Twin Creek Wind Farm

Environmental Noise Assessment

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Jason Turner
Senior Associate
Phone: +61 (0) 410 920 122
Email: jturner@sonus.com.au
www.sonus.com.au

Prepared By	**Reviewed By**
Jason Turner (MAAS)	Chris Turnbull (MAAS)

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 the existing noise sources in the environment (in the absence of the wind farm).
Associated	A landowner with a commercial agreement with the wind farm.
Background noise level	The ambient noise level which excludes intermittent noise sources.
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).*
Day	The period between 7am and 10pm.
dB(A)	A-weighted noise or sound power level in decibels.
EPA	Environment Protection Authority
EPP	*Environment Protection (Noise) Policy 2007*
Equivalent noise level	Energy averaged noise level over a prescribed period of time
Guidelines	*Wind Farms Environmental Noise Guidelines 2009*
$L_{A90,10}$	The A-weighted noise level exceeded for 90% of a 10 minute time period. Represents the background noise level.
Neighbour	A landowner without a commercial agreement with the wind farm.
Night	The period between 10pm and 7am.
Sound power level	A measure of the sound energy emitted from a source of noise.
Twin Creek Wind Farm	The wind farm
Weather category 6	Weather category which is most conducive for the propagation of noise, resulting in highest predicted noise levels when using CONCAWE.
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 comprising a three bladed, upstream facing, horizontal axis turbine mounted on steel towers with a common set of generic design components comprising a foundation, tower, nacelle, hub and blades

EXECUTIVE SUMMARY

The Twin Creek Wind Farm has been assessed against the requirements of the South Australian EPA's *Wind farms environmental noise guidelines July 2009*.

In order to develop the assessment criteria in accordance with the Guidelines, ambient noise monitoring has been conducted at locations representative of local residences in the vicinity.

A predictive noise model has been prepared for the proposed wind farm layout, which enables noise predictions to be made at local residences from each noise source including representative WTG's, transformers and battery storage.

Based on the predicted noise levels, feedback has been provided to the wind farm developer on the ability or otherwise for the proposed wind farm arrangement to comply with the Guidelines.

The assessment indicates that the Twin Creek Wind Farm will achieve the Guidelines at all residences.

Should approval of the wind farm be granted, the assessment will be repeated once the final WTG, transformer and battery storage selections are known and final micro-siting of turbines has been conducted, to ensure compliance of the final design layout with the Guidelines prior to construction. Noise level monitoring during operation of the wind farm is also typically required by the Environment Protection Authority to confirm ultimate compliance with the Guidelines.

In summary, the assessment indicates that the Twin Creek Wind Farm can be readily designed to achieve the requirements of the South Australian EPA's *Wind farms environmental noise guidelines July 2009* (the Guidelines). Should the wind farm be granted approval, there will be a review of the final design of the wind farm prior to construction and it is most likely that a condition of approval will require monitoring during operation to confirm ultimate compliance with the Guidelines.

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1. INTRODUCTION

RES Australia Pty Ltd (RES Australia) proposes to develop the Twin Creek Wind Farm (the wind farm) within the Mid North area of South Australia. The wind farm is approximately 90km north east of Adelaide and approximately 10km north east of Kapunda.

The wind farm comprises up to 51 wind turbine generators (WTGs) as generally depicted in Appendix A (Project Design Layout).

Sonus has conducted an environmental noise assessment of the wind farm against the requirements of the South Australian EPA *Wind farms environmental noise guidelines July 2009* (the Guidelines).

The assessment has been based on the following data:

- the proposed co-ordinates of each WTG as detailed in Appendix B;
- the location and status of residences in the vicinity of the proposed wind farm as detailed in Appendix C;
- *Vestas V136 3.6MW* platform representative WTGs without serrated blades and with a hub-height of 112m;
- background noise monitoring conducted at 7 representative locations, between 31 August to 14 October 2016 and 22 December 2016 to 2 February 2017.

2. PROJECT OVERVIEW

The wind farm is located on the tablelands that form the wide ridgeline associated with Bald Hill and Long Hill situated within the Northern Mount Lofty Ranges.

The landform of the area is defined by numerous ridgelines that run north-south through the site creating a series of parallel ridges, wide open valleys, tablelands and isolated topographic features. Surrounding the site of the wind farm, the landscape is dominated by grazing with open paddocks defined by fenced boundaries and occasional trees to fence lines and creek lines. The land use that occurs in the open valley floor between the local ridgelines and across the tablelands associated with Bald Hill is more diverse with areas of arable cropping and grazing.

The proposal is for a wind energy facility which will consist of the following components:

- Up to 51 Wind Turbines Generators (WTG)
- Each WTG has a capacity up to 3.6 Megawatts (MW), with a total installed wind capacity up to 185MW
- Overall height of turbines would be up to 180 metres at the blade tip
- Associated hard standing areas and access roads
- Operations and maintenance building and compound with associated car parking
- Two electrical substations
- 50MW battery energy storage
- Overhead and underground electrical cable reticulation
- Overhead transmission line for approximately 15 kilometres from the on-site substation to the existing overhead Robertstown - Tungkillo transmission line east of Truro
- Meteorological masts for measuring wind speed and other climatic conditions
- Temporary construction facilities including a borrow pit and concrete batching plant facilities.

3. PLANNING PROVISIONS

The subject land is located within the Primary Production Zones of the Light Regional Council Development Plan[1] and the Goyder Council Development Plan[2]. A terminal substation is also located within the Rural Zone of the Mid Murray Council Development Plan[3]

The Development Plans have been reviewed with particular regard given to the following provisions:

3.1. Light Regional Council

Council Wide Provisions

Interface Between Land Uses

OBJECTIVES

Objective 1: *Development located and designed to prevent adverse impact and conflict between land uses.*

Objective 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:*

...

(b) noise;

...

2 *Development should be sited and designed to minimise negative impact on existing and potential future land uses considered appropriate in the locality.*

Noise Generating Activities

9 *Development should be designed, constructed and sited to minimise negative impacts of noise and to avoid unreasonable interference.*

10 *Development should be consistent with the relevant provisions in the current Environment Protection (Noise) Policy.*

1 Consolidated 8 December 2016.
2 Consolidated 24 November 2016.
3 Consolidated 14 June 2017.

Renewable Energy Facilities

OBJECTIVES

Objective 121: *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

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;

...

Primary Production Zone Provisions

OBJECTIVES

Objective 5: *Accommodation of wind farms and ancillary development.*

3.2. Goyder Council

Council Wide Provisions

Interface Between Land Uses

OBJECTIVES

Objective 1: *Development located and designed to prevent adverse impact and conflict between land uses.*

Objective 2: *Protect community health and amenity and support the operation of all desired land uses.*

PRINCIPLES OF DEVELOPMENT CONTROL

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

...

(b) noise;

...

2 *Development should be designed and sited to minimise negative impact on existing and potential future land uses considered appropriate in the locality.*

Noise

6 Development should be designed, constructed and sited to minimise negative impacts of noise and to avoid unreasonable interference.

7 Development should be consistent with the relevant provisions each of the following documents;

...

(c) the current Environment Protection (Noise) Policy.

Renewable Energy Facilities

OBJECTIVES

Objective 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

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;

...

Primary Production Zone Provisions

OBJECTIVES

Objective 5: Accommodation of wind farms and ancillary development.

3.3. Mid Murray Council

OBJECTIVES

Interface Between Land Uses

Objective 25 Development located and designed to prevent adverse impact and conflict between land uses.

Objective 26: Protect community health and amenity and support the operation of all desired land uses.

Renewable Energy Facilities

Objective 101: 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

Interface Between Land Uses

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

...

(b) noise;

...

88 Development should be designed and sited to minimise negative impact on existing and potential future land uses considered appropriate in the locality.

Noise

92 Development should be designed, constructed and sited to minimise negative impacts of noise and to avoid unreasonable interference.

93 Development should be consistent with the relevant provisions each of the current Environment Protection (Noise) Policy.

Renewable Energy Facilities

397 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. LEGISLATION, GUIDANCE AND STANDARDS

Although the Development plan references the *Environment Protection (Noise) Policy 2007* (EPP), the Environment Protection Authority (EPA) has produced 'Guidelines' to specifically assess the environmental noise from wind farms. The EPP refers to these Guidelines. Clause 34.(1) of the EPP applies the Guidelines to wind farms, and clauses 10 and 17 exclude wind farm noise from assessment under the general provisions of the EPP.

The Guidelines were first published in 2003. Following the release, several draft and interim versions were considered prior to the current *Wind farms environmental noise guidelines* being released in July 2009. For the purposes of this assessment, compliance with the contemporary and current 2009 Guidelines is taken to satisfy all noise related provisions of the Development Plan.

5. METHODOLOGY

5.1. Propagation Model

Noise predictions for the wind farm use a recognised noise propagation model under worst-case meteorological conditions.

The predictions have been made using the CONCAWE[4] noise propagation model and SoundPLAN noise modelling software. The sound propagation model considers the following influences:

- sound power levels and locations of noise sources;
- separation distances between noise sources and receivers;
- topography of the area including the topography between the sources and receivers;
- 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).

5.2. Inputs

The assessment of the wind farm has been based on the following worst-case inputs:

- weather category 6 (night with no clouds and wind from the wind farm to the residence under consideration);
- atmospheric conditions at 10°C and 80% relative humidity;
- wind direction from all WTGs to the particular residence under consideration, even in circumstances where WTGs are located in opposite directions from the residence; and,
- maximum barrier attenuation of 2 dB.

[4] 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.

The SA Guidelines provide a default prediction method which incorporates hard ground in the noise propagation model unless justification is provided for using another input. The CONCAWE propagation model separates ground attenuation into the categories of hard ground and ground with finite acoustic impedance. CONCAWE states that hard ground should be used for surfaces such as concrete or water and all other surfaces including grass or soil should be considered as a surface with "finite acoustic impedance". The ground between the WTGs and the nearest residences is not concrete or water and therefore finite acoustic impedance (corresponding to grass or rough pasture within the CONCAWE model) has been used.

5.3. Background Noise Monitoring

Background noise monitoring was conducted at 7 locations in the vicinity of the wind farm between 31 August and 14 October 2016 and 22 December 2016 and 2 February 2017. The background noise monitoring was conducted in accordance with the SA Guidelines.

The monitoring locations are summarised in Table 5.3.1,

Table 5.3.1: Monitoring locations and periods.

Monitoring Location ID	Coordinates (GDA94 Projection MDA54)	
	Easting	Northing
H5	318425	6204359
H18	326591	6204222
H77	324320	6207653
H119	318462	6200062
H122	322874	6198829
H125	324704	6200152
H147	319969	6205165

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 D and the monitoring locations are depicted on the noise prediction contours in Appendix G.

5.4. Equipment

The background noise levels were measured using a combination of Rion NL-21 (Type 2) and Rion NL-52 (Type 1) 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 NC-74 Calibrator. All microphones were fitted with weather proof windshields, with the microphone positioned approximately 1.5 m above ground level.

The wind speed at approximately the microphone height was logged at each location and the rainfall was monitored at two locations, on opposite sides of the wind farm. The rainfall and wind speed data were collected to determine the periods when weather on the microphone may have influenced the measured background noise levels in the vicinity.

5.5. Data Collection

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

During the background noise monitoring period, RES Australia measured the average wind speed and direction at a wind mast located at the wind farm site. The wind data were measured in corresponding 10 minute intervals, at various measurement heights. Table 5.1.1 provides details of the wind mast.

Table5.1.1: Wind mast details.

Mast ID	Coordinates (GDA94 Projection MDA54)		Measurement Heights (m)
	Easting	Northing	
889	324281	6204237	100, 120 & 140m
61	321699	6201050	40, 50 & 60m

The SA 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 112m have been calculated by RES Australia using measurements at the different anemometer heights.

5.6. Data Analysis

Prior to the correlation and regression analysis, the following data were removed:

- data points corresponding to any periods of measured rainfall (including the 10 minute periods before and after the recorded period) and/or measured wind speed exceeding 5 m/s at the microphone height for more than 90% of the measurement period;
- data points corresponding to wind speeds below the cut-in (3 m/s) and above the rated power (taken to be a generic 12 m/s); and,
- data points clearly influenced by extraneous noise sources.

Table 5.6.1 summarises the number of data points at each monitoring location following data removal.

Table 7.6.1: Data points.

Monitoring Location ID	Number of Data Points
H5	3845
H18	4156
H77	3279
H119	3764
H122	3681
H125	3360
H147	3328

The resultant background noise data for each monitoring location were correlated with the wind speed data measured at the closest wind mast. A least squares regression analysis of the data was undertaken to determine the line of best fit for the correlations in accordance with the SA Guidelines. The data and the regression curves[5] are shown in Appendix E.

[5] 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.

5.7. Noise Criteria - Neighbours

The following assessment criteria are applied by the Guidelines to landowners without a commercial agreement with the wind farm:

> *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[6] from cut-in to rated power of the WTG and each integer wind speed in between.*

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

The resultant noise criteria determined using the Guidelines and the results of the Appendix E correlations are summarised in Appendix F. Where background noise monitoring has not been conducted at a residence, the lowest measured background noise levels at any monitoring location have been used to derive the criteria. This is a conservative approach.

5.8. Noise Criteria – Associated Landowners

The SA 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.*

To protect the associated landowners from unreasonable interference to their amenity, reference is made to 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.

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

The WHO Guidelines recommend an indoor noise level of 30 dB(A) be achieved to protect against sleep disturbance. The indoor limit of 30 dB(A) equates to an outdoor noise level of 45 dB(A) with windows open or 52 dB(A) with windows closed for a standard facade construction.

It is proposed that the WHO Guidelines criterion of 45 dB(A) will be used as the baseline noise level at associated landowners as this is lower than the recommended range for annoyance outdoors during the day. Appendix C identifies these landowners by an "Associated" status.

5.9. Noise Predictions

The proposed wind farm layout comprises up to 51 WTGs, a single site substation (with a total of two transformers), a remote terminal substation and a battery storage area, potentially incorporating air conditioning units for cooling. Appendix B provides the coordinates of the noise sources.

The preliminary assessment has been made based on the Vestas V136 – 3.6MW WTG (without serrated blades and with a hub height of 112 m). The WTGs have a cut-in wind speed of 3 m/s. The rated power wind speed has been taken to be 12 m/s.

The two transformers at the site substation have been based on units having a rating of up to 150 MVA each and the transformer at the terminal substation having a capacity of 300MVA. It is understood that the above is a conservative estimate as the final design might result in no transformer at the terminal substation. The design of the battery storage facility is not yet finalised, however the preliminary layout indicates there will be in the order of 22 air conditioning units for cooling. A prediction has therefore been conservatively made based on 22 air conditioning units serving the battery storage area with a nominal cooling capacity of 5 kW each.

The sound power levels used for the assessment are based on the following:

- manufacturer's 1/3 octave band sound power level data for the WTG, provided in the document titled: *V136-3.6MW Third octave noise emission*. The final data are summarised in Table 5.9.1.

Table 5.9.1: Vestas V136 sound power levels dB(A)

Frequency	Hub Height Wind Speed									
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
6.3 Hz	22	19.9	20.7	22.7	24.7	26.4	27.8	28.7	29.9	31
8 Hz	26	24	25.6	28.5	31.3	33.6	35.4	36.3	37.5	38.6
10 Hz	30.6	28.8	30.9	34.2	37.4	40	42	42.9	44.1	45.1
12.5 Hz	38.7	37.2	39.1	42.2	45.1	47.6	49.4	50.2	51.2	52.1
16 Hz	47.6	44.7	46.7	50.4	53.9	56.8	59.1	60.5	62.2	63.8
20 Hz	48.8	45.7	49.2	54.4	59.2	63.2	66.3	67.8	69.6	71.3
25 Hz	56.7	53.6	55.5	58.9	62.2	64.9	67.2	68.5	70.3	71.9
31.5 Hz	59.3	58	59.9	62.9	65.8	68.2	70.1	70.8	71.7	72.6
40 Hz	62.3	61.2	63.4	66.5	69.6	72.1	74	74.7	75.5	76.2
50 Hz	66.9	65.9	68	71.1	74	76.5	78.3	78.9	79.6	80.3
63 Hz	71.3	71.2	72.8	75	77.2	79	80.2	80.4	80.7	80.9
80 Hz	76	76.1	77.2	78.8	80.5	81.9	82.8	82.9	83	83.2
100 Hz	79.5	79.5	80.5	82	83.6	84.9	85.7	85.9	86	86.2
125 Hz	78.1	78.5	81.2	84.4	87.5	90	91.7	91.8	91.8	91.9
160 Hz	82.9	82.5	83.4	85.1	86.8	88.3	89.2	89.6	90	90.4
200 Hz	80.6	81.6	83.6	85.9	88.1	89.9	91	90.8	90.5	90.2
250 Hz	82.2	83.7	86	88.4	90.7	92.7	93.7	93.5	92.9	92.4
315 Hz	83.7	84.7	86.8	89.2	91.6	93.5	94.6	94.5	94.2	94
400 Hz	83.9	84.2	86.3	89	91.5	93.7	95	95.2	95.3	95.4
500 Hz	80.5	81.5	84.8	88.5	91.9	94.8	96.6	96.6	96.3	96.1
630 Hz	79.6	80.9	85	89.3	93.3	96.6	98.7	98.6	98.1	97.8
800 Hz	79.8	81	85.3	89.9	94.1	97.6	99.9	99.8	99.5	99.2
1 kHz	80.7	81.3	85.3	89.8	93.9	97.4	99.7	99.8	99.8	99.7
1.25 kHz	79.8	79.5	83.4	88.1	92.4	96	98.5	99	99.3	99.7
1.6 kHz	80.7	79.8	83.3	87.7	91.8	95.2	97.6	98.3	99	99.6
2 kHz	79.2	78.8	81.9	85.8	89.5	92.5	94.6	95.1	95.5	95.9
2.5 kHz	78	78.6	81.6	85.1	88.4	91.2	93	93.1	93	93
3.15 kHz	75	76.6	79.8	83.1	86.3	88.9	90.5	90.3	89.7	89.2
4 kHz	73.4	75.6	79.1	82.4	85.5	88.2	89.6	89.1	88.2	87.4
5 kHz	63	67.9	72.6	76.4	80	82.9	84.3	82.9	80.6	78.6
6.3 kHz	56.5	62.4	67.2	70.6	73.9	76.6	77.6	75.9	73	70.5
8 kHz	53.4	59.3	62.5	64.4	66.4	68	68.2	66.4	63.6	61.1
10 kHz	58.7	61.7	62.2	62.3	62.7	63	62.6	61.7	60.3	59.2
AP dB(A)	**93**	**93.6**	**96.3**	**99.8**	**103.1**	**106.1**	**108.1**	**108.2**	**108.2**	**108.2**

- derived sound power levels for the transformers from the Australian/New Zealand Standard *AS/NZS60076.10:2009, Power transformers - Determination of sound levels (IEC 60076-10, Ed. 1(2001) MOD)* (summarised in Table 5.9.2).

Table 5.9.2: Transformer sound power levels.

Transformer Rating	SWL (dB(A)) for each Octave Band Centre Frequency							Total SWL (dB(A))
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	
150 MVA	76	84	91	94	86	83	76	**96**
300MVA	80	88	95	98	90	87	80	**101**

- manufacturers' data for a generic 5 kW air conditioning unit as summarised in table 5.9.3:

Table 5.9.3: Air conditioning unit sound power levels

Cooling Capacity	SWL (dB(A)) for each Octave Band Centre Frequency							Total SWL (dB(A))
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	
5 kW	39	51	54	57	56	55	54	**63**

5.10. Predicted Noise Levels

The noise level at residences in the vicinity of the wind farm have been predicted for integer wind speeds ranging between the WTG cut-in (3 m/s) and a generic rated power wind speed of 12 m/s. The predicted noise levels at each wind speed are compared with the relevant criteria at each specific residence listed in Table 7.10.1, where the predicted noise levels are 25 dB(A) or greater.

Table 5.10.1: Predicted noise level and noise criterion at residences.

Residence ID	Occupied	Associated	Type	3 m/s		4 m/s		5 m/s		6 m/s		7 m/s		8 m/s		9 m/s		10 m/s		11 m/s		12 m/s	
				Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction
5	OCCUPIED	NO	HOUSE	40	22	40	23	40	25	40	28	40	31	40	33	40	35	40	35	40	35	40	35
6	OCCUPIED	NO	HOUSE	40	18	40	19	40	21	40	24	40	27	40	29	40	31	40	31	40	31	40	31
9	OCCUPIED	NO	HOUSE	40	23	40	23	40	25	40	28	40	31	40	33	40	35	40	35	40	35	40	35
14	OCCUPIED	NO	HOUSE	40	15	40	16	40	18	40	20	40	23	40	26	40	27	40	27	40	27	40	27
18	OCCUPIED	NO	HOUSE	40	21	40	22	40	24	40	27	40	30	40	32	40	34	40	34	40	34	40	34
25	UNOCCUPIED	NO	SHED	NA	13	NA	14	NA	16	NA	18	NA	21	NA	23	NA	25	NA	25	NA	25	NA	25
27	OCCUPIED	NO	HOUSE	40	17	40	18	40	20	40	22	40	25	40	28	40	29	40	29	40	29	40	29
28	OCCUPIED	NO	HOUSE	40	14	40	15	40	17	40	19	40	22	40	24	40	26	40	26	40	26	40	26
59	OCCUPIED	NO	HOUSE	40	15	40	15	40	17	40	20	40	22	40	25	40	26	40	26	40	26	40	26
60	OCCUPIED	NO	HOUSE	40	14	40	15	40	17	40	19	40	22	40	24	40	26	40	26	40	26	40	26
61	OCCUPIED	NO	HOUSE	40	14	40	14	40	16	40	18	40	21	40	23	40	25	40	25	40	25	40	25
73	OCCUPIED	YES	HOUSE	45	25	45	26	45	28	45	31	45	34	45	36	45	38	45	38	45	38	45	38
74	UNOCCUPIED	NO	SHED	NA	27	NA	28	NA	30	NA	33	NA	36	NA	39	NA	40	NA	40	NA	40	NA	40
75	OCCUPIED	YES	HOUSE	45	28	45	28	45	31	45	34	45	37	45	39	45	41	45	41	45	41	45	41
76	OCCUPIED	NO	HOUSE	40	19	40	19	40	21	40	24	40	27	40	30	40	31	40	31	40	31	40	31
77	OCCUPIED	NO	HOUSE	40	21	40	21	40	23	40	26	40	29	40	32	40	33	40	33	43	33	46	33
117	UNOCCUPIED	NO	HOUSE	40	16	40	17	40	18	40	21	40	24	40	26	40	28	40	28	40	28	40	28
118	OCCUPIED	YES	HOUSE	45	21	45	21	45	23	45	26	45	29	45	32	45	34	45	34	45	34	45	33
119	OCCUPIED	YES	HOUSE	45	21	45	22	45	24	45	27	45	30	45	33	45	34	45	34	45	34	45	34
120	OCCUPIED	YES	HOUSE	45	21	45	22	45	24	45	27	45	30	45	32	45	34	45	34	45	34	45	34
121	OCCUPIED	NO	HOUSE	40	16	40	17	40	19	40	21	40	24	40	27	40	28	40	28	40	28	40	28
122	OCCUPIED	NO	HOUSE	40	24	40	24	40	26	40	29	40	32	40	34	40	36	40	36	42	36	45	36
123	OCCUPIED	NO	HOUSE	40	24	40	24	40	26	40	28	40	31	40	34	40	35	40	35	40	35	40	35

Residence ID	Occupied	Associated	Type	3 m/s		4 m/s		5 m/s		6 m/s		7 m/s		8 m/s		9 m/s		10 m/s		11 m/s		12 m/s	
				Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction
124	OCCUPIED	NO	HOUSE	40	23	40	23	40	25	40	28	40	31	40	33	40	35	40	35	40	35	40	34
125	OCCUPIED	NO	HOUSE	40	25	40	26	40	27	40	30	40	33	40	35	40	37	40	37	40	37	41	37
131	OCCUPIED	NO	HOUSE	40	17	40	18	40	19	40	22	40	25	40	27	40	29	40	29	40	28	40	28
132	UNOCCUPIED	NO	HOUSE	40	16	40	17	40	18	40	21	40	23	40	26	40	27	40	27	40	27	40	27
147	OCCUPIED	YES	HOUSE	45	28	45	28	45	31	45	34	45	37	45	39	45	41	45	41	45	41	45	41
148	OCCUPIED	NO	HOUSE	40	18	40	19	40	21	40	24	40	26	40	29	40	31	40	31	40	30	40	30
150	OCCUPIED	NO	NOT SURVEYED	40	15	40	15	40	17	40	20	40	22	40	25	40	26	40	26	40	26	40	26
151	UNOCCUPIED	YES	HOUSE	45	26	45	27	45	29	45	32	45	35	45	38	45	40	45	40	45	39	45	39
177	OCCUPIED	NO	HOUSE	40	15	40	16	40	17	40	20	40	23	40	25	40	27	40	27	40	27	40	27
180	OCCUPIED	NO	HOUSE	40	21	40	22	40	23	40	26	40	29	40	31	40	33	40	33	40	33	40	32
181	OCCUPIED	NO	HOUSE	40	15	40	16	40	17	40	20	40	22	40	25	40	26	40	26	40	26	40	26
182	OCCUPIED	NO	HOUSE	40	15	40	16	40	17	40	20	40	22	40	25	40	26	40	26	40	26	40	26
183	OCCUPIED	NO	HOUSE	40	15	40	15	40	17	40	19	40	22	40	24	40	26	40	26	40	26	40	26
186	OCCUPIED	NO	HOUSE	40	14	40	15	40	16	40	19	40	21	40	24	40	25	40	25	40	25	40	25
187	OCCUPIED	NO	HOUSE	40	13	40	14	40	16	40	18	40	21	40	24	40	25	40	25	40	25	40	25
286	OCCUPIED	NO	HOUSE	40	26	40	26	40	26	40	26	40	26	40	26	40	26	40	26	40	26	40	26

Based on the predicted noise levels, the wind farm noise, including the WTGs, transformers and air conditioning units associated with battery storage will comply with the criteria at all residences, for all wind speeds.

Appendix G provides the predicted noise level contours at 10 m/s (the wind speed associated with the highest predicted noise levels). For clarity, a separate noise contour is provided for the noise from the terminal substation which is located approximately 3.5km to the southeast of the wind farm, near residence H286, should there be a transformer required as part of the final electrical design.

The predicted noise level from the combined operation of the wind farm, the site substation, the terminal substation and the battery storage is less than 30 dB(A) at H286. Therefore, whilst the assessment has considered the Guidelines at H286 which are easily achieved, the noise level also easily achieves the requirements of the *Environment Protection (Noise) Policy 2007* should the terminal substation transformer (if required) be considered an isolated and separate item of infrastructure.

6. OTHER CONSIDERATIONS

The following has been provided for information purposes.

6.1. Audible Noise

The criteria provided by the Guidelines are established to ensure that any audible wind farm noise is low enough in level such that it does not adversely impact on the health or amenity of the community.

The 2009 version of the Guidelines have been tested and accepted in the South Australian Environment, Resources and Development Court as the appropriate tool for the assessment of wind farm noise, in order to protect the acoustic amenity of the community.

In addition, the EPA has considered as well as initiated further research and testing over an extended period of time with the recent finding that the Guidelines provide an appropriate tool for a contemporary wind farm environmental noise assessment without the need for any change, modification or update.

6.2. Infrasound

Infrasound is noise at frequencies of less than 20 Hz. Modern WTGs are constructed with blades upwind of the tower resulting in infrasound noise levels well below the level of audibility at residential setback distances. Indeed, International studies have confirmed that the level and character of noise from modern WTGs are not different to the noise encountered from other natural and non-natural noise sources.

Sonus has conducted studies into the level of infrasound produced by WTGs. These studies confirm that the level of infrasound from WTGs is no greater than naturally occurring levels of infrasound from sources such as waves breaking.

The results of these studies were presented at the fourth International Conference Wind Turbine Noise 2011 in Rome[7] and appeared as a peer reviewed paper in "Acoustics Australia", the journal of the Australian Acoustical Society[8].

A recent South Australian Government study by the Environment Protection Authority into infrasound (*Infrasound levels near wind farms and in other environments*, January 2013) provided findings which were consistent with the Sonus studies and a wide range of national and international peer reviewed studies, including:

- the measured levels of infrasound from wind farms are well below the threshold of perception (that is, the level of infrasound at a residence is inaudible);
- the measured infrasound levels around wind farms are no higher than levels measured at other locations where people live, work and sleep; and
- the characteristics of noise produced by wind farms are not unique and are common in everyday life.

6.3. Low Frequency Noise

Noise sources that produce low frequency content (such as a freight train locomotive or diesel engine) have dominant noise content in the frequency range between 20 and 200 Hz. Low frequency noise is often described as a "rumble". Low frequency noise is different to infrasound in that it occurs at a higher frequency and is regularly audible in everyday life.

Aerodynamic noise from a WTG is not dominant in the low frequency range. The main content of aerodynamic noise generated by a WTG is often in the area known generically as the mid-frequencies, being between 200 and 1000Hz.

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7 Turnbull, C & Turner, J 2011, 'Measurement of Infrasound from Wind Farms and Other Sources', *Fourth International Conference on Wind Turbine Noise,* Rome, 11-14 April 2011.

8 Turnbull, C, Turner, J & Walsh, D 2012, 'Measurement and level of infrasound from wind farms and other sources', *Acoustics Australia*, vol 40, no. 1, pp. 45-50.

Noise reduces over distance due to a range of factors including atmospheric absorption. The mid and high frequencies are subject to a greater rate of atmospheric absorption compared to the low frequencies and therefore over large distances, whilst the absolute level of noise in all frequencies reduces, the relative level of low frequency noise compared to the mid and high frequency content increases. For example, when standing alongside a road corridor, the mid and high frequency noise from the tyre and road interaction is dominant, particularly if the road surface is wet. However, at large distances from a road corridor in a rural environment, the remaining audible content is the low frequency noise of the engine and exhaust and the low frequency component of the road interaction.

Low frequency sound produced by wind farms is therefore not unique in overall level or content. Low frequency sound can be easily measured and heard at a range of locations at levels well in excess of the level in the vicinity of a wind farm. Compliance with the SA Guidelines will therefore inherently provide an adequate level of protection of amenity in the surrounding area from low frequency noise impacts.

6.4. Construction Noise

The EPP 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. However, the EPP establishes a quantitative approach for night time activity, whereby an average goal noise level of 45 dB(A) and a maximum goal noise level of 60 dB(A) are to be met for activity outside of typical day time hours.

The adoption of “all reasonable and practicable” noise mitigation measures during daytime hours include the following:

- Only operating construction plant and associated activities such as batching before 7am or after 7pm where it can be shown that the above goal noise levels can be achieved;
- construction of temporary acoustic barriers for activity in close proximity to residences (often not applicable to a wind farm site due to the distances involved between the construction activity and the residences);
- proprietary enclosures around machines;
- exhaust silencers;

- substitution of the construction method with alternative processes that produce less noise;
- the fitting of broadband reversing signals to vehicles which do not leave the site; and
- administrative measures such as inspections, scheduling and providing training to establish a noise minimisation culture for the works.

It is common for the above measures to be incorporated into the project's Construction Environmental Management Plan.

6.5. Compliance Testing

Should the wind farm be granted approval, then it is common for the assessment to be repeated once the final design of the wind farm is known. The final design is influenced by the market and the WTGs available at the time of procurement as well as more detailed design items as the project matures beyond the planning stages. In addition, the EPA is likely to impose conditions which relate to the compliance monitoring of wind farms once commissioned to ensure compliance with the Guidelines. The Guidelines include detailed compliance monitoring regime requirements.

7. CONCLUSION

An environmental noise assessment has been made of the proposed Twin Creek Wind Farm.

Operational noise has been considered at residences against the requirements of the SA EPA *Wind Farms Environmental Noise Guidelines 2009* (the Guidelines).

The predicted noise levels achieve the requirements of the Guidelines at all residences.

The assessment is based the Vestas V136 3.6MW representative WTG, two 150MVA transformers at the site substation, a single 300MVA transformer at the terminal substation and twenty two 5kW air conditioning units serving the battery storage facility.

A final noise assessment will be conducted to confirm compliance with the Guidelines when the final WTG, transformer and air conditioning selections are available at the procurement stage of the project, with guaranteed sound power levels provided by the respective manufacturers. The final noise assessment report will be submitted to the relevant authorities prior to the commencement of construction. In addition, noise level monitoring during operation of the wind farm is also typically required by the Environment Protection Authority to confirm ultimate compliance with the Guidelines.

In conclusion, the assessment indicates that the Twin Creek Wind Farm can be readily designed to achieve the requirements of the South Australian EPA's *Wind farms environmental noise guidelines July 2009* (the Guidelines). Should the wind farm be granted approval, there will be a review of the final design of the wind farm prior to construction and it is most likely that a condition of approval will require monitoring during operation to confirm ultimate compliance with the Guidelines.

