, in terms of road network performance and safety, will be during the twelve (12) month construction period where a relative large number of vehicle movements will be generated over a short period of time.

An issue will be managing the number of heavy vehicles and over dimensional and over mass vehicle movements required for the delivery of the wind and solar components and subsequent equipment and other construction materials.

~~The worst case increase in daily traffic generated has been estimated to occur during the fourth month of development when about 181 trips, including 36 truck trips, 4 semi-trailers, 7 over dimensional and / or over mass trips and 136 car trips. The number of vehicle movements however, will vary on a day-to-day basis depending on the construction activity and works programme.~~

By adopting the identified site access routes, depending on the location of delivery of equipment and materials, and by implementing the management and mitigation measures as discussed in Section 7, the traffic impacts associated with the additional trips generated during the construction phase should be minimised and road safety on the surrounding road network maintained to the highest standard.

Traffic delays can be minimised by providing adequate notification to the local community, restricting over dimensional and / or mass deliveries to off-peak times where practicable and employment of appropriate warning signage and traffic control. The noise disturbance should be relatively minor considering the temporary nature of the traffic, the local population and daily traffic flows on the roads surrounding the site.

The following intersections surrounding the Crystal Brook Energy Park site would likely to be utilised heavily during construction and operational activities:

- Augusta Highway / Wilkins Highway Intersection
- Wilkins Highway / Hughes Gap Road (Gladstone – Laura Road) Intersection
- Hughes Gap Road / Goyder Highway Intersection

A detailed Traffic Management Plan (TMP) and Environmental Management Plan (EMP) will need to be prepared prior to construction in close consultation with both DPTI and VicRoads state road departments and local council's en-route to ensure that the overall impact and disturbance to infrastructure and other road users is minimal.

No major concerns should arise during the operations phase of the proposed Energy Park site as the need to access the site is minimal.

In conclusion, taking into account the current road usage near the proposed Crystal Brook site and the expected increase in traffic, particularly during the construction phase, the impacts from traffic and traffic related activities are not considered to be significant. Where impacts are identified these can be mitigated with sound management and the implementation of a detailed TMP and EMP during construction.

Based on the traffic and transportation assessment undertaken for the proposed Crystal Brook Energy Park, the following conclusions can be made:

- Existing traffic volumes surrounding the wind farm site are relatively low. There will be a substantial increase in heavy vehicle traffic during the construction phase of the project. However, existing traffic volumes are low and it is not expected this additional traffic will have a substantial impact on roadway capacity.
- Due to the substantial increase in heavy vehicle traffic in the area surrounding the proposed wind farm site, there is a risk some motorist may unexpectedly encounter slow moving vehicles. Signs warning motorists to expect slow moving traffic would be erected to manage this risk
- Also resulting from the increased heavy vehicle traffic, there is the potential for road pavement damage to occur during the construction phase. It has been proposed to undertake consultation with DPTI to identify areas most at risk of damage and implement an inspection program to monitor pavement condition.
- Sight distance at the proposed Energy Park site access point is potentially below requirements under the Austroads guidelines. Further assessment to conclusively determine sight distance will be required during the concept design stage. No sight distance issues were found at key intersections within the study area.
- Due to the greatly reduced traffic generation during the operational phase of the project, no significant operational traffic impacts have been identified in addition to construction stage impacts.
- Permits will need to be obtained from DPTI for all vehicles transporting equipment and materials to Crystal Brook Energy Park which are outside the mass and dimension limits of current gazette notices on Port Wakefield Road, Augusta Highway, Wilkins Highway, Hughes Gap Road (Gladstone – Laura Road) and any others.
- Preliminary inspection and measurement of the proposed site access point and key intersections which will be used to access Crystal Brook Energy Park did not reveal any substantial safety or sight distance issues.

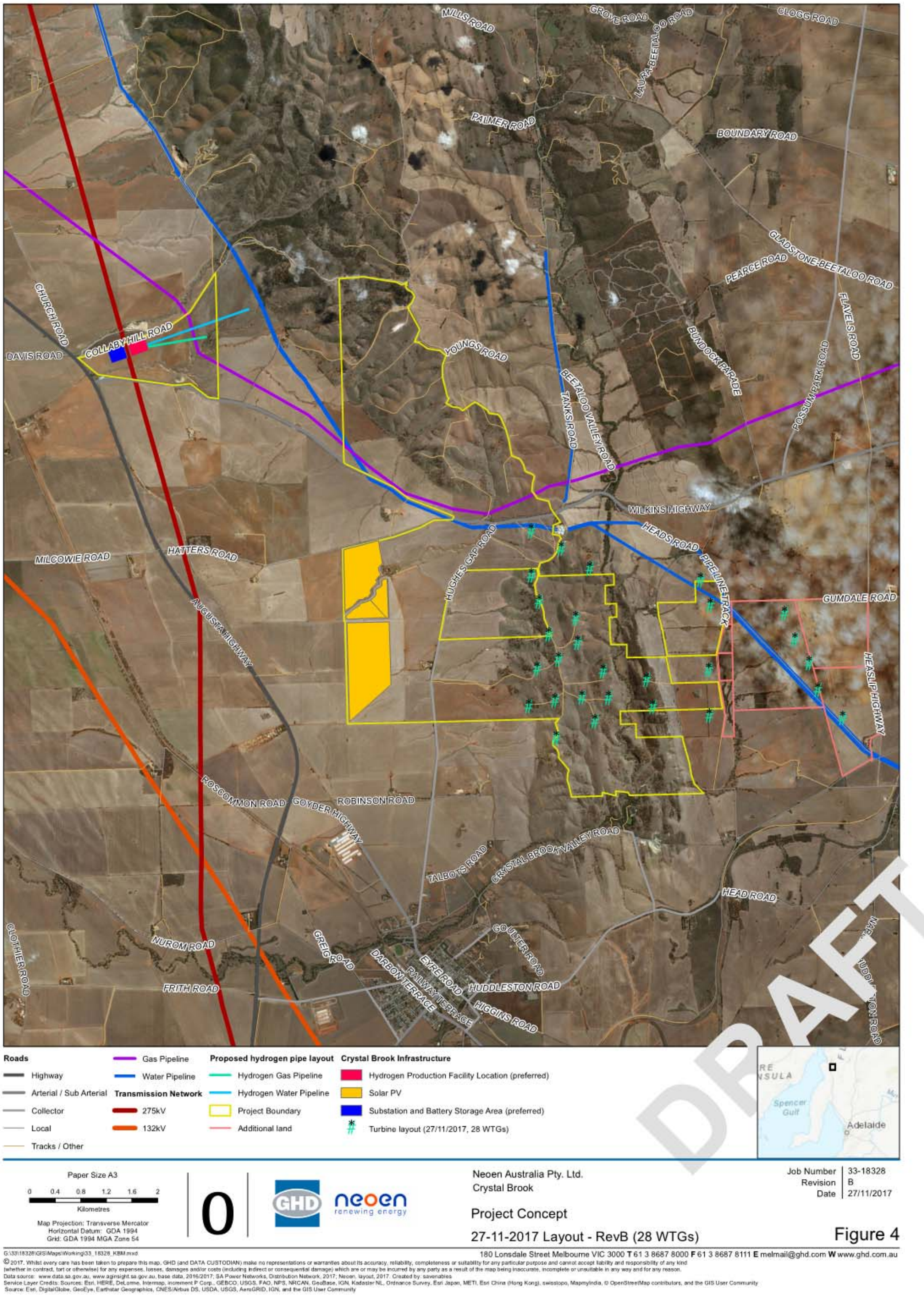
9. Glossary / Abbreviations

Table 18 Glossary of Terms

AADT	Annual Average Daily Traffic
DPTI	Department of Planning, Transport and Infrastructure
MVA	Mega Volt Ampere
RTA	Roads and Traffic Authority
TIA	Traffic Impact Assessment
TMP	Traffic Management Plan
VPD	Vehicles Per Day

Appendix A
Proposed Site Plan

Appendix A – Crystal Brook Energy Park Site



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EMI

Neoen Australia Pty Ltd

Electromagnetic Interference Assessment
Crystal Brook Energy Park

February 2018

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Appendices

1. Introduction

1.1 Purpose of this Report

The purpose of this report is to assess the potential for radio interference effects caused by the proposed wind turbines planned as part of Crystal Brook Energy Park. The solar and battery storage elements of the Energy Park are not expected to cause any EMI issues to existing telecommunications services.

The proposed Crystal Brook Energy Park is located north of the town of Crystal Brook, as shown in the drawings in Appendix A.

This report assesses potential electromagnetic interference caused by the proposed wind farm and identifies mitigation measures where required. Services identified within a 40 km radius of the wind farm included:

- Fixed point-to-point microwave radio systems,
- Digital Television Broadcast,
- Aircraft Telecommunications Systems,
- Maritime Radio Systems,
- Defence Radio Systems,
- Meteorological Radar,
- AM/FM Radio Broadcast, and
- Cellular Mobile Phone Systems.

The impact of 50Hz electromagnetic radiation is also considered in this study.

1.2 Abbreviations

The following abbreviations have been used in this report:

Table 1 Definitions

Abbreviation	Definition
ACMA	Australian Communications and Media Authority
BoM	Bureau of Meteorology
CBEP	Crystal Brook Energy Park
FM	Frequency Modulation
GHz	Giga-Hertz (10^9)
kHz	Kilo-Hertz (10^3)
LMR	Land Mobile Radio
MHz	Mega-Hertz (10^6)
PTP	Point to Point
PTMP	Point to Multi-Point

1.3 References

Table 2 References

Ref No	Reference
1	Visiwave™, http://www.vias.org/wirelessnetw/wndw_04_08b.html
2	Rat River Technologies, http://www.ratrivertech.ca/archives/tools/fresnel_zone_clearance_calculator.htm
3	Fixed-Link Wind Turbine Exclusion Zone Method, D F Bacon, Radio Communications Agency
4	Kordia, Manhinerangi Wind Farm EMI Report
5	International Telecommunications Union Recommendation ITU-R BT.1893, Assessment of impairment caused to digital television reception by a wind turbine
6	Draft National Wind Farm Development Guidelines, July 2010
7	ARPANSA Base Station Survey – Base Station Frequency Bands http://www.arpansa.gov.au/RadiationProtection/BaseStationSurvey/spectra.cfm, 9 Feb 2017

2. Electromagnetic Interference Theory

Electromagnetic fields are a combination of electric fields associated with a voltage source and magnetic fields associated with current flowing through a conductor. These fields increase in strength with voltage and current.

Radio system interference may occur when a wind turbine is located in such a way as to induce an unwanted disturbance to radio waves propagated between a signal source and signal receiver. This may occur by way of radiation of electromagnetic energy by the turbine within the operating band of the radio system, diffraction or partial reflection of the radio system signal by the turbine tower and rotor.

The following sections briefly describe the various types of interference that may impact on existing operational telecommunications services in the vicinity of Crystal Brook Energy Park to provide context to the specific findings noted in Section 3 of this report.

2.1 Radiation of Electromagnetic Energy

Electromagnetic interference potentially occurs when the wind turbine electrical infrastructure radiates energy with a frequency within the operating frequency of a radio communications system.

Turbines supplied within Australia are required to be compliant with electromagnetic compatibility as defined in relevant Australian Standards. As a result of complying to these standards, the electromagnetic interference due to radiation is negligible.

2.2 Diffraction

Diffraction occurs when the wind turbine infrastructure is positioned such that the signal of a radio communications system is partially or temporarily blocked causing a reduction in the signal power at the radio signal receiver.

For point-to-point radio systems it is understood that the radio signal travels on a path between the signal source and signal receiver defined by an ellipsoid area known as the Fresnel zone.

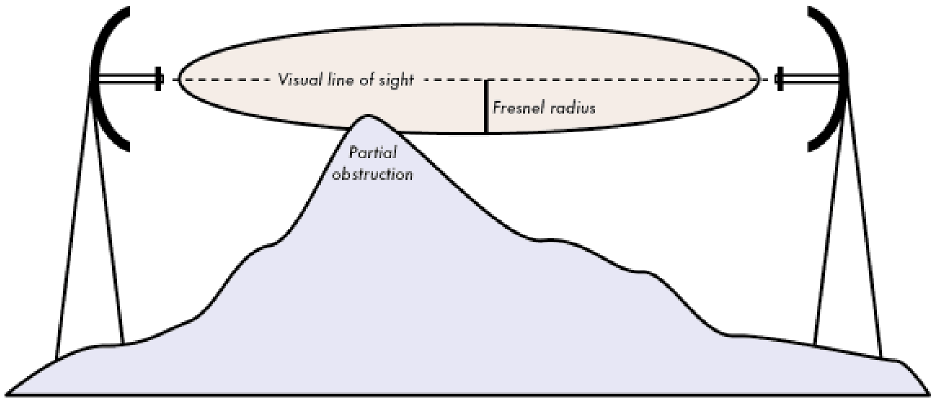


Figure 1 Fresnel Zone over the Radio Path

[Ref 1]

The Fresnel zone is defined as the locus between two points, such as a radio transmitter and receiver, where the indirect ray path length from the point T to point R is multiple of the half-wavelength distance of the radio signal. Refer to Figures 2 and 3 for further details.

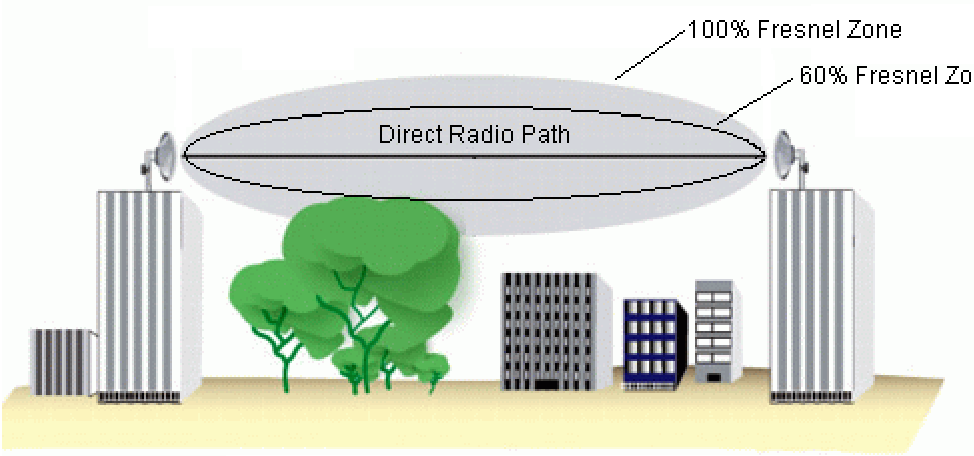


Figure 2 Fresnel Zone Clearance Criteria

[Ref 2]

In the presence of an obstruction between the signal source and the signal receiver, it is generally accepted that an obstructed path provided with 60% clearance of the first Fresnel zone will operate without degradations to the communications system.

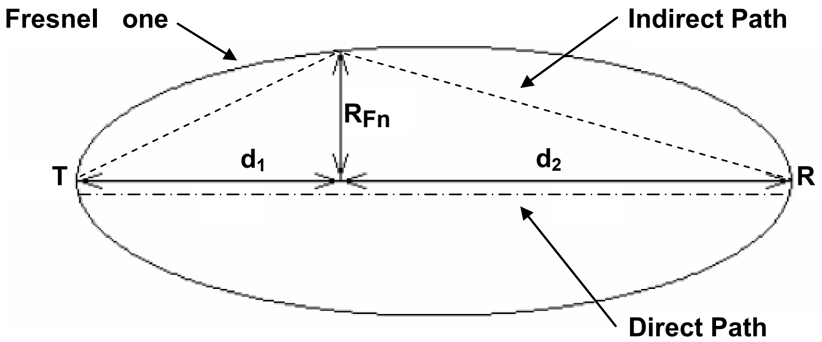


Figure 3 Fresnel Zone Calculation

[Ref 3]

The Fresnel zone is defined by the formula

$$R_{Fn} = \sqrt{\frac{n\lambda d_1 d_2}{d_1 + d_2}} \qquad (1)$$

R_{Fn}	= the nth Fresnel Zone Radius in metres
n	= the nth Fresnel zone
λ	= the wavelength of the transmitted signal in metres
d_1	= the distance from T in metres
d_2	= the distance from R in metres

F1 may be used to describe the first Fresnel zone between two points. F1 may also be described as the 100% Fresnel zone. In this case, F2 is the second Fresnel zone or the 200% Fresnel zone.

According to D F Bacon *[Ref 4]* it is recommended to design the geographic wind turbine layout such that all infrastructure including turbine blades are located outside the second Fresnel zone of all point-to-point radio systems.

The second Fresnel zone defines the region where an object such as a wind turbine may cause a reflected signal to be transmitted to the receiver at a half wavelength (180°) out of phase with the direct ray causing maximum interference potential.

The drawings included in Appendix A plot the ray-line (direct line of sight) and the second Fresnel zone for selected (high-risk) links.

2.3 Reflection

Reflection occurs when the wind turbine infrastructure is positioned such that the incident ray of a radio communication system is partially or temporarily reflected from its normal path of propagation. The complex geometrical design of the wind turbine causes the reflected signals to be dispersed or 'scattered' over a wide angle. These reflections have the potential to generate destructive interference to the radio signal resulting in signal power reduction or unwanted duplication of the radio signal as seen in Figure 4.

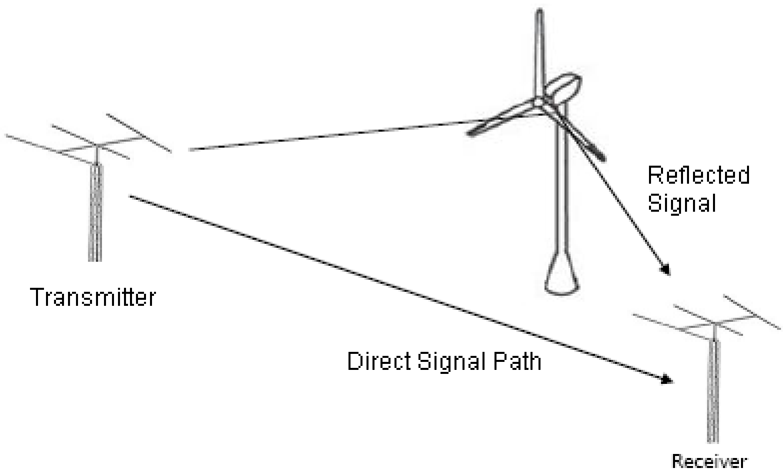


Figure 4 Reflection of Radio Signals by Wind Turbine Infrastructure

[Ref 4]

At the boundary of the second Fresnel zone, any reflected wave will be 180° out of phase with the direct signal, which can lead to cancellation effects at the receiver. As such, any turbine located along (and near) the F2 boundary has the potential to significantly degrade a radio link.

2.4 Scattering

Wind turbines have been observed to cause interference by scattering the incident signal. Scattering is described as either 'forward' or 'back' and is depicted in Figure 5 below.

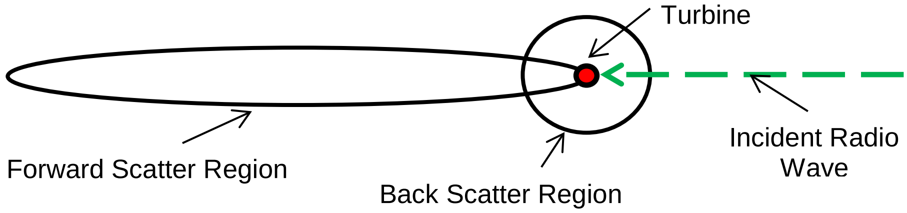


Figure 5 Scattering of Radio Signals by Wind Turbine Infrastructure

The forward scatter region is significant and can extend as far as 5 km forward of the wind turbine. Where the receiver is in direct line of sight of a turbine, but shielded from a direct signal from the transmission tower, the forward scatter region may extend beyond 5 km. The back scattering region created by the incident signal is generally less than 1 km from the turbine.

2.5 Near Field Effects

Wind turbine infrastructure located close to a radio communication system such that the separation distance is within the near field of the radiating antenna has the potential to detrimentally affect the normal radiation pattern of the antenna causing unwanted signal power reductions to the radio system service area. The result is an alteration of the antenna's impedance. The near-field exclusion zone is typically less than 200 m for microwave radio systems.

3. Analysis of Development Impact

3.1 Methodology

3.1.1 Radio System Search

A search was conducted on the Australian Communications and Media Authority (ACMA) radio communications database in February 2018 to identify all licensed radio systems, with operating frequencies above 30 MHz, within 40 km of the proposed Crystal Brook Energy Park precinct.

The results of the ACMA radio communications data extraction were reviewed and presented in graphical format depicting the radio site locations and ray-lines of the radio systems within the vicinity of the wind farm. The map was refined to only show those radio sites and services with the potential impact for radio-interference caused by the proposed Crystal Brook Wind Farm.

The resulting map (and subsequent zoomed sections in the vicinity of the wind farm site) is presented in Appendix A.

3.1.2 Assumptions

Based on information provided by Neoen, turbines are assumed to have a maximum height of 240 m and comprising blades of approximately 79 m length.

3.1.3 Radio Technology Review

The following radio system technologies were considered in this assessment:

- Fixed point-to-point microwave radio systems,
- Fixed point-to-multi point systems,
- Land Mobile Radio systems,
- Digital Television Broadcast,
- Aircraft Telecommunications Systems,
- Maritime Radio Systems,
- Defence Radio Systems,
- Meteorological Radar,
- AM/FM Radio Broadcast, and
- Cellular Mobile Phone Systems.

Radio services below 30 MHz, including AM Radio Broadcast services, were excluded from this assessment as the propagation characteristics of the radio wave does not rely on direct-ray transmission characteristic between the transmitting and receiving antennas, e.g. AM radio broadcast services, operating within the Medium Frequency band of 300Hz-3kHz, relies on ground wave (surface wave) propagation.

3.2 Fixed Point-to-Point Microwave

There are numerous microwave radio systems of interest that operate within the vicinity of the proposed wind farm, as shown in the drawings in Appendix A. The ray line of each system not extending outside of the study area has been indicated.

Table 3 lists the three microwave radio systems identified as passing through, or adjacent to, the wind farm and solar farm areas. For these links, the 200% Fresnel zone (second Fresnel zone) has also been indicated on the point to point link drawings.

Table 3 Microwave Radio Systems

Licence No.	Licensee	Radio Site A	Radio Site B	Operating Frequency
1193638	South Australian Water Corporation	SA Water Depot Eyre Rd, CRYSTAL BROOK (305015)	Broadcast Australia Site TV Track, THE BLUFF (24650)	404.65 MHz 414.1 MHz
9966954	5AU Broadcasters Pty Ltd	Broadcast Australia Site TV Track, THE BLUFF (24650)	5AU STL Mast 1142 Georgetown-Huddleston Rd HUDDLESTON (141423)	451.325 MHz 460.825 MHz
1954253	5AU Broadcasters Pty Ltd	Telstra 20m Tower, Broadcast Australia Site TV Track, THE BLUFF (24637)	5AU STL Mast 1142 Georgetown-Huddleston Rd HUDDLESTON (141423)	847.4 MHz

The two 5AU Broadcasters Pty Ltd owned services traverse close to turbines 14 and 18, however are sufficiently far away from turbines to experience any noticeable signal degradation.

The SA Water link to their Crystal Brook depot passes over the proposed solar farm location. Care will be required to avoid interrupting these services during construction (i.e. temporary obstruction due to crane arms). It is not expected that the final build will have any object sufficiently tall to interfere with the radio links.

3.3 Point to Multipoint Services

One point to multipoint transmission site of concern has been identified, which is approximately 4.6 km away from the wind farm.

Table 4 Point to Multipoint Sites

ACMA Site No.	Location (AMG66)	Site Name	Licensee(s)	Operating Frequency
9000152	Mt Zion 9.5 km NE WARNERTOWN	PORT PIRIE - PETERBOROUGH	SA Water	461.725 MHz 452.225 MHz

GHD have attempted to liaise with SA Water to determine if there will be any impact on their point to multi-point system, as the receiving ends are not listed in the ACMA radio communications database. To date, SA Water have failed to respond to emails regarding this matter

3.4 Land Mobile Radio Systems

No land mobile radio base-station sites of concern were identified during the radio services search as outlined in Section 3.1. Interference to land mobile radio coverage by the proposed Crystal Brook Energy Park is anticipated to be minimal, as the only LMR transmitters within range of the wind farm are localised services and not operating within the wind farm area.

3.5 Digital Television Broadcast

Table 4 lists the television broadcast sites identified during the radio services search as outlined in Section 3.1. The locations of these facilities are identified in the TV and radio broadcast transmitter drawing included in Appendix A.

Table 5 Television Broadcast Services

Callsign	Licence No.	Operating Frequency
Broadcast Australia Site, TV Track, THE BLUFF (Tx Australia) ACMA Site Number: 24650 AMG66: Z54 E235230 N6333444		
SGS40 (Spencer Gulf South Australia / Southern Cross Ten)	1942528	613.5 MHz
SBS41 (Special Broadcasting Service)	1931753	620.5 MHz
GDS42 (Gulf South Australia / Nine Network)	1942529	627.5 MHz
ABC43 (Australian Broadcasting Service)	1957972	634.5 MHz
GTS44 (Gulf Telecasters South Australia / Southern Cross)	1384236	641.5 MHz

Wind farms have the potential to cause signal degradation to TV reception due to scattering, diffraction and near field effects. Digital TV is not susceptible to visible “ghosting” degradation as was experienced with analogue broadcasts; any impact of reflections from the turbines would be a minor reduction of coverage at the limit of the service area.