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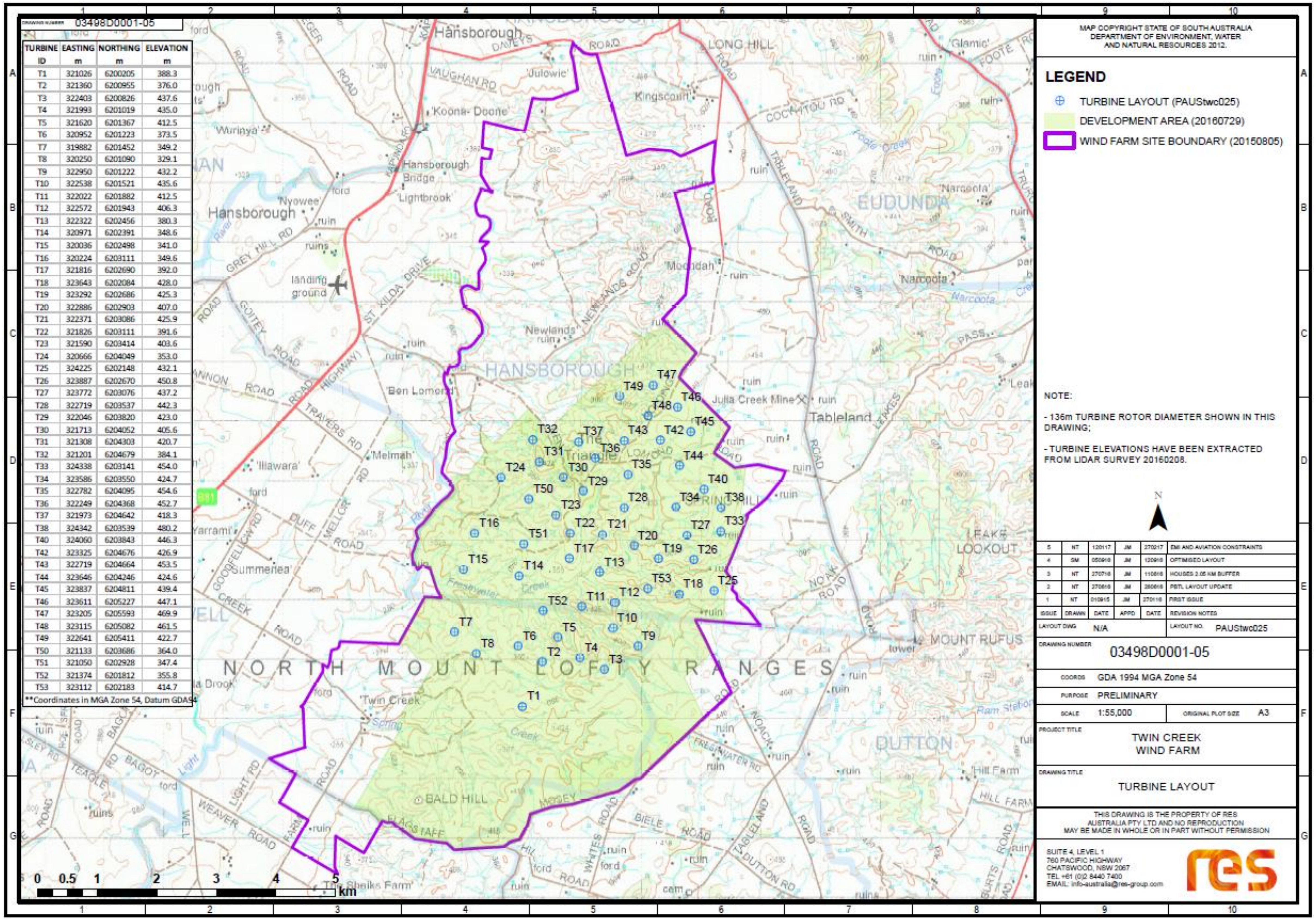
APPENDIX A: PROJECT DESIGN LAYOUT



TURBINE ID	EASTING m	NORTHING m	ELEVATION m
T1	321026	6200205	388.3
T2	321360	6200955	376.0
T3	322403	6200826	437.6
T4	321993	6201019	435.0
T5	321620	6201367	412.5
T6	320952	6201223	373.5
T7	319882	6201452	349.2
T8	320250	6201090	329.1
T9	322950	6201222	432.2
T10	322538	6201521	435.6
T11	322022	6201882	412.5
T12	322572	6201943	406.3
T13	322322	6202456	380.3
T14	320971	6202391	348.6
T15	320036	6202498	341.0
T16	320224	6203111	349.6
T17	321816	6202690	392.0
T18	323643	6202084	428.0
T19	323292	6202686	425.3
T20	322886	6202903	407.0
T21	322371	6203086	425.9
T22	321826	6203111	391.6
T23	321590	6203414	403.6
T24	320666	6204049	353.0
T25	324225	6202148	432.1
T26	323887	6202670	450.8
T27	323772	6203076	437.2
T28	322719	6203537	442.3
T29	322046	6203820	423.0
T30	321713	6204052	405.6
T31	321308	6204303	420.7
T32	321201	6204679	384.1
T33	324338	6203141	454.0
T34	323586	6203550	424.7
T35	322782	6204095	454.6
T36	322249	6204368	452.7
T37	321973	6204642	418.3
T38	324342	6203539	480.2
T40	324060	6203843	446.3
T42	323325	6204676	426.9
T43	322719	6204664	453.5
T44	323646	6204246	424.6
T45	323837	6204811	439.4
T46	323611	6205227	447.1
T47	323205	6205593	469.9
T48	323115	6205082	461.5
T49	322641	6205411	422.7
T50	321133	6203686	364.0
T51	321050	6202928	347.4
T52	321374	6201812	355.8
T53	323112	6202183	414.7

**Coordinates in MGA Zone 54, Datum GDA94

APPENDIX B: PROPOSED WIND FARM LAYOUT AND NOISE SOURCES

Coordinates of WTGs and Substations

WTG ID	Coordinates (GDA94 PROJECTION MGA54)	
	Easting	Northing
T1	321026	6200205
T2	321360	6200955
T3	322403	6200826
T4	321993	6201019
T5	321620	6201367
T6	320952	6201223
T7	319882	6201452
T8	320250	6201090
T9	322950	6201222
T10	322538	6201521
T11	322022	6201882
T12	322572	6201943
T13	322322	6202456
T14	320971	6202391
T15	320036	6202498
T16	320224	6203111
T17	321816	6202690
T18	323643	6202084
T19	323292	6202686
T20	322886	6202903
T21	322371	6203086
T22	321826	6203111
T23	321590	6203414
T24	320666	6204049
T25	324225	6202148
T26	323887	6202670
T27	323772	6203076
T28	322719	6203537
T29	322046	6203820
T30	321713	6204052
T31	321308	6204303
T32	321201	6204679

WTG ID	Coordinates (GDA94 PROJECTION MGA54)	
	Easting	Northing
T33	324338	6203141
T34	323586	6203550
T35	322782	6204095
T36	322249	6204368
T37	321973	6204642
T38	324342	6203539
T40	324060	6203843
T42	323325	6204676
T43	322719	6204664
T44	323646	6204246
T45	323837	6204811
T46	323611	6205227
T47	323205	6205593
T48	323115	6205082
T49	322641	6205411
T50	321133	6203686
T51	321050	6202928
T52	321374	6201812
T53	323112	6202183

	Approximate Coordinates (GDA94 PROJECTION MGA54)	
	Easting	Northing
Site substation 2 transformers	323384	6201035
Battery storage	323478	6200754
Terminal substation (if required)	333313	6191876

APPENDIX C: RESIDENCES IN THE VICINITY

Residence ID	Coordinates (GDA94 PROJECTION MGA54)		Occupied	Associated	Building	"Baseline" Noise Criterion
	Easting	Northing				
1	333402	6212941	OCCUPIED	NO	NOT SURVEYED	40
2	332889	6208870	OCCUPIED	NO	NOT SURVEYED	40
3	317966	6209162	OCCUPIED	NO	NOT SURVEYED	40
4	328759	6208684	OCCUPIED	NO	NOT SURVEYED	40
5	318425	6204359	OCCUPIED	NO	HOUSE	40
6	317441	6204023	OCCUPIED	NO	HOUSE	40
7	314690	6200064	UNOCCUPIED	NO	HOUSE	40
8	317532	6197178	OCCUPIED	NO	HOUSE	40
9	324339	6199469	OCCUPIED	NO	HOUSE	40
10	332956	6200681	OCCUPIED	NO	NOT SURVEYED	40
11	315260	6200442	OCCUPIED	NO	HOUSE	40
12	332692	6205239	OCCUPIED	NO	NOT SURVEYED	40
13	333156	6212589	OCCUPIED	NO	NOT SURVEYED	40
14	323507	6197563	OCCUPIED	NO	HOUSE	40
15	321443	6211068	OCCUPIED	NO	HOUSE	40
16	332053	6213021	OCCUPIED	NO	NOT SURVEYED	40
17	316653	6209849	OCCUPIED	NO	NOT SURVEYED	40
18	326591	6204222	OCCUPIED	NO	HOUSE	40
19	319693	6211627	OCCUPIED	NO	NOT SURVEYED	40
20	330489	6211539	OCCUPIED	NO	NOT SURVEYED	40
21	321390	6210185	UNOCCUPIED	YES	HOUSE	45
22	316087	6197701	OCCUPIED	NO	HOUSE	40
23	319090	6211336	OCCUPIED	NO	NOT SURVEYED	40
24	331055	6202837	OCCUPIED	NO	NOT SURVEYED	40
25	317428	6198149	UNOCCUPIED	NO	SHED	NA
26	330378	6205007	OCCUPIED	NO	NOT SURVEYED	40
27	316856	6202618	OCCUPIED	NO	HOUSE	40
28	316348	6204184	OCCUPIED	NO	HOUSE	40
29	317896	6207851	OCCUPIED	NO	NOT SURVEYED	40
30	316038	6210298	OCCUPIED	NO	NOT SURVEYED	40
31	319234	6211695	OCCUPIED	NO	NOT SURVEYED	40
32	314980	6201698	OCCUPIED	NO	NOT SURVEYED	40
33	318887	6210081	OCCUPIED	NO	NOT SURVEYED	40
34	316892	6212587	OCCUPIED	NO	NOT SURVEYED	40
35	318683	6213276	OCCUPIED	NO	NOT SURVEYED	40
36	320026	6212872	OCCUPIED	NO	NOT SURVEYED	40
37	320360	6213355	OCCUPIED	NO	NOT SURVEYED	40
38	321846	6212649	OCCUPIED	NO	NOT SURVEYED	40
39	323271	6212624	OCCUPIED	NO	NOT SURVEYED	40

Residence ID	Coordinates (GDA94 PROJECTION MGA54)		Occupied	Associated	Building	"Baseline" Noise Criterion
	Easting	Northing				
40	326660	6213122	OCCUPIED	NO	NOT SURVEYED	40
41	327250	6212452	OCCUPIED	NO	NOT SURVEYED	40
42	331257	6213255	OCCUPIED	NO	NOT SURVEYED	40
43	331793	6210204	OCCUPIED	NO	NOT SURVEYED	40
44	331902	6209525	OCCUPIED	NO	NOT SURVEYED	40
45	330253	6209655	OCCUPIED	NO	NOT SURVEYED	40
46	330760	6210910	OCCUPIED	NO	NOT SURVEYED	40
47	329548	6210857	OCCUPIED	NO	NOT SURVEYED	40
48	328334	6211145	OCCUPIED	NO	NOT SURVEYED	40
49	327768	6211498	OCCUPIED	NO	NOT SURVEYED	40
50	320263	6212613	OCCUPIED	NO	NOT SURVEYED	40
51	320282	6212500	OCCUPIED	NO	NOT SURVEYED	40
52	319846	6212278	OCCUPIED	NO	NOT SURVEYED	40
53	319737	6212327	OCCUPIED	NO	NOT SURVEYED	40
54	314685	6206976	OCCUPIED	NO	NOT SURVEYED	40
55	314798	6206455	OCCUPIED	NO	NOT SURVEYED	40
56	314913	6206182	OCCUPIED	NO	NOT SURVEYED	40
57	315169	6206334	OCCUPIED	NO	NOT SURVEYED	40
58	314945	6203986	OCCUPIED	NO	NOT SURVEYED	40
59	316285	6203701	OCCUPIED	NO	HOUSE	40
60	316133	6202968	OCCUPIED	NO	HOUSE	40
61	315845	6202465	OCCUPIED	NO	HOUSE	40
62	314649	6201555	OCCUPIED	NO	NOT SURVEYED	40
63	321440	6211313	OCCUPIED	NO	HOUSE	40
64	329377	6208084	OCCUPIED	NO	NOT SURVEYED	40
65	329672	6207896	OCCUPIED	NO	NOT SURVEYED	40
66	328249	6207469	OCCUPIED	NO	HOUSE	40
67	329079	6205727	OCCUPIED	NO	HOUSE	40
68	330079	6207149	OCCUPIED	NO	NOT SURVEYED	40
69	328912	6206433	OCCUPIED	NO	HOUSE	40
70	327001	6207829	UNOCCUPIED	NO	HOUSE	40
71	317366	6208478	OCCUPIED	NO	NOT SURVEYED	40
72	319006	6208941	OCCUPIED	NO	NOT SURVEYED	40
73	319843	6205696	OCCUPIED	YES	HOUSE	45
74	320270	6205615	UNOCCUPIED	NO	SHED	NA
75	321830	6206405	OCCUPIED	YES	HOUSE	45
76	324379	6207966	OCCUPIED	NO	HOUSE	40
77	324320	6207653	OCCUPIED	NO	HOUSE	40
78	323818	6210616	OCCUPIED	NO	HOUSE	40
79	323873	6210441	OCCUPIED	NO	HOUSE	40
80	324097	6210418	OCCUPIED	NO	HOUSE	40
81	333163	6204041	OCCUPIED	NO	NOT SURVEYED	40

Residence ID	Coordinates (GDA94 PROJECTION MGA54)		Occupied	Associated	Building	"Baseline" Noise Criterion
	Easting	Northing				
82	332114	6199930	OCCUPIED	NO	NOT SURVEYED	40
83	331318	6199253	OCCUPIED	NO	NOT SURVEYED	40
84	330876	6199742	OCCUPIED	NO	NOT SURVEYED	40
85	330199	6199883	OCCUPIED	NO	NOT SURVEYED	40
86	330014	6199830	OCCUPIED	NO	NOT SURVEYED	40
87	328452	6199011	OCCUPIED	NO	NOT SURVEYED	40
88	330707	6195869	OCCUPIED	NO	NOT SURVEYED	40
89	329182	6196326	OCCUPIED	NO	NOT SURVEYED	40
90	329251	6196299	OCCUPIED	NO	NOT SURVEYED	40
91	329366	6196323	OCCUPIED	NO	NOT SURVEYED	40
92	329477	6196741	OCCUPIED	NO	NOT SURVEYED	40
93	329375	6196658	OCCUPIED	NO	NOT SURVEYED	40
94	329394	6196597	OCCUPIED	NO	NOT SURVEYED	40
95	329439	6196657	OCCUPIED	NO	NOT SURVEYED	40
96	329316	6196623	OCCUPIED	NO	NOT SURVEYED	40
97	329248	6196582	OCCUPIED	NO	NOT SURVEYED	40
98	329163	6196530	OCCUPIED	NO	NOT SURVEYED	40
99	329163	6196557	OCCUPIED	NO	NOT SURVEYED	40
100	329174	6196594	OCCUPIED	NO	NOT SURVEYED	40
101	329184	6196620	OCCUPIED	NO	NOT SURVEYED	40
102	329214	6196373	OCCUPIED	NO	NOT SURVEYED	40
103	328993	6196382	OCCUPIED	NO	NOT SURVEYED	40
104	328943	6196320	OCCUPIED	NO	NOT SURVEYED	40
105	329118	6196714	OCCUPIED	NO	NOT SURVEYED	40
106	329158	6196489	OCCUPIED	NO	NOT SURVEYED	40
107	329020	6196732	OCCUPIED	NO	NOT SURVEYED	40
108	328227	6196021	OCCUPIED	NO	NOT SURVEYED	40
109	328868	6196628	OCCUPIED	NO	NOT SURVEYED	40
110	328765	6196749	OCCUPIED	NO	NOT SURVEYED	40
111	327910	6197263	OCCUPIED	NO	NOT SURVEYED	40
112	325928	6196512	OCCUPIED	NO	NOT SURVEYED	40
113	323876	6195866	OCCUPIED	NO	NOT SURVEYED	40
114	316390	6196126	OCCUPIED	NO	NOT SURVEYED	40
115	323124	6196480	OCCUPIED	NO	NOT SURVEYED	40
116	323256	6196546	OCCUPIED	NO	NOT SURVEYED	40
117	321750	6197065	UNOCCUPIED	NO	HOUSE	40
118	318374	6200027	OCCUPIED	YES	HOUSE	45
119	318462	6200062	OCCUPIED	YES	HOUSE	45
120	318362	6200119	OCCUPIED	YES	HOUSE	45
121	316698	6201396	OCCUPIED	NO	HOUSE	40
122	322874	6198829	OCCUPIED	NO	HOUSE	40
123	324465	6199580	OCCUPIED	NO	HOUSE	40

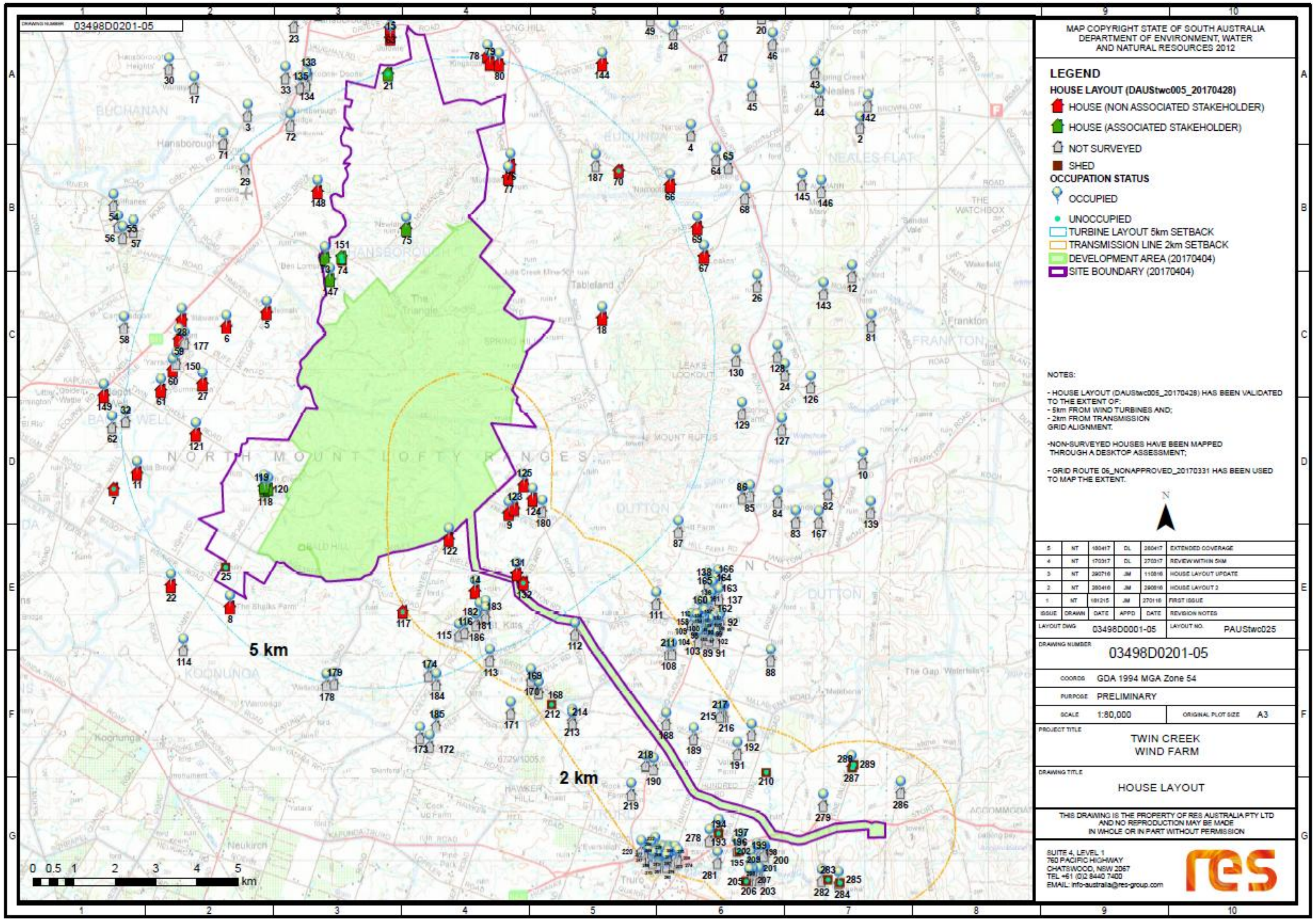
Residence ID	Coordinates (GDA94 PROJECTION MGA54)		Occupied	Associated	Building	"Baseline" Noise Criterion
	Easting	Northing				
124	324921	6199805	OCCUPIED	NO	HOUSE	40
125	324704	6200152	OCCUPIED	NO	HOUSE	40
126	331687	6202536	OCCUPIED	NO	NOT SURVEYED	40
127	330979	6201508	OCCUPIED	NO	NOT SURVEYED	40
128	330871	6203287	OCCUPIED	NO	NOT SURVEYED	40
129	330007	6201895	OCCUPIED	NO	NOT SURVEYED	40
130	329866	6203188	OCCUPIED	NO	NOT SURVEYED	40
131	324533	6197985	OCCUPIED	NO	HOUSE	40
132	324698	6197761	UNOCCUPIED	NO	HOUSE	40
133	319433	6210179	OCCUPIED	NO	NOT SURVEYED	40
134	319393	6209917	OCCUPIED	NO	NOT SURVEYED	40
135	319245	6209852	OCCUPIED	NO	NOT SURVEYED	40
136	329263	6197269	OCCUPIED	NO	NOT SURVEYED	40
137	329442	6197354	OCCUPIED	NO	NOT SURVEYED	40
138	329172	6197743	OCCUPIED	NO	NOT SURVEYED	40
139	333146	6199476	OCCUPIED	NO	NOT SURVEYED	40
140	330772	6211625	OCCUPIED	NO	NOT SURVEYED	40
141	331628	6212480	OCCUPIED	NO	NOT SURVEYED	40
142	333080	6209399	OCCUPIED	NO	NOT SURVEYED	40
143	331996	6204819	OCCUPIED	NO	NOT SURVEYED	40
144	326589	6210431	OCCUPIED	NO	HOUSE	40
145	331473	6207476	OCCUPIED	NO	NOT SURVEYED	40
146	331945	6207310	OCCUPIED	NO	NOT SURVEYED	40
147	319969	6205165	OCCUPIED	YES	HOUSE	45
148	319669	6207310	OCCUPIED	NO	HOUSE	40
149	314445	6202336	OCCUPIED	NO	HOUSE	40
150	316224	6203117	OCCUPIED	NO	NOT SURVEYED	40
151	320252	6205722	UNOCCUPIED	YES	HOUSE	45
152	329320	6196662	OCCUPIED	NO	NOT SURVEYED	40
153	329222	6196619	OCCUPIED	NO	NOT SURVEYED	40
154	329050	6196585	OCCUPIED	NO	NOT SURVEYED	40
155	329084	6196649	OCCUPIED	NO	NOT SURVEYED	40
156	329037	6196731	OCCUPIED	NO	NOT SURVEYED	40
157	329091	6196837	OCCUPIED	NO	NOT SURVEYED	40
158	328914	6196750	OCCUPIED	NO	NOT SURVEYED	40
159	328900	6196737	OCCUPIED	NO	NOT SURVEYED	40
160	328983	6197055	OCCUPIED	NO	NOT SURVEYED	40
161	329223	6197127	OCCUPIED	NO	NOT SURVEYED	40
162	329189	6197081	OCCUPIED	NO	NOT SURVEYED	40
163	329315	6197629	OCCUPIED	NO	NOT SURVEYED	40
164	329376	6197622	OCCUPIED	NO	NOT SURVEYED	40
165	329283	6197521	OCCUPIED	NO	NOT SURVEYED	40

Residence ID	Coordinates (GDA94 PROJECTION MGA54)		Occupied	Associated	Building	"Baseline" Noise Criterion
	Easting	Northing				
166	329427	6197811	OCCUPIED	NO	NOT SURVEYED	40
167	331881	6199249	OCCUPIED	NO	NOT SURVEYED	40
168	325069	6195084	OCCUPIED	NO	NOT SURVEYED	40
169	324942	6195205	OCCUPIED	NO	NOT SURVEYED	40
170	324876	6195388	OCCUPIED	NO	NOT SURVEYED	40
171	324384	6194580	OCCUPIED	NO	NOT SURVEYED	40
172	322403	6193774	OCCUPIED	NO	NOT SURVEYED	40
173	322166	6193978	OCCUPIED	NO	NOT SURVEYED	40
174	322377	6195495	OCCUPIED	NO	NOT SURVEYED	40
175	321305	6214520	OCCUPIED	NO	NOT SURVEYED	40
176	322134	6214224	OCCUPIED	NO	NOT SURVEYED	40
177	316423	6203609	OCCUPIED	NO	NOT SURVEYED	40
178	319884	6195267	OCCUPIED	NO	NOT SURVEYED	40
179	320076	6195303	OCCUPIED	NO	NOT SURVEYED	40
180	325159	6199502	OCCUPIED	NO	NOT SURVEYED	40
181	323623	6197004	OCCUPIED	NO	NOT SURVEYED	40
182	323772	6197057	OCCUPIED	NO	NOT SURVEYED	40
183	323773	6196905	OCCUPIED	NO	NOT SURVEYED	40
184	322571	6195278	OCCUPIED	NO	NOT SURVEYED	40
185	322560	6194278	OCCUPIED	NO	NOT SURVEYED	40
186	323539	6196728	OCCUPIED	NO	NOT SURVEYED	40
187	326433	6207948	OCCUPIED	NO	NOT SURVEYED	40
188	328156	6194319	OCCUPIED	NO	NOT SURVEYED	40
189	328827	6193956	OCCUPIED	NO	NOT SURVEYED	40
190	327849	6193219	OCCUPIED	NO	NOT SURVEYED	40
191	329897	6193600	OCCUPIED	NO	NOT SURVEYED	40
192	330243	6194049	OCCUPIED	NO	NOT SURVEYED	40
193	329437	6191717	OCCUPIED	NO	NOT SURVEYED	40
194	329439	6191654	UNOCCUPIED	NO	SHED	NA
195	329883	6191224	OCCUPIED	NO	NOT SURVEYED	40
196	329942	6191210	UNOCCUPIED	NO	SHED	NA
197	329987	6191376	OCCUPIED	NO	NOT SURVEYED	40
198	330371	6191129	OCCUPIED	NO	NOT SURVEYED	40
199	330424	6191076	OCCUPIED	NO	NOT SURVEYED	40
200	330575	6191066	OCCUPIED	NO	NOT SURVEYED	40
201	330532	6191090	OCCUPIED	NO	NOT SURVEYED	40
202	330214	6190939	OCCUPIED	NO	NOT SURVEYED	40
203	330462	6190513	OCCUPIED	NO	NOT SURVEYED	40
204	330420	6190543	OCCUPIED	NO	NOT SURVEYED	40
205	330236	6190480	OCCUPIED	NO	NOT SURVEYED	40
206	330272	6190519	OCCUPIED	NO	NOT SURVEYED	40
207	330182	6190514	OCCUPIED	NO	NOT SURVEYED	40

Residence ID	Coordinates (GDA94 PROJECTION MGA54)		Occupied	Associated	Building	"Baseline" Noise Criterion
	Easting	Northing				
208	330115	6190492	UNOCCUPIED	NO	SHED	NA
209	330290	6190746	OCCUPIED	NO	NOT SURVEYED	40
210	330599	6193136	UNOCCUPIED	NO	SHED	NA
211	328296	6196025	OCCUPIED	NO	NOT SURVEYED	40
212	325385	6194799	UNOCCUPIED	NO	SHED	NA
213	325861	6194403	OCCUPIED	NO	NOT SURVEYED	40
214	325870	6194335	OCCUPIED	NO	NOT SURVEYED	40
215	329570	6194498	OCCUPIED	NO	NOT SURVEYED	40
216	329530	6194510	OCCUPIED	NO	NOT SURVEYED	40
217	329469	6194508	OCCUPIED	NO	NOT SURVEYED	40
218	327658	6193293	OCCUPIED	NO	NOT SURVEYED	40
219	327302	6192599	OCCUPIED	NO	NOT SURVEYED	40
220	327546	6191204	OCCUPIED	NO	NOT SURVEYED	40
221	327813	6191195	OCCUPIED	NO	NOT SURVEYED	40
222	327884	6191280	OCCUPIED	NO	NOT SURVEYED	40
223	327845	6191144	OCCUPIED	NO	NOT SURVEYED	40
224	327814	6191146	OCCUPIED	NO	NOT SURVEYED	40
225	327926	6191067	OCCUPIED	NO	NOT SURVEYED	40
226	327891	6191081	OCCUPIED	NO	NOT SURVEYED	40
227	328051	6191084	OCCUPIED	NO	NOT SURVEYED	40
228	328176	6191074	OCCUPIED	NO	NOT SURVEYED	40
229	328105	6191058	OCCUPIED	NO	NOT SURVEYED	40
230	328221	6191050	OCCUPIED	NO	NOT SURVEYED	40
231	328227	6191071	OCCUPIED	NO	NOT SURVEYED	40
232	328289	6191043	OCCUPIED	NO	NOT SURVEYED	40
233	328285	6191021	OCCUPIED	NO	NOT SURVEYED	40
234	328259	6190995	OCCUPIED	NO	NOT SURVEYED	40
235	328202	6191014	OCCUPIED	NO	NOT SURVEYED	40
236	328378	6191064	OCCUPIED	NO	NOT SURVEYED	40
237	327895	6191019	OCCUPIED	NO	NOT SURVEYED	40
238	327736	6191073	OCCUPIED	NO	NOT SURVEYED	40
239	327771	6191057	OCCUPIED	NO	NOT SURVEYED	40
240	327724	6190994	OCCUPIED	NO	NOT SURVEYED	40
241	327772	6190979	OCCUPIED	NO	NOT SURVEYED	40
242	327781	6190978	OCCUPIED	NO	NOT SURVEYED	40
243	327794	6190972	OCCUPIED	NO	NOT SURVEYED	40
244	327806	6190972	OCCUPIED	NO	NOT SURVEYED	40
245	327823	6190964	OCCUPIED	NO	NOT SURVEYED	40
246	327863	6190961	OCCUPIED	NO	NOT SURVEYED	40
247	327800	6191000	OCCUPIED	NO	NOT SURVEYED	40
248	327778	6191009	OCCUPIED	NO	NOT SURVEYED	40
249	327827	6190995	OCCUPIED	NO	NOT SURVEYED	40

Residence ID	Coordinates (GDA94 PROJECTION MGA54)		Occupied	Associated	Building	"Baseline" Noise Criterion
	Easting	Northing				
250	327751	6191015	OCCUPIED	NO	NOT SURVEYED	40
251	327880	6190979	OCCUPIED	NO	NOT SURVEYED	40
252	327917	6190967	OCCUPIED	NO	NOT SURVEYED	40
253	327918	6190931	OCCUPIED	NO	NOT SURVEYED	40
254	327932	6190959	OCCUPIED	NO	NOT SURVEYED	40
255	328046	6190889	OCCUPIED	NO	NOT SURVEYED	40
256	328050	6190919	OCCUPIED	NO	NOT SURVEYED	40
257	328084	6190905	OCCUPIED	NO	NOT SURVEYED	40
258	328113	6190894	OCCUPIED	NO	NOT SURVEYED	40
259	328141	6190886	OCCUPIED	NO	NOT SURVEYED	40
260	328136	6190860	OCCUPIED	NO	NOT SURVEYED	40
261	328044	6190850	OCCUPIED	NO	NOT SURVEYED	40
262	328057	6190809	OCCUPIED	NO	NOT SURVEYED	40
263	328086	6190833	OCCUPIED	NO	NOT SURVEYED	40
264	328100	6190829	OCCUPIED	NO	NOT SURVEYED	40
265	327999	6190852	OCCUPIED	NO	NOT SURVEYED	40
266	327962	6190865	OCCUPIED	NO	NOT SURVEYED	40
267	327909	6190891	OCCUPIED	NO	NOT SURVEYED	40
268	327878	6190901	OCCUPIED	NO	NOT SURVEYED	40
269	327935	6190882	OCCUPIED	NO	NOT SURVEYED	40
270	327824	6190926	OCCUPIED	NO	NOT SURVEYED	40
271	328179	6190855	OCCUPIED	NO	NOT SURVEYED	40
272	328198	6190850	OCCUPIED	NO	NOT SURVEYED	40
273	328216	6190866	OCCUPIED	NO	NOT SURVEYED	40
274	328416	6190927	OCCUPIED	NO	NOT SURVEYED	40
275	328439	6190984	OCCUPIED	NO	NOT SURVEYED	40
276	328206	6190972	OCCUPIED	NO	NOT SURVEYED	40
277	327791	6191184	OCCUPIED	NO	NOT SURVEYED	40
278	329216	6191476	OCCUPIED	NO	NOT SURVEYED	40
279	331991	6192334	OCCUPIED	NO	NOT SURVEYED	40
280	328154	6190849	OCCUPIED	NO	NOT SURVEYED	40
281	329412	6190930	OCCUPIED	NO	NOT SURVEYED	40
282	331957	6190500	OCCUPIED	NO	NOT SURVEYED	40
283	332111	6190531	UNOCCUPIED	NO	SHED	NA
284	332360	6190441	OCCUPIED	NO	NOT SURVEYED	40
285	332404	6190454	UNOCCUPIED	NO	SHED	NA
286	333877	6192644	OCCUPIED	NO	NOT SURVEYED	40
287	332679	6193278	OCCUPIED	NO	NOT SURVEYED	40
288	332708	6193251	UNOCCUPIED	NO	SHED	NA
289	332743	6193332	UNOCCUPIED	NO	SHED	NA

sonus.


03498D0201-05
MAP COPYRIGHT STATE OF SOUTH AUSTRALIA
DEPARTMENT OF ENVIRONMENT, WATER
AND NATURAL RESOURCES 2012
LEGEND
HOUSE LAYOUT (DAUStwc005_20170428)
HOUSE (NON ASSOCIATED STAKEHOLDER)
HOUSE (ASSOCIATED STAKEHOLDER)
NOT SURVEYED
SHED
OCCUPATION STATUS
OCCUPIED
UNOCCUPIED
TURBINE LAYOUT 5km SETBACK
TRANSMISSION LINE 2km SETBACK
DEVELOPMENT AREA (20170404)
SITE BOUNDARY (20170404)
NOTES:
- HOUSE LAYOUT (DAUStwc005_20170428) HAS BEEN VALIDATED TO THE EXTENT OF:
- 5km FROM WIND TURBINES AND;
- 2km FROM TRANSMISSION GRID ALIGNMENT.
-NON-SURVEYED HOUSES HAVE BEEN MAPPED THROUGH A DESKTOP ASSESSMENT;
- GRID ROUTE 06_NONAPPROVED_20170331 HAS BEEN USED TO MAP THE EXTENT.
N
LAYOUT DWG 03498D0001-05
LAYOUT NO. PAUStwc025
DRAWING NUMBER 03498D0201-05
COORDS GDA 1994 MGA Zone 54
PURPOSE PRELIMINARY
SCALE 1:80,000
ORIGINAL PLOT SIZE A3
PROJECT TITLE
TWIN CREEK WIND FARM
DRAWING TITLE
HOUSE LAYOUT
THIS DRAWING IS THE PROPERTY OF RES AUSTRALIA PTY LTD
AND NO REPRODUCTION MAY BE MADE
IN WHOLE OR IN PART WITHOUT PERMISSION
SUITE 4, LEVEL 1
760 PACIFIC HIGHWAY
CHATSWOOD, NSW 2067
TEL +61 (0)2 8440 7400
EMAIL: info-australia@res-group.com
res
5 km
2 km
NORTH MOUNT LOFTY RANGES
0 0.5 1 2 3 4 5 km

APPENDIX D: PHOTOGRAPHS OF EQUIPMENT AT MONITORING LOCATIONS

Noise logging equipment at location H5

Noise logging equipment at location H18

Noise logging equipment at location H77

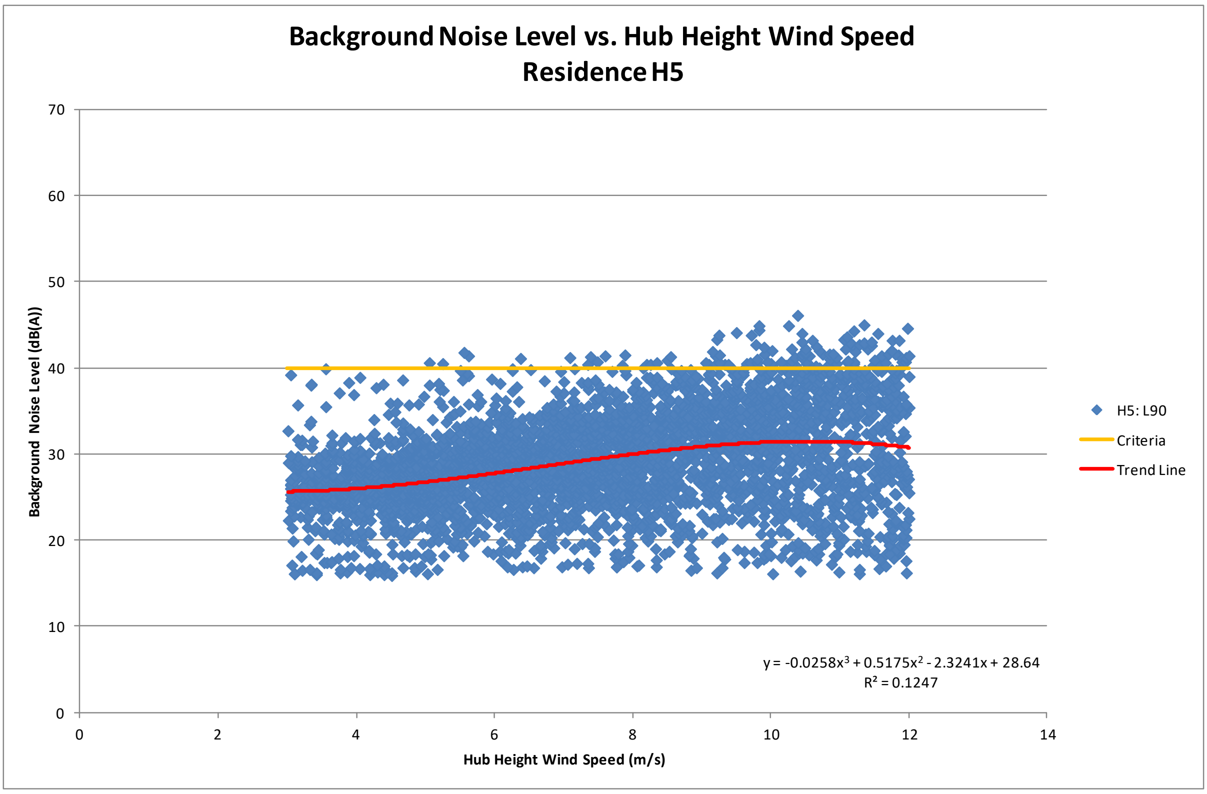
Noise logging equipment at location H119

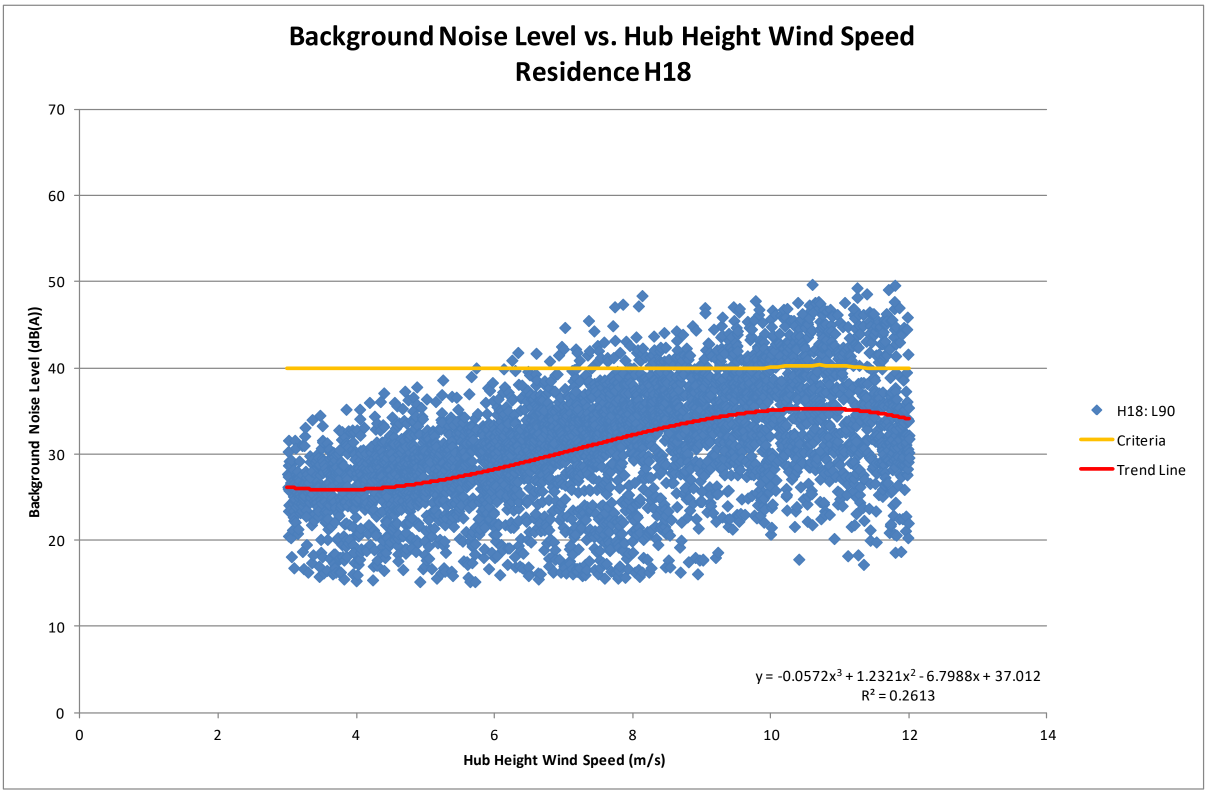
Noise logging equipment at location H122

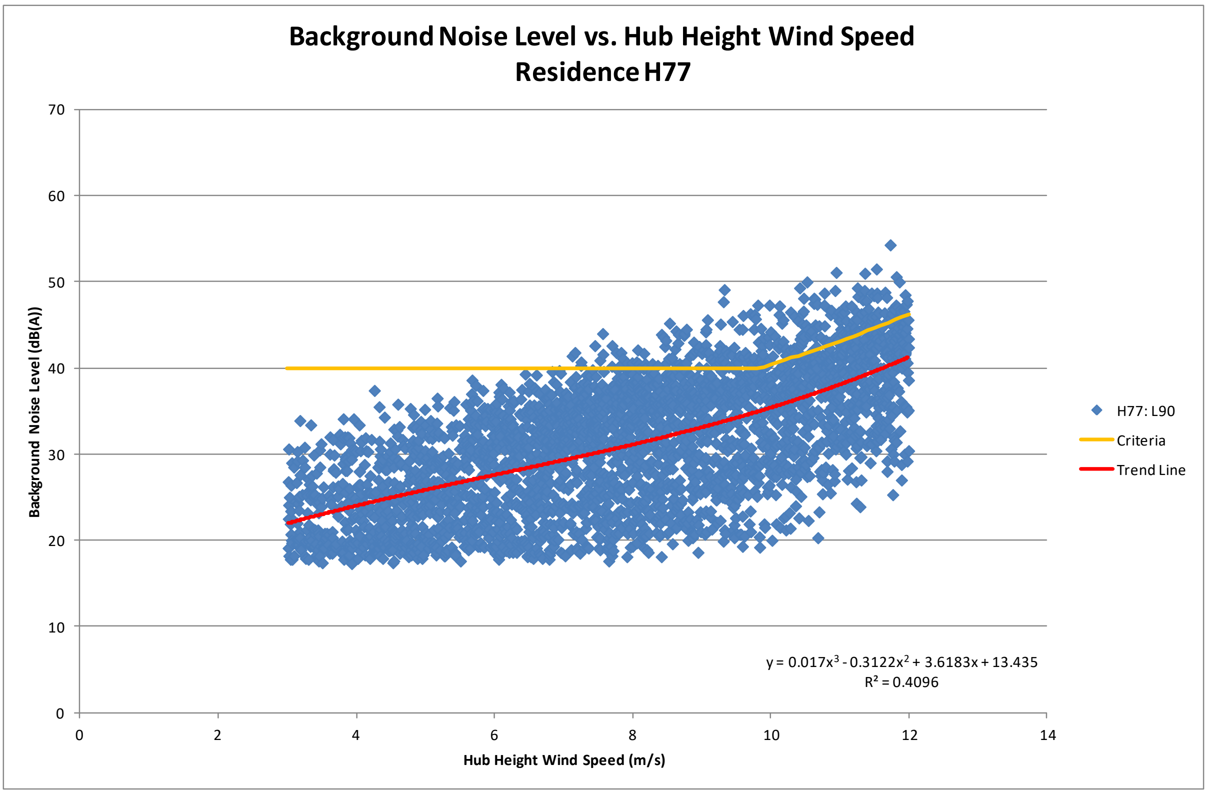
Noise logging equipment at location H125

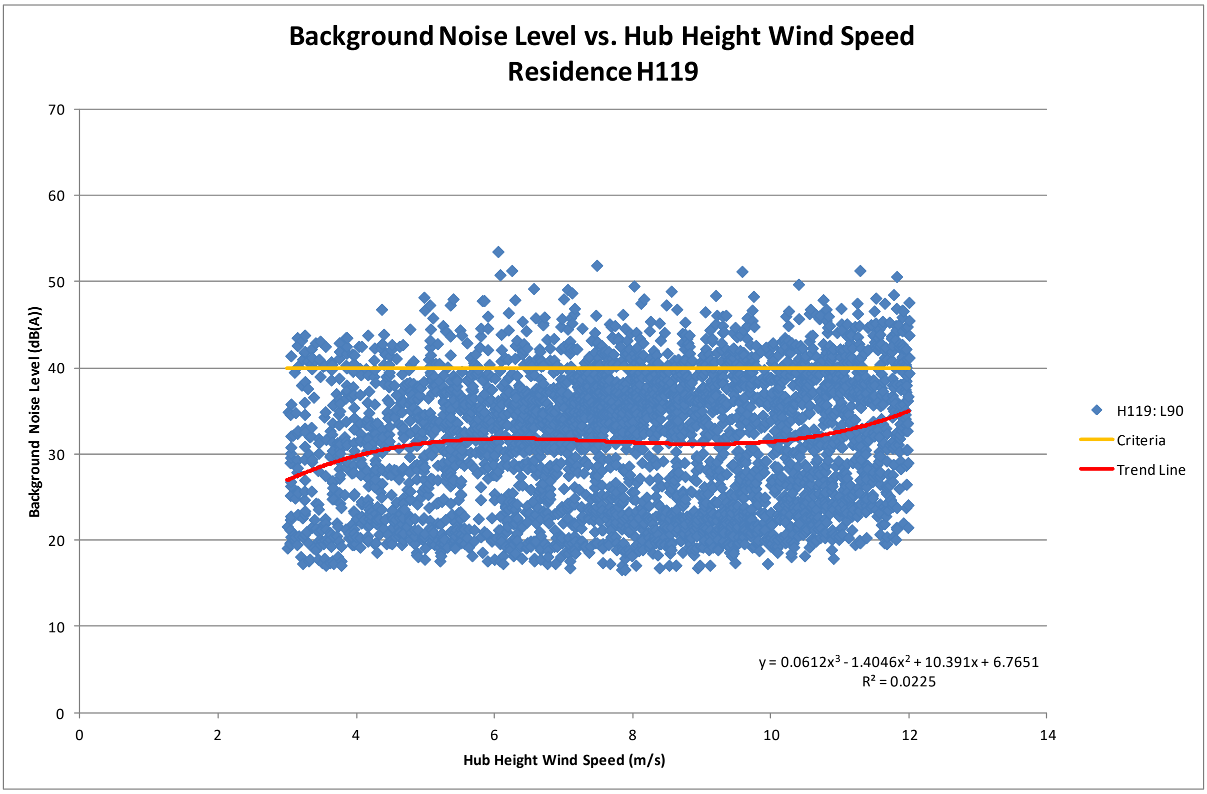
Noise logging equipment at location H147

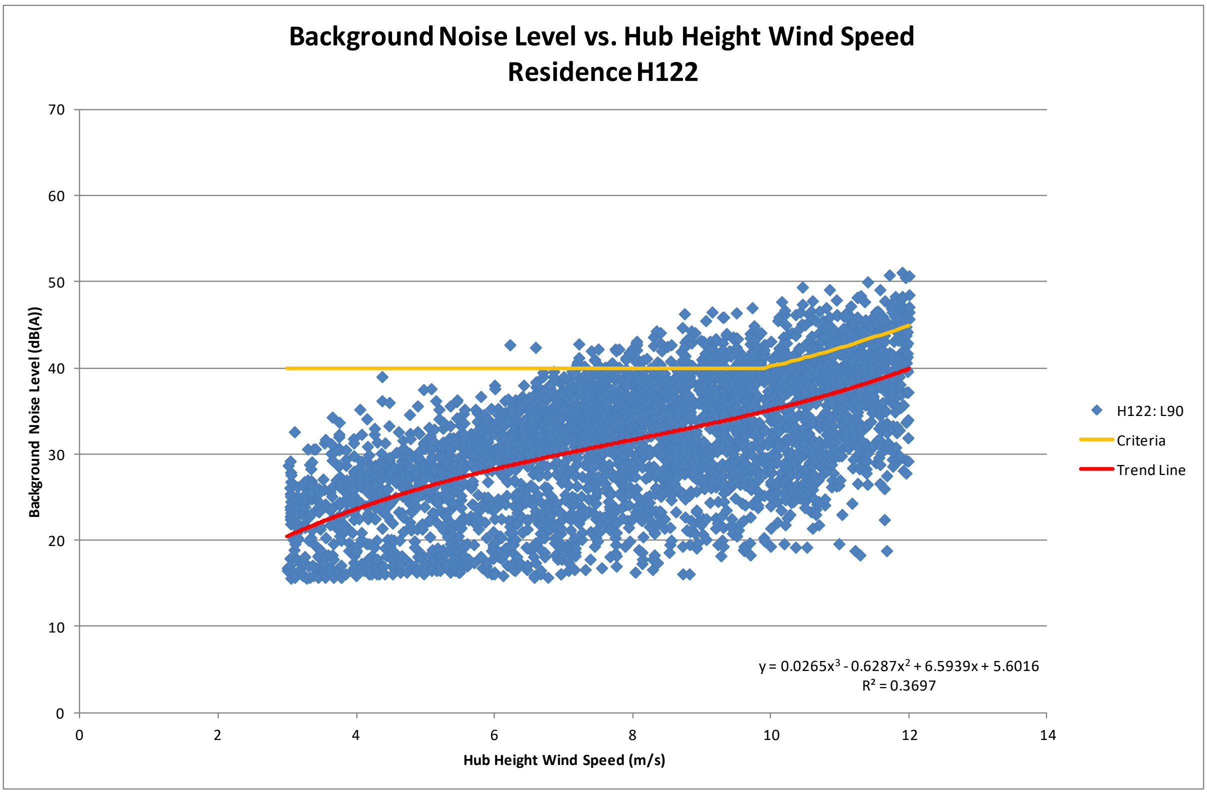
APPENDIX E: CORRELATIONS AND REGRESSION ANALYSES

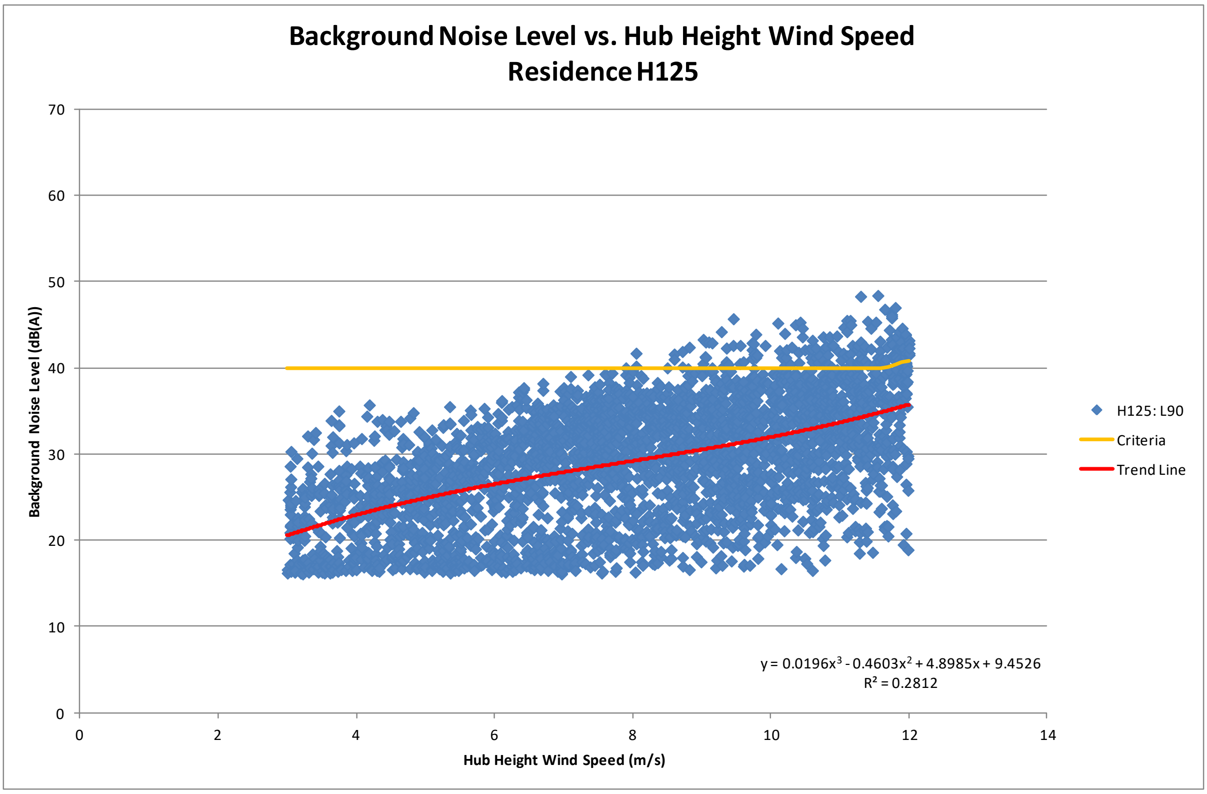


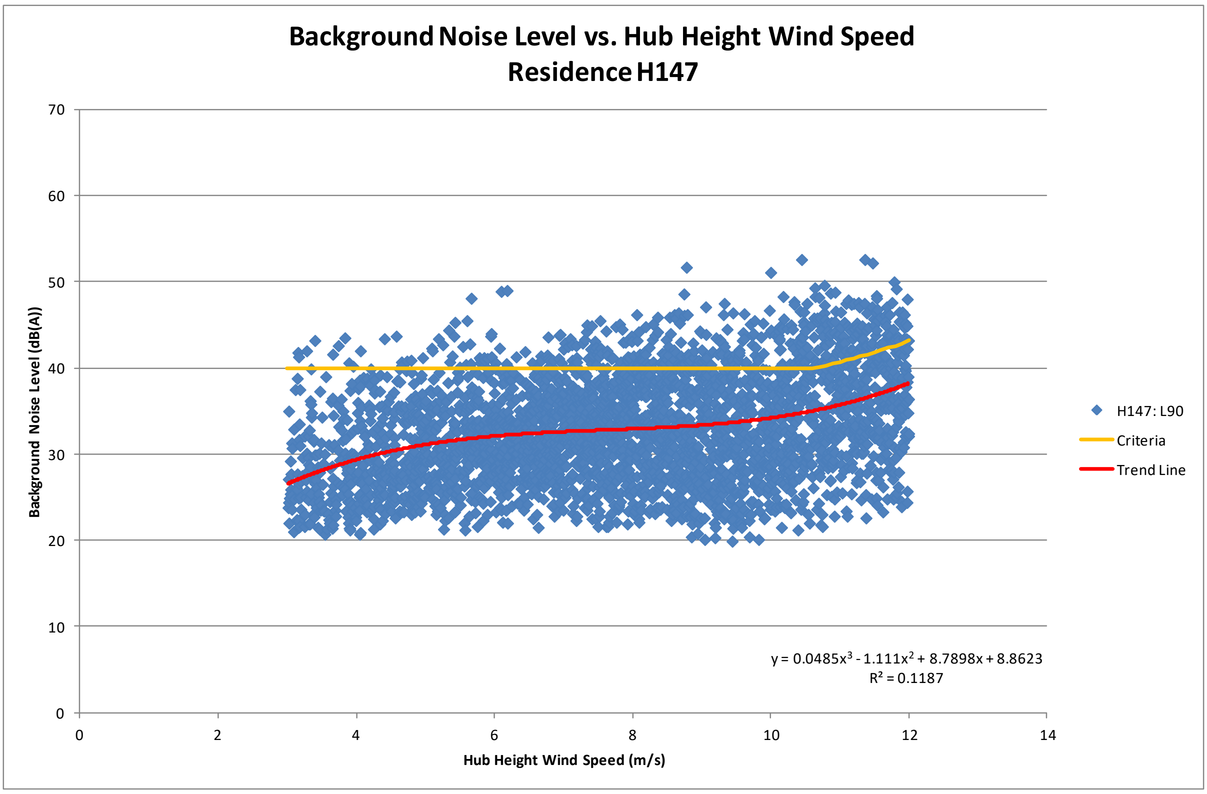



Background Noise Level vs. Hub Height Wind Speed
Residence H77
Background Noise Level (dB(A))
Hub Height Wind Speed (m/s)
H77: L90
Criteria
Trend Line
y = 0.017x³ - 0.3122x² + 3.6183x + 13.435
R² = 0.4096


Background Noise Level vs. Hub Height Wind Speed
Residence H119
Background Noise Level (dB(A))
Hub Height Wind Speed (m/s)
H119: L90
Criteria
Trend Line
y = 0.0612x³ - 1.4046x² + 10.391x + 6.7651
R² = 0.0225


Background Noise Level vs. Hub Height Wind Speed
Residence H122
Background Noise Level (dB(A))
Hub Height Wind Speed (m/s)
0
10
20
30
40
50
60
70
0
2
4
6
8
10
12
14
H122: L90
Criteria
Trend Line
y = 0.0265x³ - 0.6287x² + 6.5939x + 5.6016
R² = 0.3697


Background Noise Level vs. Hub Height Wind Speed
Residence H125
Background Noise Level (dB(A))
Hub Height Wind Speed (m/s)
0
10
20
30
40
50
60
70
0
2
4
6
8
10
12
14
H125: L90
Criteria
Trend Line
y = 0.0196x³ - 0.4603x² + 4.8985x + 9.4526
R² = 0.2812


Background Noise Level vs. Hub Height Wind Speed
Residence H147
Background Noise Level (dB(A))
Hub Height Wind Speed (m/s)
0
10
20
30
40
50
60
70
0
2
4
6
8
10
12
14
H147: L90
Criteria
Trend Line
y = 0.0485x³ - 1.111x² + 8.7898x + 8.8623
R² = 0.1187

APPENDIX F: ASSESSMENT CRITERIA

Residence	Associated	Noise Criterion dB(A) at Integer Wind Speeds (m/s)									
		3	4	5	6	7	8	9	10	11	12
1	NO	40	40	40	40	40	40	40	40	40	40
2	NO	40	40	40	40	40	40	40	40	40	40
3	NO	40	40	40	40	40	40	40	40	40	40
4	NO	40	40	40	40	40	40	40	40	40	40
5	NO	40	40	40	40	40	40	40	40	40	40
6	NO	40	40	40	40	40	40	40	40	40	40
7	NO	40	40	40	40	40	40	40	40	40	40
8	NO	40	40	40	40	40	40	40	40	40	40
9	NO	40	40	40	40	40	40	40	40	40	40
10	NO	40	40	40	40	40	40	40	40	40	40
11	NO	40	40	40	40	40	40	40	40	40	40
12	NO	40	40	40	40	40	40	40	40	40	40
13	NO	40	40	40	40	40	40	40	40	40	40
14	NO	40	40	40	40	40	40	40	40	40	40
15	NO	40	40	40	40	40	40	40	40	40	40
16	NO	40	40	40	40	40	40	40	40	40	40
17	NO	40	40	40	40	40	40	40	40	40	40
18	NO	40	40	40	40	40	40	40	40	40	40
19	NO	40	40	40	40	40	40	40	40	40	40
20	NO	40	40	40	40	40	40	40	40	40	40
21	YES	45	45	45	45	45	45	45	45	45	45
22	NO	40	40	40	40	40	40	40	40	40	40
23	NO	40	40	40	40	40	40	40	40	40	40
24	NO	40	40	40	40	40	40	40	40	40	40
25	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
26	NO	40	40	40	40	40	40	40	40	40	40
27	NO	40	40	40	40	40	40	40	40	40	40
28	NO	40	40	40	40	40	40	40	40	40	40
29	NO	40	40	40	40	40	40	40	40	40	40
30	NO	40	40	40	40	40	40	40	40	40	40
31	NO	40	40	40	40	40	40	40	40	40	40
32	NO	40	40	40	40	40	40	40	40	40	40
33	NO	40	40	40	40	40	40	40	40	40	40
34	NO	40	40	40	40	40	40	40	40	40	40
35	NO	40	40	40	40	40	40	40	40	40	40
36	NO	40	40	40	40	40	40	40	40	40	40
37	NO	40	40	40	40	40	40	40	40	40	40
38	NO	40	40	40	40	40	40	40	40	40	40
39	NO	40	40	40	40	40	40	40	40	40	40
40	NO	40	40	40	40	40	40	40	40	40	40
41	NO	40	40	40	40	40	40	40	40	40	40
42	NO	40	40	40	40	40	40	40	40	40	40
43	NO	40	40	40	40	40	40	40	40	40	40

Residence	Associated	Noise Criterion dB(A) at Integer Wind Speeds (m/s)									
		3	4	5	6	7	8	9	10	11	12
44	NO	40	40	40	40	40	40	40	40	40	40
45	NO	40	40	40	40	40	40	40	40	40	40
46	NO	40	40	40	40	40	40	40	40	40	40
47	NO	40	40	40	40	40	40	40	40	40	40
48	NO	40	40	40	40	40	40	40	40	40	40
49	NO	40	40	40	40	40	40	40	40	40	40
50	NO	40	40	40	40	40	40	40	40	40	40
51	NO	40	40	40	40	40	40	40	40	40	40
52	NO	40	40	40	40	40	40	40	40	40	40
53	NO	40	40	40	40	40	40	40	40	40	40
54	NO	40	40	40	40	40	40	40	40	40	40
55	NO	40	40	40	40	40	40	40	40	40	40
56	NO	40	40	40	40	40	40	40	40	40	40
57	NO	40	40	40	40	40	40	40	40	40	40
58	NO	40	40	40	40	40	40	40	40	40	40
59	NO	40	40	40	40	40	40	40	40	40	40
60	NO	40	40	40	40	40	40	40	40	40	40
61	NO	40	40	40	40	40	40	40	40	40	40
62	NO	40	40	40	40	40	40	40	40	40	40
63	NO	40	40	40	40	40	40	40	40	40	40
64	NO	40	40	40	40	40	40	40	40	40	40
65	NO	40	40	40	40	40	40	40	40	40	40
66	NO	40	40	40	40	40	40	40	40	40	40
67	NO	40	40	40	40	40	40	40	40	40	40
68	NO	40	40	40	40	40	40	40	40	40	40
69	NO	40	40	40	40	40	40	40	40	40	40
70	NO	40	40	40	40	40	40	40	40	40	40
71	NO	40	40	40	40	40	40	40	40	40	40
72	NO	40	40	40	40	40	40	40	40	40	40
73	YES	45	45	45	45	45	45	45	45	45	45
74	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
75	YES	45	45	45	45	45	45	45	45	45	45
76	NO	40	40	40	40	40	40	40	40	40	40
77	NO	40	40	40	40	40	40	40	40	43	46
78	NO	40	40	40	40	40	40	40	40	40	40
79	NO	40	40	40	40	40	40	40	40	40	40
80	NO	40	40	40	40	40	40	40	40	40	40
81	NO	40	40	40	40	40	40	40	40	40	40
82	NO	40	40	40	40	40	40	40	40	40	40
83	NO	40	40	40	40	40	40	40	40	40	40
84	NO	40	40	40	40	40	40	40	40	40	40
85	NO	40	40	40	40	40	40	40	40	40	40
86	NO	40	40	40	40	40	40	40	40	40	40
87	NO	40	40	40	40	40	40	40	40	40	40
88	NO	40	40	40	40	40	40	40	40	40	40

Residence	Associated	Noise Criterion dB(A) at Integer Wind Speeds (m/s)									
		3	4	5	6	7	8	9	10	11	12
89	NO	40	40	40	40	40	40	40	40	40	40
90	NO	40	40	40	40	40	40	40	40	40	40
91	NO	40	40	40	40	40	40	40	40	40	40
92	NO	40	40	40	40	40	40	40	40	40	40
93	NO	40	40	40	40	40	40	40	40	40	40
94	NO	40	40	40	40	40	40	40	40	40	40
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97	NO	40	40	40	40	40	40	40	40	40	40
98	NO	40	40	40	40	40	40	40	40	40	40
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100	NO	40	40	40	40	40	40	40	40	40	40
101	NO	40	40	40	40	40	40	40	40	40	40
102	NO	40	40	40	40	40	40	40	40	40	40
103	NO	40	40	40	40	40	40	40	40	40	40
104	NO	40	40	40	40	40	40	40	40	40	40
105	NO	40	40	40	40	40	40	40	40	40	40
106	NO	40	40	40	40	40	40	40	40	40	40
107	NO	40	40	40	40	40	40	40	40	40	40
108	NO	40	40	40	40	40	40	40	40	40	40
109	NO	40	40	40	40	40	40	40	40	40	40
110	NO	40	40	40	40	40	40	40	40	40	40
111	NO	40	40	40	40	40	40	40	40	40	40
112	NO	40	40	40	40	40	40	40	40	40	40
113	NO	40	40	40	40	40	40	40	40	40	40
114	NO	40	40	40	40	40	40	40	40	40	40
115	NO	40	40	40	40	40	40	40	40	40	40
116	NO	40	40	40	40	40	40	40	40	40	40
117	NO	40	40	40	40	40	40	40	40	40	40
118	YES	45	45	45	45	45	45	45	45	45	45
119	YES	45	45	45	45	45	45	45	45	45	45
120	YES	45	45	45	45	45	45	45	45	45	45
121	NO	40	40	40	40	40	40	40	40	40	40
122	NO	40	40	40	40	40	40	40	40	42	45
123	NO	40	40	40	40	40	40	40	40	40	40
124	NO	40	40	40	40	40	40	40	40	40	40
125	NO	40	40	40	40	40	40	40	40	40	41
126	NO	40	40	40	40	40	40	40	40	40	40
127	NO	40	40	40	40	40	40	40	40	40	40
128	NO	40	40	40	40	40	40	40	40	40	40
129	NO	40	40	40	40	40	40	40	40	40	40
130	NO	40	40	40	40	40	40	40	40	40	40
131	NO	40	40	40	40	40	40	40	40	40	40
132	NO	40	40	40	40	40	40	40	40	40	40
133	NO	40	40	40	40	40	40	40	40	40	40

Residence	Associated	Noise Criterion dB(A) at Integer Wind Speeds (m/s)									
		3	4	5	6	7	8	9	10	11	12
134	NO	40	40	40	40	40	40	40	40	40	40
135	NO	40	40	40	40	40	40	40	40	40	40
136	NO	40	40	40	40	40	40	40	40	40	40
137	NO	40	40	40	40	40	40	40	40	40	40
138	NO	40	40	40	40	40	40	40	40	40	40
139	NO	40	40	40	40	40	40	40	40	40	40
140	NO	40	40	40	40	40	40	40	40	40	40
141	NO	40	40	40	40	40	40	40	40	40	40
142	NO	40	40	40	40	40	40	40	40	40	40
143	NO	40	40	40	40	40	40	40	40	40	40
144	NO	40	40	40	40	40	40	40	40	40	40
145	NO	40	40	40	40	40	40	40	40	40	40
146	NO	40	40	40	40	40	40	40	40	40	40
147	YES	45	45	45	45	45	45	45	45	45	45
148	NO	40	40	40	40	40	40	40	40	40	40
149	NO	40	40	40	40	40	40	40	40	40	40
150	NO	40	40	40	40	40	40	40	40	40	40
151	YES	45	45	45	45	45	45	45	45	45	45
152	NO	40	40	40	40	40	40	40	40	40	40
153	NO	40	40	40	40	40	40	40	40	40	40
154	NO	40	40	40	40	40	40	40	40	40	40
155	NO	40	40	40	40	40	40	40	40	40	40
156	NO	40	40	40	40	40	40	40	40	40	40
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164	NO	40	40	40	40	40	40	40	40	40	40
165	NO	40	40	40	40	40	40	40	40	40	40
166	NO	40	40	40	40	40	40	40	40	40	40
167	NO	40	40	40	40	40	40	40	40	40	40
168	NO	40	40	40	40	40	40	40	40	40	40
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174	NO	40	40	40	40	40	40	40	40	40	40
175	NO	40	40	40	40	40	40	40	40	40	40
176	NO	40	40	40	40	40	40	40	40	40	40
177	NO	40	40	40	40	40	40	40	40	40	40
178	NO	40	40	40	40	40	40	40	40	40	40

Residence	Associated	Noise Criterion dB(A) at Integer Wind Speeds (m/s)									
		3	4	5	6	7	8	9	10	11	12
179	NO	40	40	40	40	40	40	40	40	40	40
180	NO	40	40	40	40	40	40	40	40	40	40
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187	NO	40	40	40	40	40	40	40	40	40	40
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189	NO	40	40	40	40	40	40	40	40	40	40
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192	NO	40	40	40	40	40	40	40	40	40	40
193	NO	40	40	40	40	40	40	40	40	40	40
194	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
195	NO	40	40	40	40	40	40	40	40	40	40
196	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
197	NO	40	40	40	40	40	40	40	40	40	40
198	NO	40	40	40	40	40	40	40	40	40	40
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208	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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210	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
211	NO	40	40	40	40	40	40	40	40	40	40
212	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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222	NO	40	40	40	40	40	40	40	40	40	40
223	NO	40	40	40	40	40	40	40	40	40	40

Residence	Associated	Noise Criterion dB(A) at Integer Wind Speeds (m/s)									
		3	4	5	6	7	8	9	10	11	12
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225	NO	40	40	40	40	40	40	40	40	40	40
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232	NO	40	40	40	40	40	40	40	40	40	40
233	NO	40	40	40	40	40	40	40	40	40	40
234	NO	40	40	40	40	40	40	40	40	40	40
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237	NO	40	40	40	40	40	40	40	40	40	40
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239	NO	40	40	40	40	40	40	40	40	40	40
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245	NO	40	40	40	40	40	40	40	40	40	40
246	NO	40	40	40	40	40	40	40	40	40	40
247	NO	40	40	40	40	40	40	40	40	40	40
248	NO	40	40	40	40	40	40	40	40	40	40
249	NO	40	40	40	40	40	40	40	40	40	40
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254	NO	40	40	40	40	40	40	40	40	40	40
255	NO	40	40	40	40	40	40	40	40	40	40
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266	NO	40	40	40	40	40	40	40	40	40	40
267	NO	40	40	40	40	40	40	40	40	40	40
268	NO	40	40	40	40	40	40	40	40	40	40