The zone of potential interference for a wind farm on digital television broadcast is the resultant total of the effects from the individual turbines. The International Telecommunications Union Recommendation ITU-R BT.1893 *[Ref 7]* states that impacts beyond 10 km from a wind farm are unlikely. The key factors listed by this recommendation that lead to degraded TV reception are when the receiver is already at the fringe of television reception zone and when the receiver is located within approximately 2 km of the wind farm (i.e. in the range affected by back scattering of signals off the turbine). The biggest effect occurs when the receiver is near the wind farm and in line of sight of the turbines but not in line of sight of the TV transmitter.

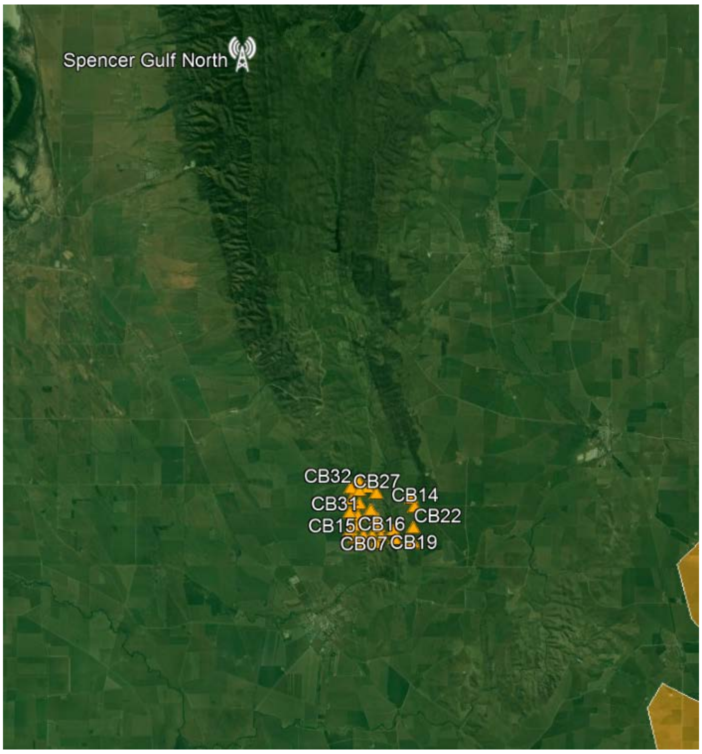


Figure 6 ABC Digital TV Coverage in Wind Farm Area

Note: Signal level information retrieved from http://reception.abc.net.au/

All areas up to 10 km away from the wind farm (i.e. the areas most likely to be affected) currently have a high signal quality, as shown in the figure above using coverage information from the ABC network. A small amount of reception degradation may occur due to the wind farm, but it is likely to have minimal impact.

The impact of the wind farm on digital TV services may be quantified by performing and recording pre and post installation signal level measurements in and around the wind farm areas; however, the mitigation measures remain the same.

3.6 AM / FM Narrowcast and Broadcast

The following FM Radio services were identified within 40 km of the proposed Crystal Brook Wind Farm development area. Services nominated as narrowcast are typically low powered services located within their respective townships for local service only (no applicable services have been identified). Services nominated as broadcast are typically high-powered services for wider area coverage.

Table 9 lists the FM broadcast radio services identified during the radio services search.

Table 7 AM / FM Broadcast Services

Callsign	Licence No.	Operating Frequency
Broadcast Australia Site, TV Track, THE BLUFF (Tx Australia) ACMA Site Number: 24650	AMG66: Z54 E235230 N6333444	
5PNN	1189260	102.7 MHz
5JJJ	1152238	103.5 MHz
5ABCFM	1198424	104.3 MHz
5AUU	1384942	105.9 MHz
5ABCRN	1198434	106.7 MHz
Community Radio Broadcasters Site, THE BLUFF (Pirie Community Radio B casters) ACMA Site Number: 305536	AMG66: Z54 E235274 N6333213	
5TRX	1170708	105.1 MHz
Radio 5AU Broadcasters Site, HUDDLESTON (5AU Broadcasters) ACMA Site Number: 152608	AMG66: Z54 E246405 N6309080	
5AU	10285559	1044 kHz
Broadcast Australia Site, Crystal Brook (Australian Broadcasting Corporation) ACMA Site Number: 24593	AMG66: Z54 E244303 N6306935	
5CK	1198408	639 kHz

Overseas and local experience indicates that radio reception is unlikely to be affected by operating wind farms. The majority of FM services transmitting in the vicinity of the wind farm are narrowcast services not focussed on servicing the wind farm area.

Broadcast FM services are in a low frequency range and hence they are more resilient to disturbances. There is a minor chance of signal degradation for services broadcast from The Bluff for receivers in the immediate vicinity of the wind farm.

3.7 Cellular Mobile Telephone Systems (CMTS) and Wireless Broadband

Details of the closest CMTS and Wireless Broadband sites up to 40 km from the wind farm are included on the cellular and spectrum licence transmitter drawing in Appendix A. These sites operate in the 700MHz, 850 MHz, 900 MHz, 1.8 GHz, 2.1 GHz and 2.3 GHz bands depending on function and licensee. *[Ref 10]*

Cellular mobile phone technologies provide for robust communications in areas of significant obstruction via multi-path communications between customer equipment and the network base station sites. The CMTS services to the immediate area around the wind farm site are provided by three operators (Optus, Telstra and VHA) from multiple base station sites.

Given the prevalence of cellular towers in several directions around the wind farm, interference to cellular phone coverage is anticipated to be minimal except for those users operating in close proximity to the proposed wind farm such as maintenance staff, and potentially for those travelling along Wilkins Highway through the wind farm area.

Wireless Broadband is being rolled out in Crystal Brook and surrounding areas as the preferred service type provided by NBN Co. Some houses in close vicinity to the wind farm may experience a degraded service if they are located near a turbine. If the degradation of the service is too great, Neoen can facilitate a transition to NBN delivery via the satellite broadband service platform.

The impact of the wind farm on wireless broadband services may be quantified by performing and recording pre and post installation signal level measurements in and around the wind farm areas; however, the mitigation measures remain the same.

3.8 Aircraft Navigational Systems

One aeronautical service has been identified in the licence database. The Airservices Australia transmitter is located approximately 14.5 km away from the nearest turbine for the Crystal Brook Wind Farm. The transmitter at The Bluff is used for the CTAF (common traffic advisory frequency) for Peterborough Airport.

Table 8 Aircraft Navigational Services

ACMA Site No.	Location (AMG66)	Site Name	Licensee(s)	Operating Frequency
24650	Z54 E235230 N6333444	Broadcast Australia Site, THE BLUFF	Airservices Australia	123.9 MHz

Wind farms have the potential to disturb the navigational signals, which can distort the accuracy of the aircraft positioning systems and/or introduce ‘false targets’. It is not expected that the Crystal Brook Energy Park will cause issues due to the distance from Peterborough Airport and on the basis that closer wind farms, including Hornsdale, have not caused any issues for this service.

3.9 Maritime Radio Systems

Since the wind farm location is not sited between the transmitter location identified (The Bluff) and the Spencer Gulf, it is anticipated that there will be no impact upon Limited Coast Assigned System maritime services caused by the wind farm development.

Table 9 Maritime Radio Services

ACMA Site No.	Location (AMG66)	Site Name	Licensee(s)	Operating Frequency
24650	Z54 E235230 N6333444	Broadcast Australia Site, THE BLUFF	Department for Transport, Energy and Infrastructure	156.375 MHz 156.8 MHz

3.10 Meteorological Radar

The results of the radio services search indicated that the Bureau of Meteorology does not operate radar facilities within the study area. As there are already operational wind farms closer to the nearest radar station than CBEP, it is not expected that the turbines will cause interference with BoM radar installations.

Figure 7 BoM Radar Stations relative to Wind Farm Area

It is likely that terrain features will intercept the radar signals before they are able to be influenced by the turbines.

3.11 Defence Radio Systems

Defence radio systems are not required to be listed in the ACMA radio communications database.

GHD have attempted to liaise with the Defence Spectrum Office to determine if there will be any impact on Defence radio systems. To date, Defence Spectrum Office have failed to respond to emails regarding this matter.

3.12 50 Hz Radiation

The main sources of electromagnetic fields associated with wind farms are the substations and transmission lines. The transmission line and substation, while not included in this study, will be equivalent to others in the electricity transmission network, with comparable electromagnetic field levels.

The reticulation throughout the Energy Park will be both overhead and underground, with voltages of 33kV and 275kV. Buried cables produce smaller electromagnetic fields than overhead lines.

Designing to the standards utilised by ElectraNet (275kV) and SA Power Networks (33kV) will ensure safe levels of electromagnetic radiation are achieved.

4. Predicted Impact and Mitigation Strategies

4.1 Mitigation Strategies

Table 10 below provides a summary of the potential electromagnetic interference issues due to Crystal Brook Energy Park identified in this report, the respective mitigation measures and suggested recommendations.

Table 10 Summary of Issues, Mitigation Strategies and Recommendations

Technology	Impact	Mitigation Strategy	Recommendation
Fixed PTP Microwave	Minor to no impact anticipated to services.	Nil.	Due to proximity to existing radio link services, continue to review any amendments to the wind farm layout
LMR and Point to Multipoint Services	Potential impact anticipated to SA Water mobile radio services.	Dependent on level of impact (to be determined).	Liaise with SA Water to determine the usage area of mobile radios associated with this transmitter to determine impact.
Digital TV	Potential minor service degradation to local community, i.e. TV reception within 10 km of wind farm may be affected.	Use (wherever practical) of equipment complying with the Electromagnetic Emission Standard, AS/NZS 61000.6.4:2012. Neoen Australia Pty Ltd will commit to addressing and fixing TV signal issues if experienced (potential solutions available include re-orientation of antennas to alternative transmitter sites to achieve higher signal level, upgrade of affected television user infrastructure to include a combination of high performance antennas and signal amplifiers, or offering a satellite television alternative if available).	Neoen Australia may choose to monitor TV signal reception within vicinity of proposed wind farm before and after turbine installations to verify any complaints by local residents
Aircraft Navigational Systems	Minor to no impact anticipated to services.	Nil.	Nil.
Maritime Radio Systems	Minor to no impact anticipated to services.	Nil.	Nil.
Meteorological Radar	Minor to no impact anticipated to weather-watch radar systems.	Nil.	Nil.

Technology	Impact	Mitigation Strategy	Recommendation
Defence Radio Systems	TBC.	TBC.	TBC.
AM / FM Broadcast	Minor to no impact anticipated to services.	Nil.	Nil.
Cellular Mobile Phone Systems	Minor to no impact anticipated to services.	Nil.	Nil.
Wireless Broadband	Potential minor service degradation to local community, i.e. wireless broadband reception within 3km west of the wind farm may be affected.	Use (wherever practical) of equipment complying with the Electromagnetic Emission Standard, AS/NZS 61000.6.4:2012. Neoen Australia Pty Ltd will commit to addressing and fixing wireless broadband signal issues if experienced (potential solutions available include re-orientation of antennas to alternative transmitter sites to achieve higher signal level, upgrade of affected wireless broadband user infrastructure to include a combination of high performance antennas and signal amplifiers, or offering a satellite broadband alternative if available).	Neoen Australia may choose to monitor wireless broadband signal reception within vicinity of proposed wind farm before and after turbine installations to verify any complaints by local residents

4.2 Consultation

The following points of contact have been identified for consultation with the respective organisations:

Table 11 Points of Contact

Organisation	Contact Person	Contact Details
Department of Defence	Glen Odlum	glen.odlum@defence.gov.au
SA Water	Tony Zelipski	tony.zelipski@sawater.com.au

5. Scope and Limitations

This report has been prepared by GHD for Neoen Australia Pty Ltd and may only be used and relied on by Neoen Australia Pty Ltd for the purpose agreed between GHD and Neoen Australia Pty Ltd as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Neoen Australia Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

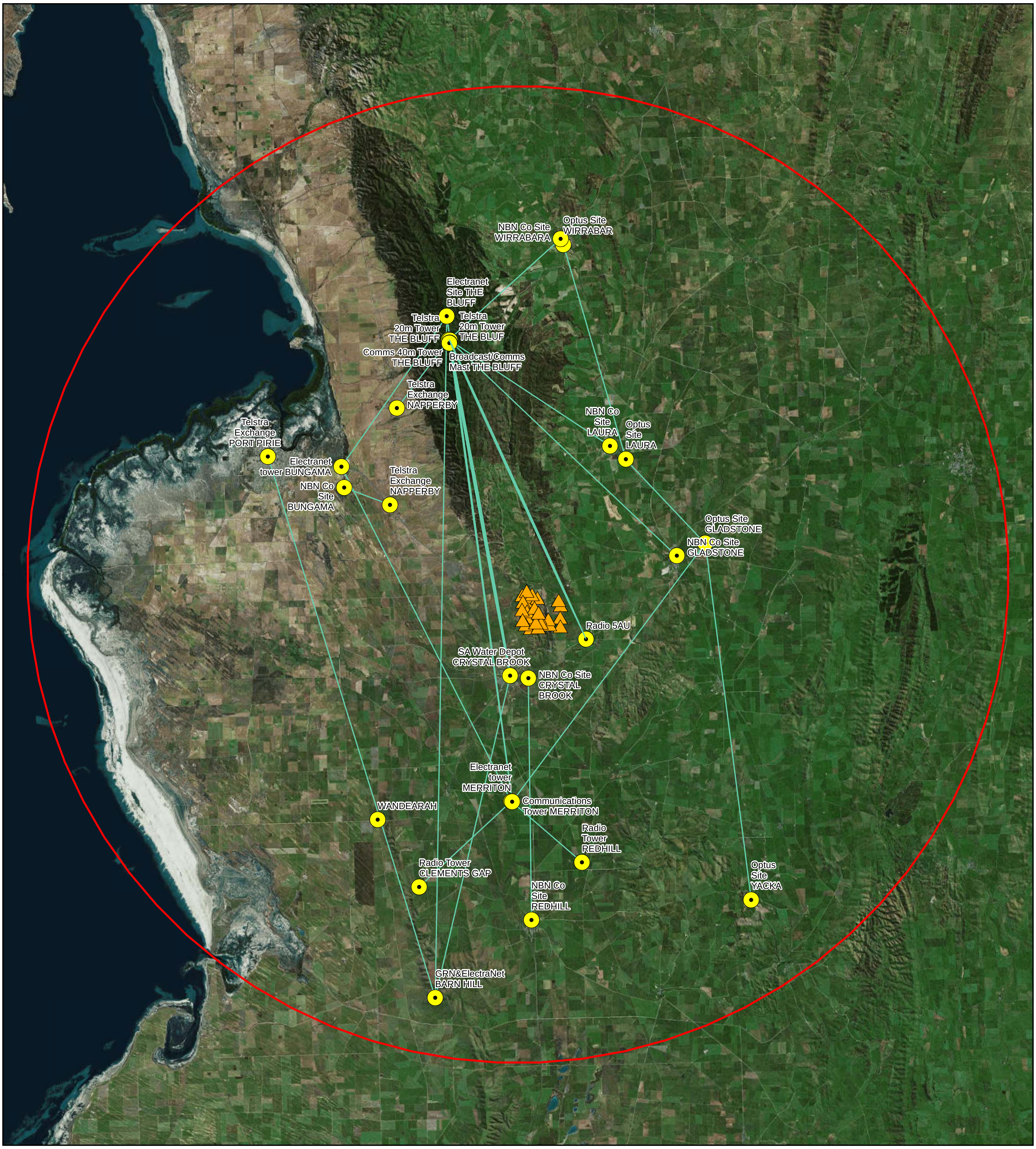
GHD has prepared this report on the basis of information provided by Neoen Australia Pty Ltd, publicly available details on the ACMA radio communications Licence database and information from consultation with other entities impacted by the proposed wind farm, which GHD has not independently verified or checked the information beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Appendices

Appendix A –
Radio Sites & Links in Vicinity of Wind Farm

Contents

- Electromagnetic Interference Study – Figure 1 – Point to Point Transmitters
- Electromagnetic Interference Study – Figure 2 – Point to Point in Wind Farm Vicinity
- *Electromagnetic Interference Study – Figure 3 – [excluded]*
- Electromagnetic Interference Study – Figure 4 – Cellular and Spectrum Licence Transmitters
- Electromagnetic Interference Study – Figure 5 – Mobile Radio or Point-to-Multipoint Transmitters
- Electromagnetic Interference Study – Figure 6 – Radio and Television Broadcast Transmitters
- Electromagnetic Interference Study – Figure 7 – Maritime and Aeronautical Transmitters



40km Study Boundary

Licensed Point to Point Links

Wind Turbine Locations

Telecommunications Site

Paper Size A3

0 2.5 5 7.5 10 12.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Neoen Australia Pty. Ltd.
Crystal Brook

Job Number 33-18328
Revision 0
Date 27 Feb 2018

Electromagnetic Interference Study
Point to Point Transmitters

Figure 1

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180 Lonsdale Street Melbourne VIC 3000 **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com.au

Data source: www.data.sa.gov.au, www.aginsight.sa.gov.au, base data, 2016/2017; SA Power Networks, Distribution Network, 2017; Neoen, layout, 2017. Created by: aldaniele
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

- Licensed Point to Point Links
- Wind Turbine Locations

Paper Size A3

0 0.2 0.4 0.6 0.8 1
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Neoen Australia Pty. Ltd.
Crystal Brook

Job Number	33-18328
Revision	0
Date	27 Feb 2018

Electromagnetic Interference Study
Point to Point Transmitters in Wind Farm Vicinity

Figure 2

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180 Lonsdale Street Melbourne VIC 3000 **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com.au

Data source: www.data.sa.gov.au, www.aginsight.sa.gov.au, base data, 2016/2017; SA Power Networks, Distribution Network, 2017; Neoen, layout, 2017. Created by: aldaniele
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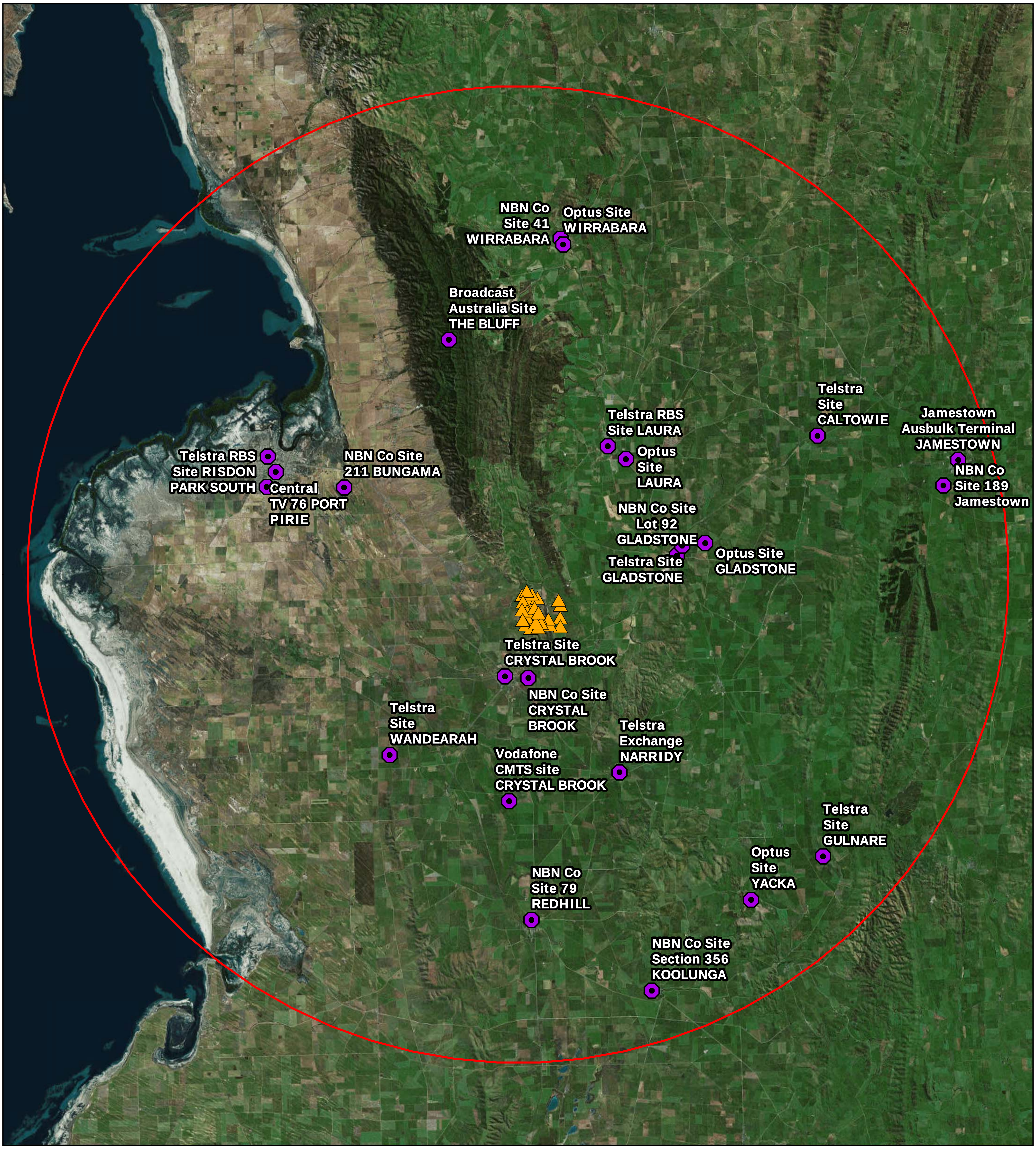
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



40km Study Boundary

Wind Turbine Locations

Mobile Phone Towers

Paper Size A3

0 2.5 5 7.5 10 12.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Neoen Australia Pty. Ltd.
Crystal Brook

Job Number 33-18328
Revision 0
Date 27 Feb 2018

Electromagnetic Interference Study
Cellular and Spectrum Licence Transmitters

Figure 4

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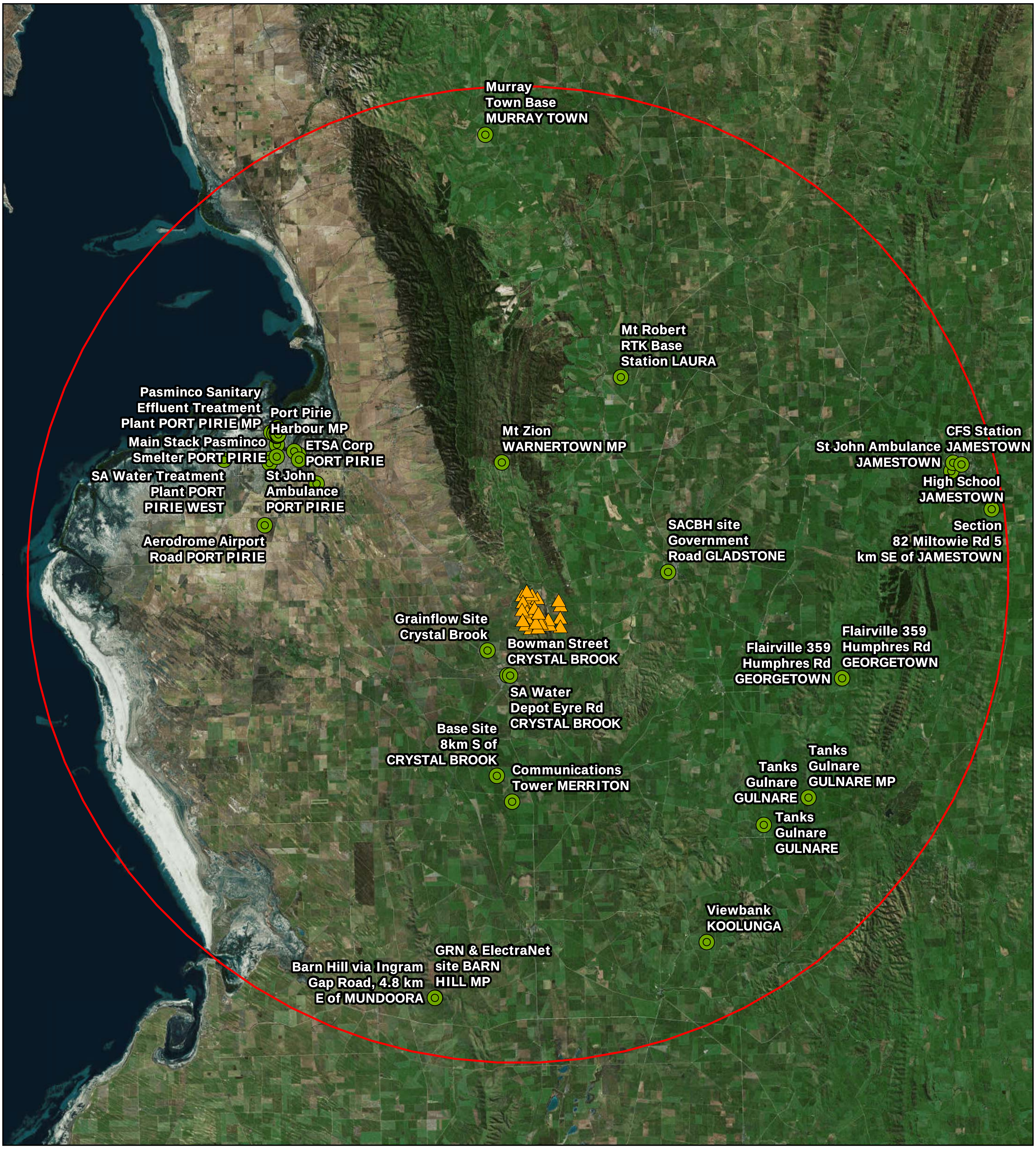
180 Lonsdale Street Melbourne VIC 3000 **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com.au