Residence	Associated	Noise Criterion dB(A) at Integer Wind Speeds (m/s)									
		3	4	5	6	7	8	9	10	11	12
269	NO	40	40	40	40	40	40	40	40	40	40
270	NO	40	40	40	40	40	40	40	40	40	40
271	NO	40	40	40	40	40	40	40	40	40	40
272	NO	40	40	40	40	40	40	40	40	40	40
273	NO	40	40	40	40	40	40	40	40	40	40
274	NO	40	40	40	40	40	40	40	40	40	40
275	NO	40	40	40	40	40	40	40	40	40	40
276	NO	40	40	40	40	40	40	40	40	40	40
277	NO	40	40	40	40	40	40	40	40	40	40
278	NO	40	40	40	40	40	40	40	40	40	40
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281	NO	40	40	40	40	40	40	40	40	40	40
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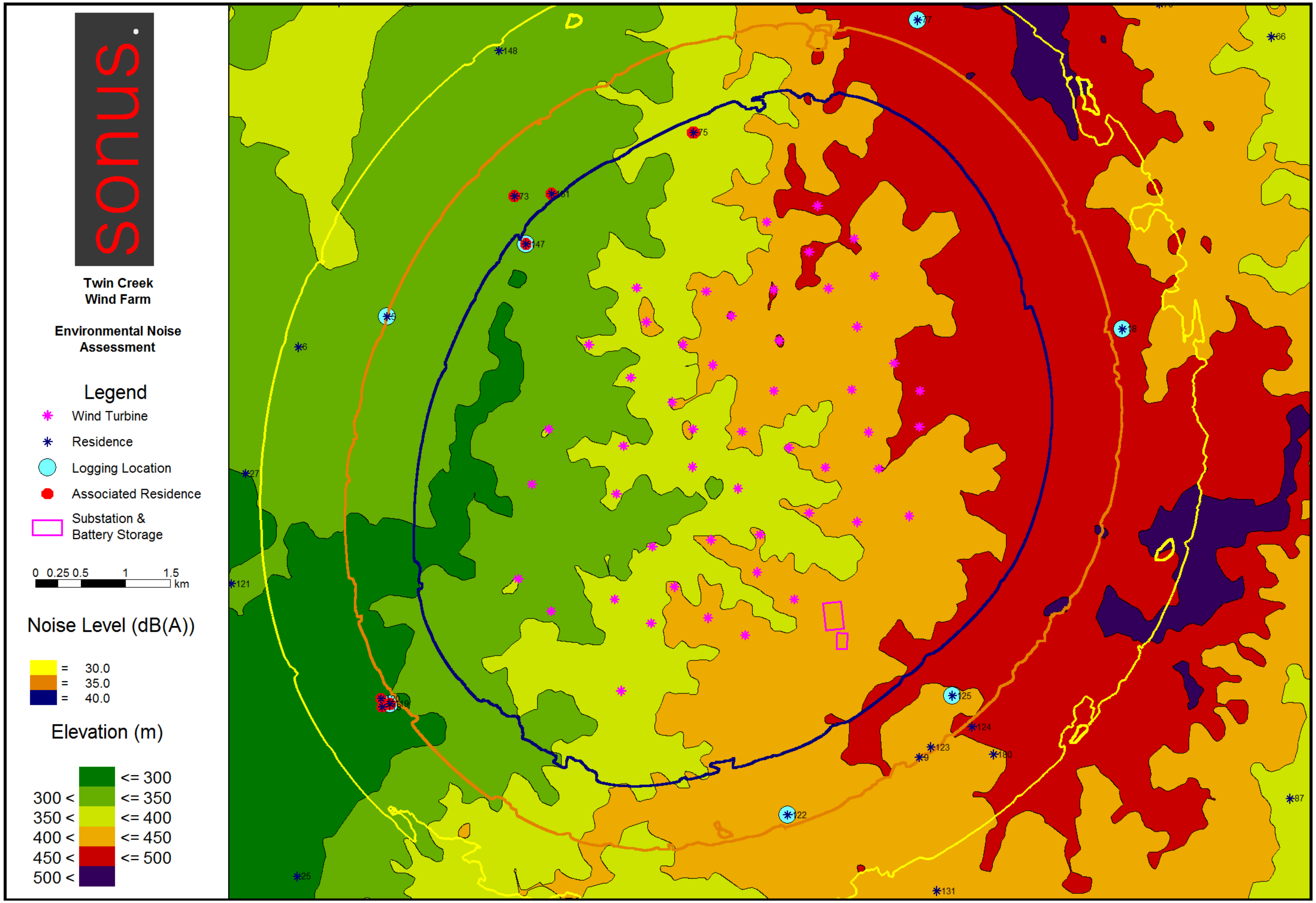
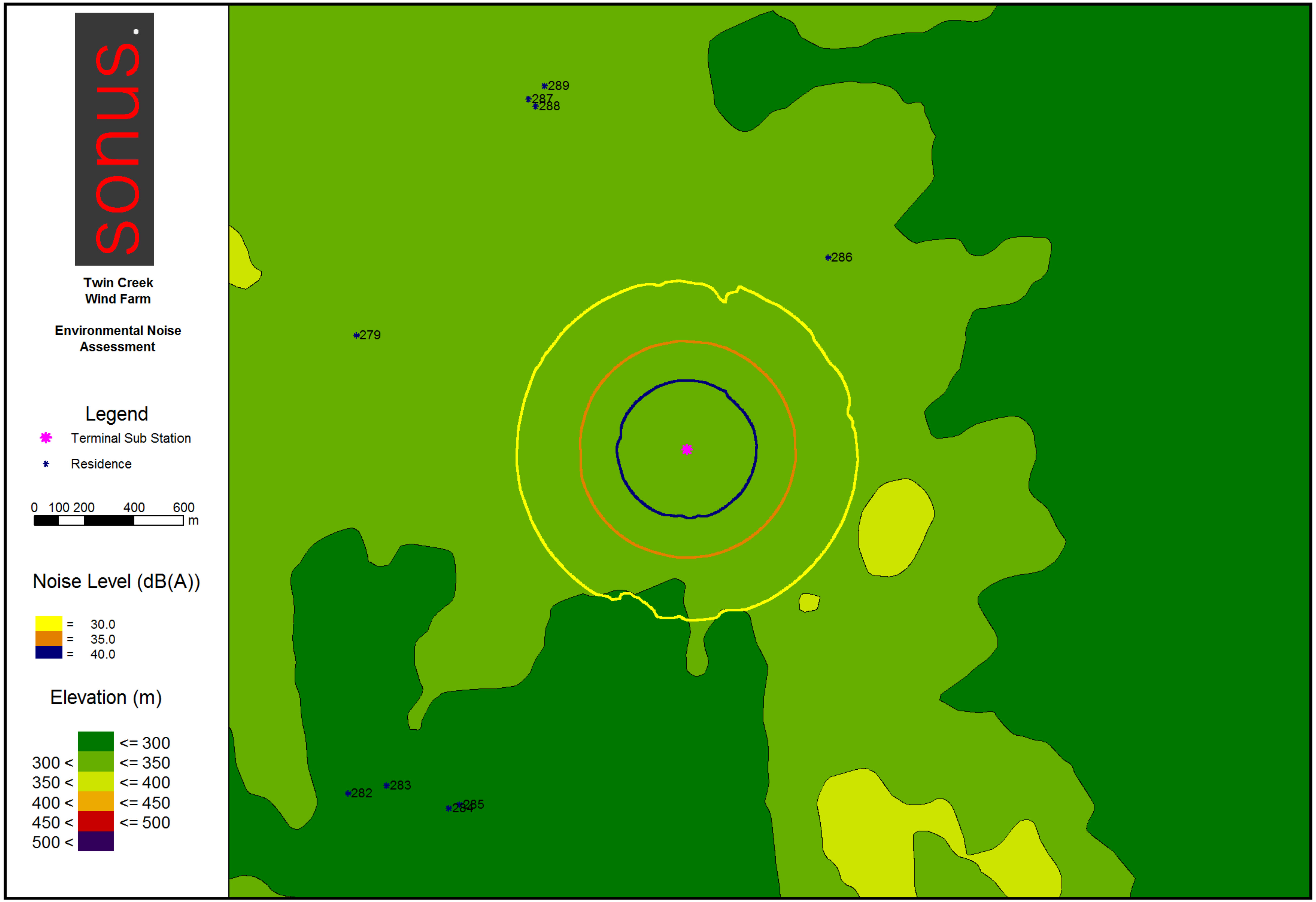
283	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
284	NO	40	40	40	40	40	40	40	40	40	40
285	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
286	NO	40	40	40	40	40	40	40	40	40	40
287	NO	40	40	40	40	40	40	40	40	40	40
288	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
289	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

APPENDIX G: PREDICTED NOISE LEVEL CONTOURS




sonus.
Twin Creek Wind Farm
Environmental Noise Assessment
Legend
Terminal Sub Station
Residence
0 100 200 400 600 m
Noise Level (dB(A))
= 30.0
= 35.0
= 40.0
Elevation (m)
<= 300
300 < <= 350
350 < <= 400
400 < <= 450
450 < <= 500
500 <
289
287
288
286
279
282
283
284
285

Desktop Cultural Heritage Assessment

Twin Creek Windfarm

Desktop Cultural Heritage Assessment Twin Creek Windfarm

14 March 2017

Version 2

Prepared by EBS Heritage for RES Australia Pty Ltd

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EBS Heritage
3/119 Hayward Avenue
Torrensville, South Australia 5031
t: 08 7127 5607
http://www.ebsheritage.com.au
email: info@ebsheritage.com.au

GLOSSARY AND ABBREVIATION OF TERMS

Abbreviation	
AHA	South Australian *Aboriginal Heritage Act* 1988
DEWNR	Department of Environment, Water and Natural resources
DSD AAR	Department of Premier and Cabinet, Aboriginal Affairs and Reconciliation
EBS	Environmental, Biodiversity Services Pty Ltd.
EPBC Act	*Commonwealth Environment Protection and Biodiversity Conservation Act 1999*
NTA	*Native Title Act 1993 (Commonwealth)*
RES	RES Australian Pty Ltd
SAM	South Australian Museum

EXECUTIVE SUMMARY

EBS Heritage was engaged by RES Australia Pty Ltd (RES) to undertake a desktop cultural heritage assessment for the proposed Twin Creek Wind Farm, located approximately 10 km north east of Kapunda in South Australia.

This report contains the results of a detailed cultural heritage desktop assessment for the project area, and includes, the results of searches of the relevant heritage databases, an outline of relevant heritage legislation and a review of background information relating to the occupation and use of the study area. It further documents previous archaeological research relevant to the study area, identifies the relevant Traditional Owner representative body, considers the relationship between study area landforms and Aboriginal sites and provides recommendations relating to cultural heritage management within the study area in light of this research.

This desktop study has highlighted the potential for archaeological surface and subsurface features to be present throughout the project area in undisturbed areas. Intact subsurface deposits may also be present below the plough zone in heavily farmed areas, with this potential increasing closer to water sources. This general conclusion could be made more specific following a field inspection.

In light of this study:

- EBS Heritage recommends a risk management strategy that includes a site discovery procedure (Appendix 1) for all earthworks into undisturbed sediments, as well as a site induction to ensure all project staff are aware of the risks and have idea of how to identify Aboriginal cultural materials.
- Although not required under the South Australian *Aboriginal Heritage Act 1988* (AHA), RES may wish to engage a qualified archaeologist and/or the Ngadjuri Nation Aboriginal Corporation to monitor earthworks into undisturbed sediments as a means of mitigating the risk of site disturbance and breaching the AHA.
- The South Australian Aboriginal Heritage Act (1988) states that works must not "damage, disturb or interfere" with an item, object site of Aboriginal Heritage. To this end, RES may want to consider conducting an archaeological field survey as a means of mitigating the risk of breaching the AHA. A field survey will identify any surface heritage sites present for avoidance during development and better inform an assessment of areas with potential sub surface deposits.

EBS Heritage understands that RES has chosen to engage with Ngadjuri and this work is currently underway.

Table of Contents

ebs heritage

List of Maps

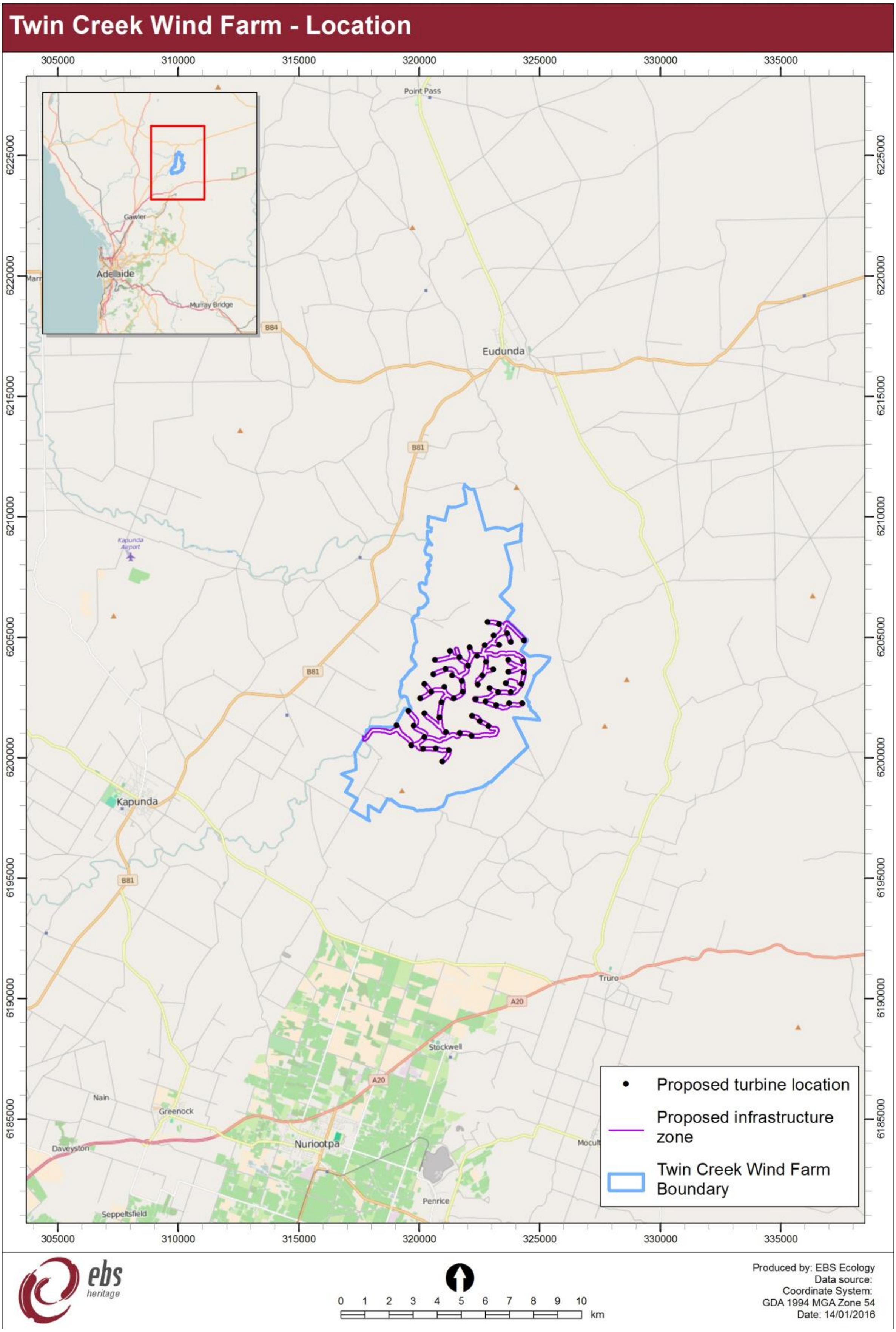
1 INTRODUCTION

EBS Heritage was engaged by RES Australia Pty Ltd (RES) to undertake a desktop cultural heritage assessment for the proposed Twin Creek Wind Farm, located approximately 10 km north east of Kapunda in South Australia (Map 1).

This report contains the results of a detailed cultural heritage desktop assessment for the project area, and includes, the results of searches of the relevant heritage databases, an outline of relevant heritage legislation and a review of background information relating to the occupation and use of the study area. It further documents previous archaeological research relevant to the study area, identifies the relevant Traditional Owner representative body, considers the relationship between study area landforms and Aboriginal sites and provides recommendations relating to cultural heritage management within the study area in light of this research.

1.1 Objectives

- Conduct background research including a review of the relevant heritage registers and the South Australian Museum Database
- Identify State and Commonwealth legislative requirements pertinent to heritage in the current project area
- Review previous relevant archaeological research for the wider area
- Provide background information on the relevant Traditional Owner group
- Provide contact details for engaging the relevant Traditional Owner group
- Review the relationship between environmental landforms and Aboriginal heritage sites within the study area
- Provide recommendations relating to cultural heritage management for the study area in light of relevant heritage legislation



Map 1. Location of Twin Creek Wind Farm Project Area

2 PROJECT DESCRIPTION

The Twin Creek Wind Farm will be located on farming land used primarily for livestock grazing and cultivating canola. The preliminary layout of the wind farm includes approximately 51 wind turbine locations and associated wind farm infrastructure. The total maximum capacity is expected to be approximately 175 mW.

Wind farm infrastructure will include site access roads, foundations and crane hard standing areas, transformer housings at each turbine location, a site substation, control room, monitoring masts and temporary construction compounds. Underground electrical cables will link each turbine with cables planned to be located adjacent to the site access road. The wind farm will be connected to the high voltage electrical network by overhead lines.

Turbine foundations will be subsurface and soil will be returned to the tower base upon completion. Civil works including road verges and the areas surrounding turbines will generally be revegetated upon completion.

Temporary infrastructure will be required during the construction phase, including quarries, batching plants, water sources for concrete, spoil heap locations, equipment lay down areas, site compounds and temporary facilities for the workforce etc. (RES request for proposal 2014).

The wind farm has been designed following technical investigations and community consultation. The turbines are generally located along the ridgelines.

3 IDENTIFICATION OF KEY STAKEHOLDERS

The South Australian Department of State Development, Aboriginal Affairs and Reconciliation (DSD-AAR) have informed EBS that consultation with the Ngadjuri people is administered through the Ngadjuri Nation Aboriginal Corporation. Contact with the corporation is through:

Chairperson:	Quenten Agius
Address:	46 Maitland Road, Point Pearce, SA 5573
Mobile:	0429 367 121
Email:	Traditionalowners@adjahdura.com.au

4 COMPLIANCE AND LEGISLATIVE SUMMARY

4.1 Aboriginal Heritage Act 1988 (SA)

The South Australian *Aboriginal Heritage Act 1988* (AHA) is administered by DSD-AAR. This legislation outlines that any Aboriginal site, object or remains whether previously recorded or not, are covered by the AHA. The Act provides the following definition of an Aboriginal site in section 3.

> *"Aboriginal Site" means an area of land;*
>
> *That is of significance according to Aboriginal tradition;*
>
> *That is of significance according to Aboriginal archaeology, anthropology or history.*

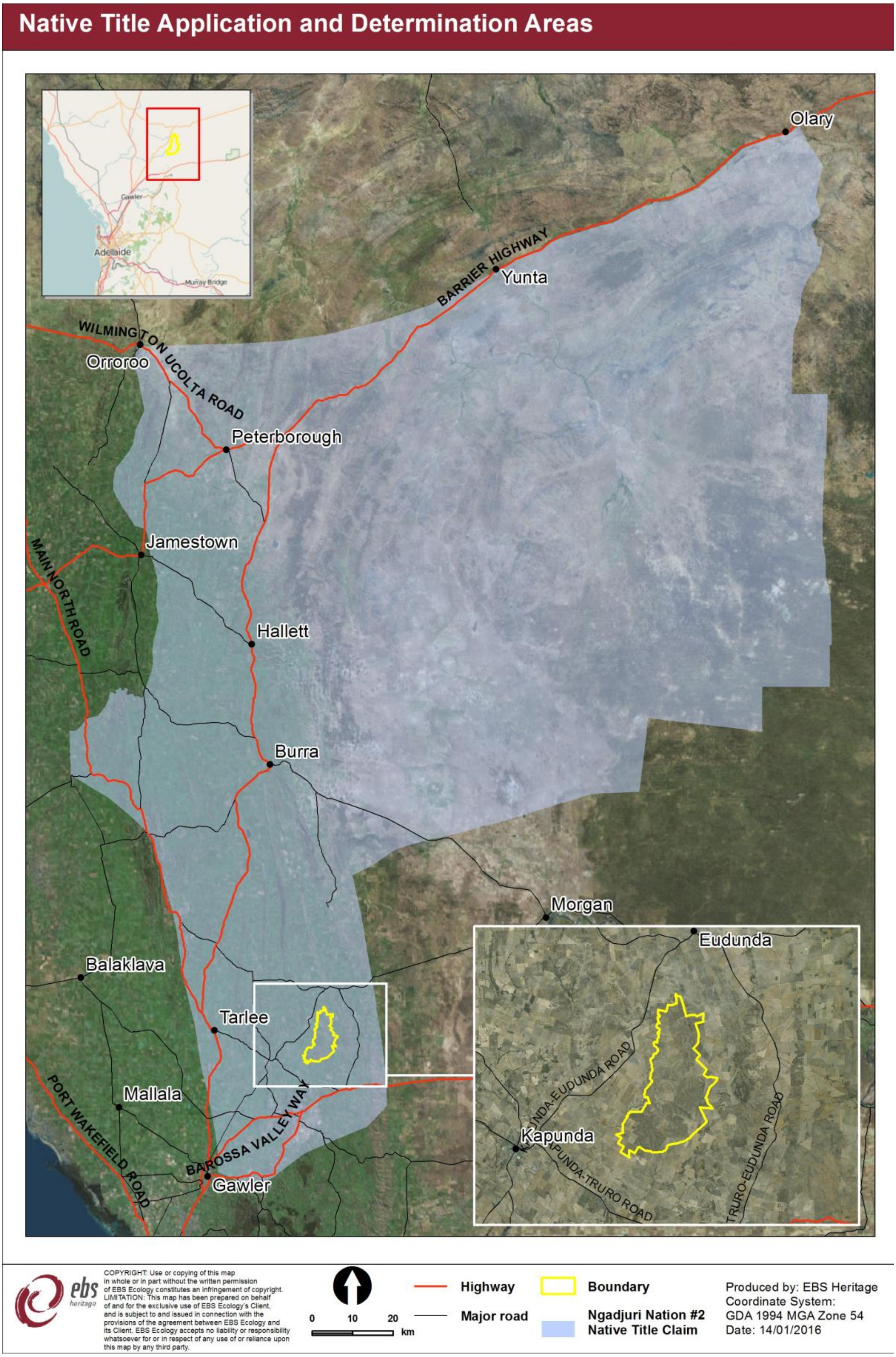
The AHA states that it is an offence under section 23 (s.23) to 'damage, disturb or interfere' with an Aboriginal site, object or remains unless written authorisation is obtained from the Minister for Aboriginal Affairs and Reconciliation. Penalties for an offence under s.23 are up to $10,000 or six months' imprisonment for an individual or $50,000 in the case of a corporate body.

It is also an offence under s.35 of the Act to divulge information relating to an Aboriginal site, object, remains or Aboriginal tradition without authorisation from the relevant Aboriginal group or groups. Penalties for an offence under this section are up to $10,000 or six months imprisonment.

4.2 Native Title Act 1993 (Commonwealth)

The *Commonwealth Native Title Act 1993* (NTA) is part of the Commonwealth's response to the High Court's decision in *Mabo* v *Queensland* (No.2) and adopts the common law definition of Native Title which is defined as the rights and interests that are possessed under the traditional laws and customs of Aboriginal people in lands and waters.

The NTA recognises the existence of Indigenous land ownership tradition where connections to country have been maintained and where acts of government have not extinguished this connection. The current project area is within the Ngadjuri Nation #2 Native Title Claim (SC2011/002 see Map 2) and under the NTA, consultation should occur between the client and claimant representatives if any land subject to Native Title is to be affected.



Map 2. Ngadjuri Nation #2 Native Title Claim Area in Relation to the Project Area

4.3 Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth)

The *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act* 1984 provides a mechanism for the Commonwealth Minister for Environment to make declarations regarding the protection of an Aboriginal area when the Minister is not satisfied that under State or Territory Law there is effective protection of the area from a threat of injury or desecration. Declarations made under this Act involve restricting activities and/or access to an Aboriginal site.

Under section 21H of the *Aboriginal and Torres Strait Islander Protection Act 1984* it is an offence to conduct behaviour or partake in an action that contravenes a declaration made by the Minister. Penalties under this section are $10,000 or imprisonment for 5 years, or both for an individual, or $50,000 for a corporate body where an Aboriginal place is concerned and $5,000 and imprisonment for 2 years or both for an individual, or $25,000 for a corporate body where an Aboriginal object is concerned.

If the requirements of the South Australian *AHA* are adhered to and sufficiently protect any Aboriginal heritage in the eyes of the Federal Minister, the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* will not be relevant within the project area.

4.4 Environment Protection & Biodiversity Conservation Act 1999 (amended 2003)

The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) protects places of national cultural and environmental significance from damage and interference by establishing a National Heritage list (for places outside of Commonwealth land) and a Commonwealth Heritage List (for places within Commonwealth land). Under the EPBC Act any action that has, will have, or is likely to have a significant impact on a place of national cultural and/or environmental significance must be referred to the Minister for the Environment for approval. The EPBC Act sets out a procedure for obtaining approval, which may include the need to prepare an environmental impact statement for the proposed action (an action is defined in section 523 to include a project, development or undertaking or an activity or series of activities).

The EPBC Act is only relevant in relation to Aboriginal heritage sites if the site is entered onto the National Heritage List or the Register of the National Estate. If not, there is no current referral process required to the Commonwealth Department for Environment under the EPBC Act and this Act has little relevance for an Aboriginal site that may be in the project area.

4.5 Heritage Places Act 1993 (SA)

The *Heritage Places Act* 1993 makes provision for the identification, recording and conservation of places and objects of non-Aboriginal heritage significance in South Australia. A State Heritage Place is entered in the SA Heritage Register or contained within an area established as a State Heritage Area. Once registered, State Heritage Places are protected under the *Heritage Places Act* 1993 and the *Development Act* 1993.

The *Heritage Places Act 1993* is governed by the Department of Environment, Water and Natural Resources (DEWNR) and the South Australian Heritage Council.

A person must not without a permit from the Council, disturb a State Heritage Place of archaeological significance; or excavate anywhere else, for the purpose of searching or recovering artefacts of heritage significance, or with the knowledge that excavation will likely result in an archaeological artefact of heritage significance being discovered, exposed, moved, damaged or destroyed. This carries a maximum penalty of $75000.

4.6 Development Act 1993 (SA)

The *Development Act 1993* enables local councils to identify and list places of local heritage value. A place or object may be considered to have local heritage value if it meets one or more of the following criteria:

- Demonstrates important aspects of the evolution or pattern of the State's history
- It has rare, uncommon or endangered qualities that are of cultural significance
- It may yield information that will contribute to an understanding of the State's history, including its natural history
- It is an outstanding representative of a particular class of places of cultural significance
- It demonstrates a high degree of creative, aesthetic or technical accomplishment or is an outstanding representative of particular construction techniques or design characteristics
- It has strong cultural or spiritual associations for the community or a group within it
- It has special association with the life or work of a person or organisation or an event of historical importance.

A development proposal for a state listed heritage place is referred to the Minister responsible for the Heritage Places Act for consideration and must be approved under the *Development Act 1993* if it directly affects a state heritage place or area, or affects the context of the place or area, including adjacent or nearby sites.

5 HERITAGE REGISTER SEARCHES

5.1 DSD-AAR Register Search

The Central Archive is maintained by DSD-AAR and includes the Register of Aboriginal Sites and Objects. The Central Archive is a record of previously recorded heritage sites in South Australia and facilitates the identification of known sites within a project development area. The Central Archive is not an exhaustive list of heritage sites in a specific area, it contains only sites that have been reported and/or registered.

A search of the AAR Register was carried out for known Aboriginal sites located in, and within a 1 km radius of, the project area and it revealed that there are no entries held for the search area.

5.2 SA Museums Database

The South Australian Museum (SAM) database is an inventory of Aboriginal cultural material and skeletal remains held by SAM. A search of the database for entries relating to the project area was carried out using the following key words: Kapunda, Koonunga, Freeling, Noorootpa, Daveyston and Tarlee.

The search revealed one record for skeletal material that has been found in the general region of the project area (Table 1).

Table 1. SAM Database Search Results

Museum Registry Number	Description	Location
A38544	Skull, no Jaw, bones	Freeling

The result of this search indicates that there is potential for undisturbed soil deposits within the project area to contain buried cultural material. However, the single search result would suggest that this potential is low. This being said, it should be noted that the SAM database only contains entries for cultural remains that have been presented to the SAM. It is conceivable that unearthed Aboriginal remains weren't always reported to the SAM during the 20th Century, in which case the single record may not be indicative of a dearth of subsurface cultural remains. Rather, it may be indicative of trepidation toward reporting such finds, or a general ignorance toward the process of reporting. It may also be that minimal earthworks have been carried out in the area.

Taking all this into account, EBS Heritage considers there is a low potential for earthworks to uncover Aboriginal cultural remains within the project area. Although the potential remains low, it increases in the vicinity of water bodies due to a direct correlation between the density of archaeological sites and the presence of fresh water sources. The easy to excavate alluvial sediments found alongside water bodies were commonly targeted for Aboriginal burials (Butler et al 2012).

5.3 Australian Heritage Database

The Australian Heritage Database contains information about more than 20,000 natural, historic and Indigenous places.

- The database includes:
- places in the World Heritage List
- places in the National Heritage List
- places in the Commonwealth Heritage list
- places in the Register of the National Estate
- places in the List of Overseas Places of Historic Significance to Australia
- places under consideration, or that may have been considered for, any one of these lists (Department of the Environment n.d).

5.3.1 Australian Heritage Database Search results

A search of the Database revealed that there are no listed heritage places within the Twin Creek Wind Farm project area.

5.4 South Australian Heritage Register

The South Australian Heritage Register contains information about places of heritage significance in South Australia. It includes places and related objects of State significance and records other categories of heritage places in South Australia (including local, national and world heritage places) which are protected under legislation.

The Register is administered by the South Australian Heritage Council. The Council will provisionally enter a place that is deemed to be of State significance, and a decision based on the outcome of public consultation will either confirm or remove the entry.

There are over 2,280 confirmed State heritage places entered in the Register. In addition, 17 State heritage areas have been designated.

The *Heritage Places Act 1993* also requires that the Register includes:

- local heritage places designated by a development plan
- local heritage zones and policy areas designated by a development plan (ie Contributory local heritage)
- places within the State entered in any register of places of natural or historic significance kept under the law of the Commonwealth (i.e. the Commonwealth Heritage List, National Heritage List and declared World Heritage Properties)
- State heritage areas

- heritage agreements made under the *Heritage Places Act 1993* (Department of Environment, Water and Natural Resources 2014).

5.4.1 South Australian heritage Register Search Results

A search of the South Australian Heritage Register revealed that there are no listed places of State significance within the project area.

6 BACKGROUND RESEARCH

6.1 Aboriginal Occupation

Norman Tindale (1974) described the Ngadjuri as:

> ***Location***: *From Angaston to Freeling north to Clare, Crystal brook, Gladstone, Carrieton, and north of Waukaringa to Koonamore; east to Mannahill; in Orroroo, Peterborough, Burra, and Robertstown districts; inhabitants of the gum forest areas. In the period just before the arrival of white people, they were making movements towards the Murray River near Morgan in aggressive attempts to impose the rite of circumcision on the river people. Miranda was a leading male until his death in 1849. The Mimbra horde remained living in the northern bushlands until 1905, the last "wild" group in South Australia. In their last years these people lived near Quorn, at Riverton, and on Willochra Creek. The term Aluri also spelled variously as Hilleri, Yilrea, Eeleeree, etc., is a general term used for several tribes here and on the west coast of South Australia.*
>
> ***Coordinates***: *139°0'E x 33°5'S*
>
> ***Area:*** *11,500 sq. M. (29,900 sq. km).*
>
> ***Alternatives:*** *Ngadluri, Ngaluri, Aluria, Alury, Eeleeree, Hilleri, Yirrea, Wiramaju ([wira] = gum tree [meju] = men, lit. Gum forest men), Wirrameyu, Wirramayo, Wirramaya, Wiramaya, Wirra, Weera, Eura (general term for several tribes), Manuri (Nganguruku tribe term, means "big goanna people") Manuri (Nukunu term claimed to mean inland people), Manu, Monnoo, Manuley, Youngye, (name on the language), Boanawari (term meaning "bat people", and linked with circumcision; applied by non circumcising eastern tribes who feared their proselytising urges), Doora, Burra Burra or Abercrombie Tribe (two names for one horde of this tribe), Mimbara (name of the northernmost horde)*
>
> ***References:*** *Angas, 1847; Noble in Taplin, 1879; LeBrun in Curr, 1886; Valentine in Curr, 1886; East, 1889; Matthews, 1900 (Gr. 5626, 6448), Hossfeld, 1926; Gray, 1930; Elkin, 1931; Tindale, 1937, 1940, 1952, and 1964 MSS, Berndt and Vogelsang, 1941; Tindale and Lindsey, 1963; Bernt 1965; R.D.J. Weathersbee, 1971.*

Barney Waria, a Ngadjuri man who spoke to anthropologists in the 1940s, told Berndt that the Ngadjuri land extended from Angaston and Gawler in the south to Panaramittee and Yunta in the north. The Ngadjuri interacted closely with the people from the north, called Jadliaura and Wailpi by Tindale, but known as the Adnyamathanha or 'stone people' by the Ngadjuri (Warrior et al 2005).

The Ngadjuri also had contact with the Nukunu to their west, the Kaurna from the Adelaide plains to the south, the Narungga of Yorke Peninsula, the Wilyakali and Danggali 'salt bush' people to their east and Ngaiawang, a River Murray group to the south east (Warrior et al 2005).

The Ngadjuri fished with the Nukunu, Kaurna and Narungga, which suggests that good relations existed between these groups. However, relations to the east were not always friendly and the Ngadjuri were said to have sent sorcerers or 'clever men' there and made occasional raids on the Murray River people (Berndt et al 1964); and as Tindale (1974) mentions above, they made aggressive attempts to impose the rite of circumcision on the river people. All this aside, the Ngadjuri and the Murray River people shared some similar beliefs and practices (Warrior et al 2005).

There are limited publications available relating to specific Ngadjuri ethno-history and this may be due in part to European interaction. Ngadjuri informant, Barney Waria addressed the reduction of Ngadjuri numbers following European settlement of the region, explaining that those remaining had either been scattered across the country, were living in the townships or had joined the Adnyamathanha (Warrior et al 2005). Tindale (1937) further reinforces the absence of published material about the Ngadjuri when he noted that it was probable that less has been written about this tribe than any other in South Australia. Regardless, some cultural information is available for consideration.

The Ngadjuri are known to have lived a rich ceremonial life with some ceremonies lasting over a week (Gray 1930). In preparation for such events, the Ngadjuri greased their hair and painted themselves with white and red colours, tied leaves and feathers around the waist and around the head (Mawson and Hossfeld 1926). The women beat sticks on tightly rolled possum skins to make music for the dancing (Noye 1974). Artist George Angas and colonial observer William Cawthorne witnessed the Ngadjuri perform the Kuri dance a number of times when the annual meeting of different groups took place around Adelaide and described it as very dramatic and the most exciting they had witnessed (Tindale and Lindsay 1963).

The structure of Ngadjuri social organisation was similar to the Adnyamathanha to the north, involving matrilineal moieties and matrilineal social totemic clans (Elkin 1940:372). These required complex laws to be followed regarding marriage that related to the women of the group. The Ngadjuri followed a system where descent was counted through the mother's father and the father's father; and a system of cross-cousin marriage whereby daughters of uncles and aunts could be eligible wives. There were exceptions to this system that were controlled by complicated rules relating to the marriage participants (Elkin 1940: 428-430).

Ngadjuri people had their own system of laws and punishments. Tindale (1932) recorded an incident witnessed by Mrs A Moyle in 1847:

> *Mrs. A. Moyle, who arrived in South Australia as a child in 1847 relates the following incident regarding the Wirra Natives. A woman was stolen from the Burraburra natives by a Kapunda man, one of a party who often made their camp at Allandale. The Burra natives therefore came down to Kapunda in force. A group of fully armed men from both camps stood and watched a set combat between the two principals. At first songs were sung and there was much shouting. The two men, both old then came out of the crowd each armed with a spear, spear thrower and shield. The Burra man first pierced the Kapunda man through the left arm; his opponent thereupon retaliated with a blow that pierced him through the heart. His body was placed on a bier and was carried back to the Burra, accompanied by a group of wailing mourners. In 1850 the natives in the district around Kapunda were still wild. They camped near the local dam (as it is now).*
>
> Tindale 1932

Mountford (1940) provided insight into Ngadjuri burial customs when he documented the following:

> *When a person dies, as soon as the body is cold, they are smoke dried for a few days in a seated position. Their body may then be subjected to an inquest, in case death had been caused by magic. It is not known whether this applies to women and men, or to men only. The body is placed on a framework of sticks and carried around the camp and surrounding country on the heads of four male relatives, usually the father's brothers and mother's brothers. A number of ritual steps are then followed which lead to a verdict. If the dead man has been found to have been 'boned' for no good reason, the accused's moiety is ordered a punishment. If the murder has occurred out of retaliation for a similar offence to the accused's moiety, then no punishment is enforced. Soon after the inquest (possibly the next day) the body is straightened out and buried in a grave about two metres deep and covered over with earth almost to the top. The dead man's brother visits the grave every evening at sunset and lights a small fire at the grave.*
>
> Mountford 1940

According to Barney Waria, when you look at these fires you can see the image of the living man and his dead brother. After about a week of fire lighting, the brother then informs the people that the spirit – *wangjipi* – is going away. The *wangjipi* goes to a place called *Kintjura*, somewhere in the west for a few days and then returns to the body in the ground, particularly when relatives are nearby. The grave is then filled in and logs are placed lengthwise over it. The ground surface around the grave is then swept clean, after which everyone leaves the location for approximately 12 months (Warrior et al 2005:61).

6.2 European Land Use

The formal occupation of the South Australian mainland by Europeans began with the foundation of Adelaide and the proclamation of South Australia in 1836. A period of land exploration followed, driven by the colonial administration's desire to learn more about the interior. In 1839, Edward John Eyre travelled north from Adelaide along the east coast Spencer Gulf to Mount Arden. He noted his encounters with Aboriginal people along the way. In one of his journal entries he noted:

> *.....some natives in the vicinity.....at other times, when riding with only a native boy over the plains of the interior I have seen the blue smoke of the native fires..... and have come suddenly upon a party encamped in the hollow.*
>
> Eyre 1839

Eyre's party were the first Europeans to set foot in the Upper North region and his expedition was the precursor to many more, including another journey north by Eyre in 1840 commissioned by a syndicate of hopeful pastoralists in search of grazing land. This time he took a more inland route through the ranges (Bell 1998:6).

Deputy Surveyor-General Thomas Burr was probably the most influential European to encourage pastoralists to move north. He wrote that the country around Mount Remarkable was well wooded and watered and the grass was as luxuriant as seen in any part of the province. It was after his visit in 1842 that sheep grazing commenced in the region, assisted by a relaxation of government land administration (Bell 1998:7).

The spread of settlement in South Australia mostly moved outward from Adelaide behind a frontier comprised of a surprisingly orderly line. And although grazing didn't commence until after 1842, by 1839 Anlaby Station, located just northwest of the project area on the Light River had been taken up (Bell 1998:8).

Mining also played a part in encouraging development and the migration of European workers northward. The town of Kapunda, located close by to the south west of the project area, became Australia's first copper mining town in 1842. Mining dominated the town for more than 30 years until 1877 when the mine closed, at which point the town became the centre for a thriving pastoral industry (URPS:2008).

European settlement brought conflict and disease. Although the Ngadjuri population was decimated by two small pox epidemics before South Australia was officially established as a colony. It is believed that the disease travelled westwards from New South Wales soon after 1800 and again around 1820, along the densely populated river systems, including the River Murray (Curr 1886-7). Diseases may have also been spread by the sealers, who were operating out of Kangaroo Island from the early 1800s, when they raided the mainland around Rapid Bay and Second Valley for women (Warrior 2005:73).

Conflict began when the Aboriginal people realised their laws were being ignored and their lives were under threat and resistance began with a form of guerrilla warfare. Sheep and cattle were taken, fences and survey markers destroyed, homesteads attacked and bushfires lit which frightened animals and settlers (Warrior 2005:77). As early as 1840, a group of roughly 200 Aboriginals attacked a survey camp approximately 30 km north of Adelaide (The Register 1840).

European settlement was followed by an obvious period of adjustment that certainly involved conflict between the newcomers and Aboriginal people, however there were also examples of good relations such as the provision of rations to Aboriginal people and the employment of Aboriginal workers on pastoral runs, whose knowledge of the country made the early period of European pastoral settlement possible (Bell 1998).

New legislation, loosely known as the Strangways Act, since its implementation in 1869, was part of a worldwide movement to break up grazing lands and make them available to small farmers. The resulting influx of wheat farmers was the most significant event in the European settlement of the Upper North and one of the most dramatic population migrations in South Australian history (Bell 1998).

In the twentieth century, European occupation of traditional Ngadjuri lands has been characterised by consolidation and orderly retreat, with traditional industries having concentrated on efficiency to cope with new economic circumstances. Towns have downsized and traditional farming practices that made the northern areas a success in the nineteenth century have made way for highly mechanised technological innovations (Bell 1998).

6.3 Previous Archaeological Research

Lower (2009) investigated the breakdown of Ngadjuri heritage reports held by AARD. She found that 75% were heritage reports driven by development, 11% were heritage reports not driven by development, 8% related to academic rock art research by Margaret Nobbs, 3% were theses and 3% community driven projects.

As the above data illustrates, the majority of archaeological research carried out in Ngadjuri country can be attributed to Margaret Nobbs (1984, 1991, 1993; Nobbs & Dorn 1988). Her main focus was on the rock art of the Olary district a significant distance to the northeast of the project area.

The following studies have been carried out closer to the project area and provide an overview of site types located within the region.

6.3.1 Lower 2009

Lower (2009) carried out a community based project with the Ngadjuri for her Masters research. Her research involved the creation of a GIS database for the community, which included spatial data for previously recorded archaeological sites and surveyed areas on their traditional lands. This data was then applied to a landscape archaeological analysis of the region (Lower 2009). The relationship between site location and various environmental features, such as water sources and ground slope, were investigated and the findings can assist with predictive modelling. Lower (2009) used a data set of 265 sites in her analysis, comprised of 12 site types found in Ngadjuri country including, open sites, rock engravings, isolated stone artefacts, rock holes, hunting hides, quarries, rock paintings, burials, cairns, a habitation site with whirlies, a scarred tree and a significant tree.

6.3.2 Gara & Turner 1982

In 1982, Gara and Turner conducted an archaeological survey for a section of 275 kV transmission line route between Tungkillo and Eudunda, for the Electricity Trust of South Australia. During the course of the survey, three Aboriginal sites were located within the proposed easement and two more were located outside. Archaeological features within these sites consisted of stone arrangements, culturally modified trees, engravings, paintings, rockshelters and stone artefacts.

6.3.3 Hossfeld 1926

In 1926, Hossfeld was engaged in a geological survey of the Eden Valley and Angaston districts. Investigations resulted in the discovery of a number of Aboriginal campsites, several caves containing rock art, a burial ground and the collection of ethnographic data from old local residents.

6.3.4 Chilman 1990

In 1990, Chilman conducted an Aboriginal heritage survey in the Barossa Valley for the Aboriginal Heritage Branch of the South Australian Department of Environment and Planning. The brief for this pilot study was to collect information relating to the Aboriginal occupation of the Barossa Valley and produce a report for the Heritage Commission detailing the results of the project and outlining a proposal for a major survey of the Aboriginal heritage of the area. Chilman concluded within the constraints of the small pilot study that sufficient information was available to make conducting a major anthropological, historical and archaeological study of the area feasible, and that such a study was much needed.

6.3.5 Coles 1991

In 1991, Coles carried out an Aboriginal heritage survey of archaeological sites in the Barossa Valley. Among the sites recorded or examined were a painting site, culturally modified trees, and campsites with hearths and flaked stone artefacts. A series of interviews with residents of Moorooroo, Moculta and Truro were also reported on.

6.4 Discussion

This overview of previous archaeological research in the Twin Creeks Wind Farm region highlights Aboriginal site types that are characteristic of the region including, culturally modified trees, stone arrangements, burials, rock holes, quarries, hunting hides, rock art sites including both paintings and engravings, rockshelters and campsites with the refuse of past cultural activities, such as hearths, whirlies and flaked stone artefacts.

7 ENVIRONMENTAL LANDFORMS AND HERITAGE SITES

7.1 General Principles of Association

Any parcel of land, whether developed or not, has the potential to contain cultural heritage sites. Aboriginal heritage sites are the physical remains of past cultural activity and use of environmental resources. They also relate to spiritual beliefs and ceremonial activities.

There are some generally accepted principles of association between environmental landforms and Aboriginal sites. The most recognised of these is the correlation between Aboriginal archaeological sites and water courses. Generally, the more permanent and reliable a water source is the more complex and dense are the associated archaeological features, reflecting more permanent and repeated occupation at the source (McDonald 1997). Water sources also hold ethnographic significance and feature in various creation and ancestor mythologies (Tindale 1987).

Based on this, the Aboriginal site types known as common to the region (rockshelters, painting & engraving sites, camp sites, hunting hides, culturally modified trees etc.) could be expected to be more prevalent with a greater density of intra-site components in the vicinity of more permanent water sources.

As Lower (2009) states, access to water sources would have been an important consideration in the semi arid and arid region of the Ngadjuri traditional lands. Her research found that the majority of known sites in Ngadjuri country are surprisingly situated a considerable distance from a major water source, but generally less than 500 m from an intermittent water source. She felt this suggested a seasonal use of some parts of the landscape, or that the significant distances from major water sources could be indicative of an intimate knowledge of the environment and diversity of economic and settlement strategies (Lower 2009:68). It may also be worth considering that major water sources were also desirable settlement locations for European graziers and pastoralists and the well watered country was the first to be taken up (Bell 1998:8). The intensity of activity that followed at such locations would have impacted upon any Aboriginal sites present, likely resulting in a dearth of known sites at such locations today. Furthermore, the phenomenon of recorded sites being mainly located near intermittent water sources may be explained to some degree by the prized, tightly held and well watered locations having not been subjected to the development driven archaeological surveys that the less desirable and less watered areas have.

Lower (2009) found some correlations between site types and environmental landforms within Ngadjuri country:

- Environmental data was available for 87% of open sites. Of these sites, 57% of open sites were located on the plains and 28% were located on hill slopes, or rock outcrops on the plains.
- Environmental data was available for 61% of rock engraving sites. Of these, 57% are located on low plain/rises with quartz outcrops, while 20% are located on footslopes and 14% are situated near a creek or drainage channel.

- Environmental data was available for 64% of documented rock painting sites. However, no obvious pattern was evident with equal distribution across the plains, hill slopes/rock outcrops on plains and hill footslopes.
- Of the remaining site types, environmental data was available for 100% of quarry sites, 82% of rock holes and 75% of hunting hides. Sixty four percent of quarries and 86% of rock holes are located on hill slopes/rock outcrops on plains. Hunting hides have been documented on the plains (50%) and hill slopes/rock outcrops upon plains (50%).

Lower (2009) also investigated the dominant vegetation types at Aboriginal site locations. She learnt that rock engravings are almost exclusively located in chenopod shrub lands, whereas open sites, although mostly recorded in chenopod shrub lands, have also been regularly located in acacia woodlands. Rock paintings and water holes have been recorded predominantly in acacia woodlands, while hunting hides have been documented equally in chenopod shrub lands and acacia woodlands (Lower 2009:74-75).

Obviously farming has resulted in the clearing of vast amounts of native vegetation within Ngadjuri country. It is worth noting that areas with remnant native vegetation and areas with limited disturbance from farming and mining etc. have the potential to contain surface archaeological features. This aside, considering that most disturbances caused by pastoral and grazing occurs within the plough zone, in disturbed areas there is potential for intact subsurface archaeological deposits to be present below this zone, with this potential increasing closer to fresh water sources.

The above principles of association can be applied to the study area to predict where Aboriginal sites may be located. It is not possible to gain an in depth understanding of the environmental landforms in the study area without inspecting the area. What is known is that the current project area appears to encompass elevated hills and ridgelines interspersed with drainage channels and a notable water course, The Light River, running north-south on the eastern side of the study area. It is unclear whether rock outcrops suitable for engravings or painting exist in the area, or whether any stands of remnant vegetation remain. When reviewing what is known in light of the principles of association above, there is potential for Aboriginal archaeological surface sites to be located throughout the entire study area in undisturbed areas. This includes the ridgelines, even though Lower (2009) mentions that none of the AAR Register sites are located on top of ridgelines within Ngadjuri country, several surface artefact sites have been previously located on elevated ridgelines during the archaeological survey carried out for the Barn Hill Wind Farm (Mullen 2009). It was evident in the field at the time that these sites were preserved because the ground disturbing pastoral activities had stopped short of the ridgelines. The elevated position would have also offered a panoramic view of the surrounding countryside to the inhabitants.

Given the long history of grazing and pastoral activity in the region, it is feasible that European heritage sites of significance exist within the study area and are not listed in the South Australian Heritage Register. European heritage sites can include standing structures such as buildings, fences, walls or generally objects associated with settlement and exploration. European sites are not afforded the same blanket protection as Aboriginal sites and for significant examples to be protected under legislation, they would generally need to be identified by, or reported to, the South Australian Heritage Council and then assessed against the criteria outlined in the *Heritage Places Act 1993*. If this process deems the site to be of State significance it is then subject to a period of public consultation to decide if the provisional entry should be confirmed in the Register.

This assessment, in particular the consideration of Aboriginal heritage sites is based largely on Lower's (2009) study where she freely acknowledges the potential for bias in her data set due to the majority of archaeological work having been focused on the rock art in the Olary area. Also, as mentioned above, additional survey work outside of the Olary district is unlikely to have occurred in the prized and well-watered parts of Ngadjuri country as these will be tightly held by farmers. This may have impacted Lower's (2009) finding that known archaeological sites are located a considerable distance from major water sources. Based on this, the above assessment should only be viewed as a general guide to potential landform/heritage site associations within the study area.

8 SUMMARY AND RECOMMENDATIONS

A review of background data and heritage database search results along with consideration of the relationship between environmental landforms and Aboriginal sites within the study area has resulted in the finding that there is potential for archaeological surface and subsurface features to be present throughout the project area in undisturbed areas. Intact subsurface deposits may also be present below the plough zone in heavily farmed areas, with this potential increasing closer to water sources. This is a general conclusion that could become more focused following a field inspection.

8.1 Recommendations

In light of this study, EBS Heritage recommends a risk management strategy that includes as a minimum a site discovery procedure (Appendix 1) for all earthworks into undisturbed sediments, as well as a site induction to ensure all project staff are aware of the risks and have an idea of how to identify Aboriginal cultural materials.

Although not required under the *AHA*, RES may wish to engage a qualified archaeologist and/or the Ngadjuri Nation Aboriginal Corporation to monitor earthworks into undisturbed sediments as a means of mitigating the risk of site disturbance and breaching the AHA.

Alternatively, RES may want to consider conducting a cultural heritage field survey as a means of mitigating the risk of breaching the *Act*. A field survey will identify any surface heritage sites present for avoidance during development and better inform an assessment of areas with potential sub surface deposits.

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10APPENDIX 1

Discovery of Aboriginal Heritage Procedure

Have you found a site, object or skeletal remains that may be Aboriginal Heritage?

- See example pictures on next page.

STOP

All works in Vicinity of Site

- Do not disturb/remove/touch or displace the site, object or skeletal remains.
- It is an offence to disturb or interfere with Aboriginal heritage or skeletal remains.
- (*SA Aboriginal Heritage Act 1988*)
- Leaving objects in place – take photos and send to archaeologists

PROTECT

Restrict access. Site supervisor to take note of:

- Location in relation to site works (pref GPS).
- Identify any immediate threats to heritage e.g. construction activities, vandalism, water level.
- Name and contact details of the person who made the discovery.
- Do not proceed with any works (or move ot touch objects) until advice has been sought from site archaeologists

NOTIFY

Site Supervisor to immediately notify:

- Client Representative
- Archaeologists (EBS)
- Local Police or 131 444. If suspected human remains have been discovered.

MANAGE

The Environmental Team will appropriately manage the incident with appropriate guidance from:

- Local Police (where skeletal remains have been discovered).
- Aboriginal Affairs and Reconciliation .
- The local Aboriginal community.
- An Archaeologist /Cultural Heritage Advisor

RESUME

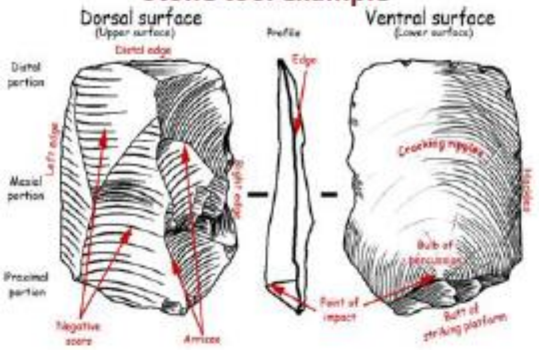
The Site Manager will advise contractors when work can resume.

- This decision will be made in consultation with the archaeologists

ebs heritage

For any site/item discoveries CALL:
EBS Office : 08 7127 5607

Stone tool example

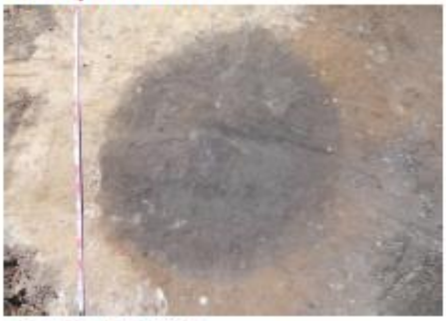


Stone Tool Example

Examples showing what an Aboriginal site may look like

Shells/Middens

Bones/Burials



Hearths/Burials

Stone Tools/Artefacts

EBS Heritage
3/119 Hayward Avenue
Torrensville, SA 5031
www.ebsheritage.com.au
t. 08 7127 5607
f. 08 8352 1222

Twin Creek Wind Farm

Bushfire Management Plan

June 2017

Disclaimer

Twin Creek Wind Farm Bushfire Management Plan has been produced by SA Bushfire Solutions.

Although every attempt has been made to ensure the contents of this assessment are as accurate as possible, it must be acknowledged that over time, changes in environmental conditions and government policy may affect the recommendations provided in this plan.

It should be noted that although reasonable steps have been taken to minimise this, SA Bushfire Solutions accepts no responsibility for any damages that may result from the implementation of recommendations from this assessment.

For clarification or further information, I invite you to contact:

Brett Stephens
Director
SA Bushfire Solutions
0427 604 253
bs_ps@outlook.com
www.sabushfiresolutions.com

Executive Summary

The plan focuses specifically to the construction and operation of the proposed Twin Creek Wind Farm, northern Mount Lofty Ranges, South Australia and defines objectives and recommendations to mitigate the threat that bushfires pose to life, property, the environment and the potential hindrance to suppression operations.

The plan makes recommendations that may support and guide management decisions to mitigate potential bushfire risks.

The evaluation of bushfire risk is extremely complex due to the range of factors that may influence potential outcomes. It is not feasible to undertake a risk assessment for every possible scenario when so many variables can affect the possible likelihood and consequence.

Bushfire suppression is also a complex activity that requires involvement from a wide range of stakeholders and it is important to note that no single approach, strategy or technique is instrumental in the mitigation of risk or successful suppression operations at bushfires.

The proposed Twin Creek Wind Farm is largely located in an excluded bushfire risk area, with the southern portion located in a general bushfire risk area largely due to the minimal vegetation and low overall fuel hazard levels. It should be noted however that nearby locations have experienced significant bushfires in recent years, notably Pinery 25th November 2015, Eden Valley 17th January 2014 and Angaston 16th December 2014.

The Twin Creek Wind Farm development will increase the number of turbine assets and associated infrastructure in the local area. This may have potential to increase bushfire risk and impact suppression operations, however, the risk from wind turbine fires is considered less than many other activities expected in these rural environments. Fires starting from headers, vehicles and other agricultural machinery, lightning and arson remain the greatest likelihood for bushfire ignitions in this area.

The Twin Creek Wind Farm is located on areas of low fuels with undulating and rocky terrain, the construction of vehicle and fire access tracks will improve emergency response and aid suppression operations.

With the recommendations provided in this plan and suggested mitigation strategies in place it is determined that the development of the wind farm will not significantly increase bushfire risk to the landscape or prevent emergency service operations.

Finally, with an assumption that all land owners and contractors undertake works as per their legal and/or contractual obligations and fire crew maintain a “safety first” approach to fire fighting it is concluded that the development poses an acceptable low overall risk.

Contents

1. INTRODUCTION

1.1 Purpose

The purpose of this plan is to assess the bushfire risk to life, property, the environment and the potential hindrance to suppression operations in relation to the construction and operation of the proposed Twin Creek Wind Farm.

1.2 Objectives

The objectives of the plan, in order of priority, are to establish policies and practices which:

- protect human life
- protect assets to maintain capability before, during and after the passage of destructive bushfires
- minimise the physical and environmental impact of bushfires
- provide for bushfire protection work to be undertaken in an environmentally sustainable and cost effective manner.
- encourage increased levels of bushfire preparedness and response capability
- assist guide management actions

Many factors influence the potential risk of bushfires; as such the Bushfire Management Plan has taken the following into consideration:

- The current context of existing risk factors
- The elements of the proposal that may increase bushfire risk
- The elements of the proposal that may aid or hinder suppression operations
- The role of key stakeholders and their legislative responsibilities
- Current best practice and existing policies.

1.3 Fire Management Planning Framework

Fire Management must take into consideration legislation and guidelines that are relevant at Local, State and Federal levels. There are a range of legislative requirements and other tools available in addressing fire management. In the context of a Development Application, the *Development Act* has a focus within a wider framework. The following provides an overview of legislation relative to fire management in South Australia.

1.4 Legislation

1.4.1 Fire and Emergency Services Act 2005

The Fire and Emergency Services Act 2005 is legislation to provide… "governance, strategic and policy aspects of the emergency services sector; continuation of a metropolitan fire and emergency service, a country fire and emergency service, and a State emergency service; to provide…prevention, control and suppression of fires and for the handling of certain emergency situations…."

Part 4 of *The Fire and Emergency Services Act 2005* identifies the Country Fire Service (CFS) as the lead combatant agency for bushfire suppression in rural South Australia and all its associated responsibilities. Key Divisions of *Part 4* include;

- Division 2 – Functions and Powers

- Division 7 – Fire Prevention Authorities
    - *Section 73A* Identifies the requirement of a Bushfire Management Area Plan (BMAP)
    - *Section 73A (3)* Outlines the requirements that the plan must address
- Division 8 – Fire Prevention
- Division 9 – Powers and Duties relating to fires and emergencies.

Part 4A of the act refers to *Fire prevention* a key division of *Part 4A* is;

- *Division 3* – Duties to prevent fires

All landholders are obliged to comply with the *Fire and Emergency Services Act 2005,* which states that property owners are required to implement works on their land to minimise the threat of fire.

1.4.2 Local Government Act 1999

Local government manage all parcels of land and reserves under its existing organisational structure in accordance with its legal obligations under the *Local Government Act 1999*.

Section 7 of the Local Government Act 1999 specifies the principle functions of a Council. Functions that are specific to Bushfire related activities include;

- Section 7(d): to take measures to protect its area from natural and other hazards and to mitigate the effect of such;
- Section 7(f): to provide infrastructure for its community and for development within its area (including infrastructure that helps to protect any part of the local or broader community from any hazard or other event, or that assists in the management of any area).
- Section 8(d) outlines the way in which councils are required to undertake their roles and functions. It specifies the need for consistency of all plans, policies and strategies with Regional, State and National objectives and strategies concerned.

1.4.3 State Emergency Management Act 2004

The State Emergency Management Act provides a framework for emergency incident response and recovery.

Section 3 of the *State Emergency Management Act 2004* specifies that an "Emergency means an event (whether occurring in or outside the state) that causes, or threatens to cause:

- The death of, or injury or other damage to the health of, any person; or
- the destruction of, or damage to, any property; or
- a disruption to essential services or to services usually enjoyed by the community; or
- harm to the environment, or to flora or fauna.

This is not limited to naturally occurring events (such as earthquakes, floods or storms) but would, for example, include fires, explosions, accidents, epidemics, sieges, riots, acts of terrorism or other hostilities directed by an enemy against Australia."

1.5 **Other Relevant Legislation, Codes and Regulations**

- *Native Vegetation Act 1991 (SA) Section 29*
- *Native Vegetation Regulations 2003 (SA) Section 5A-1 and 5(1)(zi)*

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Code of Practice for fire management on Public Land in South Australia 2012-2016*
- *National Parks and Wildlife Act 1991 (SA)*
- *Wilderness Protection Act 1991 (SA)*
- *Crown Land Management Act 2009 (SA)*
- *Development Act 1993 Development Regulations 2008*
- *Natural Resources Management Act 2004*

1.6 Existing Documents, Policies and Guidelines

Several existing strategic documents and policies from various agencies have been considered to ensure best practice is applied. These documents address a range of issues and factors and provide indicators as to whether risks can be managed.

1.6.1 Country Fire Service - Bushfire Management Planning

The CFS has an established Bushfire Management Planning Unit whose role is to assist Bushfire Management Area Committees (BMAC) prepare Bushfire Management Area Plans (BMAP).

The BMAC have a critical role in landscape scale Bushfire Risk Assessment and a key role in ensuring a coordinated approach to the implementation of mitigation strategies amongst various organisations and agencies. The Twin Creek wind farm site crosses three local government areas and two separate Bushfire Management Area Plans.

Whilst CFS engage with all stakeholders to assist in the production of a BMAP, each individual organisation is responsible for the implementation of the risk treatments on land under their care and control.

The Flinders Mid North Yorke BMAP covers the Light Regional and Goyder Local Government areas, while the Murray Mallee BMAP covers the Mid Murray Local Government area. Both are interim documents and can be found at Bushfire Management Area Plans.

1.6.2 Code of Practice for Fire Management on Public Land in South Australia

The Code of Practice for Fire Management on Public Land in South Australia (CoP) recognises the Department of Environment, Water and Natural Resources, Forestry SA and SA Water as the responsible government agencies for managing fire on all public lands in SA. The code also acknowledges the shared responsibility across the landscape with the SACFS, local Government and all private landholders to protect life, property and environmental values through the management of fire.

The CoP contains overarching principles, performance measures and desired outcomes for fire management programs, the principles complement the State Bushfire Management Plan. The CoP has been referenced to ensure a consistent approach to fire management is applied across the landscape, however the CoP specifically focuses on public land is not directly relevant to the Twin Creek wind farm located on private property.

1.6.3 Government Agencies Fire Management Working Group - *Firebreaks, Fire Access Track and Sign Standards Guidelines.*

The Firebreaks and Fire Access Tracks document has been developed by the Government Agencies Fire Management Working Group (GAFMWG) to provide guidance to Government land management agencies for the construction, maintenance and signage for fire access tracks and firebreaks.

Vehicle or Service Tracks: Includes vehicular access tracks of no fixed width for reserve management staff, apiarists or private access to heritage agreement areas. They are not suitable for fire fighting purposes. Includes vehicular access tracks of no fixed width.

Minor Fire Tracks: Trafficable in one direction, maintained at a width of four metres both at ground and canopy level;

Standard Fire Tracks: As above, trafficable in a two-way direction through the provision of passing bays at intervals of 400 metres, and;

Major Fire Tracks: Maintained at a minimum width of seven metres at both ground and canopy level to provide safe two-way access.

Other considerations include:

- Constructed roads should be a minimum of 4 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 tonnes.
- The average grade should be no more than 1 in 7 (14.4%) (8.1º) with a maximum of no more than 1 in 5 (20%) (11.3º) for no more than 50 metres.
- Dips in the road should have no more than a 1 in 8 (12.5%) (7.1º) entry and exit angle.
- Passing bays should be located every 200m on access tracks.

1.6.3.1 *Grassland Firebreaks*

The width of the grassland firebreak should be between 4 and 10m, including a track used for access. The vegetation within a grassland firebreak should be maintained at a maximum height of 10cm during the fire danger season.

1.6.3.2 *Firebreaks*

A firebreak is an area or a strip of land where vegetation has been removed or modified to reduce the risk of fires starting or reduce the intensity or rate of spread. They also serve to protect personnel and property from fire by providing an edge where fire crews can undertake fire fighting, prescribed burns or a back burning.

All firebreaks should incorporate a fuel free strip of at least 1.8m. This may form part of the access track. Grading, cultivation or herbicide application will be required to keep this area bare.

Note that firebreaks will be ineffective to stop a fire in moderate and high intensity fires and spotting is likely to occur.

1.6.4 South Australian Country Fire Service

1.6.4.1 *Operations Tri – Manual*

The manual has been separated into three sections, the Chief Officers Standing Orders (COSOs), Standing Operating Procedures (SOPs) and Operations Management Guidelines (OMGs).

<u>Chief Officer Standing Orders (COSOs)</u>

A COSO is a detailed order that pertains specifically to fire-fighter safety and is a method or instruction that must be followed in all circumstances. The COSO sets out specific responsibilities, both individual and organisational for all SACFS Personnel to follow without exception.

<u>Standard Operating Procedures (SOPs)</u>

A SOP is a detailed set of operational procedures, methods or instructions to be followed in specific circumstances. SOP's explain who does what, in what manner and in what sequence. Procedures set out the steps to follow to achieve a desired outcome.

<u>Operations Management Guidelines (OMGs)</u>

OMGs describe principles, operational systems of work and operational management structures. In places the OMGs complement or reinforce doctrine that is documented elsewhere in COSO's or SOPs.

1.6.4.2 *Joint Guidelines for Operating Farm Fire Units*

Farm fire units are an essential part of the community response to bushfires and the CFS and South Australian Farmers Federation (SAFF) are committed to ensuring the safety of all individuals engaged in fire fighting activities.

SAFF and the CFS have developed guidelines as a cooperative partnership to help farmers understand their responsibilities when fighting fires on or near their lands.

These guidelines are particularly relevant as the Twin Creek Wind farm is located on private faming lands with farmers and neighbours likely to be the initial responders or reporting bushfires

Whilst these guidelines are currently under review the intent is to:

- Promote the safe, efficient, effective and cooperative involvement of farm fire units to control a fire in the shortest possible time; and
- Give operators of farm fire units' information so that they can make informed decisions about their actions.
  Farm Fire Unit Guidelines

1.6.5 Department of Environment, Water and Natural Resources (DEWNR)

1.6.5.1 *Fire Management Zoning Policy*

Three fire management zones are used in South Australia:

<u>'Asset Protection Zones' (APZ)</u> are intensively managed to provide a defendable space by keeping fuel loads low.

Objectives include:

- protecting lives, assets and infrastructure and maintaining key access points on properties
- to provide a low fuel buffer of 40 to 100 m to protect life (personnel, contractors, visitors and fire fighters) and property/built assets from radiant heat damage, flame contact and short distance ember attack
- to provide suppression advantage should a fire ignite in the zone
- to modify the fire intensity and provide a control line for the suppression of bushfires as safely and efficiently as possible
- to provide access between properties.
- overall fuel hazards should not exceed Moderate.

'Bushfire Buffer Zones' (BBZ) adjoin other zones to provide an area (buffer) of reduced fire hazard. They are intermediate areas where the area is managed specifically to reduce fire risk.

Objectives include:

- to assist in reducing bushfire intensity, ember attack and spotting potential; and/or
- to provide suppression advantage to assist in containing bushfires within defined areas; and/or
- to enhance safe access for fire fighters; and/or
- to provide strategic fuel reduction for a landscape, larger block of native vegetation, district or region; and/or
- to allow the achievement of conservation/land management objectives.

'Conservation - Land Management Zones' (C-LMZ) are areas of vegetation managed per the land use that is dedicated for (e.g. biodiversity conservation, forestry plantations, croplands, pastures, horticulture, water supply catchment).

Areas managed for a purpose will have fire and land management requirements. Areas managed for conservation purposes should achieve an appropriate mosaic of vegetation structure to sustain native species and communities.

Fire Management Zoning Policy

1.6.5.2 Ecological Fire Management Guidelines for SA

Assists to determine appropriate fire regimes to maintain and enhance biodiversity.

Ecological strategies and guidelines

1.6.5.3 *Overall Fuel Hazard Guide*

The *Overall Fuel Hazard Guide* is a tool used in Fire Management Planning to determine the fuel structure, arrangement and establish the potential bushfire risk including propagation of fire, its sustainability and potential heat outputs. The overall fuel hazard can be assessed as: Low, Moderate, High, Very High or Extreme.

The *Overall Fuel Hazard Guide* assesses four fuel layers in the vegetation. Each layer contributes to different aspects of fire behaviour such as flame depth, height, rate of spread, spotting and crown fire.

Fuel types include:

- *bark fuel* (for example, Stringybark trees that have not been burnt will generally have an extreme level of bark fuel present, whereas smooth bark gums will be low to moderate level)
- *elevated fuel* is the component that generally refers to how 'easy' or 'hard' it is to walk through that layer of fuel
- near-surface fuel is the component that is 'connected' with the ground and is usually going to be burnt in a fire, for example, low bushy shrubs, clumps of grass and dead leaf material that rests on this type of vegetation
- surface fuel is the component that represents the layer of litter (measured by the depth of the litter fuel).

Overall Fuel Hazard guide

1.6.5.4 *Risk Assessment in Fire Management Planning Procedure*

- The risk assessment applied is Consistent with Australian and New Zealand Standard for Risk Assessment (AS/NZS ISO 31000:2009), gauging risks arising from bushfire to life, values, property and environmental values.
- Standard and consistent approach in identifying, analysing and evaluating risks.
- Assessment of overall risk is determined by combining the likelihood of an event (chance that a fire will occur) with the consequences (impact on people, property, and environment) (Table 1). The criteria adopted for consequences have been adapted to include biodiversity values.

Risk Assessment in Fire Management Planning Procedure

Table 1 - Overall Risk Analysis Matrix (adapted from Australian and New Zealand Standard for Risk Assessment (AS/NZS ISO 31000:2009)

Likelihood	Consequences Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	**High**	**High**	**Extreme**	**Extreme**	**Extreme**
Likely	Moderate	**High**	**High**	**Extreme**	**Extreme**
Possible	Low	Moderate	**High**	**Extreme**	**Extreme**

1.7 Consultation

The Twin Creek Bushfire Management Plan has been provided in draft format to CFS staff at Region 2 for their information and reference; however they have been reluctant to comment until the project has received Development approval.

Once the proposal has received development approval it is recommended that RES consult further with CFS Region 2 staff, relevant Group Officers and local brigade captains prior to the commencement of the construction design phase of the project.