Data source: www.data.sa.gov.au, www.aginsight.sa.gov.au, base data, 2016/2017; SA Power Networks, Distribution Network, 2017; Neoen, layout, 2017. Created by: aldaniele

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



40km Study Boundary

Wind Turbine Locations

Mobile Radio or Point to Multi-Point Services

Paper Size A3

0 2.5 5 7.5 10 12.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Neoen Australia Pty. Ltd.
Crystal Brook

Job Number 33-18328
Revision 0
Date 27 Feb 2018

Electromagnetic Interference Study

Mobile Radio or Point to Multi-Point Transmitters

Figure 5

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180 Lonsdale Street Melbourne VIC 3000 **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com.au

Data source: www.data.sa.gov.au, www.aginsight.sa.gov.au, base data, 2016/2017; SA Power Networks, Distribution Network, 2017; Neoen, layout, 2017. Created by: aldaniele

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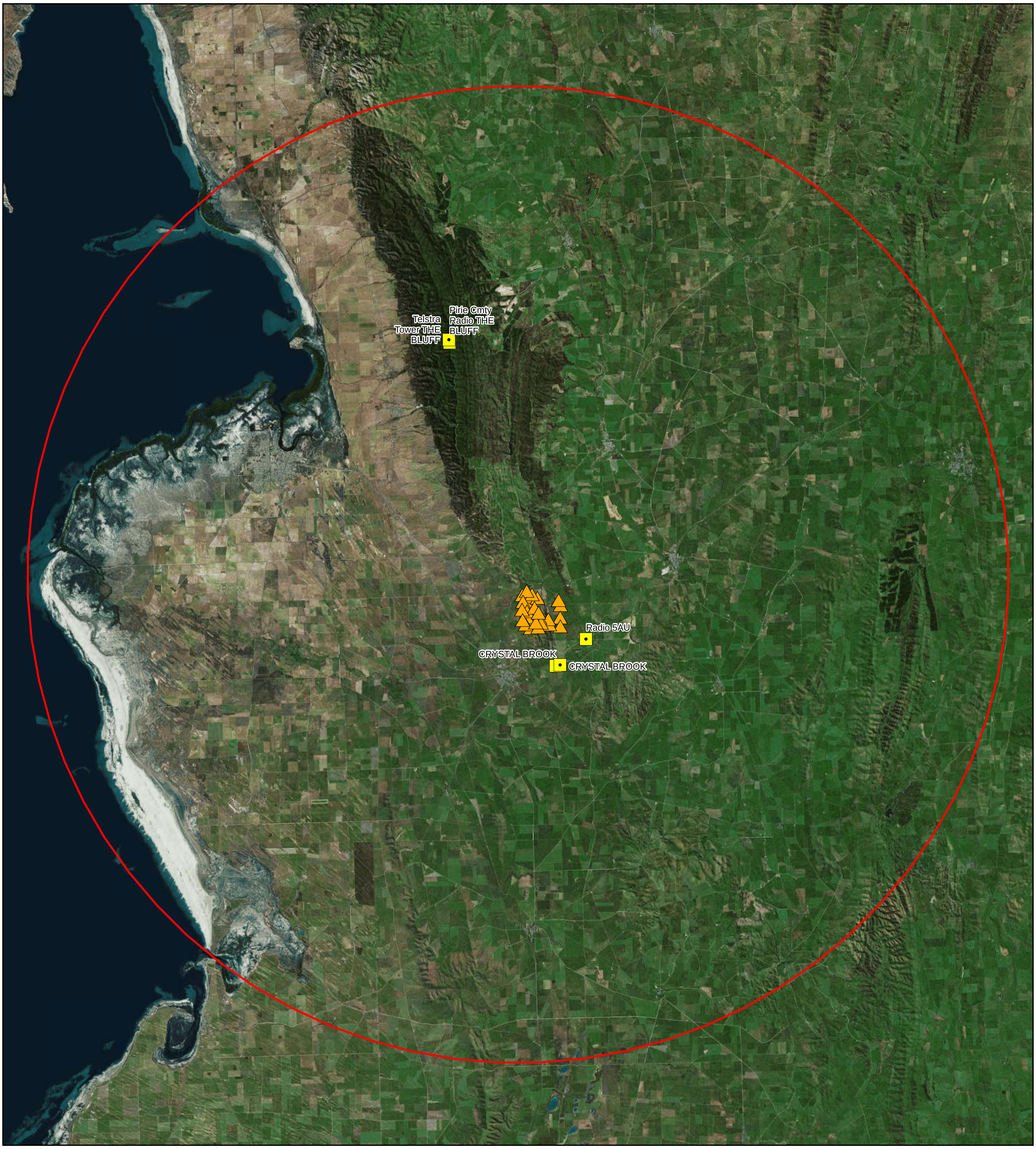

40km Study Boundary
Television/Radio Transmitter
Wind Turbine Locations

Paper Size A3

0 2.5 5 7.5 10 12.5
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Neoen Australia Pty. Ltd.
Crystal Brook

Job Number	33-18328
Revision	0
Date	27 Feb 2018

Electromagnetic Interference Study
Radio and Television Broadcast Transmitters

Figure 6

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Data source: www.data.sa.gov.au, www.aginsight.sa.gov.au, base data, 2016/2017; SA Power Networks, Distribution Network, 2017; Neoen, layout, 2017. Created by: aldaniele
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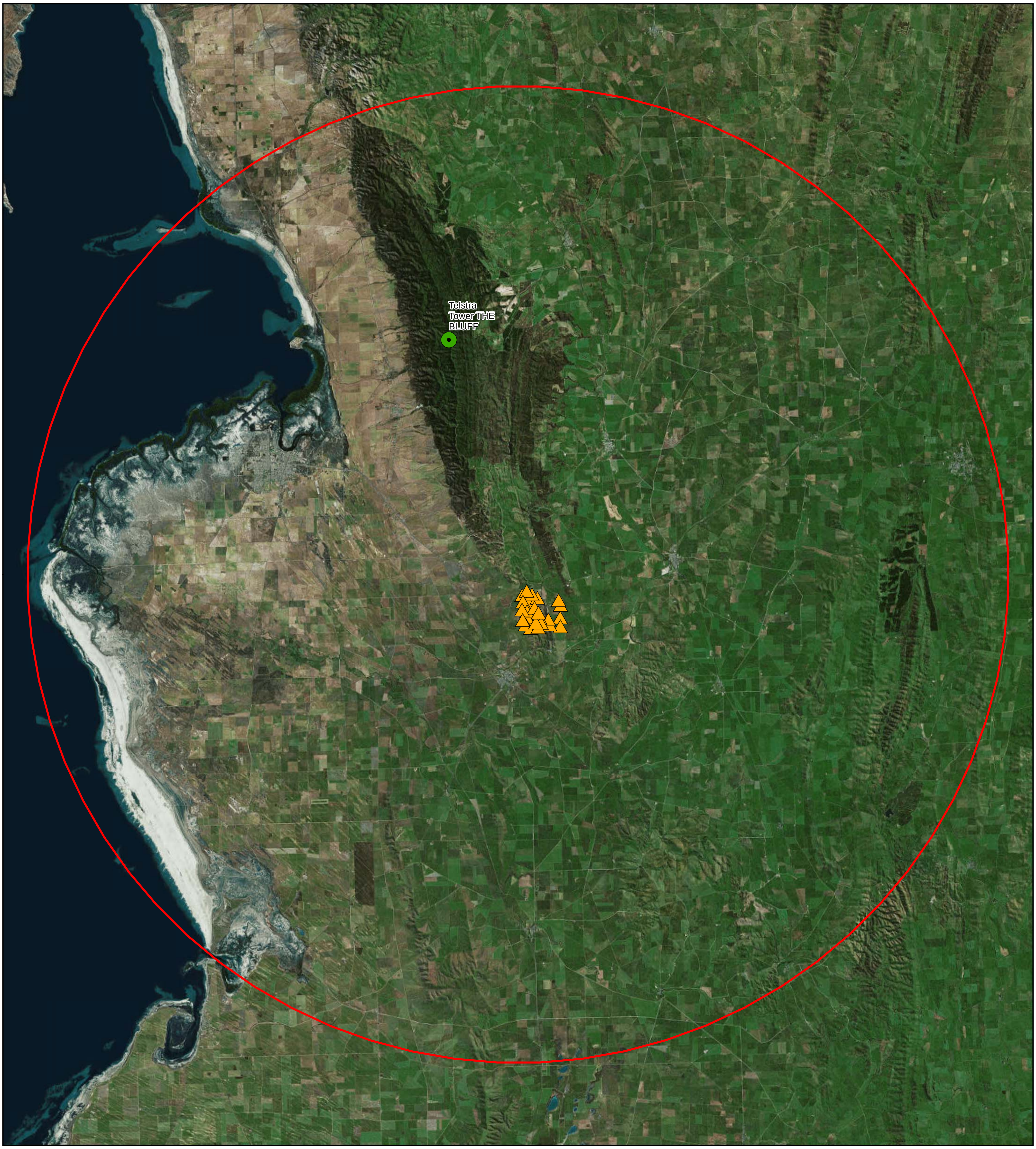

40km Study Boundary
Marine/Aeronautical Transmitter
Wind Turbine Locations

Paper Size A3

0 2.5 5 7.5 10 12.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Neoen Australia Pty. Ltd.
Crystal Brook

Job Number 33-18328
Revision 0
Date 27 Feb 2018

Electromagnetic Interference Study
Marine & Aeronautical Transmitters

Figure 7

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Shadow Flicker

CRYSTAL BROOK WIND FARM

Shadow Flicker and Blade Glint Assessment

Green Bean Design Pty Ltd

Report No.: PP203024-AUME-R-01-B
Date: 28 March 2018
Status: Final

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Task and objective:
Conduct shadow flicker and blade glint assessment for the proposed Crystal Brook Wind Farm.

Prepared by:	Verified by:	Approved by:
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Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	28 Mar 2018	First issue - DRAFT	N Brammer	M Purcell	T Gilbert
B	28 Mar 2018	FINAL issue – no changes	N Brammer	M Purcell	T Gilbert

Table of contents

EXECUTIVE SUMMARY

DNV GL Australia Pty Ltd ("DNV GL") has been commissioned by Green Bean Design Pty Ltd ("GBD" or "the Customer") to independently assess the expected annual shadow flicker duration in the vicinity of the proposed Crystal Brook Wind Farm ("the Project") and any associated impact of blade glint. This report has been prepared according to DNV GL proposal L2C-139302-AUME-P-01-A, dated 24 January 2017, and is subject to the terms and conditions contained in that document.

Regulatory requirements

Shadow flicker involves the modulation of light levels resulting from the periodic passage of a rotating wind turbine blade between the sun and an observer. The South Australian Wind Farms Development Plan Amendment [1] (SA Development Plan Amendment) states that the impacts of shadow flicker on nearby property owners and occupiers, road users, and wildlife should be minimised, but does not provide recommended limits for shadow flicker. The EPHC Draft National Wind Farm Development Guidelines [2] (Draft National Guidelines) recommend a limit on the theoretical shadow flicker duration at dwellings in the vicinity of the wind farm of 30 hours per year, and a limit on the actual shadow flicker duration of 10 hours per year.

This assessment was based on the methodology for assessing shadow flicker durations recommended by the Draft National Guidelines. Calculations were carried out assuming houses had either one or two stories with window heights of either 2 m or 6 m, respectively. The relevant shadow flicker duration at a dwelling was taken as the maximum calculated duration occurring within 50 m of the dwelling.

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

Assessment methodology

DNV GL modelled the shadow flicker based on a 26-turbine layout provided by the Customer [3, 4]. As requested by the Customer, all turbine locations were represented by a hypothetical turbine model with a hub height of 161 m, rotor diameter of 158 m, and tip height of 240 m [5].

The Customer has also provided the locations of 36 dwellings in the vicinity of the wind farm, four of which have been identified as belonging to involved landowners [6, 7]. A high-resolution digital elevation model (DEM) for the site and surrounds were also provided by the Customer [8]. These have been used to determine the theoretical duration of shadow flicker caused by the Project at each dwelling.

The theoretical shadow flicker durations at dwellings (sensitive locations) within and neighbouring the Project have been determined using a purely geometric analysis which takes into account the relative position of the sun throughout the year, the wind turbines at the site, local topography and the viewer. The actual shadow flicker duration likely to be experienced at each dwelling has then been predicted by estimating the possible reduction in shadow flicker duration due to turbine orientation and cloud cover.

Assessment results

The results of this assessment are summarised in the following table.

Summary of shadow flicker assessment results for the Project

Predicted shadow flicker within 50 m of dwelling	Number of dwellings affected	
	Total	Excluding involved dwellings
Predicted theoretical shadow flicker (recommended limit: 30 hours/year)		
Above recommended limit	3	0
Predicted actual shadow flicker (recommended limit: 10 hours/year)		
Above recommended limit	3	0

The methodology proposed in the Draft National Guidelines only considers the impact of shadow flicker above a "moderate level of intensity". To account for the possibility that residents may be annoyed by lower levels of shadow flicker intensity, DNV GL has also assessed the shadow flicker durations for shadow flicker below a "moderate level of intensity". Under these conditions, the shadow flicker durations at one additional dwelling are predicted to exceed the recommended limits.

As the calculation of the predicted actual shadow flicker duration does not consider any reduction due to low wind speed, vegetation, or other shielding effects around each house in calculating the number of shadow flicker hours, the values presented may still be regarded as conservative. Moreover, if the turbine selected for the site has dimensions smaller than those considered here, but still within the envelope specified in Section 1.2, shadow flicker durations are likely to be lower than those predicted.

Conclusion

A shadow flicker assessment has been carried out at all dwelling locations in the vicinity of the Project. The results show that, for the turbine layout and dimensions considered, three dwellings are predicted to experience theoretical shadow flicker durations that exceed the limit recommended by the Draft National Guidelines. When considering the predicted actual shadow flicker duration, which takes into account the reduction in shadow flicker due to cloud cover and rotor orientation, the same three receptors are expected to experience actual shadow flicker durations in excess of the limit recommended by the Draft National Guidelines.

It is noted that the theoretical shadow flicker durations at two of the affected dwellings are very high, with theoretical annual durations reaching approximately 119 hours. Similarly, predicted actual shadow flicker durations of up to approximately 37 hours were modelled for these dwellings.

When shadow flicker intensities below "a moderate level of intensity" are considered, the theoretical and predicted actual shadow flicker durations exceed the limits recommended by the Draft National Guidelines at one additional dwelling. Although the shadow flicker durations at this dwelling are within the recommended limits when assessed according to the Draft National Guidelines, DNV GL recommends that the potential for shadow flicker to cause annoyance at this dwelling be carefully considered.

The prediction of the actual shadow flicker duration presented here does not take into account any reduction due to low wind speed, vegetation, or other shielding effects around each sensitive receptor in calculating the number of shadow flicker hours. Therefore, the values presented may still be regarded as conservative. The effects of shadow flicker may also be reduced through a number of mitigation measures such as the installation of screening structures or planting of trees to block shadows cast by the turbines, the use of turbine control strategies which shut down turbines when shadow flicker is likely to occur, or the relocation of turbines.

Since a non-reflective finish is proposed for the blades of the wind turbines, blade glint is not expected to be an issue.

1 DESCRIPTION OF THE WIND FARM SITE

1.1 The project

The proposed Crystal Brook Wind Farm ("the Project") is located in the South Flinders Ranges in South Australia, approximately 4 km north of the town of Crystal Brook and 4 km west of Gladstone. An overview of the site location is presented in Figure 1.

The Project site is situated on a chain of hills forming a series of ridges and deep gullies at the southern end of the South Flinders Range. A digital elevation model (DEM) with a horizontal resolution of 5 m, extending up to approximately 20 km from the Project boundary, was provided by the Customer [8].

Ground cover on most of the site consists of cleared grassland with scattered patches of trees. A more densely treed area covers the top of the ridgeline to the east of the site.

1.2 Proposed wind farm layout

The turbine layout provided by the Customer [3, 4] is composed of 26 turbines, with turbine base elevations ranging from approximately 214 m to 292 m. An elevation map of the site is shown in Figure 2, and a list of coordinates of the proposed turbine locations are given in Table 1.

As requested by the Customer, DNV GL has modelled the shadow flicker based on a hypothetical turbine model with a hub height of 161 m, rotor diameter of 158 m, and an upper tip height of 240 m [5]. The maximum blade chord length, defined as the dimension through the thickest part of the blade, was specified as 4 m.

1.3 Shadow receptor locations

A list of sensitive locations or shadow receptors neighbouring the wind farm was supplied to DNV GL by the Customer [6, 7]. The coordinates of sensitive receptors within 2420 m of proposed turbine locations are presented in Table 2.

DNV GL has modelled all listed receptors as habitable building structures. It should be noted that DNV GL has not carried out a detailed and comprehensive survey of sensitive land uses and building locations in the area and is relying on information provided by the Customer. Small discrepancies have been observed between the locations given in the list of shadow receptors and satellite imagery for some buildings, as indicated in Table 2, but DNV GL does not expect these differences to affect the conclusions of this assessment.

2 REGULATORY REQUIREMENTS

2.1 Shadow flicker

The South Australian Wind Farms Development Plan Amendment [1] states that:

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

However, the SA Development Plan Amendment does not provide recommended limits for shadow flicker, or a methodology for calculating shadow flicker durations.

Recommendations for shadow flicker limits relevant to wind farms in Australia are included in the EPHC Draft National Wind Farm Development Guidelines released in July 2010 [2]. The Draft National Guidelines recommend that the modelled theoretical shadow flicker duration at a dwelling should not exceed 30 hours per year, 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 a 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 Draft National Guidelines also provide background information, a proposed methodology and a suite of assumptions for assessing shadow flicker durations in the vicinity of a wind farm.

The impact of shadow flicker is typically only significant up to a distance of around 10 rotor diameters from a turbine [9] or approximately 1200 m to 1500 m for modern wind turbines (which typically have rotor diameters of 120 m to 150 m). Beyond this distance limit the shadow is diffused such that the variation in light levels is not likely to be sufficient to cause annoyance. This issue is discussed in the Draft National Guidelines where it is stated that:

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

The Draft National Guidelines therefore suggest a distance equivalent to 265 times the maximum blade chord as an appropriate limit, which corresponds to approximately 1000 m to 1600 m for modern wind turbines (which typically have maximum blade chord lengths of 4 m to 6 m). The Draft National Guidelines further state that *"no assessment is required for residences beyond this distance"*.

2.2 Blade glint

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

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

3 ASSESSMENT METHODOLOGY

3.1 Shadow flicker

3.1.1 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:

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

3.1.2 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.

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

Shadow flicker has been calculated at 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 would be facing a particular direction. The shadow flicker calculations for dwelling locations have been carried out with a temporal resolution of 1 minute; if shadow flicker is predicted to occur in any 1-minute period, the model records this as 1 minute of shadow flicker. 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, an assumption must be made regarding the maximum length of a shadow cast by a wind turbine that will be above a "moderate level of intensity" and therefore likely to cause annoyance due to shadow flicker [2]. The UK wind industry considers that 10 rotor diameters is appropriate [9], while the Draft National Guidelines suggest a distance equivalent to 265 times the maximum blade chord as an appropriate limit.

For the current assessment, DNV GL has implemented a maximum shadow length of 10 times the rotor diameter, or 1580 m, which is the more conservative assumption for the turbine dimensions specified in Section 1.2. 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 annoyed by shadow flicker intensities below the "moderate level of intensity" assumed by this distance limit. To account for this possibility, DNV GL has also assessed the shadow flicker for an increased distance limit of 15 times the rotor diameter, or 2370 m, which includes shadow flicker below a "moderate level of intensity".

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 3.1.4. The third item means that the results generated by the model may be slightly conservative, as there will be some periods of time when the turbines are not rotating, 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 relatively flat area is shown in Figure 3. The geometry of the shadow flicker map can be characterised as a butterfly shape, with the four protruding lobes corresponding to slowing of solar north-south travel around the summer and winter solstices for morning and evening. The lobes to the north of the indicative turbine location result from the summer solstice and conversely the lobes to the south result from the winter solstice. The lobes to the west result from morning sun while the lobes to the east result from evening sun. When the sun is low in the sky, the length of shadows cast by the turbine increases, increasing the area around the turbine affected by shadow flicker.

3.1.3 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 overestimate of shadow flicker duration.

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

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

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

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

3.1.4 Predicted actual duration

As discussed above in Section 3.1.3, 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. Exclusion of these factors means that the theoretical calculation is likely to be conservative. An attempt has been made to quantify the likely reduction in shadow flicker duration due cloud cover and, therefore, produce a prediction of the actual shadow flicker duration likely to be experienced at a sensitive receptor.

Cloud cover is typically measured in 'oktas' or effectively eighths of the sky covered with cloud. DNV GL has obtained data from the following seven Bureau of Meteorology (BoM) stations:

- Port Pirie Nyrstar Comparison (021043), located approximately 27 km from the site [10]
- Snowtown (021046), located approximately 48 km from the site [11]
- Yongala (019062), located approximately 58 km from the site [12]
- Clare Post Office (021014), located approximately 65 km from the site [13]
- Whyalla Aero (018120), located approximately 77 km from the site [14]
- Whyalla (Norrie) (018103), located approximately 77 km from the site [15]
- Kadina (022006), located approximately 75 km from the site [16].

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 36% and 55%, and the average annual cloud cover is approximately 47%. This means that on an average day, 47% 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 a reasonable assumption.

Similarly, turbine orientation can have an impact on the shadow flicker duration. The shadow flicker impact is greatest when the turbine rotor plane is approximately perpendicular to a line joining the sun and an observer, and a minimum when the rotor plane is approximately parallel to a line joining the sun and an observer. A wind direction frequency distribution previously derived by DNV GL from data collected by the site monitoring masts was used to estimate the reduction in shadow flicker duration due to rotor orientation. The measured wind rose is shown overlaid on the indicative shadow flicker map in Figure 3. An 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 GL 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.

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

3.2 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.

4 ASSESSMENT RESULTS

4.1 Shadow flicker

A shadow flicker assessment was carried out at all provided dwelling locations, or 'receptors', as outlined in Table 2. A summary of the number of dwellings that are predicted to exceed relevant limits is provided in Table 4.

The theoretical predicted shadow flicker durations at all dwellings identified to be affected by shadow flicker are presented in Table 5. The maximum predicted theoretical shadow flicker durations within 50 m of these receptors are also presented in this table. The results are also shown in the form of shadow flicker maps in Figure 4 to Figure 5. The shadow flicker values presented in these maps represent the worst case between the results at 2 m and 6 m above ground for each modelled grid point.

The results indicate that, out of the dwellings identified by the Customer, four dwellings are predicted to experience some shadow flicker based on the methodology recommended by the Draft National Guidelines when considering the permitted turbine envelope.

For the turbine layout and dimensions considered, three of the four dwellings are predicted to experience theoretical shadow flicker durations that exceed the limit recommended by the Draft National Guidelines. When considering the predicted actual shadow flicker duration, which takes into account the reduction in shadow flicker due to cloud cover and rotor orientation, the same three receptors are expected to experience actual shadow flicker durations in excess of the limit recommended in the Draft National Guidelines. However, it is understood that these dwellings are owned by parties who are involved in the Project.

It is noted that the theoretical shadow flicker durations at two of the affected dwellings, both owned by involved landowners, are very high, with theoretical annual durations reaching approximately 119 hours. Similarly, predicted actual shadow flicker durations of up to approximately 37 hours were modelled for these dwellings.

When shadow flicker intensities below a "moderate level of intensity" are considered, two additional dwellings (dwellings H14 and H56) are predicted to experience some shadow flicker within 50 m of the dwelling location. At one of these dwellings (dwelling H14), both the theoretical and actual shadow flicker durations are predicted to exceed the limits recommended by the Draft National Guidelines. Although the shadow flicker durations at dwelling H14 are within the recommended limits when assessed according to the Draft National Guidelines, DNV GL recommends that the potential for shadow flicker to cause annoyance at this dwelling be carefully considered and discussed with the landowner.

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

4.2 Blade glint

As discussed in Section 3.2, blade glint is not generally a problem for modern wind turbines, provided that the blades are coated with a non-reflective paint.

5 CONCLUSION

A shadow flicker assessment has been carried out at all dwelling locations in the vicinity of the Project. The results show that, for the turbine layout and dimensions considered, four dwellings are predicted to experience some shadow flicker within 50 m of the house location.

Three of these four dwellings are predicted to experience theoretical shadow flicker durations that exceed the limit recommended by the Draft National Guidelines. When considering the predicted actual shadow flicker duration, which takes into account the reduction in shadow flicker due to cloud cover and rotor orientation, the same three receptors are expected to experience actual shadow flicker durations in excess of the limit recommended in the Draft National Guidelines. However, it is understood that these dwellings are owned by parties who are involved in the Project.