Further consultation with local fire agencies regarding the wind farm operations will greatly assist the development of appropriate bushfire response strategies. A bushfire response plan may be required and identify appropriate access points, tracks, firebreaks, hazards and water points and should be available to all local fire brigades, CFS Region 2, appropriate response agencies.

It is considered appropriate that the local CFS brigades be familiar with the wind farm site and this could be achieved via a tour prior to the wind farm becoming operational and then subsequently on a regular basis.

It is recommended that the proposed bushfire mitigation measures, including the response plan, prepared in relation to the Twin Creek Wind Farm be made available to the broader community. Methods of this dissemination maybe via the CFS and/or RES websites.

1.8 Review

This Final draft plan should be reviewed and finalised after the construction phase, or earlier if there are changes to legislative requirements, fuel loads, risk factors, infrastructure development approval or a major fire event has occurred.

The CFS is developing the BMAPs which may also affect recommendations in this plan.

Once the Twin Creek Wind Farm is operational, review time intervals of subsequent plans may be of greater length and a period of review every 5-10 years may be more appropriate.

2 THE BUSHFIRE ENVIRONMENT

To determine the potential risk of bushfires impacting on the Twin Creek Wind Farm assets and infrastructure the surrounding bushfire environment has been assessed to ensure the entire landscape bushfire risks have been considered.

This provides an indication of the extent to which the wind farm itself may be at risk of being exposed to a damaging bushfire from neighboring areas.

2.1 **Location**

Location: 90km North East of Adelaide, 5km North East of Kapunda **(Figure 1)**
Area: 5600 hectares
Bushfire Protection Area: General and Excluded **(Figure 2)**
Local Government Areas: Mid Murray, Goyder and Light Regional Council Areas **(Figure 3)**

2.2 Vegetation

The northern Mt Lofty Ranges is predominantly characterised by Casuarina and Allocasuarina forests and woodlands. Eucalyptus low open woodlands commonly dominate the higher rainfall areas and give way to Allocasuarina species in the more arid parts. Approximately less than 10% of the remnant vegetation remains.

The overall fuel hazards with these vegetation types can vary considerably and are expected to have higher fuel loads in the areas of remnant vegetation.

The vegetation in the proposed area has been extensively cleared for agriculture purposes since European settlement. The proposed site consists of predominantly native and introduced grasses (Native Spear Grass, *Austrostipa spp*, Native Wallaby Grass *Austrodanthonia spp*, and Wild oats **Avena barbata*).

The overall fuel hazard for the Twin Creek Wind Farm site is expected to vary from Medium to Very High/Extreme depending on seasonal conditions. Local landowners generally remove grazing stock from the wind farm site during summer months because of limited feed and therefore a low overall fuel hazard and reduced bushfire risk.

The neighbouring lower plains (off site further to the west) are predominantly cereal cropping lands and depending on the season can have extreme near surface / elevated fuel loads and have significant bushfire potential, especially during harvesting operations.

2.3 Terrain

The topography varies widely within the development area from hills and valleys with gently undulating slopes in the west and tablelands to very steep slopes, ridges and inaccessible areas with deep gorges. A series of generally longitudinal steep ranges with slightly undulating valleys in between and numerous water courses are present.

2.4 Surrounding Land Use

Dry land farming is the predominant land use for the area comprising cropping and grazing (sheep and cattle) enterprises. In areas where there is lower rainfall or unsuitable topography areas of remnant vegetation exist.

A large area of the southern end of the proposed Wind Farm site is very barren and unable to support livestock.

2.5 Environment

The Pygmy Bluetongue Lizard (*Tiliqua adelaidensis)* is listed as Endangered nationally under the *EPBC Act* and Endangered in South Australia under Schedule 7 of the *National Parks and Wildlife Act 1972.*

The proposed development falls within the most southerly known population of the Pygmy Bluetongue Lizard. The size of the development has been reduced to minimise the impact to this species.

Threats to this species include change in land use, ripping, ploughing and pesticide use. The impact of fire may depend on the timing, frequency and intensity of the fire. Fires in spring, late summer or early autumn may have the most impact on this species. Fires in mid-summer, late autumn or early spring may have little consequence (Recovery Plan 2012).

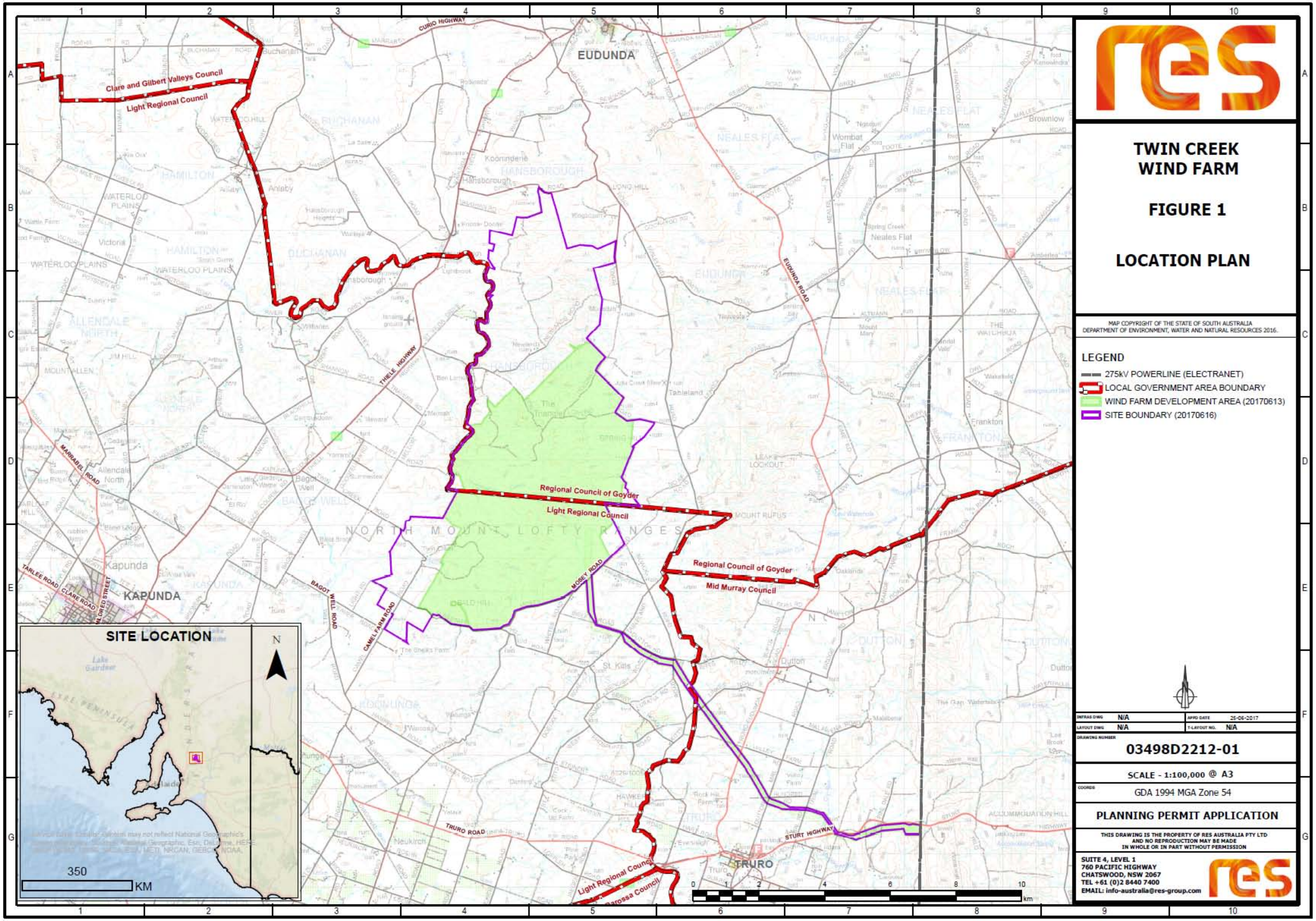


Figure 1- Wind Farm location

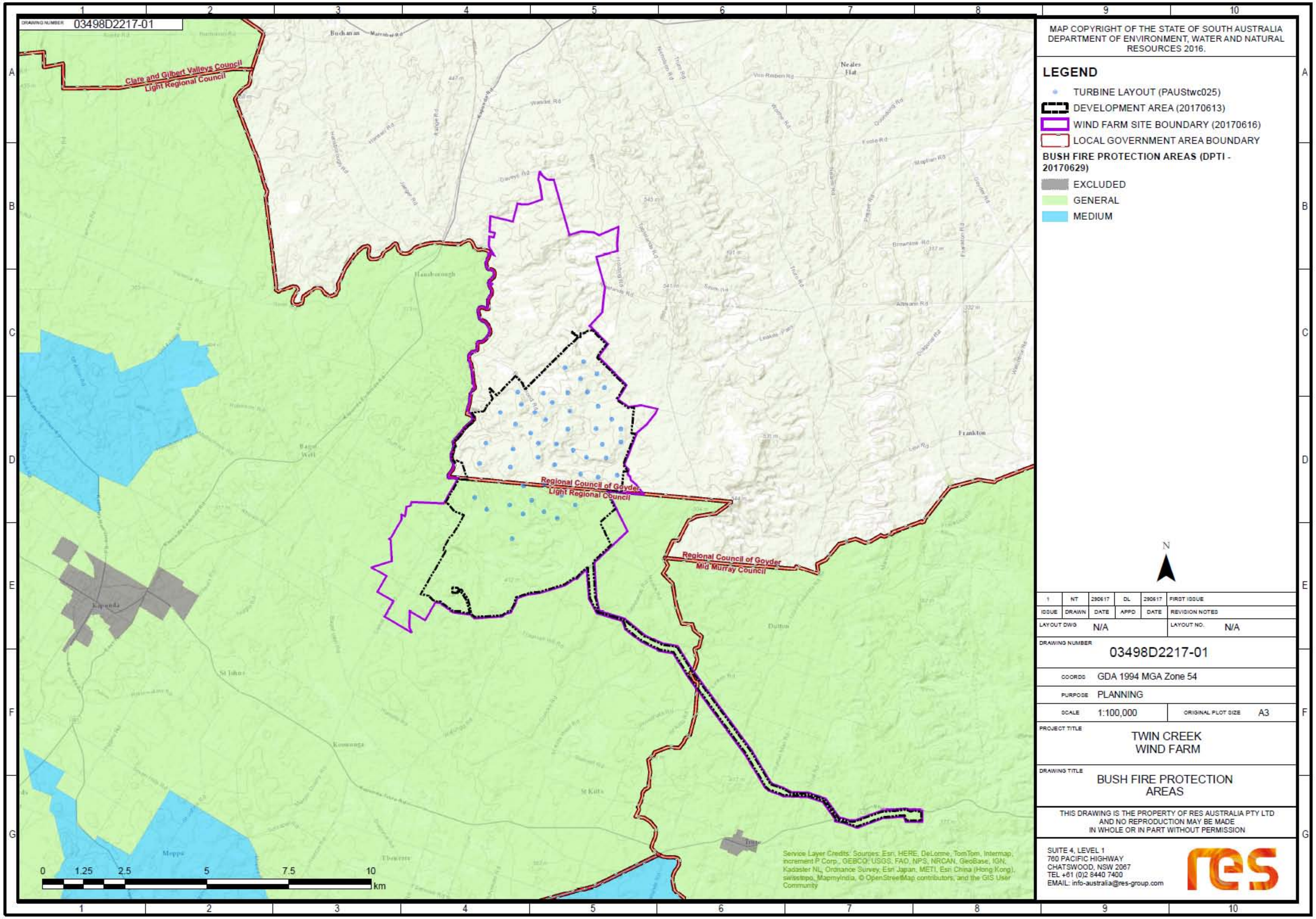


Figure 2 – Bushfire Protection Areas relative to proposed turbine locations

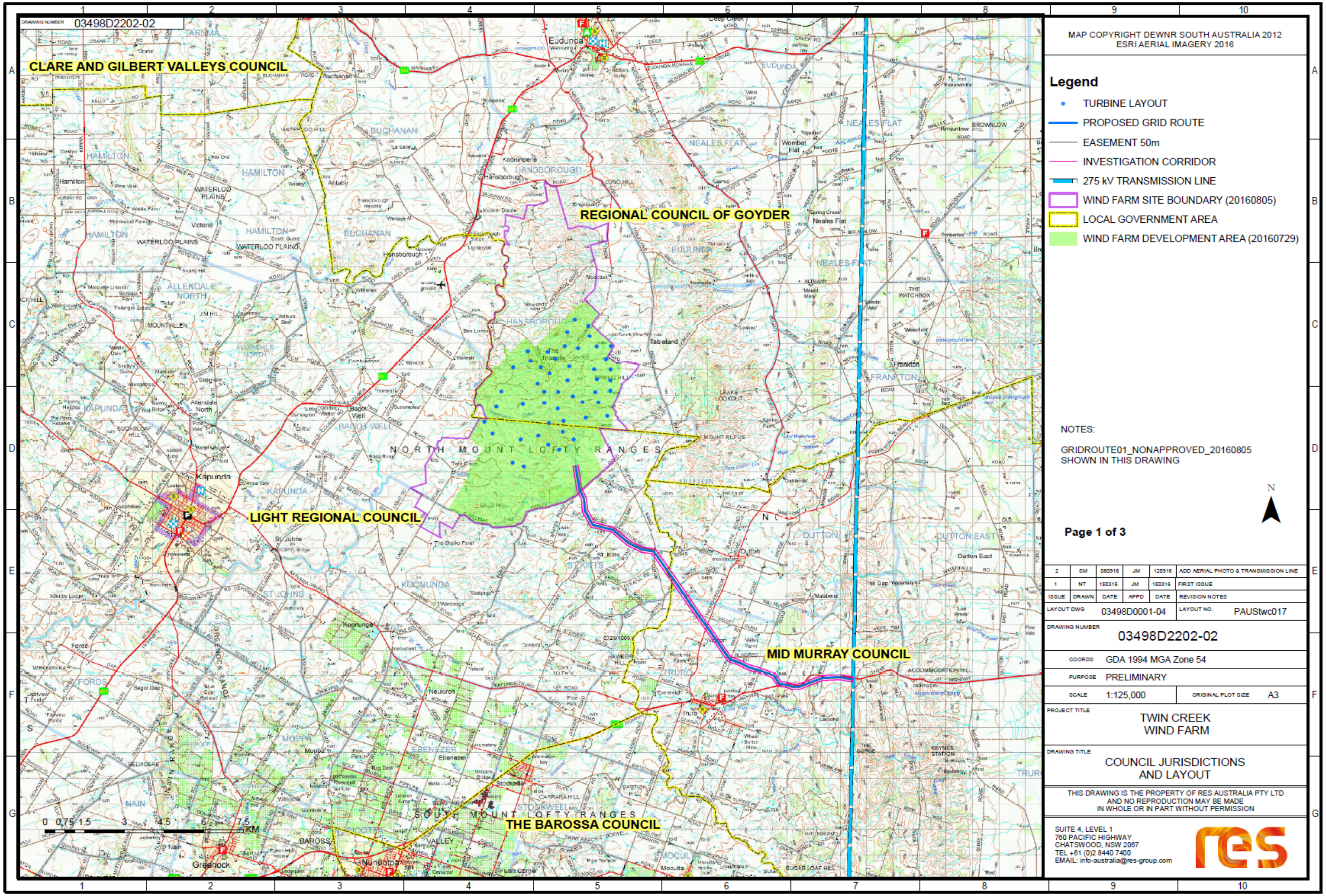


Figure 3 - Local Government Area Boundaries

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2.6 Access and Egress

Access and egress throughout many parts of the proposed development area is restricted because much of it is privately owned property. Public roads are limited and existing farm tracks are of varying standards that may not meet GAFMWG standards for emergency response vehicles.

Construction of the wind farm will include engineered access roads (greater than the identified GAFMWG standards) to each turbine location which will greatly improve fire crew access through the site and difficult terrain areas.

2.7 Assets

The protection of human life is the highest priority and consequently areas that are settled are a priority. Residential development is relatively low compared to other regions with Kapunda and Eudunda the closest towns approximately 5 and 10km away respectively. The closest non-stakeholder dwelling is over 2km away from any wind turbine generator.

The Murray Mallee BMAP primarily lists residential, infrastructure (e.g. power lines and substations) and agricultural as key assets for protection.

The Flinders Mid North Yorke BMAP also identifies special fire protection assets such as schools, childcare centres, aged care facilities, hospitals and health clinics as priorities along with identified critical infrastructure and other economic assets.

2.8 Water Infrastructure

There is limited water infrastructure close to the proposed project area. Standpipes in nearby Eudunda and Kapunda are the principal sources of water for fire fighting purposes.

There is a recommendation to increase available water via many large static water points onsite. The number of tanks, their size and strategic location will be confirmed after consultation with the CFS and pending Development application requirements.

2.9 Fire Weather

The development site experiences similar weather conditions to the Adelaide Hills, a Mediterranean climate with cool wet winters and dry, warm to hot summers.

Summer months are dominated with wind patterns generally from the south-east; however, winds from the north, with associated drier air mass and lower humidity, create the most significant fire danger. Local winds can be variable and unpredictable at times including sea breezes and strong gully influences.

2.9.1 Extreme Fire Weather Conditions

There is a dramatic increase in the likelihood and consequence of large fire events when the following conditions are met:

- Very High to Extreme fuel hazard levels in vegetation
- low humidity
- decreased soil and fuel moisture, particularly in dry seasons

- high temperatures
- high winds, changing direction during a fire
- steep slopes.

Fire Danger Indices (FDI) is used to determine fire danger and difficulty of suppression. FDI's over 50 are considered Severe, and a total fire ban is declared. A fire burning on days of Severe to Catastrophic Fire Danger Ratings (FDR) and any fire not contained within the first 5 to 10 minutes will burn out of control and will stay burning out of control until there is significant moderation in the weather (Koperberg, 2003).

Fire breaks have little effectiveness in conditions exceeding a FDI of 20 (High) nor are they generally effective control measures in contiguous vegetation and rural landscapes. Fire breaks are most effective immediately adjacent to assets. Provision of appropriate access tracks to enable crews to access the fire when conditions have abated to put out the fire edge is more appropriate.

Rates of spread for grassfires in South Australia can be up to 30 km/hr (Cheney and Sullivan 2008) in extreme conditions, such as those experienced during the Wangary Fire in 2005 and Pinery Fire in 2015.

Topography plays an important part in fire behaviour, Western and Northern aspects are generally drier compared with Southern and Eastern aspects. Slope also influences fire behaviour and rate of spread and is commonly known that for every increase of 10 degrees in slope, the rate of fire spread doubles. Thus, for a 20 degree slope the rate of spread is four times that on flat land.

Thunderstorms can be expected any time of the year, and are more frequent late spring and summer (October to January). Dry summer thunderstorms bring lightning during the Fire Danger Season and these lightning strikes can cause serious fire problems due to multiple strikes and dry fuel. This area experiences an average of 10 thunderstorm days per annum (BMAP). Lightning conductors fixed on the top of turbines will reduce the risk of lightning hitting the ground.

2.10 Climate Change and Bushfires

South-Eastern Australia is documented to be one of the most bushfire-prone areas in the world. Associated risks from climate change indicate that conditions will continue to worsen.

(DEWHA, 2009) Highlights that climate change will result in:

- Make the management of fire regimes to reduce risk to property, people and biodiversity increasingly challenging
- Warming and drying over much of Australia, especially South-Eastern Australia
- An incidence increase of 5 to 65% in extreme fire danger days by 2020
- Affect fire regimes through its effects to temperature, rainfall, humidity and wind.

2.11 Fire History

There is no recorded fire history for the proposed site for the Twin Creek Wind Farm.

However, in recent times there have been some significant fires in the neighbouring areas, notably Pinery 25th November 2015, Eden Valley 17th January 2014 and Angaston 16th December 2014 (refer Figure 4).

2.11.1 Pinery Bushfire

The 2015 Pinery bushfire was a catastrophic bushfire that burned from 25 November to 2 December 2015, and primarily affected the Lower Mid North and west Barossa Valley regions. At least 86,000 hectares (210,000 acres) of scrub and farmland in the municipalities of Clare and Gilbert Valleys, Light, Mallala & Wakefield were burnt during its duration.

The Pinery fire destroyed or rendered uninhabitable 91 houses, and destroyed 388 non-residential structures, 93 pieces of farm machinery and 98 other vehicles. It also caused significant damage to rural produce; 53,000 poultry and 17,500 head of livestock perished and up to AUS$40 million worth of fodder and unharvested grains were destroyed.

Tragically the Pinery fire also claimed two lives, with a further 90 people hospitalized and 5 of the victims suffering critical injuries.

2.11.2 Eden Valley Bushfire

The Eden Valley fire ignited just after midday on Friday 17 January burnt through almost 25,000 hectares and was declared as 'contained' by Monday 20 January.

Despite best efforts, unfortunately four houses were lost along with multiple sheds livestock, native fauna and hundreds of kilometres of fences.

2.11.3 Angaston Bushfire

Two fires broke out in the Barossa Valley area. A grassfire that burnt through 700 hectares (1,730 acres) near Springton where a fire-fighter was injured while containing the blaze. The second fire, near Angaston, ripped through 1,400 hectares (3,459 acres) in strong winds before being extinguished.

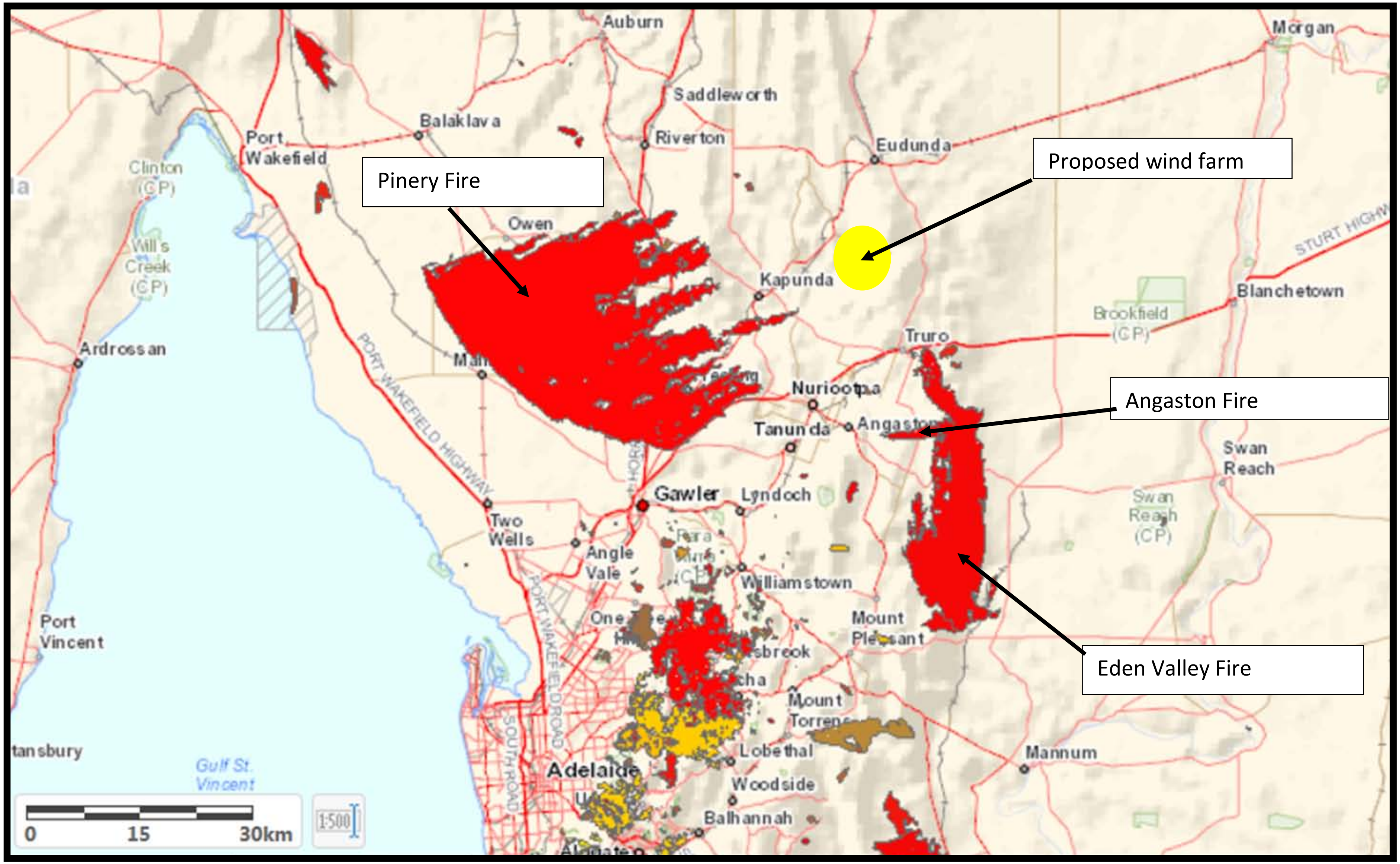

Figure 4 – Fire history Map

3 BUSHFIRE RISK

The following considers the assessment of risk from two different perspectives.

Firstly, is the wind farm likely to cause or increase risks of a bushfire (either during its construction or operational phases)? Secondly, is the wind farm likely to limit any bushfire suppression operations?

The risks vary between the construction and operational phases and are separated accordingly.

3.1 Bushfire Risks During Construction

Existing land uses and human activity already pose some level of risk of generating a bushfire event during the fire danger season; however the construction phase of the project has the potential to increase bushfire risks primarily by increasing the level of activity in the region, specifically in relation to:

- The use of heavy earthmoving machinery operating in rocky environment;
- Increasing the potential for vehicles to drive through dry grass;
- Increasing the volume of human activity and vehicle accessing the area;
- Storage and use of flammable fuels and materials;
- The use of grinders and welding equipment.

Increased activity on grassland vegetation during construction could potentially result in accidental ignition. Depending on the conditions and the location of such an event, a bushfire may become challenging to contain in the steep slopes and within areas of limited access, however, this will be offset by the construction of new roads that will improve emergency vehicle access and increase response times to reported incidents as well as serve as firebreaks.

The increased bushfire risk on the surrounding areas during construction and operation of the wind farm is not considered to be more prevalent than any other development application or existing general activity (e.g. farming, contracting or other construction).

In each case the potential of increased risk can be managed and mitigated provided appropriate training, communication and management practices are put into place in accordance with the recommendations identified in this bushfire management plan.

3.2 Bushfire Risks During Operation

The extent to which the proposed wind farm will increase overall bushfire risk will depend on the design, suitable management practices, response procedures and effective communications between stakeholders, particularly during the fire season.

The proposed wind farm development will introduce additional elements to the region that have, in theory, the potential to increase bushfire risk. Many of these elements already exist or occur in the region from other industries or operations including:

- Introducing infrastructure that can pose difficulties for suppression (e.g. Nacelle fires due to height and OH&S considerations of falling debris and tower infrastructure affecting aerial suppression);
- Increase to management and maintenance vehicles and crew working in area;

- Increase in the number of turbines, substations and power lines in area (potential for mechanical and electrical failures);
- Increasing the potential for lightning conductors;
- Electronics stored with combustible oils and lubricants.

The functioning wind turbines may experience electrical or mechanical failure causing ignition in the nacelle and may lead to subsequent bushfires if not controlled. Whilst there is evidence to prove that wind farms have caught fire from various factors the subsequent risk of these nacelle fires causing uncontrollable bushfires is considered *"less than that of many other activities expected in these rural environments"* (Australasian Fire and Emergency Service Authorities Council, 2014). It should be noted that in comparison to other power generation e.g. coal or gas, wind energy has a much lower ignition risk (see Hazelwood Mine Fire Inquiry).

The types of fire risks related to wind energy facilities may include:

- Nacelle (including turbine oil) fires;
- Electrical faults during construction or from connection lines;
- Fire fighting limitations within and adjoining the wind farm footprint, such as possible limitations on aerial support, and access and egress conditions (see 3.3 below);
- Access to water sources within or adjoining the facility;
- Operation of winches and machinery during monitoring and maintenance tasks;
- Possible impacts from downwind air turbulence on fire behaviour (see 3.31 below)
- Impacts of lightning.

Suppression of fire in the nacelle by ground crew is impossible; the initial detection of problems that may lead to fire in the nacelle and subsequent fires on the ground is the key to minimising asset and infrastructure loss and ignition of bushfires. Detection and automatic fire protection systems would reduce the risks, increase the ability to contain potential problems and decrease response times to reported incidents.

With the site proposed to be developed on lands with naturally low fuels and construction of roads to turbines increasing access for emergency vehicles through the area the overall potential for operational activities to increase the bushfire risk and impact on the surrounding areas is low, if the recommendations within this plan are implemented.

3.3 Potential Impacts on Bushfire Suppression Operations

The following includes an assessment into the potential impact of the proposed development on the conduct of bushfire suppression operations undertaken in the region.

Fire-fighter safety and the protection of life are paramount during all suppression operations. Priority suppression activities will focus on Protecting Life, Property and Environmental Assets.

The operating wind farm could potentially impact bushfire suppression operations by:

- Possible interference with radio transmissions (radio frequency);
- Increasing the total number of assets to be protected in the area;
- Increasing safety risks with nacelle fires and falling debris;

- Affecting aircraft operations (access, efficiency and turbulence);
- Increasing elevated structures as risk factors (vertical and horizontal).

The NSW Rural Fire Service submission to the Select Committee on Wind Turbines (March 2015) noted that wind turbines will not prevent the NSW RFS from fighting a fire and suppression strategies will consider a variety of factors including aviation hazards. This is effectively the same in South Australia as turbines pose no more of an obstacle than any other feature in the landscape.

The level of cooperation, support and understanding between key stakeholders including landowners, CFS and the local community is critical to successful fire suppression.

All CFS actions are in accordance with *Fire and Emergency Services Act 2005* and CFS policy and procedures (Operations Tri-Manual). Local CFS Brigades will most likely form the initial response to fire incidents. It should be noted that private farm fire units are likely to respond and aid also and must be operating as per the guidelines.

Local CFS brigades will be provided with information and become familiar with the new access tracks (especially in higher risk areas), water sources and wind farm infrastructure to assist them with determining initial suppression strategies.

The additional OH&S concerns of falling debris must be individually risk assessed. It is unlikely CFS crews will consider suppression activities with fires in a nacelle (at the top of the turbine tower) due to height and falling debris factors, but instead are likely to patrol from a safe distance at the tower base. Previous turbine fires in Australia have had responding crews establish an exclusion zone of between 50-200m to ensure the safety of crews from falling debris.

The first crews responding to a fire need to undertake dynamic risk assessments to ensure fire-fighter safety and appropriate suppression strategies are in line with any response plans. If direct fire suppression is inappropriate alternative actions including parallel or indirect strategies may be implemented.

Initial response strategies should consider using existing access tracks to gain access to the bushfire. The new service tracks will also provide increased opportunity to utilise low fuel areas between tracks to undertake indirect attack methods of fire suppression to contain fast moving bushfires that direct attack options may not be appropriate or safe.

Current access and egress to most of the area of the proposed development area is difficult due to the topography and terrain. Post construction the increased number of service tracks to the turbines and substations will improve bushfire suppression operations by increasing vehicle access, emergency assembly points, strategic observation points and safe zones to emergency crews.

3.3.1 Aerial Suppression Considerations

Twin Creek Wind Farm is in the CFS Secondary Response Zone (refer CFS Operations Tri Manual SOP 11.1 Aerial Fire Fighting). This means that bushfire suppression activities may be able to be supported by aerial suppression (rotary and fixed wing) based on a specific request by an Incident Controller and approved at a state level.

There are factors that potentially limit the effectives of aircraft use in Aerial Fire fighting, including reduced visibility (fog, dust, smoke), vertical and horizontal obstructions (trees, power lines, towers, masts and turbines), strong winds and more recently Remotely Piloted Aircrafts (refer CFS Aerial Fire fighting Limitations).

There is no guarantee that aircraft for either suppression or an observation platform will be available for immediate dispatch, particularly in the Secondary Response Zone. This will be determined at the time by the CFS State Air Resource Coordinator (SARC) in consultation with the CFS Regional Office and Incident Management.

Aircraft operations are undertaken under Visual Flight Rules which limits operational use to daylight hours and only with clear visibility of the ground and obstacles in the landscape that may put them at risk.

Pilots, air attack supervisors and air operation managers constantly undertake dynamic risk assessments to review and consider options and determine appropriate strategies to safely undertake suppression operations. In this context, aerial fire fighting will treat turbine towers the same as any other obstacle.

The Australasian Fire and Emergency Services Council (AFAC) position paper on Wind Farms and Bushfire Operations concluded …" *that wind turbines are not expected to pose increased risks due to wind turbulence or the moving blades. Local wind speeds and direction are already highly variable across landscapes affected by turbulence from ridge lines, tall trees and buildings.*"

Aerial suppression using fixed and rotary wing machines are a valuable and efficient asset that can also provide additional safety coverage to ground crews, however they must be supported by crews on the ground mopping up to ensure the fire is adequately contained.

The CFS fact sheet understanding Aerial Fire fighting highlights that "…*community perception is that aircraft alone put out bushfires, this is not true*" and the CFS website Aerial fire fighting defines aerial fire fighting as *"the use of aircraft and other aerial resources to assist fire-fighters on the ground in achieving bushfire suppression objectives"*. It is important to note, that firefighting aircraft (regardless of their size or type) **do not** extinguish a bushfire alone, but are deployed to provide an important support function to ground firefighting resources.

4 READINESS

4.1 Equipment

All staff and contractors on site should have the appropriate personal protective equipment (PPE) that meet Australian standards (where they exist) or at least comply with Fire and Emergency Services Act and AFAC guidelines, during the fire danger season.

All fire fighting equipment, pumps and sprinklers need to be checked prior to the fire danger season.

A vehicle equipped with a dedicated fire fighting unit on site, or at the very least, all vehicles carrying water and a rake hoe for initial fire suppression during the fire danger season, will assist in the rapid suppression of a small fire should it start on site.

Automated sprinklers and fire detection systems are also very effective in rapid detection and suppression once the site is operational.

All vehicles should carry a mobile phone or UHF radio to enable rapid reporting of a fire outbreak.

4.2 Training

Staff involved directly or indirectly in fire incidents should have a minimum of training and attend the Basic Fire Fighting 1 course delivered by the CFS.

Annual pre-season refresher training, including a burn over scenario, is recommended. Staff may also benefit from a bushfire awareness program.

Each staff member should be encouraged to prepare a written bushfire survival plan. A survival plan should also be prepared for the site, listing actions to take and identify Bushfire Safer Places and Last Resort Refuges should a bushfire threaten the site.

4.3 Safe Work Procedures, Policies and Guidelines

Vegetation management, firebreak and fire access track maintenance, checking of equipment, review of response plans, updating communication and contact details and training needs to be completed before the commencement of the fire season.

Ensure all staff, contractors and site visitors are informed of the fire response plan, and follow identified legislative requirements, policies and procedures, particularly in the use of grinders, welders and similar equipment that pose a potential bushfire risk during the fire danger season and on total fire ban days. Ensure that all works during the fire danger season have appropriate permits from Local Government, (Goyder, Light Regional and Mid Murray Councils).

During the fire danger season, vehicles should keep to the tracks whenever possible and restrict low clearance vehicles with catalytic converters from entering the site on high fire danger days.

Smoking should be restricted to prescribed areas that have had vegetation removed.