It is noted that the theoretical shadow flicker durations at two of the affected dwellings, both owned by involved landowners, are very high, with theoretical annual durations reaching approximately 119 hours. Similarly, predicted actual shadow flicker durations of up to approximately 37 hours were modelled for these dwellings.

The methodology proposed in the Draft National Guidelines only considers the impact of shadow flicker above a "moderate level of intensity". When shadow flicker intensities below "a moderate level of intensity" are considered, the shadow flicker durations at one additional dwelling are predicted to exceed the limits recommended by the Draft National Guidelines. Although the shadow flicker durations at this dwelling are within the recommended limits when assessed according to the Draft National Guidelines, DNV GL recommends that the potential for shadow flicker to cause annoyance at this dwelling be carefully considered.

The prediction of the actual shadow flicker duration presented here does not take into account any reduction due to low wind speed, vegetation, or other shielding effects around each sensitive receptor in calculating the number of shadow flicker hours. Therefore, the values presented may still be regarded as conservative. The effects of shadow flicker may also be reduced through a number of mitigation measures such as the installation of screening structures or planting of trees to block shadows cast by the turbines, the use of turbine control strategies which shut down turbines when shadow flicker is likely to occur, or the relocation of turbines.

Since a non-reflective finish is proposed for the blades of the wind turbines, blade glint is not expected to be an issue.

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Table 1 Crystal Brook Wind Farm turbine coordinates

WTG ID	Easting[1] [m]	Northing[1] [m]
CB01	242122	6312882
CB02	242321	6311791
CB04	243547	6310423
CB05	243449	6310846
CB07	242017	6310140
CB09	241690	6313160
CB12	242005	6310560
CB14	244447	6312007
CB15	241605	6310430
CB16	242861	6310560
CB17	241722	6311013
CB18	244294	6312405
CB19	244428	6310281
CB20	242633	6310196
CB21	241732	6312707
CB22	244421	6310997
CB23	242739	6310968
CB24	241765	6312077
CB25	242433	6310575
CB27	242567	6312607
CB30	241390	6312282
CB31	241714	6311498
CB32	241321	6312824
CB33	242658	6311387
CB34	241308	6311629
CB35	241360	6310783

Notes:

1. *Coordinate system: MGA Zone 54 South, GDA94 datum.*

Table 2 Shadow receptor locations within 2420 m of turbines at the Crystal Brook Wind Farm

Receptor ID	Landowner status	Easting[1] [m]	Northing[1] [m]	Nearest turbine ID	Distance to nearest turbine [m]
H5	Uninvolved	240889	6308157	CB07	2281
H6	Uninvolved	242167	6308295	CB07	1851
H7	Uninvolved	244759	6308437	CB19	1874
H12	Involved	240088	6311098	CB35	1310
H13	Involved	240352	6311957	CB34	1011
H14[2]	Involved	239573	6313468	CB32	1863
H15	Involved	243449	6311913	CB33	950
H16[2]	Uninvolved	243286	6308815	CB20	1527
H17	Uninvolved	242807	6313995	CB01	1306
H18	Uninvolved	242384	6315232	CB09	2185
H24	Uninvolved	240819	6309079	CB15	1563
H50	Uninvolved	245172	6314012	CB18	1832
H51[2]	Uninvolved	245204	6313575	CB18	1482
H56	Uninvolved	245814	6309334	CB19	1679
H60	Uninvolved	241011	6308319	CB07	2080
H61	Uninvolved	241010	6308257	CB07	2135
H62	Uninvolved	240853	6308122	CB07	2329
H63	Uninvolved	240824	6308097	CB07	2365
H67	Uninvolved	241107	6308030	CB07	2297

Notes:

1. *Coordinate system: MGA Zone 54 South, GDA94 datum.*
2. *Potential discrepancy observed between receptor location and satellite imagery.*

Table 3 Shadow flicker model settings for theoretical shadow flicker calculation

Model setting	Value
Maximum shadow length	1580 m
Year of calculation	2030
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[1]	8 points evenly spaced (every 45°) on 25 m and 50 m radius circles centred on the house location

Table 4 Summary of shadow flicker exceedance for the proposed Crystal Brook Wind Farm

Predicted shadow flicker within 50 m of dwelling	Number of dwellings affected	
	Total	Excluding involved dwellings
Predicted theoretical shadow flicker (recommended limit: 30 hours/year)		
Above recommended limit	3	0
Predicted actual shadow flicker (recommended limit: 10 hours/year)		
Above recommended limit	3	0

Table 5 Theoretical and predicted actual annual shadow flicker duration

House ID[1]	Easting[2] [m]	Northing[2] [m]	Contributing turbines	Theoretical annual				Predicted actual annual[3]			
				At dwelling [hr/yr]		Max within 50 m of dwelling [hr/yr]		At dwelling [hr/yr]		Max within 50 m of dwelling [hr/yr]	
				2 m	6 m	2 m	6 m	2 m	6 m	2 m	6 m
H12	240088	6311098	CB34 CB35	40.4	40.4	50.0	49.0	13.6	13.6	16.5	16.2
H13	240352	6311957	CB21 CB24 CB30 CB31 CB32 CB34	101.3	100.7	105.0	105.6	34.1	34.1	37.2	37.5
H14[4,5]	239573	6313468	-	-	-	-	-	-	-	-	-
H15	243449	6311913	CB02 CB14 CB18 CB27	103.0	102.4	119.4	118.7	31.5	31.3	37.0	36.8
H24	240819	6309079	CB07	0.0	0.0	6.8	5.9	0.0	0.0	1.2	1.0
H56[4]	245814	6309334	-	-	-	-	-	-	-	-	-
			Duration limits	***30 hr/yr***				***10 hr/yr***			

Notes:

1. *Dwellings identified in Table 2 with no theoretical shadow flicker occurrence have been omitted from this table.*
2. *Coordinate system: MGA Zone 54 South, GDA94 datum.*
3. *Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation.*
4. *Dwelling predicted to experience shadow flicker below a moderate level of intensity.*
5. *Dwelling predicted to experience shadow flicker durations above the specified limits when shadow flicker below a moderate level of intensity is considered.*

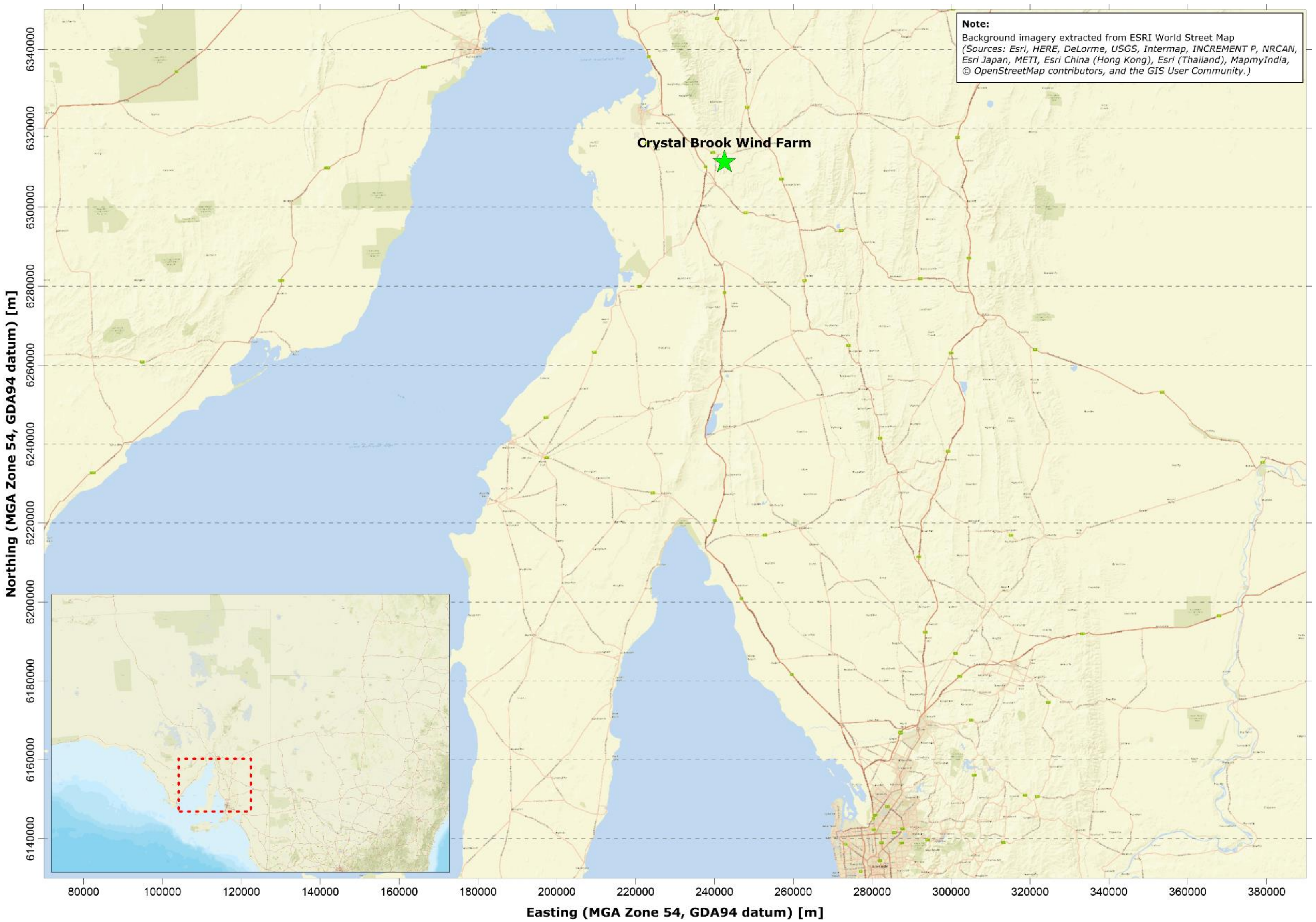

Figure 1 Location of the Crystal Brook Wind Farm

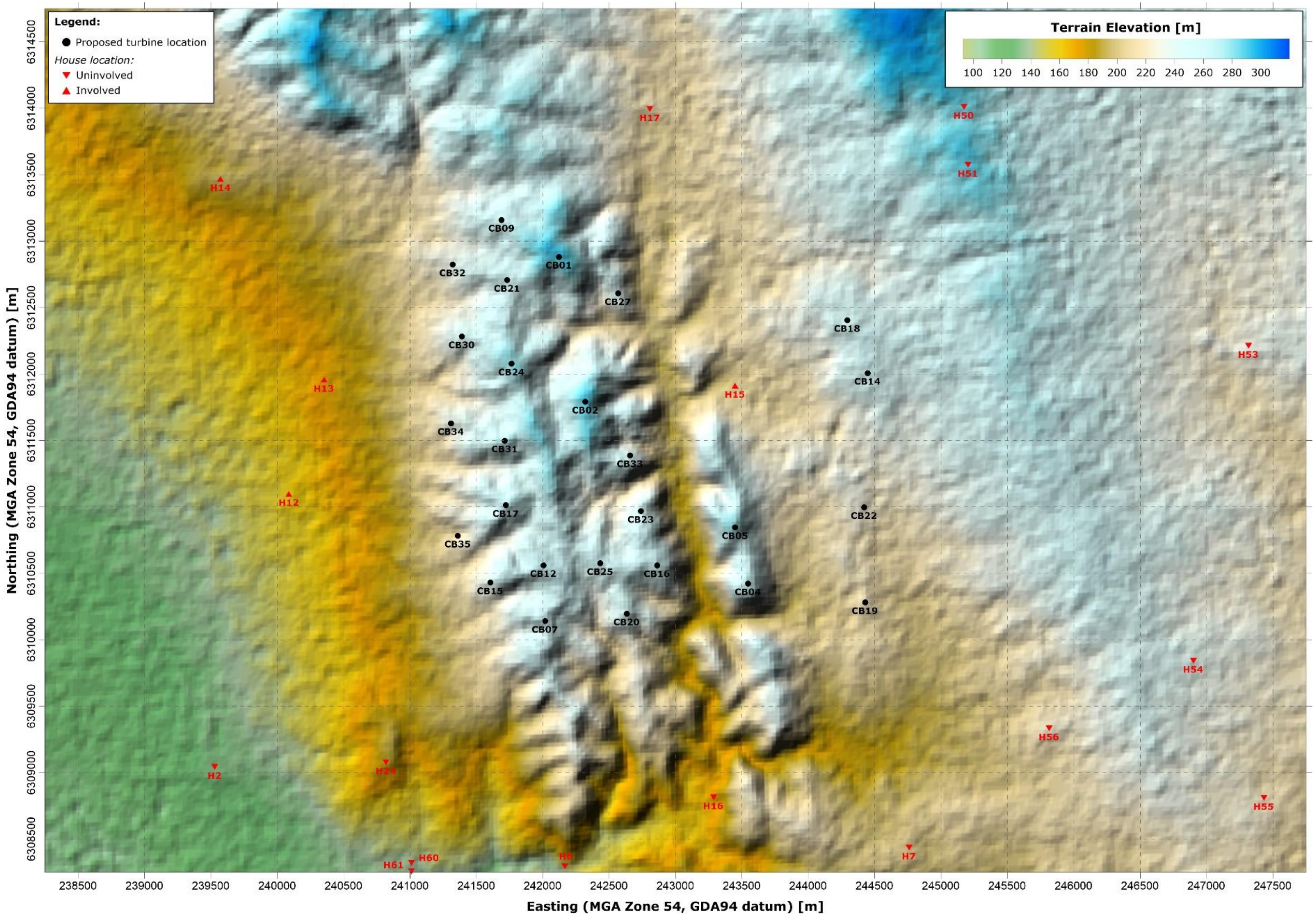

Figure 2 Elevation map of the Crystal Brook Wind Farm

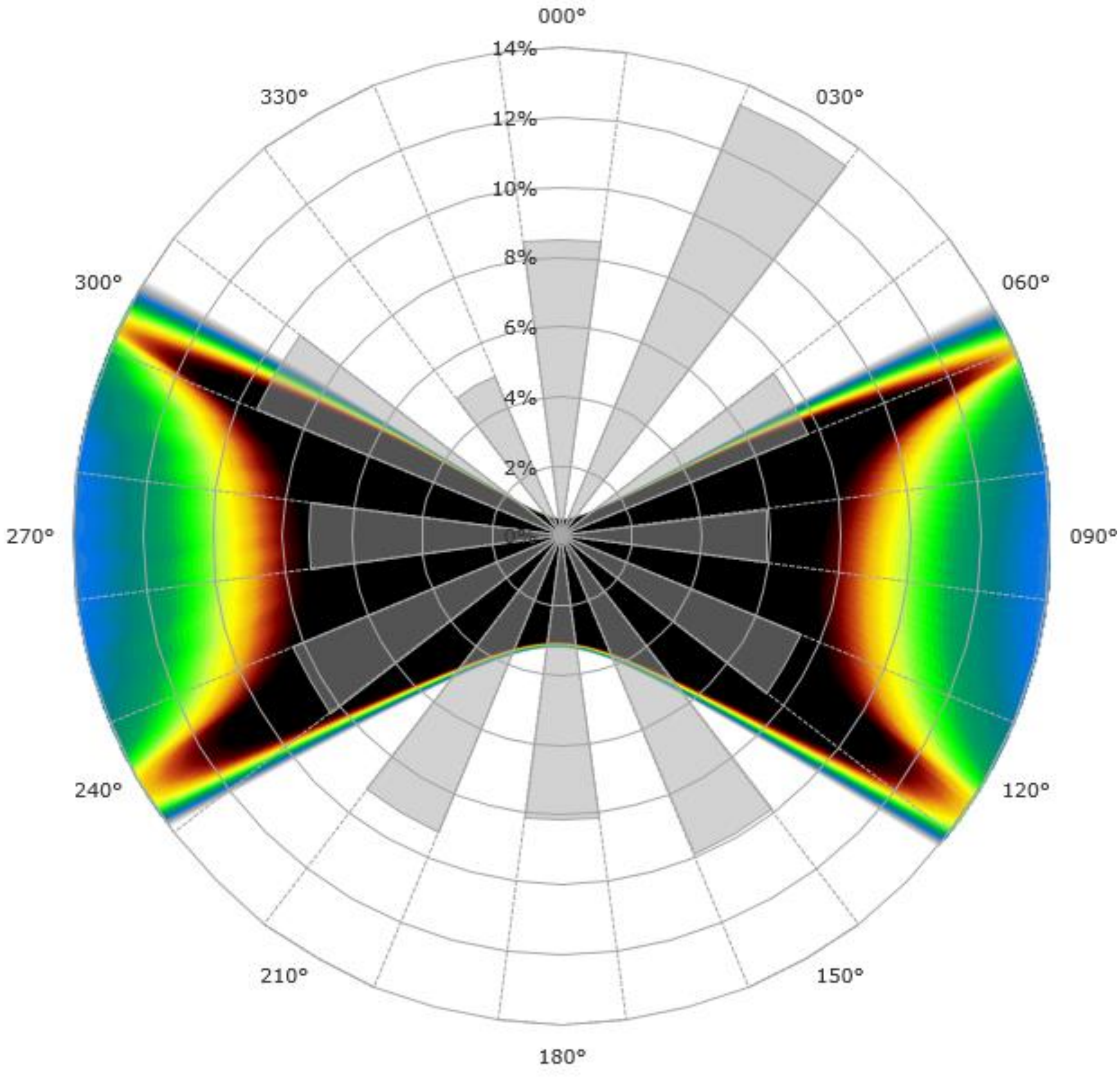

Figure 3 Indicative shadow flicker map and wind direction frequency distribution

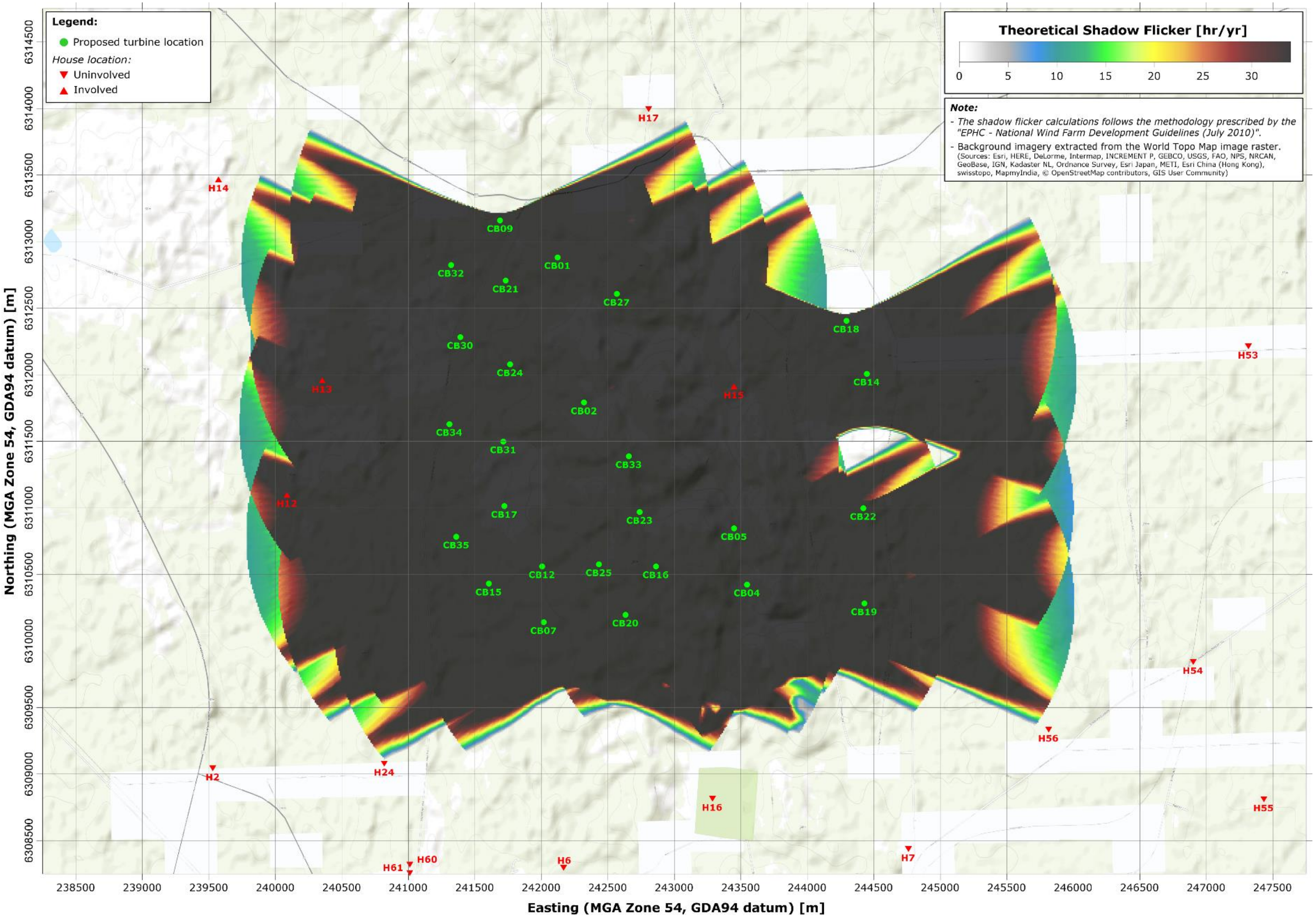

Figure 4 Theoretical annual shadow flicker duration map

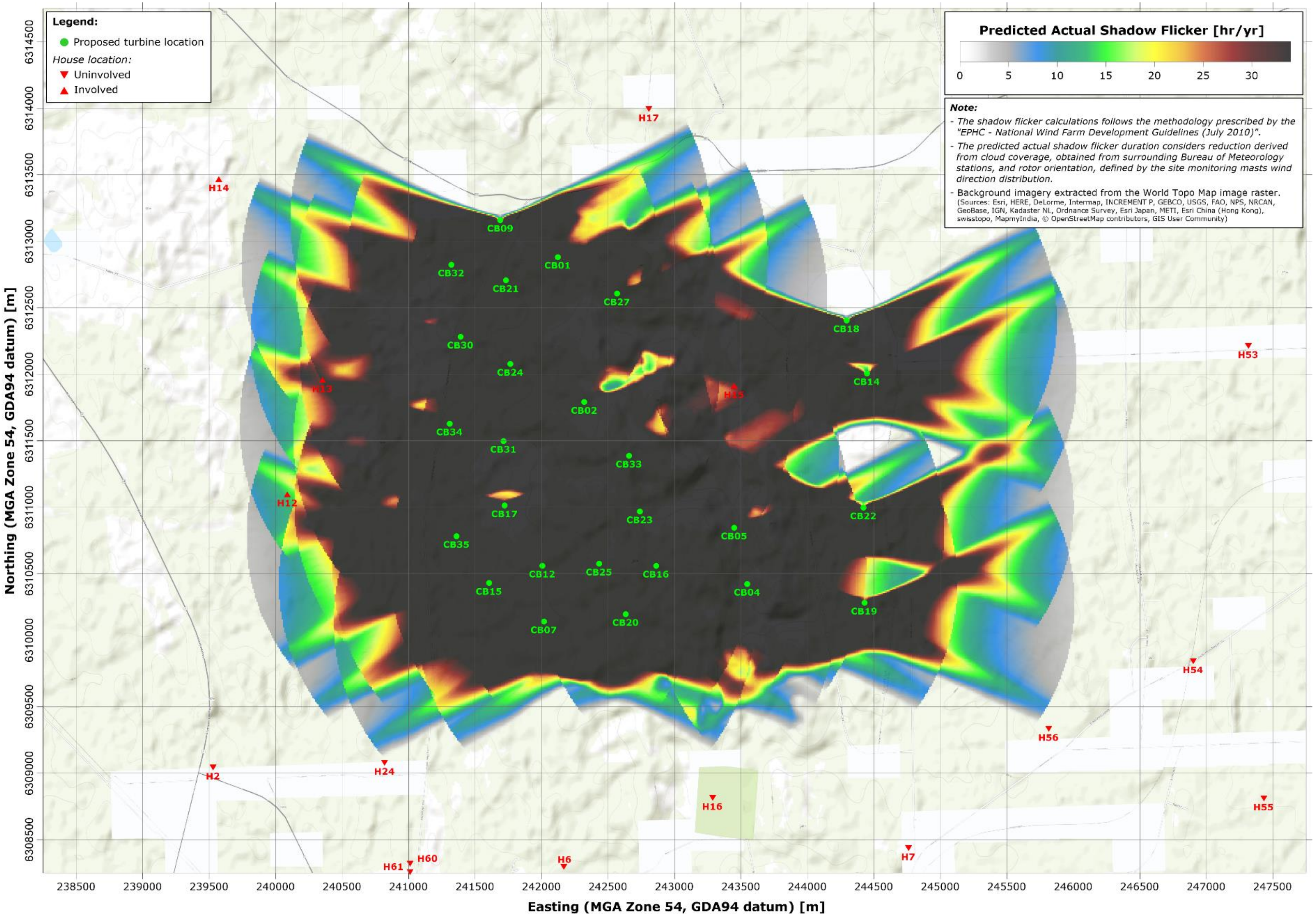

Figure 5 Predicted actual annual shadow flicker duration map

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Aeronautical and Aviation

FINAL REPORT

CRYSTAL BROOK ENERGY PARK

AVIATION IMPACT STATEMENT
SOLAR GLARE REVIEW
QUALITATIVE RISK ASSESSMENT
AND
OBSTACLE LIGHTING REVIEW

CCP01

Report to:

NEOEN

5 March 2018

Chiron Aviation Consultants
Essendon Vic 3040
Australia

DOCUMENT RELEASE APPROVAL

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V1.0	Final Report	5 March 2018	IJ	RJJ

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EXECUTIVE SUMMARY

Neoen Australia Pty Ltd have requested that Chiron Aviation Consultants provide an Aviation Impact Statement, Qualitative Risk Assessment, Obstacle Lighting Review and a Solar Glare Analysis for the Crystal Brook Energy Park near Port Pirie in South Australia. The Crystal Brook Energy Park has two components, a Wind Farm comprising 26 turbines with a tip height of 240m above ground level and a Solar Farm comprising up to 150Mw or 170ha of single axis tracking photovoltaic panels facing north and no more than 4m above ground level.