Have appropriate "initial" suppression equipment available on site i.e. carry fire extinguishers or fire fighting equipment in vehicles.

On declared Catastrophic Fire Danger Days consider adopting a policy of “no work” or “essential work only”.

4.4 Risk Mitigation Strategies

4.4.1 Fire Access Tracks

All onsite roads for the Twin Creek wind farm will have a 5.5m finished running width and the turbines are spaced between 400-600m apart with crane pads that will act as suitable passing and turn around areas.

With the adjacent low fuels, all tracks onsite will exceed the GAFMWG requirements for a major fire access track and will be suitable as firebreaks.

4.4.2 Water Points

The closest known water points are standpipes 5 and 10 km away. Valuable time will be lost during fire fighting as fire units travel to refill with water. While Bulk Water Carriers may be deployed during an incident, these resources take time to be installed and operating.

To ensure adequate access to water for CFS, the provision of static water supplies is desirable to assist safe, effective and timely fire suppression activities. Multiple tankers need to be filled rapidly and simultaneously to conduct efficient and effective fire suppression.

A number of static water storage tanks of at least 22,500 litres are recommended with CFS compliant connections. The static water storage tank must be an above ground water tank constructed of concrete or steel. The location and number of tanks should be determined in consultation with a CFS Fire Operations Officer.

If a sprinkler system is installed, that will require its own water supply separate to that allocated for fire fighting purposes

A turnaround point, an all-weather track surface, signage on tank and directional signage from the access gate to the water point, as well as an external water level indicator, are also desirable.

4.4.3 Fire Management Zones

4.4.3.1 *Asset Protection Zone*

Establish an “A Zone” of at least 40 m around each turbine and consider other zoning strategies to assist bushfire mitigation (e.g. B zone as per DEWNR zoning policy). For example, turbines near steep slopes should have an extended A zone or have an additional B Zone.

Asset Protection Zones are intensively managed to provide a defendable space by keeping fuel loads low, with the objective of protecting lives, assets and infrastructure, provide suppression advantage and maintaining key access points on properties.

Ensure vegetation within the A zone is maintained to a maximum height of 10cm over the fire danger season. This is achieved by slashing, mowing or herbicide use and trail or firebreak construction.

Overall Fuel Hazard should not exceed *Moderate*. Surface and Near Surface Fuels should be *Low* to *Moderate* and fuels should be discontinuous.

4.4.3.2 *Bushfire Buffer Zones*

Bushfire Buffer Zones adjoin other zones to provide an area (buffer) of reduced fire hazard. They are intermediate areas where the area is managed specifically to reduce fire risk and assist in reducing the speed, intensity and spotting potential of a bushfire.

B Zones aims to provide a buffer area to assist in reducing the speed, intensity and spotting potential of a bushfire. This zone is usually 20-100m wide, and may apply near assets. It may also be used to provide strategic fuel reduction for a landscape, which would otherwise carry *High* to *Extreme* fuel hazard levels.

Overall Fuel Hazard for the Bushfire Buffer Zone should not exceed *High* unless otherwise specified.

5 RESPONSE

The CFS has overall responsibility for fire suppression activities in SA country areas. Local CFS volunteer Brigades are relied upon for fire suppression activities. It should be noted however that there is no guarantee that the CFS will attend all incidents.

Attendance may depend on priority of current incidents, availability of crews, number of incidents going at that time and other factors. In a major bushfire event, do not expect or rely on CFS to arrive.

Rapid detection and suppression of a fire starting on site is desirable regardless of the fire danger rating. Rapid and early extinguishment of fires will be possible if vehicles on site are carrying communication equipment and water for fire suppression and/or there is a sprinkler systems installed on associated infrastructure.

Occasionally responding resources may be limited or delayed and therefore it is important that staff at Twin Creek know what to do to keep themselves safe. This will usually mean leaving early to a Bushfire Safer Place (e.g. Eudunda or Kapunda).

The following actions in the event of fire starting on site include:

- Calling triple zero early (even if the initial fire appears small).
- Shut down turbines in vicinity of fire.
- Commence suppression efforts before CFS arrive.
- Staff and contractors must respond to instructions and follow advice from CFS once they are on site during incidents.
- Twin Creek Wind Farm liaise with CFS incident management teams.

5.1 **Suppression Considerations**

5.1.1 Objectives for Fire Suppression

- To provide for the protection of human life during fire suppression activities.
- To provide for the protection of built assets and neighbouring properties from bushfires.
- To ensure that sound land management principles are applied to fire suppression and fire management activities.
- To provide for the strategic containment of bushfires.

5.1.2 Fire-fighters

Potential hazards to fire fighters include:

- Steep terrain, rocky hills
- Historical mine shafts in the area
- The potential of falling debris from wind turbines
- Minimal opportunity to escape in a fire event.

5.1.3 Machinery Use

Use of heavy machinery must consider:

- Steep terrain in some places will reduce the effectiveness of, and pose risks to, machinery operators
- Likelihood of success
- Positive and negative impacts on environmental sites.

5.1.4 Water

The location, access and availability of water for fire fighting purposes onsite is yet to be determined and early considerations for Bulk Water Carriers deployed by CFS may assist in suppression activities.

5.1.5 Turbine Management

Consider remote shut down of turbine operations during high bushfire risk days, actual bushfires or reported faults.

5.1.6 Stay informed

To be aware of local emergencies and to receive early warning tune into the local ABC radio station and/or download the free Smartphone app Alert SA.

There is also the Bushfire Information Hotline on **1300 362 361** and the CFS Warnings and Incidents page.

Mobile phone coverage and power can fail during major incidents, so it is important not to rely on just one method of communication.

5.1.7 Evacuation/Leaving Early

The CFS advise that everyone should have a prepared and practiced Bushfire Survival Plan and leaving early is the safest option.

Evacuation is directed only by SAPOL and Emergency Services when it is safe to do so and there are sufficient resources. During a large event, resources are stretched, so reliance on authorities to advise to leave is inherently dangerous and flawed.

If a fire is burning nearby on an Extreme or Catastrophic Day it is unlikely that staff and contractors will have the fire fighting capability in a bushfire are thus safest leaving early and seeking a Bushfire Safer Places or a Last Resort Refuge in an emergency.

If it is safe to do so it is recommended that staff leave early and go to:

- A Bushfire Safer Place (e.g. Eudunda or Kapunda). This will depend on where the fire is and which direction the fire is travelling.
- A Last Resort Refuge (e.g. Stockwell, Marrabel, ovals, rural building or cleared/burnt area) offers limited protection, however may be closer to get to than a Bushfire Safer Place in an emergency.

5.2 Response Plans

The CFS Operations Tri-manual outlines the response and operations for fire fighting. Regional and Group Response Plans prepared by CFS are more specific for this district however they are not public documents. They outline the resources and response to differing levels of threat. Once construction commences, further liaison with CFS is recommended.

5.2.1 Response Plan Contents

Suggested information for a response plan includes (items A-D below);

A. Maps highlighting:

- Site Plan
- Turbine location (number and Grid reference)
- Water points
- Access
- Hazards
- Firebreaks/refuge areas
- Assets
- Neighbouring assets
- Bushfire Safer Places and Last Resort Refuge

B. Priority Suppression Considerations

C. Emergency Contact Numbers

- Fire: 000
- CFS Regional Office: [*]
- SAPOL: [*]
- CFS Group Officer Gilbert: [*]
- CFS Group Officer Light: [*]
- Kapunda CFS Captain: [*]
- Eudunda CFS Captain: [*]
- Neales Flat CFS Captain: [*]
- Twin Creek Operational Manager: [*]
- *To be updated for construction

D. CFS Resources available, location and capability

CFS Group	Brigade	Resources List	Call Signs	Communication (GRN and VHF)
Light Group	Kapunda CFS	*	*	*
Gilbert Group	Eudunda CFS	*	*	*
	Neale's Flat CFS	*	*	*

***To be updated for construction**

E. Wind farm operator protocols:

- Procedures for the parking of wind turbines (if appropriate) for of all or any section of the windfarm to enable safer passage of aircraft through areas where turbines are erected. Turbine rotation should be parked in the preferred 'rabbit ear' position where possible (i.e. aligning one wind blade with the tower).
- The initial design, and any subsequent upgrades, of windfarm installations should reduce the quantity and height of ancillary or supporting vertical infrastructure located between the turbines.
- Wind Met Masts locations clearly recorded.
- Predetermined notification procedures to the fire fighting agencies' aircraft dispatch State Air Desk of any fire in the proximity of the windfarm.

6 RECOVERY

Post-fire it may be necessary to describe and record the areas affected and the impacts on life, property and natural assets.

Possible impacts from a fire on the Twin Creek site may include:

- stress or trauma of staff and contractors in a medium to large incident
- damage to infrastructure (turbines, building assets, gates, fences, tracks)
- damage to neighbouring properties.
- impacts on fauna (loss/decline of Pygmy Bluetongue population, loss of habitat, recovery)
- weed invasion
- vertebrate pest impact on remaining and recovering vegetation and fauna

Recovery centres are often established in large events for the community to seek shelter, comfort, advice, drinks, meals and other assistance. Organisations such as the Red Cross, the Salvation Army and the Department for Communities and Social Inclusion are involved in recovery.

Table 2 highlights possible management actions that may be needed to address fire impacts.

Table 2 Recovery Actions

Cause	Condition (effect)	Management Actions
Trauma of staff/contractors	▪ Inability to sleep ▪ Anxiety and/or depression ▪ Difficulty in concentrating ▪ Decline in productivity and/or absenteeism ▪ Accidents at work	▪ Debrief following incident ▪ Encourage staff to seek counselling and allied medical services ▪ Support staff returning to duties
Infrastructure damaged	▪ Turbines, fences, sheds, tracks and gates damaged ▪ Security compromised	▪ Repair or replace
Additional tracks & firebreaks	▪ Widened to unacceptable width ▪ Location not desirable for future management	▪ Use machinery to close and rehabilitate ▪ Push back topsoil and undertake sediment control works
Damage to neighbouring property	▪ Loss of stock ▪ Fences damaged ▪ Roads damaged ▪ Water supply damaged ▪ Buildings and sheds damaged	▪ Discuss impacts with neighbours
Vegetation removed	Issues include: ▪ Grazing impacts (rabbits, stock gaining access) ▪ Weed invasion from adjacent areas ▪ Post-fire weed response of in-situ species	▪ Survey active warrens via NRN&Y ▪ Facilitate rabbit control program via NRN&Y ▪ Replace boundary fences to exclude stock ▪ Survey weed response via NRN&Y ▪ Facilitate weed control works via NRN&Y
Fauna killed or injured	▪ Loss of habitat ▪ Injuries ▪ Increased vulnerability to predation ▪ Loss or decline of population of Pygmy Bluetongue	▪ Where necessary, contact NRN&Y to interface with wildlife rescue organisations re injured wildlife ▪ Facilitate pest control program via NRN&Y ▪ Facilitate the monitoring of Pygmy Bluetongue population through NRN&Y

7 RECOMMENDATIONS

Twin Creek Wind Farm, like any other construction project, has the potential to increase the risk of bushfire, however the considered risks and impacts on surrounding areas are significantly reduced if the plan's recommendations are implemented.

7.1 Recommendations prior to planning submission

- Provide final version of this plan to CFS Region 2, relevant Group Officers and local brigade captains.

7.2 Recommendations for the Construction Phase

- Include CFS in the consultation process in the design, construction and operational stages.
- Invite local brigades on regular site familiarisation tours.
- Communicate to community the bushfire risk mitigation works undertaken.
- Provide site plans to CFS marking assets, access points, tracks, firebreaks, hazards and water points once facility is constructed.
- Activities to be undertaken during the Fire Danger Season are appropriate under the Fire and Emergency Services Act and Regulations 2005 Division 4 - Fire Prevention of the regulations.
- Staff, contractors and site visitors to be informed of fire response procedures that follow identified legislative requirements, policies and procedures
- Works during the fire danger season to have appropriate permits from Local Government, (Goyder, Light Regional and Mid Murray Councils).
- Construction and operational works follow appropriate Work Health and Safety requirements.
- Principal Contractor to ensure there is a bushfire survival plan for personnel at the site.
- Facilitate a high standard of communication with landowners, relevant stakeholders and the community regarding daily activities through community liaison groups or similar.
- Primary contact person for the community to contact with concerns, questions or issues to be established.
- Wind monitoring masts should include markers on guy wires.
- Ensure all contractors:

— Are appropriately briefed and understand their legal obligations in relation to managing bushfire risks.
— Have appropriate procedures, safe work practices, contingency plans, MSDS for operation of all equipment, chemicals, flammable materials that may contribute to bushfires.
— Have appropriate "initial" suppression equipment available on site i.e. fire extinguishers or fire fighting equipment in vehicles.
— Carry emergency communications equipment.
— Vehicles should keep to the tracks whenever possible.
— Restrict low clearance vehicles with catalytic converters from entering the site on high fire danger days.
— Restrict smoking to prescribed areas.
— Consider a policy of "no work" or "essential work only" on declared Catastrophic Fire Danger Days.
— Provide appropriate bushfire training for contractors and staff.

- Establish an "APZ" of at least 40 m around each turbine (Clear vegetation, such as scrub, trees, etc. within 40 m of a turbine) and consider other zoning strategies to assist bushfire mitigation (e.g. BBZ as per DEWNR zoning policy).
- Ensure all building construction is in line with CFS regulations and Minister Specifications of building in Bushfire risk areas.
- Ensure appropriate bunding in areas where there is potential for flammable fuels and oils to leak and create bushfires or other environmental risks.
- Ensure all access roads and tracks are identified and meet GAFMWG standards for emergency vehicle access. (Govt SAd, 2008).
- Consider appropriate signs (as per GAFMWG standards) to assist emergency response crews determine track names, location and turbines etc.
- Establish emergency assembly areas.
- Consider the option to have all power lines underground.
- Ensure all environmental risks of construction have been considered and approved by relevant authority.
- Consider security fencing as necessary around turbines and substations to prevent public access.
- Provide adequate access tracks to assist CFS in responding to and managing fires on site.
- Ensure adequate access to water for CFS, and/or for sprinklers, and the provision of onsite static water supplies.
- Consider early fire/smoke detection systems, in built fire protection systems, remote alarming and notification systems in turbines to report potential bushfire risks from any mechanical or electrical failures.

7.3 Recommendations for the Operational Phase

- Undertake regular inspections and maintain records of all turbines, the substation, and power lines (including easements).
- Ensure suitable fire fighting equipment is available onsite or readily accessible
- Ensure staff and contractors are trained in fire fighting equipment and have appropriate personal protective clothing.
- Ensure the maintenance of fuel load management zones (A and B zones).
- Consider remote shut down possibilities of turbine operations during high bushfire risk days, actual bushfires or reported faults.
- Consider lightning conductors to dissipate electricity to ground and reduce turbine damage and bushfire risk.
- Ensure all access roads and tracks are maintained to meet GAFMWG standards for emergency vehicle access.
- Ensure wind met mast guy wires have markers for aviation visibility.
- Procedures for the parking of wind turbines (if appropriate) for of all or any section of the windfarm to enable safer passage of aircraft through areas where turbines are erected. Turbine rotation should be parked in the preferred 'rabbit ear' position where possible (i.e. aligning one wind blade with the tower).

- The initial design, and any subsequent upgrades, of windfarm installations should reduce the quantity and height of ancillary or supporting vertical infrastructure located between the turbines.
- Wind Met Masts locations clearly recorded.
- Predetermined notification procedures to the fire fighting agencies' aircraft dispatch State Air Desk of any fire in the proximity of the windfarm.

7.4 Recommendations for Fire Suppression (Response)

- Call 000
- Shut down turbines in vicinity of reported fire.
- Attempt to suppress initial ignition on site and call CFS.
- Liaise with the local CFS brigade and other emergency services, to assist familiarise them with power operations, infrastructure and procedures.
- Provide liaison person to support incident management during bushfires.
- Respond to instructions and follow all advice from CFS during incidents.
- Unless otherwise advised, or it is dangerous to do so, staff leave early and seek a Bushfire Safer Place (during a bushfire on a total fire ban day)

In addition, the CFS ensure all responding crews, including aircraft:

- Continue to encourage a Safety-First culture.
- Undertake a pre-season briefing to familiarise local crews with new access roads and tracks, infrastructure sites, evacuation points and safe zones, low fuel areas and natural firebreaks.
- Maintain watch out crew on elevated platforms.

7.5 Recommendations for Recovery

- Debrief incident with staff and/or contractors.
- Encourage staff/ contractors to seek counselling and allied medical services.
- Describe and record impacts.
- Replace or repair affected assets and infrastructure.
- Discuss impacts with neighbours.
- Facilitate control of weeds

7.6 Recommendations for Review

- The plan is reviewed after the completion of the construction phase.
- The plan is reviewed earlier if there are changes to legislative requirements, fuel loads, risk factors, infrastructure development or a major fire event has occurred.
- Subsequent plans reviewed at an interval of 5-10 years.

8 CONCLUSION

The wind turbines and associated infrastructure proposed in the Twin Creek Wind Farm development does not fundamentally pose more risk than any other form of development or activities expected in rural environments.

The existing legislative requirements and agency operating principles provide clear expectations of landholder's fire prevention responsibilities and solid operating platforms for fire crews.

Construction of roads that also serve as fire access tracks and fire breaks; managing vegetation close to assets with zoning prescriptions and liaising closely with local fire fighting brigades should provide a basis for sound fire management planning into the future.

The constant and dynamic risk that is associated with fire fighting operations is always changing and evolving. All fire-fighters and incident management teams are trained to operate safely within this complex environment.

By following the recommendations in this plan, Twin Creek Wind Farm will not significantly increase bushfire risk within the landscape or preclude emergency service operations either on the ground or in the air. It is anticipated that fire crews will maintain a "safety first" approach to fire fighting and all land owners and contractors will undertake works as per their legal obligations.

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TWIN CREEK WIND FARM

Shadow Flicker and Blade Glint Assessment

Twin Creek Energy Pty Ltd

Report No.: 170894-AUME-R-01, Rev. G
Date: 26 June 2017
Status: Final

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Contact person:	Daniel Leahy	
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DNV GL - Energy
Renewables Advisory
Suite 25, Level 8
401 Docklands Dr
Docklands, VIC 3008
Australia
Tel: +61 3 9600 1993

Task and objective:
Twin Creek Wind Farm Shadow Flicker and Blade Glint Assessment

Prepared by:	Verified by:	Approved by:
Jules Jobin Senior Engineer, Developer Support Services	Michael Quan Engineer, Developer Support Services	Trenton Gilbert Principal Engineer, Head of Section, Developer Support Services

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Reference to part of this report which may lead to misinterpretation is not permissible.

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	2016-10-06	First issue – DRAFT	J Jobin	N Brammer	T Gilbert
B	2017-03-17	Revised layout and turbine model	J Jobin	M Quan	T Gilbert
C	2017-03-17	Minor wording changes	J Jobin	M Quan	T Gilbert
D	2017-03-17	Minor wording changes	J Jobin	M Quan	T Gilbert
E	2017-05-10	Changes to dwelling list	J Jobin	M Quan	T Gilbert
F	2017-05-31	Comments regarding impact on road users	J Jobin	M Quan	T Gilbert
G	2017-06-26	Revision to project description - Final Issue	J Jobin	M Quan	T Gilbert

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EXECUTIVE SUMMARY

Garrad Hassan Pacific Pty Ltd ("DNV GL") has been commissioned by Twin Creek Energy Pty Ltd ("TCE" or "the Customer") to independently assess the expected annual shadow flicker duration in the vicinity of the proposed Twin Creek Wind Farm. This document has been prepared pursuant to DNV GL proposal L2C-124853-AUME-P-001-C, dated 04 March 2016, and a consultancy agreement between TCE and DNV GL, dated 27 June 2016, and is subject to the terms and conditions therein.

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 maximum potential duration of shadow flicker experienced at a specific location can be 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. This method has been used to determine the shadow flicker duration at sensitive locations neighbouring the Twin Creek Wind Farm.

However, this analysis method tends to be conservative and typically results in over-estimation of the number of hours of shadow flicker experienced at a dwelling /1/. Therefore, an attempt has been made to quantify the likely reduction in shadow flicker duration due to turbine orientation and cloud cover and hence predict the actual shadow flicker duration likely to be experienced at a dwelling.

TCE has commissioned DNV GL to assess the shadow flicker based upon the turbine layout currently proposed for the Twin Creek Wind Farm. The proposed layout is composed of 51 Vestas V136 turbines /2/, with a hub height of 112 m and a rotor diameter of 136 m.

TCE has also provided the locations of 289 dwellings in the area surrounding the wind farm /3/. The digital elevation model (DEM) used to define the terrain at the site was created from a high-resolution LiDAR DEM /4/ for the immediate site area, and SRTM1 DEM /5/ for the extended site area. These have been used to determine the theoretical duration of shadow flicker experienced at each dwelling due to the presence of the Twin Creek Wind Farm.

Planning SA published a draft Wind Farm Planning Bulletin (Draft SA Planning Bulletin) in 2002 /7/, which lists shadow flicker as an issue which *"need[s] to be taken into account when considering the design of wind farms"*. Similarly, the Wind Farm Development Guidelines published by the Central Local Government Region of South Australia (Central SA Guidelines) in 2014 /8/ state that shadow flicker *"need[s] to be taken into account as part of the planning assessment"* for wind farm developments.

While neither the Draft SA Planning Bulletin nor the Central SA Guidelines discuss a methodology for assessing shadow flicker, or allowable shadow flicker durations, the Central SA Guidelines also refer to the EPHC Draft National Wind Farm Development Guidelines (Draft National Guidelines) released in July 2010 /6/, which include recommendations for shadow flicker limits relevant to wind farms in Australia.

The Draft National Guidelines recommend that the modelled theoretical shadow flicker duration should not exceed 30 hours per year, and that the actual 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.

This assessment was based on the methodology recommended in the Draft National Wind Farm Development 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 results indicate that, of the dwellings identified by TCE, there are locations within 50 m of a single dwelling, identified as dwelling 147, that are predicted to experience shadow flicker, with a maximum theoretical duration of 29.3 hours per year. Based on information provided by TCE, this dwelling is owned by a project stakeholder, and it is not predicted to experience theoretical shadow flicker durations in excess of the recommended limit of 30 hours per year within 50 m of the dwelling.

When considering the predicted actual shadow flicker duration, which takes into account the reduction in shadow flicker due to turbine orientation and cloud cover, the maximum shadow flicker duration in the vicinity of dwelling 147 is predicted to reduce to 11.7 hours per year, which is above the recommended limit for actual shadow flicker of 10 hours per year within 50 m of the house location. It should however be noted that the Draft National Guidelines considers compliance in cases where the maximum theoretical duration limit is satisfied.

The prediction of the actual shadow flicker duration does not take into account any reduction due to low wind speed, vegetation, or other shielding effects around each house in calculating the number of shadow flicker hours. Therefore, the values presented may still be regarded as conservative. The effects of shadow flicker can also be reduced through a number of mitigation measures such as the installation of screening structures or planting of trees (if not already in place) to block shadows cast by the turbines, or the use of turbine control strategies which shut down turbines when shadow flicker is likely to occur.

It should also be noted that, with regards to shadow flicker impact on passing vehicles, the Draft National Guidelines state that *"there is a negligible risk associated with distraction of vehicle drivers who experience shadow flicker"*. Therefore, shadow flicker impact on passing vehicles is not expected to be a problem for the proposed wind farm.

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

1 PROJECT DESCRIPTION

Twin Creek Energy Pty Ltd ("TCE") proposes to develop the Twin Creek Wind Farm within the mid north area of South Australia. The site of the proposed wind farm is approximately 90 km northeast of Adelaide and northeast of Kapunda.

1.1 Project overview

TCE has advised that the proposed wind farm will consist of the following components:

- Up to 51 Wind Turbines Generators (WTG)
    - Each WTG has a capacity up to 3.6 Megawatts (MW), with a total installed wind capacity up to 183 MW
    - Overall height of turbines would be up to 180 metres at the blade tip
- Associated hard standing areas and access roads
- Operations and maintenance building and compound with associated car parking
- Two electrical substations
- 50 MW battery energy storage facility
- Overhead and underground electrical cable reticulation
- Overhead transmission line for approximately 15 kilometres from the on-site substation to the existing overhead Robertstown - Tungkillo transmission line east of Truro
- Meteorological masts for measuring wind speed and other climatic conditions
- Temporary construction facilities including a borrow pit and concrete batching plant facilities.

2 PROJECT SITING/LOCALITY DESCRIPTION

2.1 The site

The proposed Twin Creek Wind Farm site is located in South Australia, approximately 80 km northeast of Adelaide, near the town of Kapunda. The general location of the site is shown in Figure 1.

The site area is located on a series of hills and ridges, and is mostly composed of complex terrain, with turbine base elevations ranging from approximately 215 m to 461 m. Ground cover at the majority of the site consists of cleared fields and grassland.

The digital elevation model (DEM) used to define the terrain at the site was created from a high resolution LiDAR DEM /4/ for the immediate site area, and SRTM1 DEM /5/, for the extended site area.

2.2 Proposed wind farm layout

The shadow flicker modelling conducted for this assessment assumed the proposed wind farm will be composed of 51 wind Vestas V136 turbines, with the turbine dimensions relevant to the shadow flicker assessment as follows:

- rotor diameter of 136 m
- hub height of 112 m.

A list of coordinates of the proposed 51 turbine locations is provided in Table 1.

2.3 House locations

A list of houses neighbouring the wind farm was supplied to DNV GL by TCE /3/. The coordinates of the dwellings found within 1410 m of the turbine locations are presented in Table 2.

DNV GL has assumed that all listed houses are potential inhabited residential locations. Dwellings situated more than 1410 m from turbine locations will have predicted annual shadow flicker durations of zero hours due to the shadow flicker distance limit assumed for the analysis, as discussed further in Section 4.1 and Section 5.1.2.

It should be noted that DNV GL has not carried out a detailed and comprehensive survey of house locations in the area and is relying on information provided by the Customer.

3 INTRODUCTION

Garrad Hassan Pacific Pty Ltd ("DNV GL") has been commissioned by TCE ("the Customer") to independently assess the expected annual shadow flicker duration in the vicinity of the proposed Twin Creek Wind Farm. The results of this work are reported here. This document has been prepared pursuant to DNV GL proposal L2C-124853-AUME-P-001-C, dated 04 March 2016, and a consultancy agreement between TCE and DNV GL, dated 27 June 2016, and is subject to the terms and conditions therein.

4 REGULATORY REQUIREMENTS

4.1 Shadow flicker

Planning SA published a draft Wind Farm Planning Bulletin (Draft SA Planning Bulletin) in 2002 /7/, which lists shadow flicker as an issue which *"need[s] to be taken into account when considering the design of wind farms"*. Similarly, the Wind Farm Development Guidelines published by the Central Local Government Region of South Australia (Central SA Guidelines) in 2014 /8/ state that shadow flicker *"need[s] to be taken into account as part of the planning assessment"* for wind farm developments.

While neither the Draft SA Planning Bulletin nor the Central SA Guidelines discuss a methodology for assessing shadow flicker, or allowable shadow flicker durations, the Central SA Guidelines also refer to the EPHC Draft National Wind Farm Development Guidelines (Draft National Guidelines) released in July 2010 /6/, which include recommendations for shadow flicker limits relevant to wind farms in Australia

The Draft National Guidelines recommend that the modelled theoretical shadow flicker duration should not exceed 30 hours per year, and that the actual 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 either the Central SA Guidelines, Draft SA Planning Bulletin or 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 800 m to 1400 m for modern wind turbines (which typically have rotor diameters of 80 m to 140 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 800 m to 1325 m for modern wind turbines (which typically have maximum blade chord lengths of 3 m to 5 m).

The Draft National Guidelines also provide commentary on the negligible risk of distraction of vehicle drivers, and state the following:

> *"There is a negligible risk associated with distraction of vehicle drivers who experience shadow flicker, for the following reasons:*
>
> - *Shadow flicker is little different for a vehicle in motion than the effect of shadows from trees on the side of the road or high passing vehicles, neither of which represent a significant risk in terms of road transport.*

- *In spite of extensive searches, no references to motor vehicle accidents caused by this phenomenon have been found.*

It is noted, however, that until wind farms become widespread in Australia they will represent a novelty that could cause distraction for drivers (regardless of shadow flicker). Consideration should be given to development of viewing areas for wind farms close to high volume roads.

4.2 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."

5 ASSESSMENT METHODOLOGY

5.1 Shadow flicker

5.1.1 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).

5.1.2 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 locations.

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 (meaning that if shadow flicker is predicted to occur in any 1-minute period, the model records this as 1 minute of shadow flicker) and a line-of-sight resolution of 1 m. The shadow flicker map was generated using a temporal resolution of 5 minutes and a line-of-sight resolution of 5 m to reduce computational requirements to acceptable levels.

As part of the shadow flicker assessment, it is necessary to make an assumption regarding the maximum length of a shadow cast by a wind turbine that is likely to cause annoyance due to shadow flicker. The UK wind industry considers that a limit of 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 1360 m, based on the turbine dimensions specified in Section 2.2.

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

5.1.3 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.

5.1.4 Predicted actual duration

As discussed above in Section 5.1.3, there are a number of factors which may reduce the incidence of shadow flicker, such as cloud cover and variation in turbine orientation, that are not taken into account in the calculation of the theoretical shadow flicker duration. Exclusion of these 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 to these effects and therefore predict the actual shadow flicker duration likely to be experienced at a dwelling.

Cloud cover is typically measured in 'oktas' or eighths of the sky covered with cloud. DNV GL has obtained climate statistics data from a number of nearby Bureau of Meteorology (BoM) stations. From the stations assessed, the following five stations had the required cloud cover data available:

- 023307 Kapunda /10/
- 023373 Nuriootpa PIRSA /11/
- 023343 Rosedale (Turretfield Research Centre) /12/
- 023763 Mount Crawford Forest Headquarters /13/
- 023083 Edinburgh RAAF /14/

The cloud cover data used for the assessment consists of twice daily approximations of the percentage of cloud cover visible across the sky provided as monthly averages.

The average annual cloud cover value obtained from readings at 9 am and 3 pm at these stations is 4.1 oktas. As such, on an average day, approximately 52% of the sky in the vicinity of the wind farm is covered with clouds. An assessment of the likely reduction in shadow flicker duration due to cloud cover was conducted on a monthly basis, with average monthly cover ranging from approximately 39% to 63%.

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 was derived from data collected by the site mast, and 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 2. 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.

5.2 Blade glint

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

6 ASSESSMENT RESULTS

6.1 Shadow flicker

A shadow flicker assessment was carried out at all provided dwelling locations, or 'receptors', located within 1410 m of the proposed Twin Creek Wind Farm, as outlined in Table 2.

The theoretical predicted shadow flicker durations at all dwellings identified to be affected by shadow flicker are presented in Table 4. The maximum predicted theoretical shadow flicker durations within 50 m of these receptors are also presented in this table. In addition to the tabular results, the theoretical annual occurrence of shadow flicker is shown graphically in Figure 3, for the worst-case location within 50 m of dwelling 147.

The theoretical predicted shadow flicker durations are also shown in the form of a shadow flicker map in Figure 4 and as shadow flicker contours in Figure 6. The shadow flicker values presented in these maps represent the maximum theoretical shadow flicker duration, considering 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 TCE, a single dwelling is predicted to experience some shadow flicker based on the methodology recommended by the Draft National Guidelines. Furthermore, none of the locations modelled within 50 m of the dwelling are predicted to experience shadow flicker exceeding the limit of 30 hours per year, as recommended by the Draft National Guidelines.

An assessment of the level of conservatism associated with the theoretical results has been conducted by calculating the possible reduction in shadow flicker duration due to turbine orientation (based on the wind measurements obtained at the site) and cloud cover. These adjusted results are presented as predicted actual shadow flicker durations in Table 4 and Figure 5. Consideration of turbine orientation and cloud cover reduces the predicted shadow flicker duration at dwelling 147 by approximately 52%, resulting in an actual shadow flicker duration within 50 m of the dwelling location that is above the limit of 10 hours per year, as recommended by the Draft National Guidelines. It should however be noted that the Draft National Guidelines considers compliance in cases where the maximum theoretical duration limit is satisfied.

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 micro-siting of turbines.

6.2 Blade glint

As discussed in Section 5.2, blade glint is not generally a problem for modern wind turbines provided that the blades are coated with a non-reflective paint.

7 CONCLUSIONS

An analysis has been conducted to determine the annual duration of shadow flicker experienced at dwellings in the vicinity of the proposed Twin Creek Wind Farm, based on the methodology proposed in the Draft National Guidelines. The results of the assessment are presented in the form of shadow flicker maps in Figure 4 to Figure 6. The shadow flicker results for each house location predicted to be affected by shadow flicker are also listed in Table 4.

The theoretical shadow flicker modelling conducted at the site indicates that no dwelling is expected to exceed the 30-hr limit recommended by the Draft National Guidelines. Upon consideration of the likely shadow flicker reduction due to could cover and rotor orientation, the maximum shadow flicker duration expected within 50 m of dwelling 147 is expected to exceed the 10-hr limit recommended by the Draft National Guidelines; with a value of 11.7 hr/yr. It should however be noted that the Draft National Guidelines considers compliance in cases where the maximum theoretical duration limit is satisfied.

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

If shadow flicker presents a problem, mitigation strategies to reduce the duration of shadow flicker experienced at a dwelling can include: installation of screening structures or planting of trees to block shadows cast by the turbines, use of turbine control strategies which shut down turbines when shadow flicker is likely to occur, or relocation of turbines.

It should also be noted that, with regards to shadow flicker impact on passing vehicles, the Draft National Guidelines state that *"there is a negligible risk associated with distraction of vehicle drivers who experience shadow flicker"*. Therefore, shadow flicker impact on passing vehicles is not expected to be a problem for the proposed wind farm.

Blade glint is not likely to be an issue provided non-reflective coatings are used on the turbine blades.