The Aviation Impact Statement concludes that the Crystal Brook Energy Park **will not impact** upon the following:

- The Obstacle Limitation Surface and Procedures for Air Navigation Services ï Aircraft Operations surfaces published for any registered or certified aerodrome;
- Any air route Lowest Safe Altitudes;
- The operation of any Communication, Navigation Aids or Surveillance facilities;
- The landing or take-off phase of flight from any identified aerodromes due to glare or glint from the photovoltaic panels; and
- The normal flight of aircraft over the Solar Farm due to glare or glint from the photovoltaic panels.

The Qualitative Risk Assessment finds that for the Crystal Brook Energy Park:

- By day the wind turbines are conspicuous by their size and colour;
- Night operations of aircraft do not occur below prescribed airspace. IFR aircraft are protected by the Instrument Approach Procedures;
- Where an approach to land is undertaken operating to VFR at Night, descent below the Lowest Safe Altitude does not occur until within 3nm of the airport and with it in sight; and
- Is assessed as a **LOW risk to aviation** and is therefore ***not a hazard to aircraft safety.***

The Obstacle Lighting Review for the Crystal Brook Energy Park finds that in accordance with the NASF Guideline D risk assessment:

- **Obstacle lighting is not required** as the risk to aviation is LOW and no additional mitigating strategies are necessary.

1. Introduction

Neoen Australia Pty Ltd have requested that Chiron Aviation Consultants provide an Aviation Impact Statement, Qualitative Risk Assessment, Obstacle Lighting Review and a Solar Glare Analysis for the Crystal Brook Energy Park near Port Pirie in South Australia.

The Crystal Brook Energy Park (CBEP) has two components, a Wind Farm comprising 26 turbines with a tip height of 240m above ground level and a Solar Farm comprising up to 150Mw or 170ha of single axis tracking photovoltaic (PV) panels facing north and no more than 4m above ground level. For clarity in this report the Crystal Brook Wind Farm component is referred to as the CBWF and the Crystal Brook Solar Farm as the CBSF.

1.1 Location

The CBEP is located approximately 4km north of the town of Crystal Brook and approximately 23km southeast of Port Pirie in South Australia.

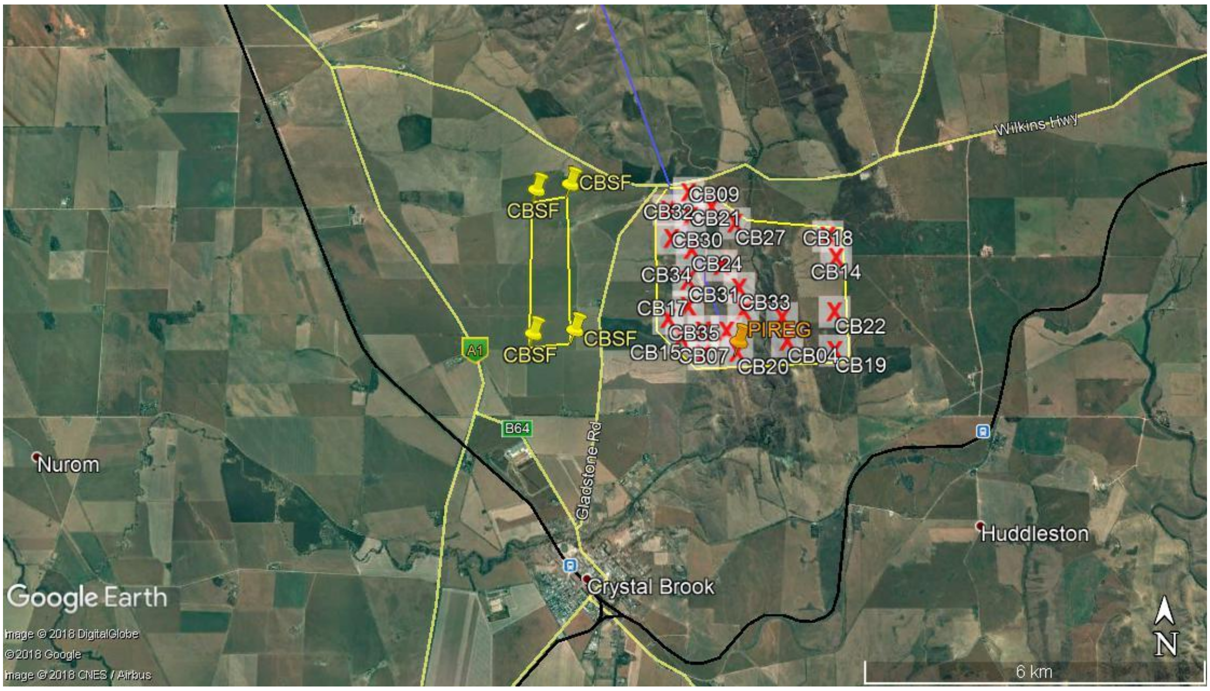

Figure 1 – Location Crystal Brook Wind and Solar Farm

The proposed CBWF comprises 26 turbines with a tip height of 240m above ground level and the solar farm [shown in yellow] comprises up to 150Mw or 170ha of single axis tracking photovoltaic (PV) panels facing north and no more than 4m above ground level.

1.2 Aerodromes and Airstrips

Aerodromes fall into four categories:

- Military or Joint (combined military and civilian);
- Certified;
- Registered; and
- Uncertified or Aeroplane Landing Areas

A Military aerodrome is operated by the Department of Defence and is suitable for the operation of military aircraft. A Joint User aerodrome is a Military aerodrome used by both military and civilian aircraft, for example Darwin International and Townsville International Airports.

A Certified Aerodrome, certified under Civil Aviation Safety Regulation (CASR) 139.040, is available for Regular Public Transport and Charter operations and has a runway suitable for use by an aircraft having a maximum carrying capacity of more than 3,400kg or a passenger seating capacity of more than 30 seats, for example Adelaide Airport, Port Augusta Airport and Whyalla Airport.

A Registered Aerodrome, registered under CASR 139.260, is one to which CASR 139.040 does not apply and the operator has applied to the Civil Aviation Safety Authority (CASA) to have it registered, for example Port Pirie Airport.

An Uncertified Aerodrome is any other aerodrome or airstrip and is referred to as an Aeroplane Landing Area (ALA). These range in capability and size from having a sealed runway with lighting capable of accommodating corporate jet aircraft to a grass paddock that is smooth enough to land a single engine light aircraft or a purpose built aerial agricultural aircraft.

Military, Certified and Registered aerodromes are listed in the Aeronautical Information Publication[1] (AIP) and are subject to a NOTAM[2] service that provides the aviation industry with current information on the status of the aerodrome facilities. This information is held in the public domain, is available through aeronautical publications and charts and is kept current by mandatory reporting requirements.

Uncertified aerodromes (ALA) are not required to be listed in the AIP so information about them is not held in the public domain, is not available through aeronautical publications and charts and is not required to be reported. Where ALA information is published in the AIP it is clearly annotated that it is not kept current. Consequently ALA can come into use and fall out of use without any formal notification to CASA or any other authority. Airstrips that appear on survey maps often no longer exist; others exist but do not feature on maps. Similarly a grass paddock used as an ALA is not usually discernable on satellite mapping services such as Google Earth.

Military, Joint, Certified and Registered aerodromes usually have Obstacle Limitation

[1] AIP; a mandatory worldwide distribution system for the promulgation of aviation rules, procedures and information

[2] NOTAM (Notice to Airmen); a mandatory reporting service to keep aerodrome and airways information current and available to the aviation industry world wide

Surfaces (OLS) and Procedures for Air Navigation ï Operations (PANS-OPS) surfaces prescribed to protect the airspace associated with published instrument approach and landing procedures. An uncertified aerodrome or ALA cannot have a published instrument approach and landing procedure so cannot have associated prescribed airspace protected by OLS or PANS-OPS. All operations into ALA therefore, must be conducted in accordance with the Visual Flight Rules (VFR) and in Visual Meteorological Conditions (VMC).

1.3 Aerodromes in the Area

There are three aerodromes within 30nm (55.6km) of the Crystal Brook Energy Park.

Port Pirie (YPIR) is the only registered or certified aerodrome, and is located 11.81nm (21.88km) northwest of the CBWF.

The other two aerodromes are significant uncertified ALA; Jamestown (YJST), 19.31nm (35.82km) east northeast and Booleroo Centre (YBOC) 24.96nm (46.15km) north northeast. Both these ALA are more than 30km (16.20nm) from the nearest CBWF turbine

1.4 Air Routes in the Area

There are several published air routes in the vicinity of the CBWF. Each of these air routes has a published Lowest Safe Altitude (LSALT).

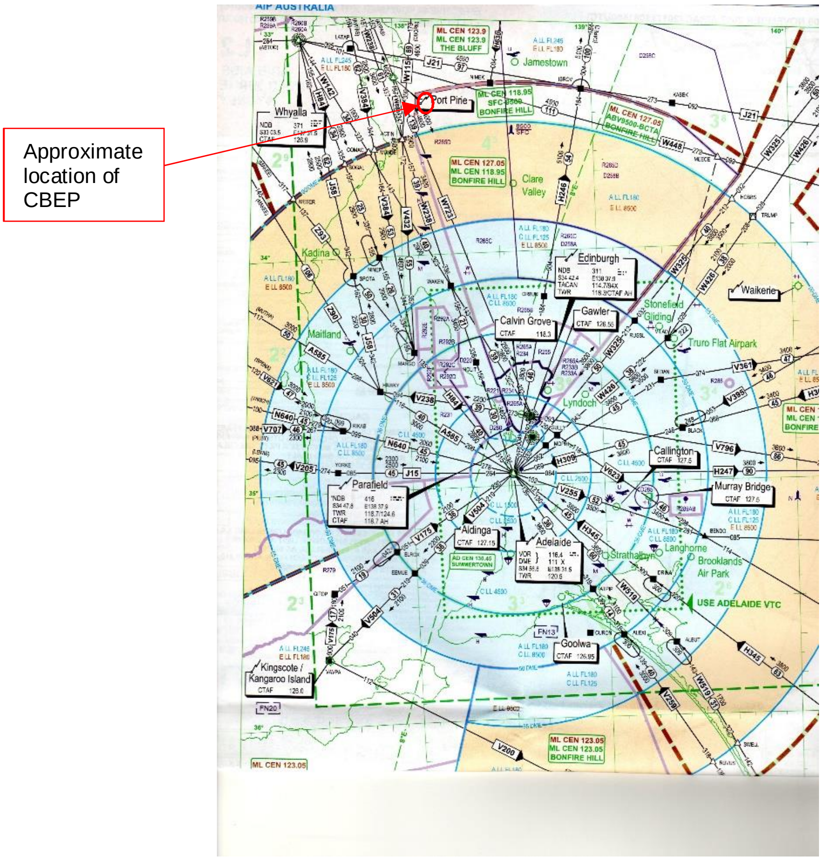

Figure 2 – Air Routes in Area[3]

1.5 Airspace

The CBWF is in Class G airspace below Class E airspace with a lower limit of FL180.

A Military Restricted Area, R265D ï Military Flying sits above CBEP. R265D is activated by NOTAM and has a Lower Limit of 9500ft with an Upper Limit set by NOTAM. R265D has a Conditional Status of RA1 whereby pilots may flight plan through the area and under normal circumstances expect a clearance from Air Traffic Control (ATC).

The CBWF does not penetrate R265D.

There are no Prohibited or Danger Areas (PRD) within the vicinity of the CBEP.

Class G airspace is non-controlled airspace where aircraft may operate without an Air Traffic Control (ATC) clearance. Aircraft may operate in accordance with either Instrument Flight Rules (IFR) or Visual Flight Rules (VFR) within Class G airspace.

Class E airspace is controlled airspace open to both IFR and VFR flights. IFR aircraft

[3] AIP Enroute Chart Low ERC L2 dated 9 Nov 2017

must have an ATC clearance and communicate with the ATC Centre.

A Control Area (CTA) is defined as a ñcontrolled airspace extending upwards from a specified limit above the earth.[4]ò

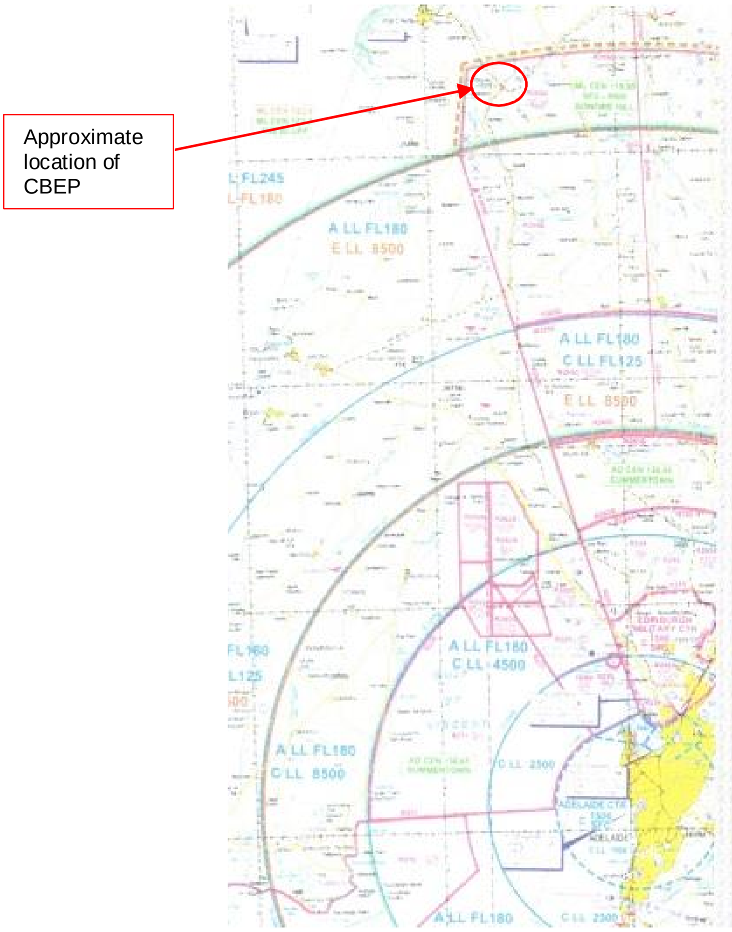

Figure 3 – Airspace surrounding CBEP[5]

Within Class G airspace an aircraft flying in accordance with the Visual Flight Rules (VFR) away from a populous area is, when flying below 3000ft, required by Civil Aviation Regulation (CAR) 157 to remain at 500ft above the highest point of the terrain **and any obstacle on it** within a radius of 600m [300m for a helicopter] from a point on the terrain directly below the aircraft. For a wind farm this equates to 500ft above the turbine tip height, which for the CBWF this is 788 + 500 = 1288ft Above Ground Level (AGL).

There are no published flying training areas in the vicinity of the CBEP.

[4] AIP Enroute, ENR 1.4 ï 3, dated 25 May 2017, available at http://www.airservicesaustralia.com/aip/current/aip/enroute.pdf last accessed 21 Feb 2018
[5] AIP Visual Navigation Chart ï Adelaide 9 Nov 2017

2. SCOPE.

To meet the requirements of Neoen Australia Pty Ltd, the study required Chiron Aviation Consultants to examine the CBEP development and undertake the following tasks.

2.1 Aviation Impact Statement

In August 2014, Airservices Australia (AsA) re-released a letter detailing requirements for an Aviation Impact Statement (AIS) for wind farm developments. The AsA letter requires that all developers of proposed wind farms prepare an Aviation Impact Statement, and submit this to AsA for evaluation and consideration. A copy of this letter is shown at Appendix A.

The AIS required the following tasks to be undertaken: -

- Provide the coordinates and elevations of the Obstacles and associated topographical drawings;
- Specify all registered and certified aerodromes within 30nm (55.6km):
  - Nominate all instrument approach and landing procedures;
  - Confirm that the obstacles do not penetrate the Annex 14 OLS;
  - Confirm that the obstacles do not penetrate the PANS-OPS;
- Specify any published air routes over or near the obstacles
- Specify the airspace classification of the airspace surrounding the development
- Investigate any impact on aviation Communications, Navigation and Surveillance (CNS) facilities

Details of Aerodromes, OLS, PANS-OPS procedures, Lowest Safe Altitudes, Navigation and Airspace Surveillance facilities were obtained from the Australian Aeronautical Information Publications (AIP), AsA sources and CASA publications.

2.2 Solar Glare Analysis

A glare assessment, using an FAA approved tool, was undertaken to ascertain the likelihood of the solar panels creating a glare hazard or pilot distraction for nearby aerodromes.

2.3 Qualitative Risk Assessment

The QRA required the following tasks to be undertaken: -

- The identification and assessment of potential aviation risk elements through:
  - Reference to CASA publications;

- Reference to the AIP;
- Reference to the National Airports Safeguarding Framework (NASF) guidelines;
- Consultations with key relevant stakeholders;

- Assessment of the perceived impacts of the turbines on the operation of aerodromes and airstrips in the immediate vicinity of the wind farm;
- Assessment of the perceived impacts of the turbines on aviation activity including:
  - General Aviation training;
  - Recreational/Commercial flying activity;
  - Air Ambulance Operations;
  - Police Aviation Operations;
  - Aerial Fire Fighting Operations;
  - Aerial Agricultural Operations;
  - Known highly trafficked VFR routes;
  - Night flying for light aircraft;
- Assessment of any implications for the above from topographical, weather and visibility issues;
- Assessment of other issues as identified through stakeholder consultations and the assessment process;
- Conclusions on the degree of aviation risk posed by the above described issues with commensurate recommendations on any mitigating actions; and
- An assessment of the need, against the outcomes of the Qualitative Risk Assessment, for obstacle lighting of the wind farm.

2.4 Obstacle Lighting Review

The OLR reviews the outcome of the QRA to determine the need or otherwise for risk mitigation by the lighting of turbines in the wind farm with aviation obstruction lighting.

3. METHODOLOGY

The following methodology was used to complete the tasks outlined in the scope

3.1 Aviation Impact Statement

To meet Airservices Australia requirements for an Aviation Impact Statement the following methodology was used: -

- The obstacle (turbines and meteorological masts) coordinates and elevations were listed to the requisite accuracy and associated drawings and charts were obtained;
- The AIP was reviewed to determine;
    - All registered/certified and military/joint aerodromes located within 30nm (55.6km) of the wind farm
    - Any associated Instrument Departure and Approach Procedures (DAP);
    - The extent of the OLS and PANS-OPS surfaces for the identified DAP;
    - Published air routes located over or near the wind farm;
    - The classification of the airspace surrounding the wind farm;
- Ascertain the locations of CNS facilities that may be impacted and analyse the impact on;
    - Communications facilities;
    - Navigation facilities;
    - Surveillance facilities (in accordance with EUROCONTROL Guidelines); and
- Compile a report for review by Airservices Australia.

3.2 Solar Glare Analysis

A glare assessment, using an FAA approved tool, was undertaken to ascertain the likelihood of the solar panels creating a glare hazard or pilot distraction for nearby aerodromes.

3.3 Qualitative Risk Assessment

A Qualitative Risk Assessment is the analysis for risks, through facilitated interviews or meetings with stakeholders and outside experts, as to their probability of occurrence and impact expressed using non-numerical terminology; for example low, medium and high. The basis for the QRA is ASNZS ISO 31000-2018 *Risk Management –Guidelines.*

The methodology for the Qualitative Risk Assessment was as follows:

- The Australian AIP and CASA documents were reviewed to identify relevant physical and operational aviation issues that may impact on the requirement for lighting of the wind farm;

- Current topographical maps were studied to assess the local terrain and identify any local airstrips and any other relevant features;

- Key stakeholders, including local operators, recreational aviation groups and State Government Police Air Wing, Air Ambulance and Fire Services, were identified, contacted and interviewed to ascertain the extent of local aviation activity in the vicinity of the proposed wind farm. See Appendix E for a Stakeholder List. This included any informal low flying areas and highly trafficked unpublished air routes that may exist within the vicinity of the proposed wind farm;

- Based on the above, the nature of any impacts as a consequence of the operation of the wind farm was considered and discussed in regard to;

    - General Aviation training;
    - Recreational and sport aviation activities;
    - Approved low flying activities (including aerial agricultural applications)
    - Any known highly trafficked VFR routes; and
    - Emergency Services (air ambulance, police and fire service);

- In addition, further consideration was given to the consequences (for the above elements) of the potential influence of topography and poor weather; and

- Consideration of the NASF, Guideline D *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* in relation to the QRA findings.

3.4 Obstacle Lighting Review

The Obstacle Lighting Review investigates the current Australian standards and regulatory requirements for obstacle lighting of wind farms. From this review an assessment of the need or otherwise for aviation obstruction lighting is made.

The methodology for the Obstacle Lighting Review was as follows: -

- Review the Australian regulatory requirements and standards;

- Review the NASF Guidelines for wind farms; and

- From the QRA, assess the need for aviation obstruction lighting as a risk mitigator.

4. AVIATION IMPACT STATEMENT

The Aviation Impact Statement meets the requirements of Airservices Australia for their assessment of the CBEP potential impact on the items listed in paragraph 3.1 above. The AIS is submitted to both Airservices Australia and the Department of Defence for assessment in relation to civil and military facilities.

4.1 Location

The Crystal Brook Wind Farm (CBWF) is located approximately 4km north of the town of Crystal Brook and approximately 23km southeast of Port Pirie in South Australia.

The Crystal Brook Solar Farm (CBSF) is adjacent to the CBWF approximately 2km to the west, 4.5km north northwest of the town of Crystal Brook and approximately 19.25km southeast of Port Pirie.

Figure 1 in section 1.1 above shows the locations.

4.2 Obstacles

A list of the proposed turbine locations is shown at Appendix B.

The tallest turbine is CB01 at 292m (958.01ft) above the Australian Height Datum (AHD) plus 240m (787.40ft) to give a turbine tip height of 532m (1745.41ft) AHD. Adding the required Minimum Obstacle Clearance (MOC) of 1000ft gives a Lowest Safe Altitude (LSALT) of 2746ft rounded up to 2800ft.

The CBSF covers an area of up to 170ha with an array of single axis tracking photovoltaic (PV) panels, facing north and no more than 4m above ground level (AGL). The area of the CBSF is shown in yellow in Figure 2 in section 4.3 below.

4.3 Drawings

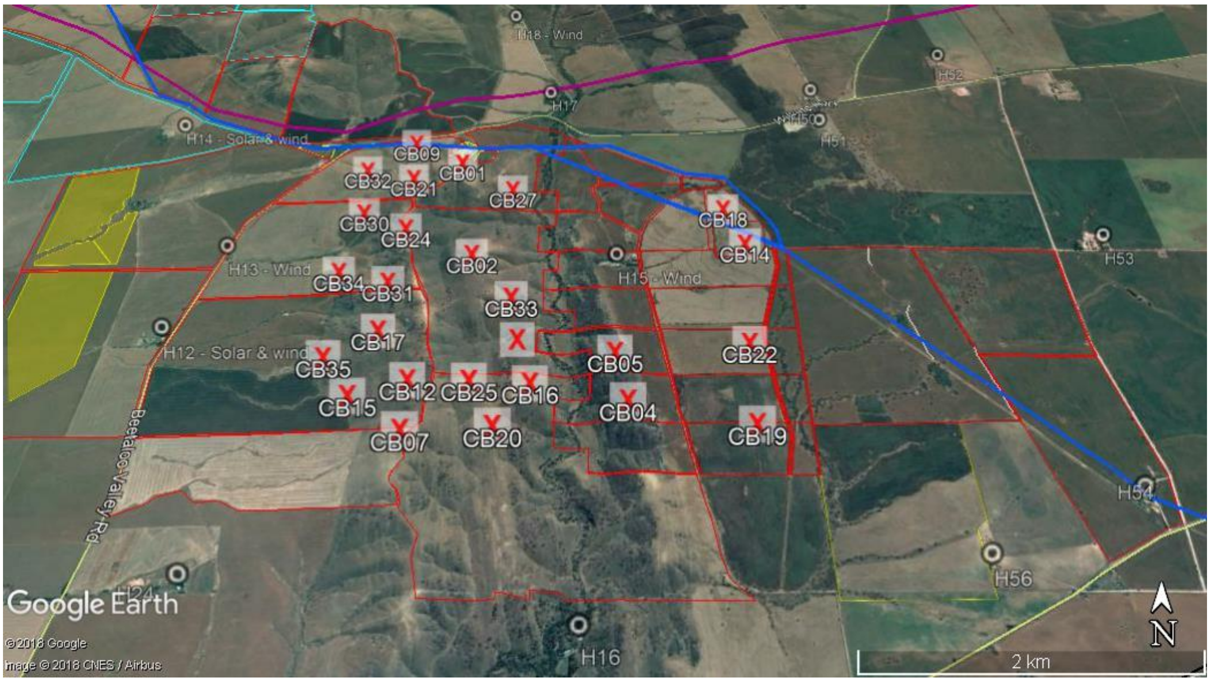

Figure 4 – CBWF and CBSF layout and location.

4.4 Aerodromes within 30nm

4.4.1 Certified or Registered aerodromes

Port Pirie (YPIR) is the only registered or certified aerodrome within 30nm (55.6km) of the CBWF.

YPIR has three runways with runway 08/26 being the only one with permanent pilot activated (PAL) runway lighting for night operations.

The obstacle limitation surface (OLS) extends to 15km. The CBWF, at 21.88km from YPIR, does not penetrate the OLS.

There are two published non-precision instrument approach procedures at Port Pirie. They are RNAV (GNSS) RWY 26 and RNAV (GNSS) RWY 08. Part of the RNAV (GNSS) RWY 26 Approach[6] passes over the CBWF.

The 25nm Minimum Sector Altitude (MSA) for these Approach Procedures is 4400ft in the sector over the CBWF. The tallest turbine, CB01 has a tip height of 240m and is located on ground that is 292m AHD. This gives a tip height of 532m (1745.41ft) AHD.

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[6] AIP DAP PIRGN02-144, dated 20 August 2015 as printed in AIP DAP issued 01 March 2018. Available at http://www.airservicesaustralia.com/aip/pending/dap/PIRGN02-144_01MAR2018.pdf last accessed 29 January 2018

With the required Minimum Obstacle Clearance (MOC) of 1000ft added, the LSALT over the CBWF is 1745.41 + 1000 = 2745.41ft. This is rounded up to 2800ft.

The DAP plate for the RNAV (GNSS) RWY 26 Approach shows an entry attitude of 4400ft at the Initial Approach Fix (IAF) at PIREG and a crossing altitude of 3270ft at the Intermediate Fix (IF) at PIREI. The sector between PIREG and PIREI passes over the CBWF. The segment minimum safe altitude for this segment of the approach is 2900ft which is above the LSALT of 2800ft for the CBWF.

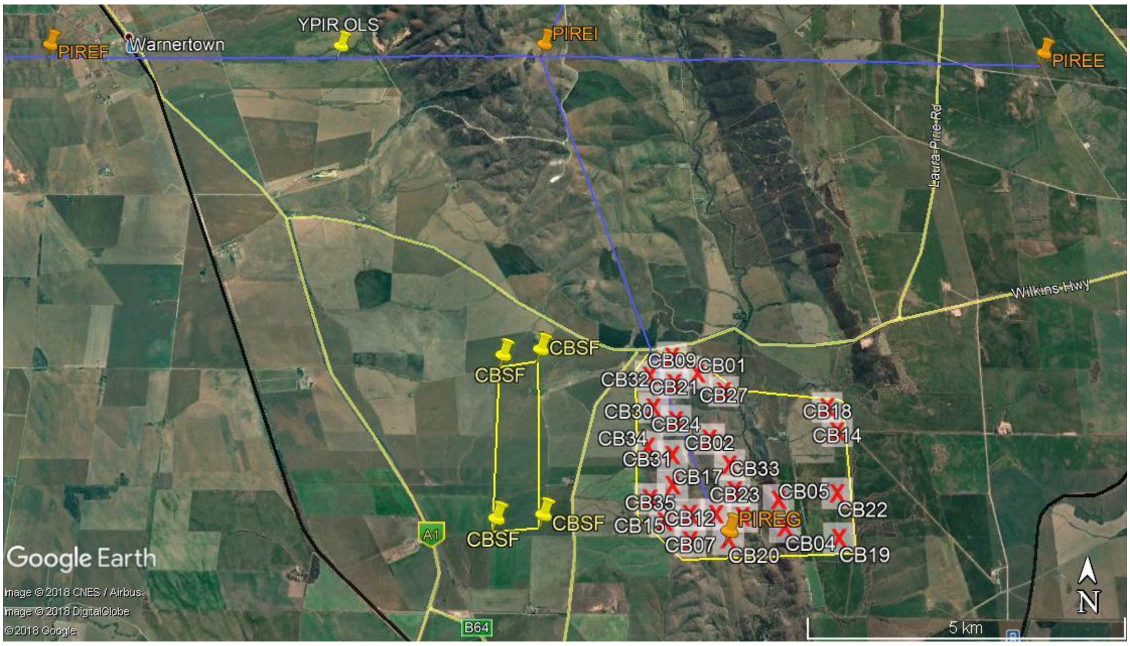

Figure 5 – YPIR RWY 26 RNAV IAF to IF

Turbine CB09 is the closest to the IF at PIREI at 3.3nm from the IF. This turbine has a tip height of 1647ft AHD. With the MOC of 1000ft added gives a LSALT of 2647 rounded to 2700ft. This is below the 3^0 approach angle height of 3910 at 2nm from PIREI and the IF crossing altitude of 3270ft at PIREI.

There are existing towers of 1270ft and 1401ft depicted on the DAP plate for the RNAV (GNSS) RWY 26 close to the approach path.

This is shown in Figure 6 below.

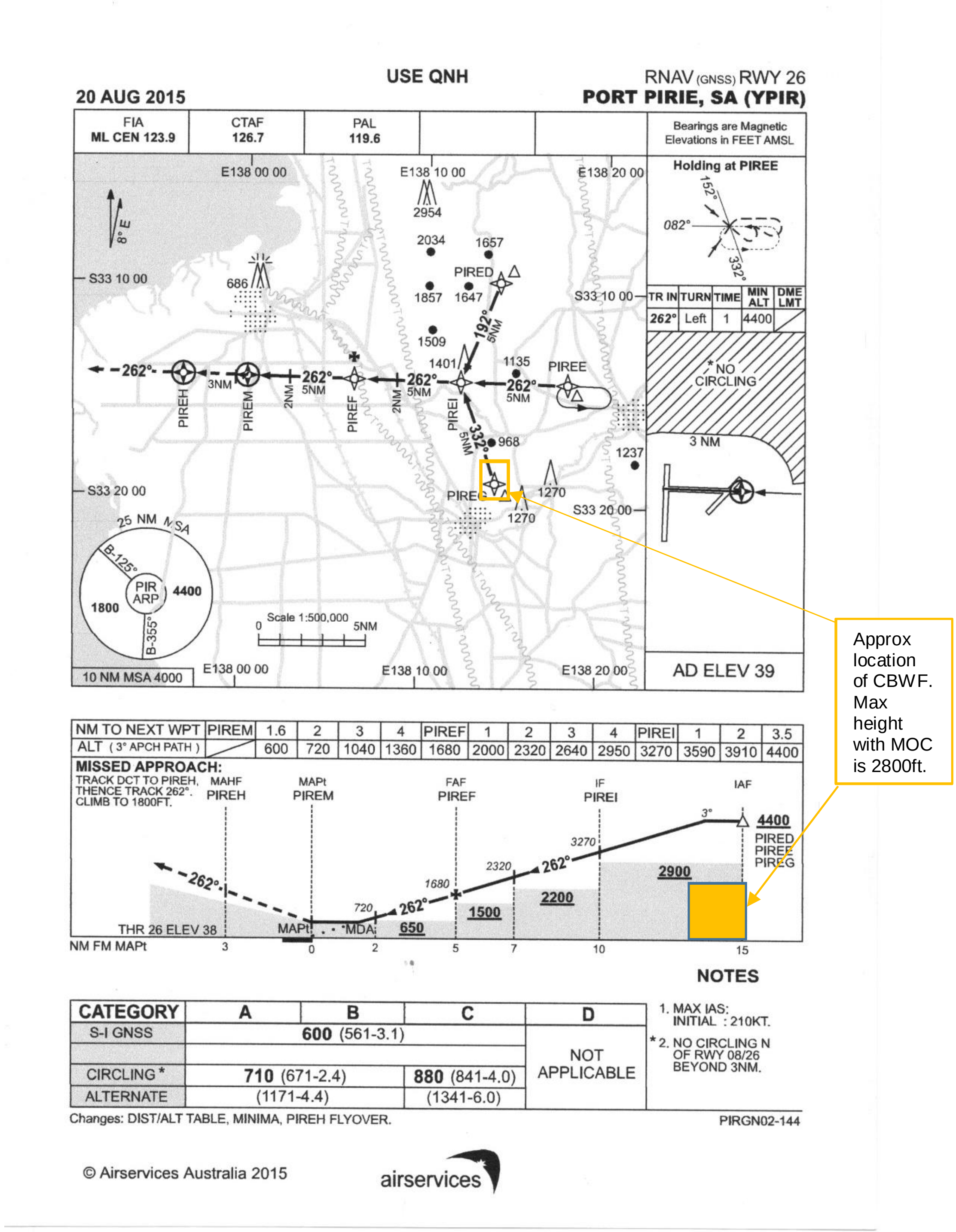

Figure 6 – YPIR RNAV RWY 26[7]

The CBWF **does not impact** on the RWY 26 RNAV Approach.

[7] AIP DAP PIRGN02-144, dated 20 August 2015 as printed in AIP DAP issued 01 March 2018.

4.4.2 Significant ALA

There are two significant ALA within 30nm. They are Jamestown (YJST) 19.31nm (35.82km) east northeast and Booleroo Centre (YBOC) 24.92nm (46.15km) north northeast of the CBWF.

Jamestown has a single unsealed runway aligned 16/34 with Pilot Activated Runway lighting and is suitable for night operations. It is operated by the Northern Areas Council at Jamestown.

Booleroo Centre has a single unsealed runway aligned 17/35 and is operated by the District Council of Mount Remarkable.

The extended runway centrelines of both these ALA are clear of the CBEP and the wind farm is considered to be sufficiently distant, therefore it is considered that the wind farm and the solar farm will not impact on the operation of either Jamestown or Booleroo Centre aerodromes.

The CBWF **does not impact** on the operations at YJST and YBOC.

4.5 Air Routes and Lowest Safe Altitudes

The significant published air routes in the vicinity of the CBWF and their LSAT are shown in the table below.

Route	Segment	LSALT
Grid	West of 135^0 East	2900
Grid	East of 135^0 East	4500
W448	MEECE ï YWHA	4500
W723	ED ï AVPAS	4600
W723	AVPAS ï ED	4000
W238	AVPAS - WAKEN -	3400
W238	OLD ï AVPAS	4200

Table 1 – Published LSALT

The tallest turbine tip is CB01 at 1746ft AHD. Adding the required MOC of 1000ft gives a lowest safe altitude of 2746ft rounded up to 2800ft. This is below the lowest published LSALT.

The CBWF **does not impact** any published LSALT for with air routes in the vicinity.

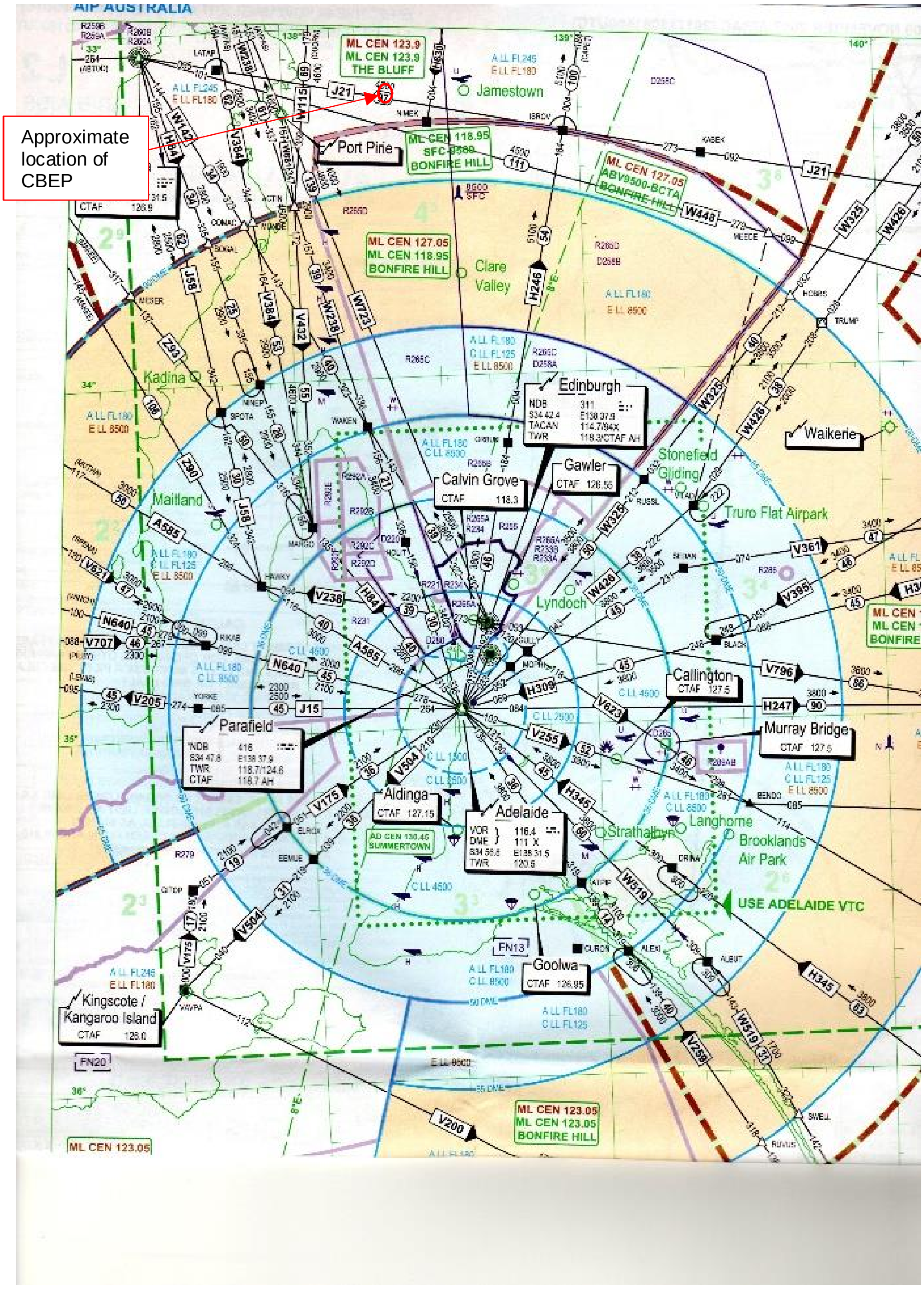

Figure 7 – Air Routes in vicinity[8]

[8] AIP Enroute Chart Low ERC L2 dated 9 Nov 2107

4.6 Airspace

The CBWF is in Class G airspace below Class E airspace with a lower limit of FL180.

A Military Restricted Area, R265D ï Military Flying sits above CBEP. R265D is activated by NOTAM and has a Lower Limit of 9500ft with an Upper Limit set by NOTAM. R265D has a Conditional Status of RA1 whereby pilots may flight plan through the area and under normal circumstances expect a clearance from ATC.

The CBWF **does not penetrate** R265D.

There are **no Prohibited or Danger Areas (PRD)** within the vicinity of the CBEP.

There are **no published flying training areas** in the vicinity of the CBEP.

4.7 Communications, Navigation and Surveillance Facilities

Wind turbines by their size and construction may cause interference to air traffic control communications, navigation and surveillance (CNS) facilities. Airservices Australia (AsA) recommends the use of the *EuroControl Guidelines on How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors*[9]*.*

The CASR Part 139 Manual of Standards ï Aerodromes, Chapter 11, sets out the general requirements for navigation aid sites and air traffic control (ATC) facilities, including the clearance planes for planned and existing facilities.

4.7.1 Communications

There are no known civil ATC or military communications facilities in area of the CBEP.

4.7.2 Navigation

The NDB at Whyalla is approximately 70km (38nm) from the wind farm and is considered sufficiently distant to be unaffected by the CBEP.

4.7.3 Surveillance

There are no known civil ATC or military surveillance facilities in area.

The CBEP will not impact on the operation of any known civil ATC or military CNS facilities.

[9] Available at http://www.eurocontrol.int/sites/default/files/publication/files/20140909-impact-wind-turbines-sur-sensors-guid-v1.2.pdf last accessed 10 January 2018

4.8 Solar Glare Analysis

The nature of photovoltaic (PV) panels is such that they may create sun glare as a result of reflection from the outer covering of the panel. At close range this glare may pose a hazard to aircraft safety. This is particularly so for solar PV installations within direct line and close to runways where glare may distract an aircraft pilot at a critical phase of flight.

The ForgeSolar[10] tools (as used throughout the world by consultants, PV installers and researchers to predict and plan for glare) is the preferred tool used to conduct a solar glare analysis. ForgeSolar use SGHAT[11] technology to offer a suite of glare analysis tools that meet all United States Federal Aviation Administration (FAA) standards.

The CBSF is adjacent to the CBWF approximately 2km to the west, 4.5km north northwest of the town of Crystal Brook and approximately 19.25km southeast of Port Pirie. The CBSF will cover approximately 170ha and use single axis tracking from east to west with the panels facing north. The panels will not be more than 4m above ground level.

No solar glare assessment was carried out for the Crystal Brook site because there are no aerodromes in close proximity.

Due to its location away from any aerodromes the Crystal Brook Solar Farm will have no impact on aviation safety. Aircraft operating in the area are required to overfly at a minimum height of 500ft above the solar facility, thus there should be no glare issues from the panels.

4.9 AIS Conclusions

The AIS concluded that the CBWF will **not impact** upon the following:

- The OLS and PANS-OPS surfaces of any registered or certified aerodrome;
- The LSALT for air routes in the vicinity;
- The performance of Navigation Aids and Communication Facilities; or
- The performance of any surveillance radars.

The AIS concluded that the CBSF will **not impact** on aviation safety.

[10] The ForgeSolar tools are available at https://www.forgesolar.com/
[11] Solar Glare Hazard Analysis Tool developed by Sandia National Laboratories https://share.sandia.gov/phlux

4.10 Airservices Australia Response

Airservices Australia is yet to respond. Their assessment will be included in a supplementary report.

4.11 Department of Defence Response

Department of Defence is yet to respond. Their assessment will be included in a supplementary report.

5. QUALITATIVE RISK ASSESSMENT

The expression ñin the vicinity of the aerodromeòis considered by CASA to mean within the boundaries of either the OLS or the PANS-OPS surfaces.

The NASF Guideline D considers 30km (16.2nm) from a certified or registered aerodrome to be ñin the vicinity.ò

More generally the impact on any aerodrome within 56km (30nm) of a wind farm is considered.

5.1 Certified and Registered Aerodromes

As noted in Section 4.4 above the only certified or registered aerodrome within 30nm of the CBEP is Port Pirie (YPIR) which has runway lighting and two non-precision RNAV (GNSS) Instrument Approaches. As discussed in section 4.4.1 the CBWF does not impact on the RNAV Approaches nor penetrate the OLS for Port Pirie aerodrome.

Discussion with the aerodrome operator confirms that the CBWF will **not impact** on the operation of YPIR.

5.2 Identified ALA within 30nm

As discussed in Section 4.4.2 there are two significant ALA within 30nm. They are Jamestown (YJST) 19.31nm (35.82km) east northeast and Booleroo Centre (YBOC) 24.92nm (46.15km) north northeast of the CBWF.

Both ALA are more than 30km from of the CBEP and are considered to be sufficiently distant such that the wind farm and the solar farm will not impact on the operation of either Jamestown or Booleroo Centre aerodromes.

The CBWF does not impact on the operations at YJST and YBOC.

Discussion with the aerodrome operators of both YJST and YBOC confirms that the CBWF **will not impact** on the operations at either aerodrome.

5.3 Airspace

The CBWF is in Class G airspace below Class E airspace with a lower limit of FL180.

Within Class G airspace an aircraft flying in accordance with the Visual Flight Rules (VFR) away from a populous area is, when flying below 3000ft, required by Civil Aviation Regulation (CAR) 157 to remain at 500ft above the highest point of the terrain **and any obstacle on it** within a radius of 600m [300m for a helicopter] from a point on the terrain directly below the aircraft. For a wind farm this equates to 500ft above the turbine tip height, which for the CBWF is 788ft + 500ft = 1288ft Above Ground Level (AGL).

A Military Restricted Area, R265D ï Military Flying sits above CBEP. R265D is activated by NOTAM and has a Lower Limit of 9500ft with an Upper Limit set by NOTAM. R265D has a Conditional Status of RA1 whereby pilots may flight plan through the area and under normal circumstances expect a clearance from ATC.

The CBWF **does not penetrate** R265D.

There are **no Prohibited or Danger Areas (PRD)** within the vicinity of the CBEP.

There are **no published flying training areas** in the vicinity of the CBEP.

5.4 Relevant Air Routes

As noted in section 4.5 above the CBWF **does not impact** any published LSALT for with air routes in the vicinity.

5.5 Night Flying

Aircraft flying at night under either IFR or VFR are protected by published or calculated LSALT. For VFR at Night flight descent below the LSALT is restricted to within 3nm (5.4km) of the aerodrome and with it in sight. Where an IFR aircraft is using a published instrument approach it is protected by PANS-OPS surfaces.

YPIR has Pilot Activated Lighting (PAL) and published Instrument Approach Procedures on Runway 08/26. Flight into YPIR can be conducted under either IFR or VFR at Night. The CBWF does not penetrate the PANS-OPS or OLS for YPIR and is below the published LSALTõs. Night operations into YPIR are not affected by the CBWF.

The YJST ALA has PAL and no published Instrument Approach Procedure, consequently any night flight into YJST must be conducted in accordance with the VFR; that is, descent below the LSALT only occurs within 3nm of the aerodrome and with it in sight.

The YBOC ALA does not have runway lighting.

The CBWF will **not affect night flying** operations in the area.

5.6 General Aviation Flying Training

There is little or no General Aviation Flying Training undertaken in the CBWF area. General Aviation flying training is initially conducted in accordance with VFR. Wind turbines, by their size and colour are considered to be highly conspicuous and therefore not an issue for VFR flight by day.

There are several significant geographical features and landmarks that would assist VFR pilots to remain clear of the wind farm, even in marginal visual weather conditions.

The CBWF will **not affect General Aviation flying training** operations in the area.

5.7 Recreational and Sport Aviation

Recreational and Sport aircraft, particularly ultra-lights registered with Recreational Aviation Australia (RA-Aus) are limited to daytime flight in accordance with the Visual Flight Rules (VFR). This requires the aircraft to remain clear of cloud and a minimum of 500ft above the ground or highest obstacle. Ultra-light aircraft have a Maximum Take-Off Weight (MTOW) of 600kgs or less. A small General Aviation aircraft such as a Cessna C172 have a MTOW of 1110kg.

There is an RA-Aus flying training school at YPIR. The owner and Chief Instructor advised that all training is done by day and within 10nm of the aerodrome and that the CBWF will not affect these training operations. The instructor also advised that there are several significant geographical features and landmarks that will allow VFR pilots to remain clear of the wind farm, even in marginal weather conditions. There is a group of RA-Aus aviators at Jamestown. *The photo shows an Australian built Lightwing ultra-light aircraft.*

The CBWF is **not considered to pose a hazard** to flights conducted by these aircraft.

5.8 Approved Low Flying Activities

There are no published Flying Training Areas in the vicinity of the CBWF.

5.9 Aerial Agricultural Application Activity

The Aerial Agricultural Association of Australia opposes wind farm developments unless the developer has (inter alia):

- Consulted in detail with local operators;
- Received independent expert advice on safety and economic impacts; and
- Considered the impacts on the aerial application industry.[12]

An aerial agricultural operator made the comment that *"the decision to host wind turbines is one made by the landholder who must accept that there will most probably be limitations to any aerial applications on the property[13]."*

[12] http://www.aerialag.com.au/ResourceCenter/Policies.aspx
[13] Expert opinion obtained by the author during previous QRA work

One of the major aerial agricultural operators advised that they undertake aerial applications in the area, however it is dependent on the seasons, pests and the farmers' needs. This operator has an airstrip in the Crystal Brook area but did not disclose its location. The same operator uses YPIR and YJST and is a primary aerial firefighting contractor for the South Australian Country Fire Service. The operator made the comment that "wind farms are becoming common, they're a fact of life, we know more about them and can operate safely in their vicinity."[14]

5.10 Known Highly Trafficked Areas

There are no known highly trafficked areas in the vicinity of the wind farm.

5.11 Emergency Services Flying

All Emergency Services flying is subject to ongoing dynamic risk assessment throughout the flight. The safety of the aircraft and its crew is paramount.

5.11.1 Police Air Wing

The South Australian Police utilise the services of the MAC Helicopters (see 5.12.2 below) for police operations.

5.11.2 Air Ambulance

The MAC Helicopter Air Ambulance uses helicopters capable of IFR flight. The helicopter operations are sometimes conducted at low level for patient retrieval from accident sites. The Senior Base pilot advises that for low level operations there is a dynamic risk assessment process undertaken and where the operation is considered too risky it is aborted. Night low level operations are sometimes undertaken using night vision goggles (NVG) and at the destination the "night sun" searchlight is used to illuminate the operational area. It was also noted that any LED type obstacle lights need to be within a specific wavelength spectrum for successful use of NVG.

The CBWF will **not have any undue effect** on the operations of the MAC helicopters.

[14] Stakeholder interview with aerial agricultural applications operator for Aerotech.

5.12 Fire Fighting

5.12.1 Aerial Firefighting

"It is important to remember that aircraft alone do not extinguish fires."[15]

From previous work undertaken by the author regarding firefighting within wind farms it is noted that the rural firefighting agencies in Victoria, New South Wales, South Australia and Western Australia all view wind turbines and wind farms to be ӗust another hazardô that has to be considered in the risk management process associated with aerial firefighting[16].

The State rural firefighting agencies made submissions to the Senate Select Committee on Wind Turbines. All these submissions attached the Australian Fire and Emergency Service Authorities Council (AFAC) *Wind Farms and Bushfire Operations Position Paper 30 October 2014* document. See Appendix D.

The AFAC paper states:

> *"Aerial firefighting operations will treat the turbine towers similar to other tall obstacles. Pilots and Air Operations Managers will assess these risks as part of routine procedures. Risks due to wake turbulence and the moving blades should also be considered. Wind turbines are not expected to pose unacceptable risks."*[17]

All these agencies make the point that firefighting aircraft operate to the Visual Flight Rules so can only operate during daylight hours and must remain clear of smoke in order to maintain the required visibility of the ground and obstacles such as trees, power lines, radio masts, houses and ground based fire fighters. The Victorian Country Fire Authority (CFA) recommends:

> *"… … a minimum distance between turbines of 300 metres. This provides adequate distance for aircraft to operate around a wind energy facility given the appropriate weather and terrain conditions. Fire suppression aircraft operate under the 'Visual Flight Rules'. As such, fire suppression aircraft only operate in areas where there is no smoke and during daylight hours. Wind turbines, similar to high voltage transmission lines, are a part of the landscape and would be*

[15] NSW Rural Fire Service submission to the Senate Select Committee on Wind Turbines, 6 March 2015, page 2

[16] Expert opinion formed by the author from previous QRA work

[17] AFAC *Wind Farms and Bushfire Operations Position version 2.0 30 October 2014, page 2*

> *considered in the incident action plan."*[18]

The South Australian Country Fire Service has published a fact sheet titled *Understanding Aerial Firefighting* which explains the use and limitations of aircraft in firefighting. The major point made is that:

> *"The popular perception amongst much of the population is that aircraft alone can put out bushfires. This is not true. CFS firefighters and fire appliance for the vast majority of instances are the primary and only method of controlling bushfires.*[19]*"*

A further point made by the CFS is that firefighting aircraft are a limited resource and are not routinely allocated to every fire. See Appendix C.

5.12.2 Ground Based Firefighting

From previous work done by the author regarding firefighting within wind farms it is noted that the rural fire fighting agencies in Victoria, New South Wales, South Australia, and Western Australia all make the point that access for fire trucks and personnel, and consequently their ability to fight the fire within a wind farm, is greatly enhanced by the access roads built for the construction and maintenance of the turbines. These roads also act as fire breaks which can slow or contain the fire spread across the open ground. The area around the base of each tower is kept clear of vegetation and as such offers a refuge for fire fighters and their vehicles.

The CFA recommends:

> *"To enable access for fire appliances the following provisions should be considered:*
>
> - *Constructed roads should be a minimum of 3.5 metres in trafficable width (with 0.5m each side) with a four (4) metre vertical clearance for the width of the formed road surface*
> - *Roads should be constructed to a standard so that they are accessible in all weather conditions and capable of accommodating a vehicle of 15 tonnes and 30 tonne, if a CFA aerial appliance, is within the District, for the trafficable road width."*[20]

[18] CFA Emergency Management Guidelines for Wind Energy Facilities August 2017 section 2
[19] SA CFS Fact Sheet 10-01, *Understanding Aerial Firefighting,* August 2017
[20] CFA Emergency Management Guidelines for Wind Energy Facilities August 2017 section 3

The CFA further recommends:

> *Wind Energy Facility operators must ensure that the following fuel management measures are included in their plans during the Fire Danger Period:*
>
> - *Grass should be no more than 100mm in height and leaf litter no more that 10mm deep for a distance of thirty (30) metres around constructed buildings and viewing platforms;*
> - *A fuel reduced area of four (4) metres width should be maintained around the perimeter of electricity compounds and substation type facilities;"*[21]

5.13 Topographical and Marginal Weather Conditions

The topography of the area surrounding Port Pirie and Crystal Brook is coastal plains with a rising north/south ridge line at Crystal Brook. There are several prominent geographical features and landmarks that provide significant navigational cues for VFR flight. In particular the Princes Highway and the railway line provide navigational cues that keep VFR flights clear of the CBWF.

Aircraft operating under Instrument Flight Rules (IFR) can operate in poor weather conditions and in cloud which precludes visual acquisition of obstacles and terrain. These operations are protected from obstacles and terrain by PANS OPS surfaces and LSALT's that are designed to keep the aircraft above obstacles and terrain.

Otherwise the flight must be operating under Visual Flight Rules (VFR) and CAR 157 states (in part) that an aircraft operating under VFR must not fly lower than 152m/500ft over a non-populated area being terrain or obstacles on that terrain and within, for an aircraft other than a helicopter, 600m horizontally and, in the case of a helicopter, 300m horizontally to the same, unless:

- Due to stress of weather or any other unavoidable cause it is essential that a lower height be maintained; or
- It is engaged in approved low flying private or aerial work; or
- It is engaged in flying training and flies over part of a flying training area in respect of which low flying is authorised by CASA under sub regulation 141(1); or
- It is undertaking a baulked approach; or
- It is flying in the course of actually taking-off or landing at an aerodrome.

[21] CFA Emergency Management Guidelines for Wind Energy Facilities May 2015 section 9

In this regard, the Aeronautical Information Publication (AIP) states that a pilot of a fixed wing aircraft operating under VFR (by day in Class G airspace[22]) must have 5km forward visibility and remain clear of clouds and in sight of ground or water when operating below 3000ft AMSL. Helicopters are approved in the regulations to operate with 800m visibility if operating at a reduced speed.

In regard to the first bullet point above it is possible that due to lowering cloud base, and through poor airmanship the aircraft had "pressed on" to the point that it was unable to execute a turn and fly away from the weather, an aircraft could find itself lower than 152m/500ft above the terrain or obstacles. The operative word in this case is unavoidable; flying into deteriorating weather is avoidable. As noted above there are several prominent visual features that provide significant navigational cues for VFR flight.

5.14 Solar Glare Analysis

The nature of photovoltaic (PV) panels is such that they may create sun glare as a result of reflection from the outer covering of the panel. At close range this glare may pose a hazard to aircraft safety. This is particularly so for solar PV installations within direct line and close to runways where glare may distract an aircraft pilot at a critical phase of flight.

The ForgeSolar[23] tools (as used throughout the world by consultants, PV installers and researchers to predict and plan for glare) is the preferred tool used to conduct a solar glare analysis. ForgeSolar use SGHAT[24] technology to offer a suite of glare analysis tools that meet all United States Federal Aviation Administration (FAA) standards.

The CBSF is adjacent to the CBWF approximately 2km to the west, 4.5km north northwest of the town of Crystal Brook and approximately 19.25km southeast of Port Pirie. The CBSF will cover approximately 150ha and use single axis tracking from east to west with the panels facing north. The panels will not be more than 4m above ground level.

No solar glare assessment was carried out for the Crystal Brook site because there are no aerodromes in close proximity.

Due to its location away from any aerodromes the Crystal Brook Solar Farm will **not impact** on aviation safety. Aircraft operating in the area are required to overfly at a minimum height of 500ft above the CBSF, thus there should be no glare issues from the panels.

[22] Class G: IFR and VFR flights are permitted and do not require an airways clearance. IFR flights must communicate with air traffic control and receive traffic information on other IFR flights and a flight information service. VFR flights receive a flight information service on request.

[23] The ForgeSolar tools are available at https://www.forgesolar.com/

[24] Solar Glare Hazard Analysis Tool developed by Sandia National Laboratories https://share.sandia.gov/phlux

5.15 NASF Guidelines

The National Airports Safeguarding Framework ï Guideline D *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* provides guidance for the siting and marking of the turbines and meteorological monitoring towers associated with wind farms.

5.15.1 Notification to Authorities

Paragraph 20 of Guideline D advises that:

> *When wind turbines over 150m above ground level are to be built within 30km (16.2nm) of a certified or registered aerodrome, the proponent should notify the Civil Aviation Safety Authority and Airservices. If the wind farm is within 30km of a military aerodrome, Defence should be notified.*

The turbines are greater than 150m and are within 30km of the Port Pirie registered aerodrome.

The turbines and meteorological monitoring towers used in the CBWF must be reported to CASA and the RAAF in accordance with AC 139-08(1) *Reporting of Tall Structures* for inclusion on aeronautical charts.

5.15.2 Risk Assessment

The NASF Guideline has the following requirements for a risk assessment.

> *26. Following preliminary assessment by an aviation consultant of potential issues, proponents should expect to commission a formal assessment of any risks to aviation safety posed by the proposed development. This assessment should address any issues identified during stakeholder consultation.*

The preliminary risk assessment for the CBWF indicates that the overall risk to aviation is LOW. A risk assessment of LOW indicates that the wind farm is *'not a hazard to aircraft safety'.*

> *27. The risk assessment should address the merits of installing obstacle marking or lighting. The risk assessment should determine whether or not a proposed structure will be a hazardous object. CASA may determine, and subsequently advise a proponent and relevant planning authorities that the structures have been determined as:*
>
> *(a) Hazardous but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking;*

or

(b) Hazardous and should not be built, either in the location and/or to the height proposed as an unacceptable risk to aircraft safety will be created; or

(c) Not a hazard to aircraft safety.

By day the CBWF turbines are conspicuous by their size and colour. The CBWF does not impact on any LSALT in the area. Night operations for aircraft do not occur below the LSALT for IFR and VFR at night. IFR aircraft are protected by the LSALT and DAP prescribed airspace at each aerodrome. Where an approach to land is undertaken operating to VFR at night, descent below the LSALT does not occur until within 3nm of the airport, in VMC and with the aerodrome in sight. The nearest aerodrome equipped for night operations is the Port Pirie 12nm (22km) to the northeast.

Given the above, the CBWF does not require obstacle lighting as the risk to aviation is LOW and no additional mitigating strategies are required.

Overall the risk assessment demonstrates that the CBWF is a LOW risk to aviation and is therefore *not a hazard to aircraft safety.*

28 If CASA advice is that the proposal is hazardous and should not be built, planning authorities should not approve the proposal. If a wind turbine will penetrate a PANS-OPS surface, CASA will object to the proposal. Planning decision makers should not approve a wind turbine to which CASA has objected.

The CBWF does not penetrate any OLS or PANS-OPS surfaces either civil or military, therefore CASA has no reason to object.

29 In the case of military aerodromes, Defence will conduct a similar assessment to the process described above if required. Airservices, or in the case of a military aerodrome, Defence, may object to a proposal if it will adversely impact on Communications, Navigation or Surveillance (CNS) infrastructure. Airservices/ Defence will provide detailed advice to proponents on request regarding the requirements that a risk assessment process must meet from the CNS perspective.

There is no civil or known military CNS infrastructure that will be impacted by the CBWF.

30 During the day, large wind turbines are sufficiently conspicuous due to their shape and size, provided the colour of the turbine is of a contrasting colour to the background. Rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study. Other colours are also acceptable, unless the colour of the turbine is likely to blend in with the background.

The CBWF turbines will be appropriately marked to ensure they are conspicuous by day.

5.15.3 Lighting of Wind Turbines

> *33 Where a wind turbine 150m or taller in height is proposed away from aerodromes, the proponent should conduct an aeronautical risk assessment.*
>
> *34. The risk assessment, to be conducted by a suitably qualified person(s), should examine the effect of the proposed wind turbines on the operation of aircraft. The study must be submitted to CASA to enable an assessment of any potential risk to aviation safety. CASA may determine that the proposal is:*
>
> *(a) hazardous, but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking; or*
>
> *(b) not a hazard to aircraft safety.*

The CBWF does not penetrate any LSALT, OLS or PANS-OPS airspace; therefore it is assessed as a **LOW risk to aviation** and is therefore ***not a hazard to aircraft safety.***

5.16 QRA Findings

Risk Element	Assessed Level of Risk	Comment
Airport Operations	LOW	
Aircraft Landing Area Operations	LOW	Suitability for use is a pilot responsibility.
Jamestown	LOW	36km away, RWY centreline clear of CBWF
Booleroo Centre	LOW	46km away, RWY centreline clear of CBWF
Known Highly Trafficked Routes	LOW	None identified
Published Air Routes	LOW	Nil impact
Restricted Airspace	LOW	Sits below and clear of R265D
Promulgated Flying Training Areas	LOW	Nil exist in the area
GA Flying	LOW	
Night Flying	LOW	
Emergency Services Flying	LOW	
Commercial Flying	LOW	
Recreational and Sport Aviation	LOW	
Recreational Pilot Training (RA-AUS)	LOW	Training area is clear of CBWF
GA Pilot Training	LOW	
Weather and Topographical Issues	LOW	
Solar Glare	LOW	

Table 2 – Risk Assessment Summary

6. OBSTACLE LIGHTING REVIEW

6.1 Australian Regulatory Framework for Obstacle Lighting of Wind Farms

The Civil Aviation Safety Authority (CASA) has limited regulatory authority over the lighting of obstacles (tall structures) away from an aerodrome. This is particularly applicable to wind farms, which are generally beyond the Obstacle Limitation Surface (OLS) of aerodromes. It must be noted that Civil Aviation Safety Regulations (CASR) Part 139 ï Aerodromes are applicable to certified and registered aerodromes only [Military and Joint User apply the same general form].

CASA can only make recommendations regarding the lighting of wind farms, and not determinations/directions mandating lighting of wind farms that are not in the vicinity of an aerodrome. It is noted that in the Senate Select Committee on Wind Turbines (2015) CASA provided evidence to the committee about the limited role it plays in regulating airspace around wind farms.

> *We know our responsibilities and the power of our legislation, which is very limited. For the most part, wind turbines are built away from aerodromes and certainly away from federally leased aerodromes. So the only power we have is to make a recommendation to the planning authority about whether the turbine is going to be an obstacle and, if we decide it is an obstacle, we can make a recommendation as to whether it should be lighted and marked. This is the extent of our power.*[25]

In my experience, CASA has emphasised the view that ñ*it is a matter for the appropriate Land Use Planning Authority to consider the implementation of our recommendations"* regarding aviation obstacle lighting of wind farms.

6.1.1 Civil Aviation Safety Regulations

The Civil Aviation Safety Regulations (CASR) Part 139 ï Aerodromes, Section E contains the regulations governing obstacles. These regulations are applicable to the protection of airspace and aircraft operations in the vicinity of aerodromes. They are not applicable to obstacles that are beyond the vicinity of aerodromes; that is beyond the OLS.

6.1.2 Manual of Standards Part 139 – Aerodromes

The Manual of Standards (MOS) Part 139 provides amplification and methods of compliance to the CASR Part 139 Aerodromes. As the Crystal Brook Wind Farm is beyond the vicinity (OLS) of any military, certified or registered aerodrome MOS 139

[25] Senate Select Committee on Wind Turbines, Final Report, August 2015, paragraph 5.38

does not apply.

6.1.3 National Airports Safeguarding Framework

The Australian National Airports Safeguarding Advisory Group (NASAG) produced a set of guidelines called the National Airports Safeguarding Framework (NASF) in 2012.

The purpose of the National Airports Safeguarding Framework (the Safeguarding Framework) is to enhance the current and future safety, viability and growth of aviation operations at Australian airports, by supporting and enabling:

- the implementation of best practice in relation to land use assessment and decision making in the vicinity of airports;
- assurance of community safety and amenity near airports;
- better understanding and recognition of aviation safety requirements and aircraft noise impacts in land use and related planning decisions;
- the provision of greater certainty and clarity for developers and land owners;
- improvements to regulatory certainty and efficiency; and
- the publication and dissemination of information on best practice in land use and related planning that supports the safe and efficient operation of airports.

Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation* provides information regarding wind farms. This guideline provides the following information: -

> *20 When wind turbines over 150m above ground level are to be built within 30km (16.2nm) of a certified or registered aerodrome, the proponent should notify the Civil Aviation Safety Authority and Airservices. If the wind farm is within 30km of a military aerodrome, Defence should be notified.*
>
> *33 Where a wind turbine 150m or taller in height is proposed away from aerodromes, the proponent should conduct an aeronautical risk assessment.*
>
> *34. The risk assessment, to be conducted by a suitably qualified person(s), should examine the effect of the proposed wind turbines on the operation of aircraft. The study must be submitted to CASA to enable an assessment of any potential risk to aviation safety. CASA may determine that the proposal is:*
>
> > *(a) hazardous, but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking; or*
> >
> > *(b) not a hazard to aircraft safety.*

The CBWF is not sited within the vicinity of any aerodrome and does not penetrate any OLS or PANS-OPS airspace; and is assessed as a LOW risk to aviation and is therefore *not a hazard to aircraft safety.*

Given the above, the CBWF **does not require obstacle lighting** as the risk to aviation is LOW and no additional mitigating strategies are required.

6.2 Obstacle Lighting Summary

The Crystal Brook Energy Park does not penetrate any OLS or PANS-OPS surfaces or any LSALT's. The Crystal Brook Wind Farm is not in the vicinity of any military or regulated aerodrome.

ICAO recommends in areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150m or more AGL should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.

The NASF Guideline D recommends that any structure of 150m or taller AGL be subjected to a risk assessment to determine any hazard to aircraft safety.

The CBWF turbines have a tip height of 240m AGL and therefore can be regarded as an obstacle and be subject to a Risk Assessment to ascertain whether they constitute a hazard to aviation safety.

This Risk Assessment finds that the overall risk to aviation in the area of the CBWF is LOW; therefore the CBWF is *not a hazard to aircraft safety* and no further mitigation is required.

Aviation obstacle lighting is not required.

7. WIND MONITORING TOWERS

Meteorological Monitoring Masts are very difficult to see due to their slender construction and guy wires. The masts are often a grey (galvanised steel) colour that readily blends with the background.

The photograph in Fig 8 below shows a Meteorological Monitoring Mast as seen from the ground.

Figure 8 – A Meteorological Monitoring Mast photographed from the ground

The aerial agricultural applications operators and the emergency services pilots all note the danger of meteorological monitoring masts to low flying aircraft. All these pilots made comment that ﾓmet masts are extremely dangerous.ﾔ Each of these stakeholders request that the NASF Guidelines, except for the strobe light, be used to make the masts more visible and that the markings be maintained in a serviceable condition.

7.1 NASF Guidelines – Marking of Meteorological Monitoring Masts

The NASF guideline also refers to the marking and lighting of wind monitoring towers. The relevant points are summarised as:

> *Wind monitoring towers are very difficult to see from the air due to their slender construction and guy wires. This is a particular problem for low flying aircraft, particularly aerial agricultural and emergency services operations.*
>
> *Measures to be considered to improve visibility include:*
>
> - *The top one third of wind monitoring towers be painted in alternating contrasting bands of colour. Examples can be found in the CASA MOS 139 sections 8 and 9;*
> - *Marker balls, high visibility flags or high visibility sleeves*

placed on the outer guy wires;

- *Ensuring the guy wire ground attachment points have contrasting colours to the surrounding ground and vegetation; or*
- *A flashing strobe light during daylight hours.*

7.2 Federal Aviation Administration – Marking of Met Towers

It is noted that the Federal Aviation Administration (FAA) has issued, on 24th June 2011, guidance material for the marking of Meteorological Evaluation Towers (METS) of less than 200ft (61m) in height to enhance visibility to low flying aircraft. The FAA recommends that the entire tower be painted in alternating contrasting bands of colour, the guy wires have high visibility balls or sleeves and that the markings are replaced when faded or otherwise deteriorated.[26]

7.3 Reporting of Tall Structures

The turbines proposed for the CBWF have a tip height of 240m (788ft) AGL; therefore they need to be reported to CASA.

CASR 139.365 requires the turbines and the meteorological monitoring masts to be reported as tall structures in accordance with AC 139-08(0) *Reporting of Tall Structures* for inclusion on appropriate aeronautical charts. This reporting facilitates the inclusion of the tall structures on the appropriate aeronautical charts.

7.4 Recommendation

It is recommended that Neoen Australia Pty Ltd ensure the wind monitoring towers used in the CBWF are:

- Appropriately marked;
- Reported as tall structures in accordance with AC139-08;
- Notified to the Aerial Agricultural Association of Australia;
- Notified to local Aerial Agricultural Applications operators;
- Notified to the Emergency Services aviation groups in SA: and
- Notified to the aerodrome operators at Port Pirie, Jamestown and Booleroo Centre.

[26] NAAA (US) website http://www.agaviation.org/content/faa-releases-guidance-marking-met-towers accessed 27/05/2014

8. CONCLUSIONS

8.1 AIS

The CBEP development will **not impact** upon the following:

- The OLS and PANS-OPS surfaces published for any registered or certified aerodrome;
- Any published air route Lowest Safe Altitudes;
- The operation of any Communication, Navigation Aids or Surveillance facilities.

The CBSF is sufficiently distant from any aerodrome for there to be no glint or glare issues for aircraft in the take-off or landing phase of flight. Any aircraft at cruising altitude will be at least 500ft above the CBSF and at that height it is considered that any glare or glint will not be a hazard to aircraft safety.

8.1.1 Airservices Response to AIS

Airservices Australia is yet to respond. Their assessment will be included in a supplementary report.

8.1.2 Defence Response to AIS

The Department of Defence is yet to respond. Their assessment will be included in a supplementary report.

8.2 Risk Assessment

The QRA demonstrates that the CBEP will ***"not be a hazard to aircraft safety"*** and therefore *"not of operational significance"* to aircraft operations.

8.3 Obstacle Lighting

The CBWF turbines have a tip height of 240m AGL and therefore can be regarded as an obstacle and be subject to a Risk Assessment to ascertain whether they constitute a hazard to aviation safety.

The Risk Assessment finds that the overall risk to aviation in the area of the CBWF is LOW. On this basis no further mitigation is required.

Obstacle lighting is not required.

.

APPENDIX A

Airservices Australia

Aviation Assessments for Wind Farm Developments

19 August 2014

APPENDIX A

airservices

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To Whom It May Concern

Airservices Aviation Assessments for Wind Farm Developments

Guidelines to manage the risk to aviation safety from wind turbine installations (Wind Farms/Wind Monitoring Towers) are under development by the National Airports Safeguarding Advisory Group (NASAG). NASAG is comprised of high-level Commonwealth, State and Territory transport and planning officials and has been formed to develop a national land use planning regime to apply near airports and under flight paths.

The wind farm guidelines will provide information to proponents and planning authorities to help identify any potential safety risks posed by wind turbine and wind monitoring installations from an aviation perspective.

Potential safety risks include (but are not limited to) impacts on flight procedures and aviation communications, navigation and surveillance (CNS) facilities which require assessment by Airservices.

To facilitate these assessments all wind farm proposals submitted to Airservices must include an Aviation Impact Statement (AIS) prepared by an aeronautical consultant in accordance with the AIS criteria set out below.

AIS must be undertaken by an aeronautical consultant with suitable knowledge and capabilities to provide a reliable and comprehensive report. All data is to be supplied in electronic form. If you are not familiar with any aeronautical consultants, you may wish to view the list on the Civil Aviation Safety Authority (CASA) website:

http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_90412

AIS Criteria

The AIS must provide a detailed analysis covering, as a minimum:

Airspace Procedures:

1. Obstacles
   - Co-ordinates in WGS 84 (to 0.1 second of arc or better)
   - Elevations AMSL (to 0.3 metres)
2. Drawings
   - Overlayed on topographical base not less that 1:250,000. Details of datum and level of charting accuracy to be noted.
   - Electronic format compatible with Microstation version 8i.
3. Aerodromes
   - Specify all registered/certified aerodromes that are located within 30nm (55.56km) from any obstacle referred to in (1) above.
   - Nominate all instrument approach and landing procedures at these aerodromes.
   - Confirmation that the obstacles do not penetrate Annex 14 or OLS for any aerodrome. If an obstacle does penetrate, specify the extent.
4. Air Routes
   - Nominate air routes published in ERC-L & ERC-H which are located near/over any obstacle referred to in (1) above.
   - Specify two waypoint names located on the routes which are located before and after the obstacles.
5. Airspace
   - Airspace classification – A, B, C, D, E, G etc where the obstacles are located.

Navigation/Radar:

1. Detect the presence of dead zones
2. False target analysis
3. Target positional accuracy
4. Probability of detection
5. Radar coverage implications
6. We would expect the analysis to follow the guidelines outlined in the EUROCONTROL Guidelines on How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors.

http://www.eurocontrol.int/sites/default/files/field_tabs/content/documents/events/guidelines-to-assess-potential-impact-of-wind-turbines.pdf

NOTE: Within the Eurocontrol Guidelines there are specific assumptions about the type of Wind Turbine for which the Guidelines are applicable (i.e. 3 blades, 30-200 m height, and horizontal rotation axis). For any deviations to the Wind Turbine characteristics listed within the Eurocontrol Guidelines, the proponent should justify to Airservices why the Eurocontrol Guidelines are still applicable.

Airservices Review of AIS

Airservices will review the quality and completeness of an AIS and will undertake limited modelling and analysis to confirm the findings and recommendations of the report.

Provided the AIS is of sound quality and is complete in accordance with the above criteria, there will be no charge for the review or limited modelling and analysis.

If the AIS is not of sound quality or is not complete in accordance with the above criteria, no modelling or analysis will be undertaken. Airservices will advise the proponent that the AIS does not meet the requirements and that the proposal cannot be assessed by Airservices.

If Airservices review of an AIS confirms impacts identified in the report (or identifies additional impacts), Airservices will advise the proponent of the impacts and the required mitigating actions (where mitigation is feasible). The proponent will also be advised that there will be charges for any mitigation actions to be undertaken by Airservices.

These charges may be advised at the time but it is likely that a detailed quote will be needed and this will only be provided on request from the proponent.

Please contact Airport Relations on 02 6268 4725 or airport.developments@airservicesaustralia.com if you have any questions.

Current as at 19 August 2014

APPENDIX B

Turbine Locations and Heights

Appendix B

WTG ID	Easting MGA54	Northing MGA54	Latitude	Longitude	Elev m AHD	Elev ft AHD	Tip Ht m	Tip Ht ft
CB01	242121.839	6312882.257	-33.292329	138.230722	292	958.01	532	1745.41
CB02	242320.8163	6311790.734	-33.30221	138.232546	288	944.88	528	1732.28
CB04	243547	6310423	-33.314825	138.245314	267	875.98	507	1663.39
CB05	243449	6310846	-33.310991	138.244382	277	908.79	517	1696.19
CB07	242016.5443	6310139.78	-33.317012	138.22881	261	856.30	501	1643.70
CB09	241689.5437	6313160.178	-33.289721	138.226164	262	859.58	502	1646.98
CB12	242005.433	6310559.92	-33.313224	138.228811	268	879.27	508	1666.67
CB14	244447	6312007	-33.300768	138.255419	250	820.21	490	1607.61
CB15	241605	6310430	-33.314298	138.224477	241	790.68	481	1578.08
CB16	242861.1368	6310559.119	-33.313436	138.237993	262	859.58	502	1646.98
CB17	241721.6864	6311013.233	-33.309072	138.225896	266	872.70	506	1660.11
CB18	244294	6312405	-33.297146	138.25389	250	820.21	490	1607.61
CB19	244428	6310281	-33.316314	138.254728	222	728.35	462	1515.75
CB20	242633.0942	6310195.831	-33.316654	138.235442	251	823.49	491	1610.89
CB21	241731.8131	6312706.937	-33.293815	138.226488	254	833.33	494	1620.73
CB22	244421	6310997	-33.309862	138.254855	225	738.19	465	1525.59
CB23	242738.7292	6310968.01	-33.309723	138.236796	249	816.93	489	1604.33
CB24	241764.6864	6312076.547	-33.299502	138.226661	279	915.35	519	1702.76
CB25	242432.5172	6310575.007	-33.31319	138.233398	256	839.90	496	1627.30
CB27	242566.5224	6312606.72	-33.294918	138.235414	241	790.68	481	1578.08
CB30	241390.0282	6312281.57	-33.297565	138.2227	246	807.09	486	1594.49
CB31	241714.2039	6311498.226	-33.3047	138.225954	269	882.55	509	1669.95
CB32	241320.5333	6312823.871	-33.292663	138.222109	235	771.00	475	1558.40
CB33	242658.2669	6311386.624	-33.305932	138.236051	242	793.96	482	1581.36
CB34	241308.4243	6311629.352	-33.303422	138.221638	235	771.00	475	1558.40
CB35	241359.6867	6310782.529	-33.311063	138.221946	214	702.10	454	1489.50

Ident and Location of CBWF turbines
CB01 is the tallest turbine – denoted by yellow
Note: WTG ID is not consecutive

APPENDIX C

South Australian Country Fire Service Understanding Aerial Firefighting

South Australian
COUNTRY FIRE SERVICE
Aircraft **SUPPORT**, *Firefighters* **SUPPRESS**

Understanding Aerial Firefighting

The CFS combats bush, grass, scrub and forest fires primarily through the deployment of fire appliances and firefighters for the protection of life, property and the environment. These resources are complimented in a number of areas of the State with farm fire units, as they are a valuable resource in the overall control strategy when available.

At times, firefighting operations may be supported by firefighting aircraft and/or earth moving plant and equipment. Firefighting aircraft are a limited resource and therefore CFS places these aircraft in locations where life and assets are at the highest risk. There is no guarantee that every fire in the State will be serviced by aircraft, and the primary form of fire suppression has, and will always be, firefighters on the ground.

Community expectations

The popular perception amongst much of the community is that aircraft alone can put out bushfires. This is not true. CFS firefighters and fire appliances for the vast majority of instances are the primary and only method of controlling bushfires.

In many cases smoke from the fire ahead of the fire front makes it very difficult, if not impossible, for aircraft to identify and bomb specific targets. Aircraft cannot fly through heavy smoke, as there is a real danger that dense smoke will cause a 'flameout' of the jet turbine engine which is used to power each rotary or fixed wing aircraft in the firefighting fleet.

Deployment of aircraft to fires

The deployment of aircraft to any fire is made after consideration of many variables, risks, aircraft suitability and aircraft availability. Once committed, the decision to attack a fire is made by the air attack supervisor and the CFS Officer on the ground, based on firefighting tactics and a dynamic risk assessment. This will include an assessment of localised weather conditions, the fire's behaviour, obstructions to aircraft in the area, smoke and its effect on visibility, assets at risk, and aircraft performance parameters.

The final decision to fly or not fly the mission remains with the pilot in command of the firefighting aircraft.

In some circumstances aircraft cannot be deployed due to other higher priority fires, unfavourable wind and weather conditions, adverse terrain or obstructions that prevent safe flying environments.

Where vertical obstructions exist in the airspace around a fire, such as powerlines, weather masts, radio and television transmission towers, tall trees and wind turbines, a dynamic risk assessment is undertaken prior to the aircraft being committed to fire bombing operations. In some circumstances aircraft will not be utilised because risks caused by vertical obstructions exceed safe operating conditions.

Remotely Piloted Aircraft and Drones

In the event that a Remotely Piloted Aircraft RPA *(this includes Unmanned Aerial Vehicles (UAVs) or Drones)* is detected operating within the vicinity of a fire, **CFS may suspend aerial firefighting operations until it is considered safe to resume**. If aerial firefighting operations are suspended, the CFS will instigate an immediate media alert to request that the drone operator cease operations, or if members of the community are aware of the drone operator to immediately contact Police.

For further information on Aerial Firefighting go to:
http://www.cfs.sa.gov.au

www.cfs.sa.gov.au
ABN 97 677 077 835

Government of South Australia

APPENDIX D

Australian Fire and Emergency Services Authorities Council
Wind Farms and Bushfire Operations

afac
Australasian Fire and Emergency Service Authorities Council

Wind Farms and Bushfire Operations

POSITION

Version 2.0

30 October 2014

Version Control

Version	Author	Edits	Date
0.1	Gary Featherston	First draft requested by the Rural and Land Management Group at its meeting of 7 May 2013	28 August 2013
0.2	Gary Featherston	Updated wind farm numbers and included comments from earlier reviewers.	30 August 2013
0.3	Gary Featherston	Approved by the RLM group before edits to include EMR and Total fire ban legislation.	9 September 2013
0.4	Gary Featherston	Added comments provided by the Clean Energy Council.	19 September 2013
1.0	Gary Featherston	Approved by Council	24 October 2013
1.1	Gary Featherston	Minor revision to add monitoring towers.	15 September 2014
2.0	Gary Featherston	Approved by Council, published.	30 October 2014

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Disclaimer:

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Table of Contents

1 Introduction

Wind power is a rapidly expanding mode of renewable energy production in Australia with installed capacity doubling in the past five years. As of September 2013, Australia has 64 wind farms with an installed capacity of 3058 megawatts (MW), with another ten wind farms under construction.

The increasing number of wind farms makes it important for AFAC member agencies to clarify their position and to identify those issues important for their operations in and around these facilities.

2 Purpose

This is a position to state AFAC member agencies attitude towards wind farms and their development. It aims to clarify the risks in order to inform stakeholders including regulators, members of the community and the wind farm industry.

3 Scope

The scope of this paper is limited to the issues relating to planning for bushfire prevention, preparedness, response and to recovery operations in and around existing and planned wind farms.

It excludes the environmental, social and economic issues associated with wind farms. It does not provide any judgments on the values or otherwise of wind farms.

4 Position

Bushfire management issues are best treated at the planning stage of a wind farm project. This includes the impact of bushfires on the wind farm and the potential for fires to start within the development boundaries. Local planning controls are in place to regulate these issues with respect to any infrastructure development and some local planning controls refer specifically to wind farms.

Wind monitoring towers associated with wind farm investigations and planning can be very much taller than the planned turbines and can be less visible. The location and height of monitoring towers should be noted during aerial firefighting operations.

Wind farms can interfere with local and regional radio transmissions by physical obstruction and radio frequency electromagnetic radiation. Any interference can be minimised or eliminated though appropriate turbine siting at the planning stage and by moving away from the tower if experiencing local interference during operations.

Wind farms are an infrastructure development that must be considered in the preparation of Incident Action Plans for the suppression of bushfires in their vicinity. These considerations are routine and wind farms are not expected to present elevated risks to operations compared to other electrical infrastructure.

Aerial fire fighting operations will treat the turbine towers similar to other tall obstacles. Pilots and Air Operations Managers will assess these risks as part of routine procedures. Risks due to wake turbulence and the moving blades should also be considered. Wind turbines are not expected to pose unacceptable risks.

Wind farms are not expected to adversely affect fire behaviour in their vicinity. Local wind speeds and direction are already highly variable across landscapes affected by turbulence from ridge lines, tall trees and buildings.

Turbine towers are not expected to start fires by attracting lightning.

Turbines can malfunction and start fires within the unit. Automatic shutdown and isolation procedures are installed within the system. Although such fires may start a grass fire within the wind farm, planning for access and fire breaks can reduce the likelihood of the fire leaving the property. This risk from such fires is less than that of many other activities expected in these rural environments.

Wind farms may operate on days of Total Fire Ban subject to relevant national, state and territory legislation.

Liaison with wind farm operators and energy industry representatives during and after bushfires should aim to ensure minimal disruption to generation capacity and rapid resumption of essential services to the community.

5 Supporting Documentation

There's power in the wind: national snapshot.
Clean Energy Council, April 2012

There's power in the wind: fact sheet.
Clean Energy Council, June 2011

Both sourced from
http://www.cleanenergycouncil.org.au/resourcecentre/factsheets.html
on 29 August 2013

Emergency Management Guidelines for Wind Farms
Country Fire Authority, April 2007

Fact Sheet 10. Wind Farming, Electromagnetic Radiation & Interference.
Australian Wind Energy Association.
Sourced from
http://www.synergy-wind.com/documents/10Electromagnetic.pdf
9 September 2013

APPENDIX E

Stakeholder List

Appendix E

Stakeholder	Contact
Port Pirie Aerodrome	Airport operator ï Port Pirie Regional Council
Jamestown Aerodrome	Airport operator ï Northern Areas Council
Booleroo Centre Aerodrome	Airport operator ï District Council of Mount Remarkable
Spencer Gulf Flight Training, Port Pirie	Owner and Chief Flying Instructor
Jamestown Flying Group	Committee member and pilot
Aerotech ï Aerial Agricultural Operator	Hoyleton Base
ñMAC Helicopterò	Babcock Mission Critical Adelaide Base
RFDS	Adelaide Base

Stakeholder List.

APPENDIX F

Glossary of Terms and Abbreviations

APPENDIX F

AERONAUTICAL STUDY GLOSSARY

To facilitate the understanding of aviation terminology used in this report, the following is a glossary of terms and acronyms that are commonly used in aeronautical impact assessments and similar aeronautical studies. A full list of terms and abbreviations used in this report is included in this Appendix. It should be noted that, within aviation, the International standard unit for altitude is feet (ft.) and distance is nautical mile (nm).

AC (Advisory Circulars) are issued by CASA and are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with the *Regulations*.

Aeronautical study is a tool used to review aerodrome and airspace processes and procedures to ensure that safety criteria are appropriate.

AHD (Australian Height Datum) is the datum to which all vertical control for mapping is to be referred. The datum surface is that which passes through mean sea level at the 30 tide gauges and through points at zero AHD height vertically below the other basic junction points.

AIP (Aeronautical Information Publication) is a publication promulgated to provide operators with aeronautical information of a lasting character essential to air navigation. It contains details of regulations, procedures and other information pertinent to flying and operation of aircraft. In Australia, the AIP may be issued by CASA or Airservices Australia.

Air routes exist between navigation aid equipped aerodromes or waypoints to facilitate the regular and safe flow of aircraft operating under Instrument Flight Rules (IFR).

Airservices Australia is the Australian government-owned corporation providing safe and environmentally sound air traffic management and related airside services to the aviation industry.

Altitude is the vertical distance of a level, a point or an object, considered as a point, measured from mean sea level.

AMSL (Above Mean Sea Level) is the elevation (on the ground) or altitude (in the air) of any object, relative to the average sea level datum. In aviation, the ellipsoid known as World Geodetic System 84 (WGS 84) is the datum used to define mean sea level.

ATC (Air Traffic Control) service is a service provided for the purpose of:

a. preventing collisions:

   1. between aircraft; and

   2. on the manoeuvring area between aircraft, vehicles and obstructions; and

b. expediting and maintaining an orderly flow of air traffic.

CASA (Civil Aviation Safety Authority) is the Australian government authority responsible under the *Civil Aviation Act 1988* for developing and promulgating appropriate, clear and concise aviation safety standards. As Australia is a signatory to the ICAO *Chicago Convention,* CASA adopts the standards and recommended practices established by ICAO, except where a difference has been notified.

CASR (Civil Aviation Safety Regulations) are promulgated by CASA and establish the regulatory framework *(Regulations)* within which all service providers must operate.

Civil Aviation Act 1988 (the Act) establishes the CASA with functions relating to civil aviation, in particular the safety of civil aviation and for related purposes.

ICAO (International Civil Aviation Organization) is an agency of the United Nations which codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth. The ICAO Council adopts standards and recommended practices concerning air navigation, its infrastructure, flight inspection, prevention of unlawful interference, and facilitation of border-crossing procedures for international civil aviation. In addition, the ICAO defines the protocols for air accident investigation followed by transport safety authorities in countries signatory to the Convention on International Civil Aviation, commonly known as the *Chicago Convention*. Australia is a signatory to the *Chicago Convention.*

IFR (Instrument Flight Rules) are rules applicable to the conduct of flight under IMC. IFR is established to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals. It is also referred to as, ña term used by pilots and controllers to indicate the type of flight plan an aircraft is flying,òsuch as an IFR or VFR flight plan.

IMC (Instrument Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, less than the minimum specified for visual meteorological conditions.

LSALT (Lowest Safe Altitudes) are published for each low level air route segment. Their purpose is to allow pilots of aircraft that suffer a system failure to descend to the LSALT to ensure terrain or obstacle clearance in IMC where the pilot cannot see the terrain or obstacles due to cloud or poor visibility conditions. It is an altitude that is at least 1,000 feet above any obstacle or terrain within a defined safety buffer region around a particular route that a pilot might fly.

MOS (Manual of Standards) comprises specifications *(Standards)* prescribed by CASA, of uniform application, determined to be necessary for the safety of air navigation.

NASAG (National Airports Safeguarding Advisory Group) set up in May 2010 to implement the Australian Governmentôs National Aviation Policy White Paper, *Flight Path to the Future* initiatives relating to safeguarding airports and surrounding communities from inappropriate development. NASAG comprises representatives from state and territory planning and transport departments, the Civil Aviation Safety Authority (CASA), Airservices Australia, the Department of Defence and the Australian Local Government Association (ALGA) and is chaired by the Department of Infrastructure and Regional Development (DIRD).

NASF (National Airports Safeguarding Framework) is the set of guidelines, adopted in July 2012, developed by NASAG to safeguard airports and surrounding communities.

NOTAMs (Notices to Airmen) are notices issued by the NOTAM office containing information or instruction concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations.

Obstacles - All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

OLS (Obstacle Limitation Surfaces) are a series of planes associated with each runway at an aerodrome that defines the desirable limits to which objects may project into the airspace around the aerodrome so that aircraft operations may be conducted safely.

PANS-OPS (Procedures for Air Navigation Services - Aircraft Operations) is an Air Traffic Control term denominating rules for designing instrument approach and departure procedures. Such procedures are used to allow aircraft to land and take off under Instrument Meteorological Conditions (IMC) or Instrument Flight Rules (IFR). ICAO document 8168-OPS/611 (volumes 1 and 2) outlines the principles for airspace protection and procedure design which all ICAO signatory states must adhere to. The regulatory material surrounding PANS-OPS may vary from country to country.

PANS-OPS Surfaces - Similar to an Obstacle Limitation Surface, the PANS-OPS protection surfaces are imaginary surfaces in space which guarantee the aircraft a certain minimum obstacle clearance. These surfaces may be used as a tool for local governments in assessing building development. Where buildings may (under certain circumstances) be permitted to penetrate the OLS, they cannot be permitted to penetrate any PANS-OPS surface, because the purpose of these surfaces is to guarantee pilots operating under IMC an obstacle free descent path for a given approach.

Prescribed airspace is an airspace specified in, or ascertained in accordance with, the Regulations, where it is in the interests of the safety, efficiency or regularity of existing or future air transport operations into or out of an airport for the airspace to be protected. The prescribed airspace for an airport is the airspace above any part of either an OLS or a PANS OPS surface for the airport and airspace declared in a declaration relating to the airport.

Regulations (Civil Aviation Safety Regulations)

VFR (Visual Flight Rules) are rules applicable to the conduct of flight under VMC. VFR allow a pilot to operate an aircraft in weather conditions generally clear enough to allow the pilot to maintain visual contact with the terrain and to see where the aircraft is going. Specifically, the weather must be better than basic VFR weather minima. If the weather is worse than VFR minima, pilots are required to use instrument flight rules.

VMC (Visual Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, equal or better than specified minima

ABBREVIATIONS

Abbreviations used in this report, and the meanings assigned to them for the purposes of this report are detailed in the following table:

Abbreviation	Meaning
AC	Advisory Circular (document support CASR 1998)
ACFT	Aircraft
AD	Aerodrome
AHD	Australian Height Datum
AHT	Aircraft height
AIP	Aeronautical Information Publication
Airports Act	Airports Act 1996, as amended
AIS	Aeronautical Information Service
ALA	Aircraft Landing Area
Alt	Altitude
AMSL	Above Minimum Sea Level
A(PofA)R	Airports (Protection of Airspace) Regulations, 1996 as amended
APARs	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
Cat	Category
DAP	Departure and Approach Procedures (charts published by AsA)
DER	Departure End of (the) Runway
DEVELMT	Development
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DIRD	Department of Infrastructure and Regional Development. (Formerly Department of Infrastructure and Transport)
DoIT	Department of Infrastructure and Transport. Also called ñInfrastructureò (Formerly Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG) and previously the Department of Transport and Regional Services (DoTARS))
DITRDLG	See DoIT above
DOTARS	See DITRDLG above
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	Enroute Supplement Australia
FAF	Final Approach Fix
FAP	Final Approach Point

Abbreviation	Meaning
ft	feet
GA	General Aviation
GNSS	Global Navigation Satellite System
GP	Glide Path
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System
ISA	International Standard Atmosphere
km	kilometres
kt	Knot (one nautical mile per hour)
LAT	Latitude
LLZ	Localizer
LONG	Longitude
LSALT	Lowest Safe Altitude
m	metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOS	Manual of Standards, published by CASA
MSA	Minimum Sector Altitude
SSR	Monopulse Secondary Surveillance Radar
MVA	Minimum Vector Altitude
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NDB	Non Directional Beacon
NE	North East
NM or nm	Nautical Mile (= 1.852 km)
nnDME	Distance from the DME (in nautical miles)
NNE	North East
NOTAM	NOtice To AirMen
OAS	Obstacle Assessment Surface
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OHS	Outer Horizontal Surface
OIS	Obstacle Identification Surface
OLS	Obstacle Limitation Surface
PANS-OPS	Procedures for Air Navigation Services ï Aircraft Operations, ICAO Doc 8168
PRM	Precision Runway Monitor
PROC	Procedure

Abbreviation	Meaning
PSR	Primary Surveillance Radar
QNH	An altimeter setting relative to height above mean sea level
Rnnn	Restricted Airspace ï promulgated in AIP as R with 3 numbers
REF	Reference
RL	Relative Level
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes ð replaced by the MOS Part 139 ð Aerodromes
RPT	Regular Public Transport
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SOC	Start Of Climb
SSR	Secondary Surveillance Radar
STAR	Standard ARrival
TAR	Terminal Area Radar
TAS	True Air Speed
THR	Threshold (Runway)
TNA	Turn Altitude
TODA	Take-Off Distance Available
VFR	Visual Flight Rules
V_n	aircraft critical Velocity reference
VOR	Very high frequency Omni directional Range

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		Name	Signature	Name	Signature	Date

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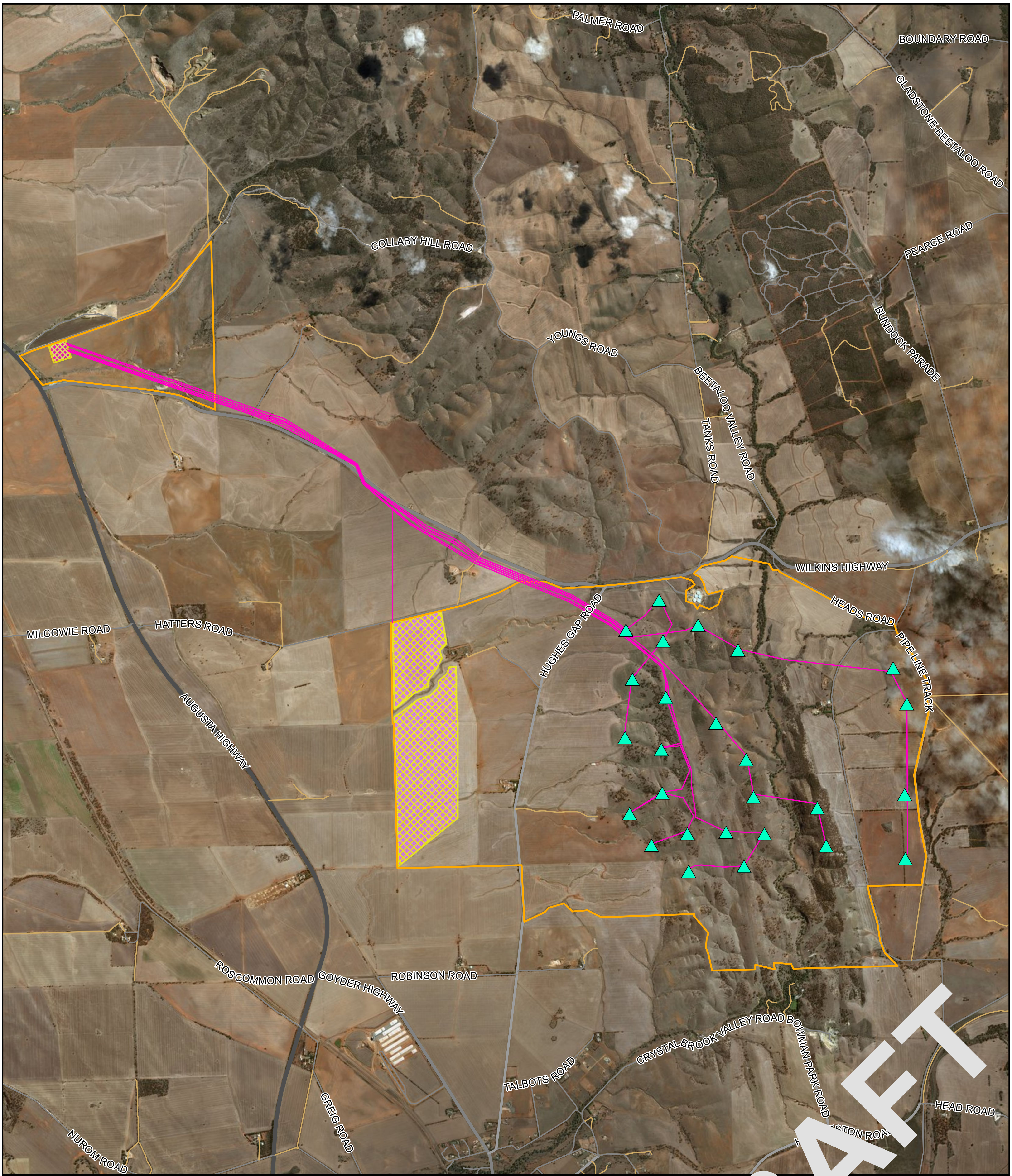

Project boundary

Crystal Brook Substation and Battery

Crystal Brook Solar Farm Area

Wind turbine

Underground cabling (indicative)

Roads

Highway

Arterial / Sub Arterial

Collector

Local

Tracks / Other

Paper Size A3

0 0.3 0.6 0.9 1.2 1.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

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NEOEN

Neoen Australia Pty. Ltd.
Crystal Brook

Crystal Brook Turbines, Solar Farm, Substation and Connecting Cabling

Job Number	33-18328
Revision	A
Date	11/05/2018

Figure 1

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