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Table 1 Turbine layout for the proposed Twin Creek Wind Farm

WTG ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	WTG ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
T1	321026	6200205	388	T27	323772	6203076	437
T2	321360	6200955	376	T28	322719	6203537	442
T3	322403	6200826	438	T29	322046	6203820	423
T4	321993	6201019	435	T30	321713	6204052	406
T5	321620	6201367	412	T31	321308	6204303	421
T6	320952	6201223	374	T32	321201	6204679	384
T7	319882	6201452	349	T33	324338	6203141	454
T8	320250	6201090	329	T34	323586	6203550	425
T9	322950	6201222	432	T35	322782	6204095	455
T10	322538	6201521	436	T36	322249	6204368	453
T11	322022	6201882	412	T37	321973	6204642	418
T12	322572	6201943	406	T38	324342	6203539	480
T13	322322	6202456	380	T40	324060	6203843	446
T14	320971	6202391	349	T42	323325	6204676	427
T15	320036	6202498	341	T43	322719	6204664	453
T16	320224	6203111	350	T44	323646	6204246	425
T17	321816	6202690	392	T45	323837	6204811	439
T18	323643	6202084	428	T46	323611	6205227	447
T19	323292	6202686	425	T47	323205	6205593	470
T20	322886	6202903	407	T48	323115	6205082	462
T21	322371	6203086	426	T49	322641	6205411	423
T22	321826	6203111	392	T50	321133	6203686	364
T23	321590	6203414	404	T51	321050	6202928	347
T24	320666	6204049	353	T52	321374	6201812	356
T25	324225	6202148	432	T53	323112	6202183	415
T26	323887	6202670	451				

Notes:

1. Coordinate system: MGA Zone 54, GDA94 datum.

Table 2 Dwelling locations within 1410 m of turbines at the Twin Creek Wind Farm

House ID	Easting[1] [m]	Northing[1] [m]	Nearest turbine ID	Distance to nearest turbine [m]
74	320270	6205615	T32	1320
75	321830	6206405	T49	1283
147	319969	6205165	T24	1316

Notes:

1. Coordinate system: MGA Zone 54, GDA94 datum.

Table 3 Shadow flicker model settings for theoretical shadow flicker calculation

Model setting	Value
Maximum shadow length	1360 m
Year of calculation	2029
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	25 m grid centred on house location and 8 points evenly spaced on a 50 m radius circle centred on the house location
Grid resolution for shadow flicker mapping	10 m

Table 4 Theoretical and predicted actual annual shadow flicker durations for the proposed Twin Creek Wind Farm

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]	
				SF at 2 m	SF at 6 m	SF at 2 m	SF at 6 m	SF at 2 m	SF at 6 m	SF at 2m	SF at 6 m
147	319969	6205165	T32	23.8	24.2	29.1	29.3	9.4	9.7	11.7	11.6
			Annual duration limits	***30***		***30***		***10***		***10***	

Notes:

1. *Dwellings identified in Table 2 with no shadow flicker limit have been omitted from this table.*
2. *Coordinate system: MGA Zone 54, GDA94 datum.*
3. *Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation.*

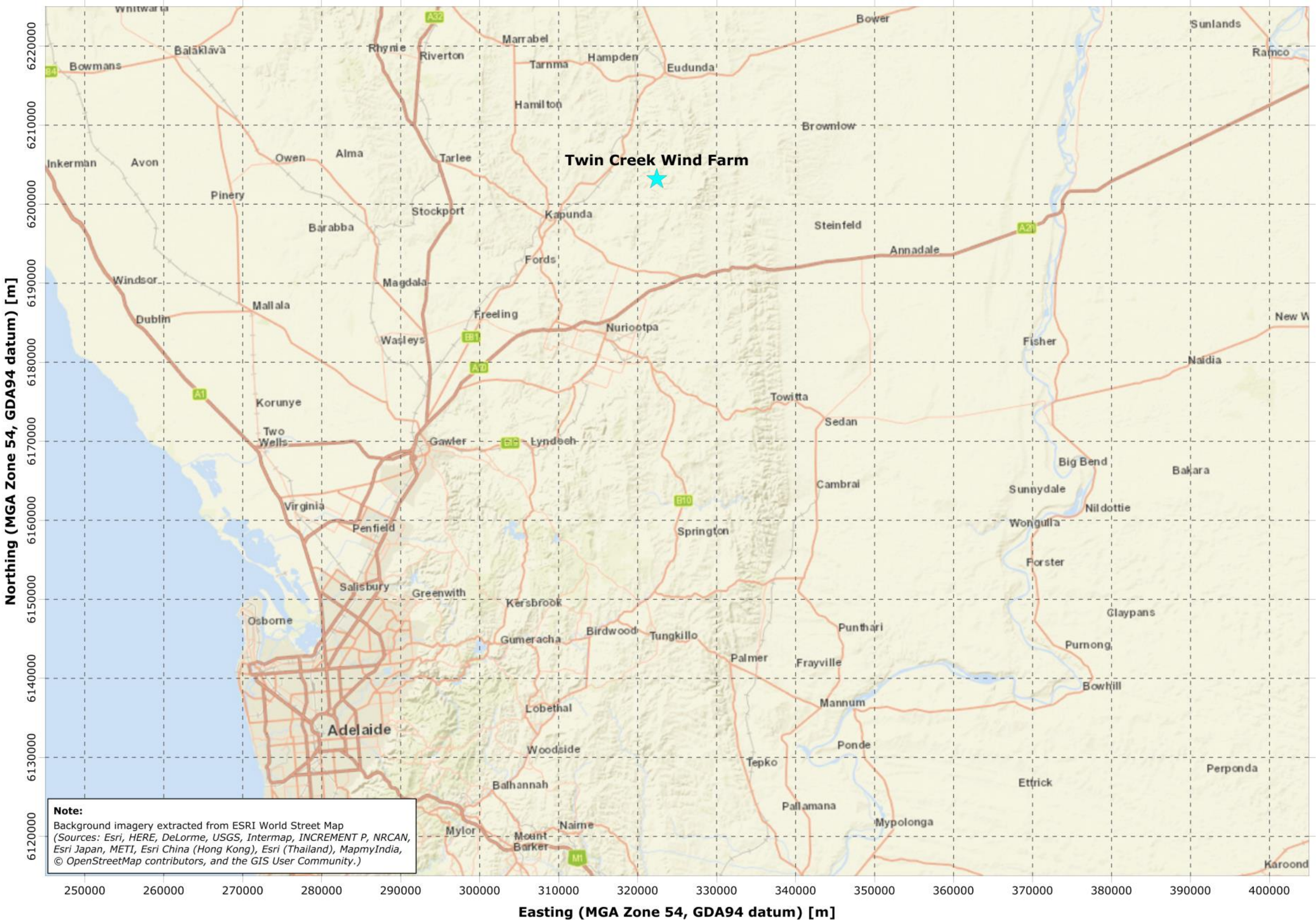

Figure 1 Location of the Twin Creek Wind Farm

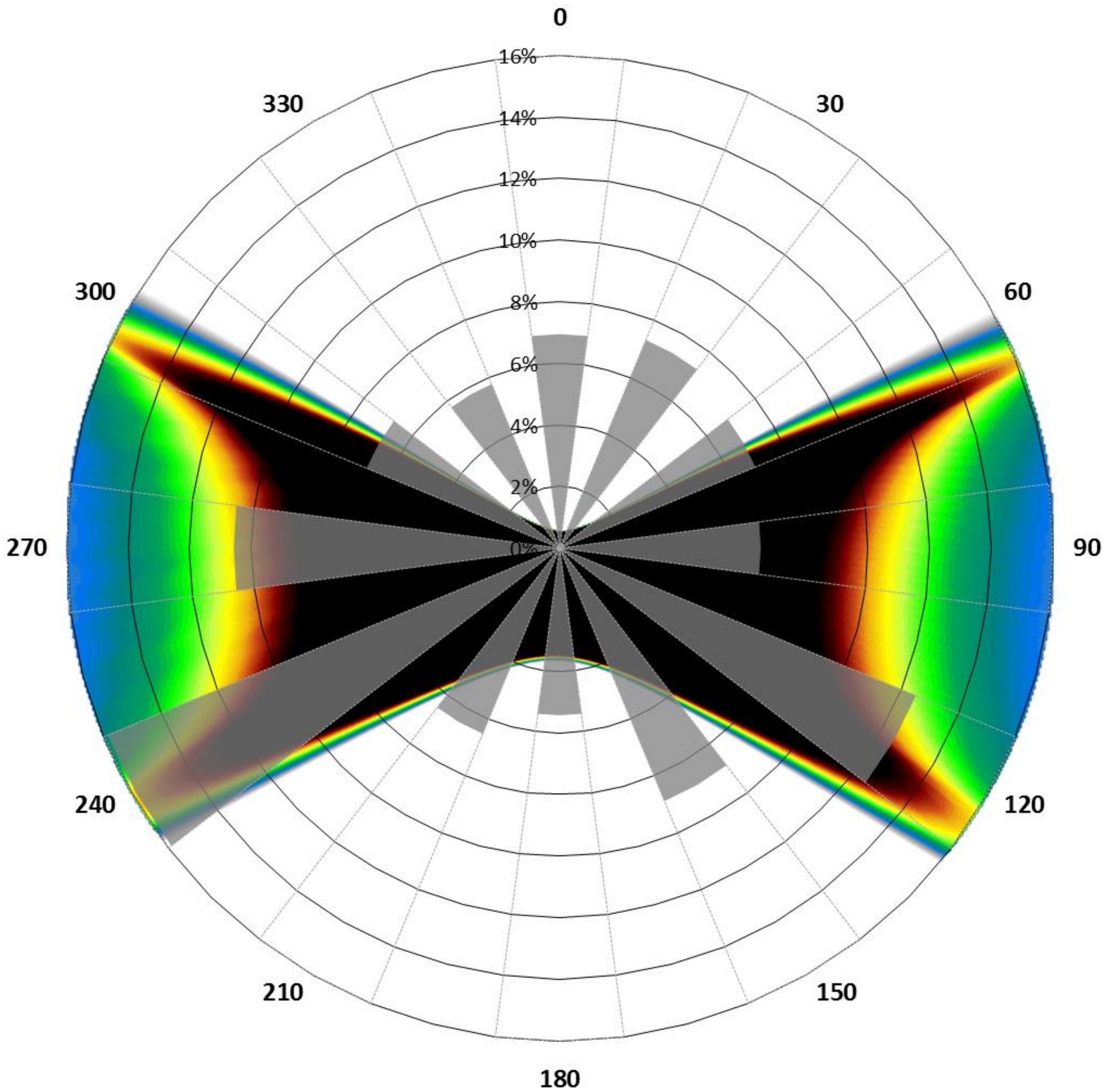

Figure 2 Indicative shadow flicker map and wind direction frequency distribution

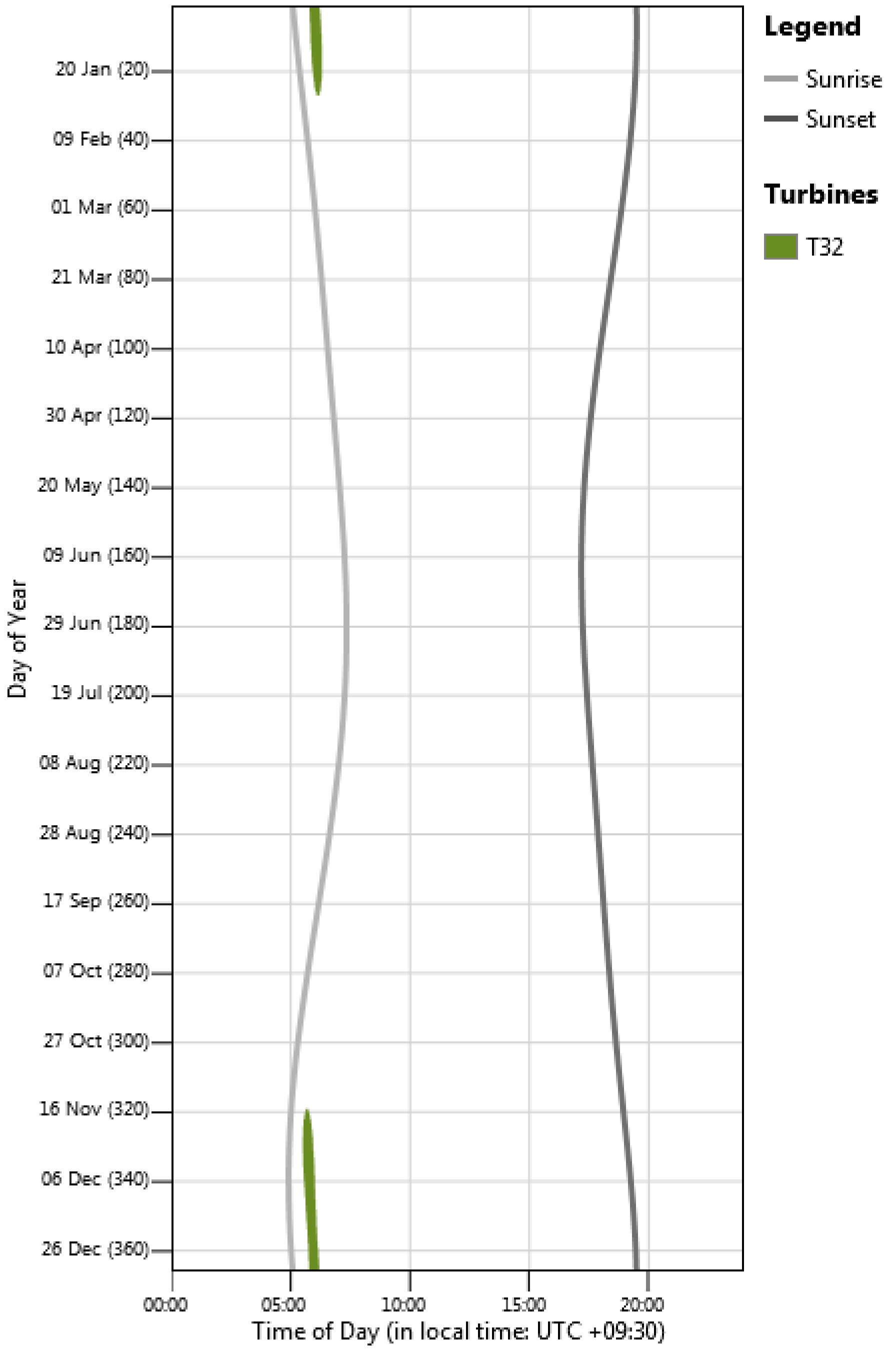

Figure 3 Worst case annual theoretical shadow flicker occurrence at dwelling 147

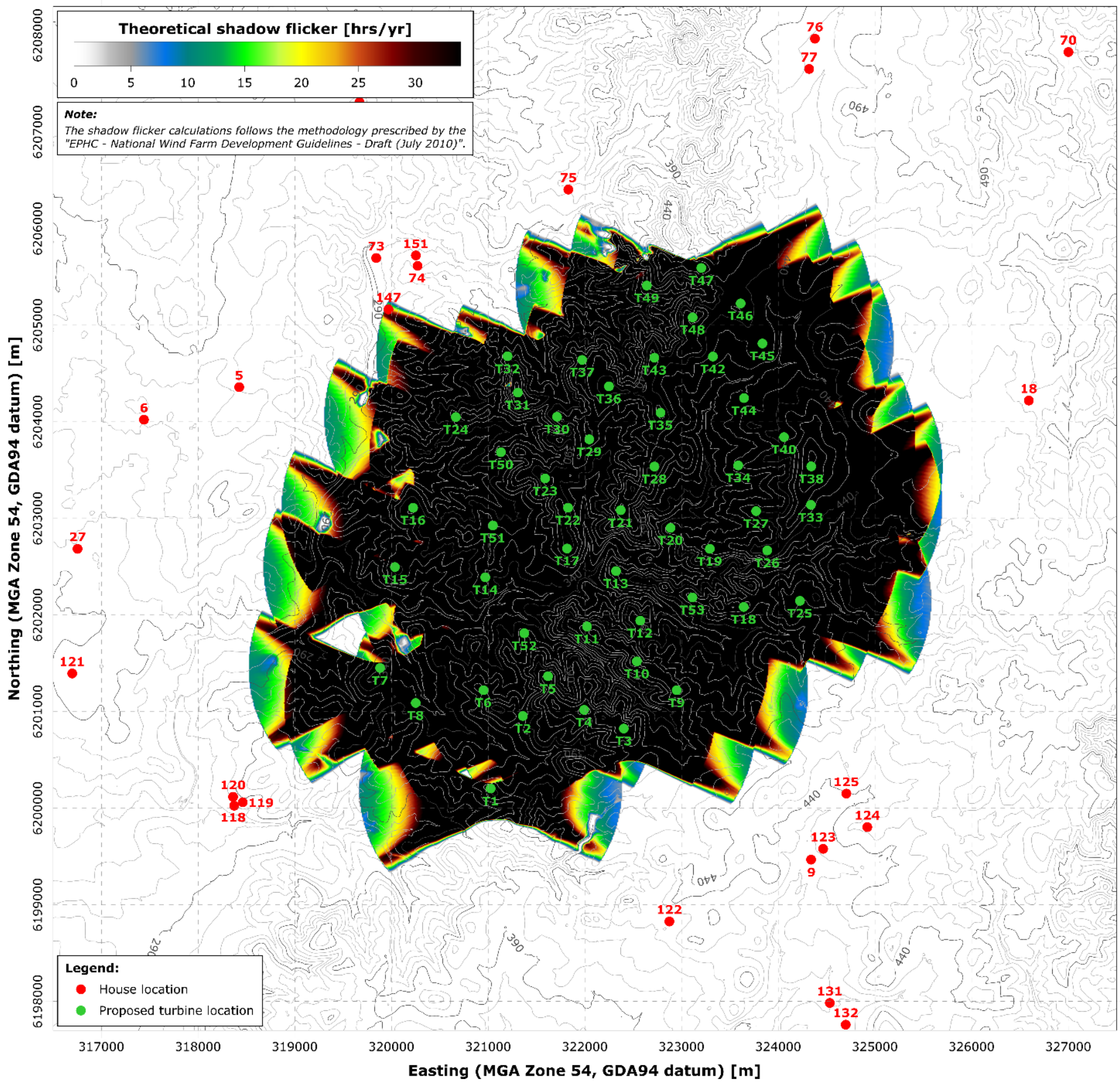

Figure 4 Theoretical annual shadow flicker duration map for the proposed Twin Creek Wind Farm, considering shadow flicker at 2 m and 6 m above ground level

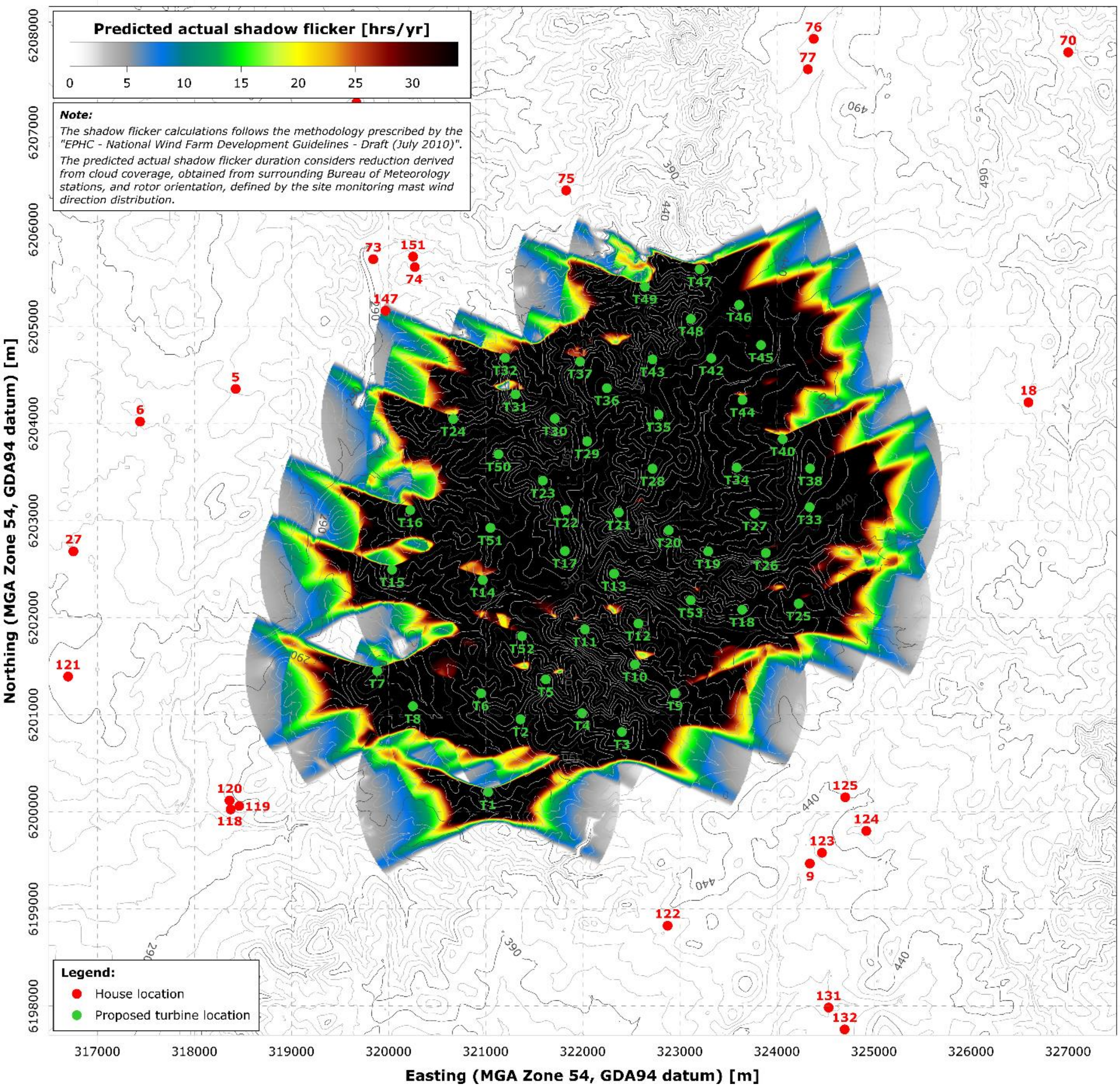

Figure 5 Predicted actual annual shadow flicker duration map for the proposed Twin Creek Wind Farm, considering shadow flicker at 2 m and 6 m above ground level

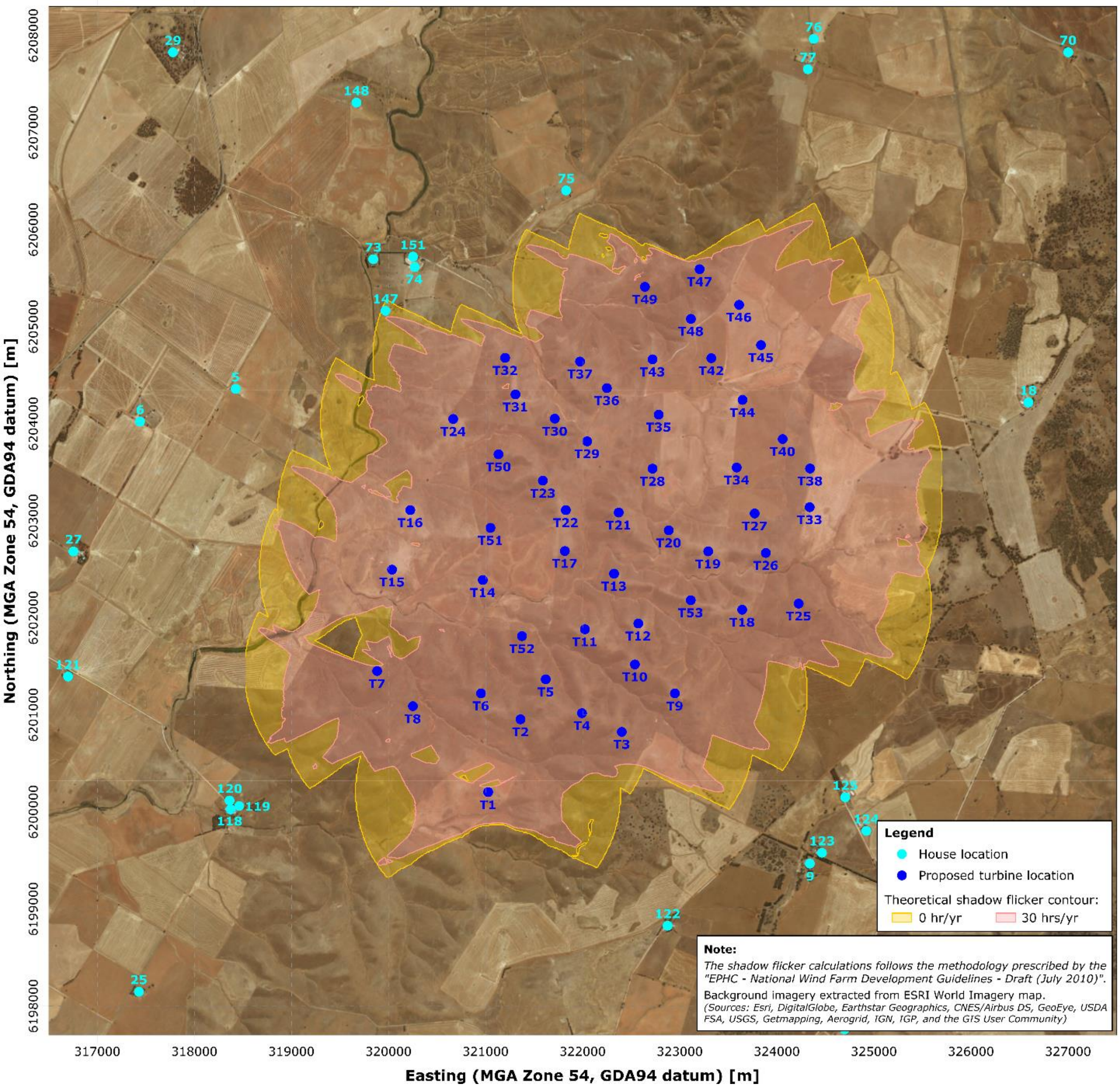

Figure 6 Theoretical annual shadow flicker duration contours for the proposed Twin Creek Wind Farm, considering shadow flicker at 2 m and 6 m above ground level

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TWIN CREEK WIND FARM

EMI Assessment

Twin Creek Energy Pty Ltd

Report No.: 170894-AUME-R-02, Rev. E
Date: 26 June 2017
Status: Final

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Report title:	EMI Assessment	Renewables Advisory
Customer:	Twin Creek Energy Pty Ltd	Suite 25, Level 8
	Suite 4, Level 1	401 Docklands Drive
	760 Pacific Highway	Docklands, VIC 3008
	Chatswood, NSW 2067	Australia
Contact person:	Daniel Leahy	Tel: +61 3 9600 1993
Date of issue:	26 June 2017	ABN 19 094 520 760
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Twin Creek Wind Farm EMI Assessment

Prepared by:	Verified by:	Approved by:
Naomi Brammer Engineer	Fowzi Dahhan Engineer	Trenton Gilbert Principal Engineer

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Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	2016-10-07	First issue – DRAFT	N Brammer	F Dahhan	T Gilbert
B	2017-03-17	Revision to include feedback from stakeholder consultation and updated turbine layout and dimenions – DRAFT	N Brammer	F Dahhan	T Gilbert
C	2017-04-08	Revision based on client comments	N Brammer	F Dahhan	T Gilbert
D	2017-05-17	Revision to include updated dwelling list	N Brammer	F Dahhan	T Gilbert
E	2017-06-26	Revision of project description - Final Issue	N Brammer	F Dahhan	T Gilbert

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EXECUTIVE SUMMARY

DNV GL Australia Pty Ltd ("DNV GL") has been commissioned by Twin Creek Energy Pty Ltd ("TCE" or "the Customer") to independently assess potential electromagnetic interference (EMI) impacts associated with the development and operation of the proposed Twin Creek Wind Farm ("the Project") in the mid north area of South Australia.

This report summarises the results of an EMI assessment conducted for the site.

Regulatory requirements

This document assesses the potential risks regarding interference with radiocommunication services operating in the vicinity of the Project in accordance with the Draft South Australian Planning Bulletin [1], Central South Australian Guidelines [2], and Draft National Wind Farm Development Guidelines [3]. In relation to EMI, these guidelines provide advice and methodologies to identify likely affected parties, assess EMI impacts, consult with affected parties, and develop mitigation steps to address the likely EMI impacts.

Methodology

The Customer has asked DNV GL to assess the potential EMI impacts of the Project based upon a layout consisting of 51 wind turbines, as outlined in Table 5 and Figure 1.

The Vestas V136-3.45MW turbine with a rotor diameter of 136 m and tip height of 180 m has been considered for the EMI assessment. These dimensions represent the maximum overall tip height within the maximum blade/rotor and tower hub height dimensions. Two hundred and eighty-nine dwellings have been identified in the vicinity of the Project [4], as outlined in Table 6, eight of which belong to associated landholders.

Information relating to telecommunication licences in the vicinity of the Project has been obtained from the Australian Communications and Media Authority [5], with other relevant information obtained from publicly-available sources as required. Services considered include fixed point-to-point links, fixed point-to-multipoint links, emergency services radiocommunications, meteorological radars, trigonometrical stations, Citizen's band radio and mobile phones, wireless internet, satellite television and internet, and broadcast radio and television.

The assessment methodology employed throughout this study has been informed by the methodology outlined in the relevant planning guidelines and various standard industry practices. For point-to-point microwave links, typically used for line-of-sight transmissions between two sites, an exclusion zone has been established around each signal path based on the operating frequency, distance along the link, and turbine blade length. Turbines located within the calculated exclusion zone have the potential to interfere with that signal. Similarly, turbines that intersect the line-of-sight for satellite television and internet signals at dwellings in the vicinity of the Project may interfere with those services. For terrestrial television broadcasts, dwellings that have increased potential to experience interference to broadcast signals have been identified based on the regions around each turbine in which forward scattering and back scattering of signals is likely to occur.

In many cases, however, assessment of the potential EMI impacts on radiocommunication services requires additional information from the service operators. DNV GL has contacted the operators of services in the vicinity of the Project to inform them of the proposed wind farm development and seek feedback regarding the potential for interference to their operations and services.

Results and findings

The results of this assessment, including the expected EMI impacts for the Project and feedback obtained from stakeholders, are summarised in the table on the following page.

Interference to fixed point-to-point links passing over the Project boundaries is considered unlikely as there are no turbines located within the calculated exclusion zones for those links.

Although base to mobile station style communications such as television and radio broadcasting and commercial and private mobile telephony services are generally unlikely to be affected by wind farms, interference may be experienced in areas of poor or marginal reception. If interference to television and radio reception is increased as a result of the Project, a range of options are available to rectify difficulties.

Conclusions

This EMI assessment has found that the Project has the potential to impact on a number of radiocommunication services in vicinity of the Project. Specifically, the turbines at the Project may interfere with digital television broadcast signals received from the Adelaide broadcast towers at houses surrounding the Project, particularly in areas where the residents currently experience poor or marginal reception. Interference to the FM radio signal broadcast by the nearby Flow FM transmission tower may also be experienced near the edges of the signal coverage area to the west and northwest of the Project.

DNV GL has assessed potential EMI impacts on point-to-multipoint links, emergency services, and wireless internet services through consultation with service operators. DNV GL has also consulted with other organisations operating services that may be affected by the development and operation of the Project to seek feedback regarding any potential EMI-related impact the Project could have on their operations and services. While DNV GL considers that interference to fixed point-to-point links passing over the Project boundaries is unlikely, it is noted that one operator, SA Water, has expressed concerns regarding potential impacts on their link. All other responses received to date indicate that the Project is unlikely to have any impact on the relevant services.

Summary of EMI assessment results for the proposed Project

Licence or service type	Assessment findings	Stakeholder feedback (to date)
Fixed point-to-point links	Three links crossing Project boundary: *SA Water* No turbines in exclusion zone	Potential for interference
	W & L Phillips Pty Limited (Flow FM) No turbines in exclusion zone	No concerns raised
	NBN Co No turbines in exclusion zone	No concerns raised
Fixed point-to-multipoint links	Seven base stations within 20 km of Project boundary: Aussie Broadband (one site) Barossa Valley Golf Club (one site) SA Water (two sites) SA Power Networks / Telstra (one site – shared) The Barossa Council (one site) Treasury Wine Estates Vintners (one site)	Potential for interference to SA Power Networks point-to-multipoint link; resolved with proposed exclusion zone
Emergency services	Point-to-point links: No links crossing boundary Mobile telephony systems: unlikely to be affected	No concerns raised
Meteorological radar	Unlikely to be affected	Potential for interference to Buckland Park radar; satisfied with proposed turbine locations
Trigonometrical stations	Unlikely to be affected	No concerns raised
Citizen's band radio	Unlikely to be affected	-
Mobile phones	Unlikely to be affected, may experience interference in areas with marginal coverage	No concerns raised
Wireless internet	Available services: Agile Communications, Aussie Broadband, NBN May experience interference in areas with marginal coverage	No concerns raised
Satellite television and internet	No signals intercepted	-
Radio broadcasting	AM signals: unlikely to be affected FM signals: may experience interference in close proximity to turbines FM signals from nearby Flow FM transmission tower: may experience interference in areas with marginal reception to the east and northeast of the Project Digital radio signals: unlikely to be affected	AM and digital radio signals: no consultation required FM signals: potential for interference to Flow FM signal
Television broadcasting	May experience interference in areas with poor or marginal reception *Adelaide tower: 'variable' to 'good' coverage across site* Ten dwellings in potential interference zone	-
	Eudunda, Renmark/Loxton, and Waikerie towers: 'variable' coverage to north and east of site No dwellings with coverage in potential interference zone	-

1 PROJECT DESCRIPTION

Twin Creek Energy Pty Ltd ("TCE" or "the Customer") proposes to develop the Twin Creek Wind Farm within the mid-north area of South Australia. The site of the proposed wind farm is approximately 90 km northeast of Adelaide, and northeast of Kapunda.

1.1 Project overview

TCE has advised that the proposed wind farm will consist of the following components:

- up to 51 wind turbines generators (WTG)
  - each WTG has a capacity up to 3.6 megawatts (MW), with a total installed wind capacity up to 183 MW
  - overall height of turbines would be up to 180 m at the blade tip
- associated hard standing areas and access roads
- operations and maintenance building and compound with associated car parking
- two electrical substations
- 50 MW battery energy storage facility
- overhead and underground electrical cable reticulation
- overhead transmission line for approximately 15 km from the on-site substation to the existing overhead Robertstown - Tungkillo transmission line east of Truro
- meteorological masts for measuring wind speed and other climatic conditions
- temporary construction facilities including a borrow pit and concrete batching plant facilities.

2 PROJECT SITING/LOCALITY DESCRIPTION

TCE proposes to develop the Twin Creek Wind Farm within the mid north area of South Australia. The site of the proposed wind farm is approximately 90 km northeast of Adelaide and 11 km northeast of Kapunda. The proposed development is located between the townships of Kapunda, Eudunda, and Truro.

The site is located on the tablelands that form the wide ridgeline associated with Bald Hill and Long Hill situated within the Northern Mount Lofty Ranges.

Landform of the area is defined by numerous ridgelines that run north-south through the site creating a series of parallel ridges, wide open valleys, tablelands, and isolated topographic features.

Surrounding the site of the proposed development, the landscape is dominated by grazing with open paddocks defined by fenced boundaries and occasional trees to fence lings and creek lines. The land use that occurs in the open valley floor between the local ridgelines and across the tablelands associated with Bald Hill is more diverse with areas of arable cropping and grazing.

3 INTRODUCTION

Twin Creek Energy Pty Ltd ("TCE" or "the Customer") has commissioned DNV GL Australia Pty Ltd (DNV GL) to carry out an independent assessment of electromagnetic interference (EMI) related impacts associated with the proposed Twin Creek Wind Farm ("the Project"). The results of this work are reported here. This document has been prepared pursuant to DNV GL proposal L2C-124853-AUME-P-001 Issue C, dated 4 March 2016, and a consultancy agreement between TCE and DNV GL, dated 27 June 2016, and is subject to the terms and conditions therein.

In accordance with the Planning Bulletin: Wind Farms – Draft for Consultation (Draft SA Planning Bulletin) prepared by Planning SA in August 2002 [1], the Wind Farm Development Guidelines for Developers and Local Government Planners (Central SA Guidelines) prepared by the Central Local Government Region of South Australia in June 2014 [2], and the National Wind Farm Development Guidelines – Draft (Draft National Guidelines) prepared by the Environment Protection and Heritage Council (EPHC) in July 2010 [3], this assessment investigates the potential EMI impact of the Project on:

- fixed point-to-point links
- fixed point-to-multipoint links
- radiocommunications assets belonging to emergency services
- meteorological radars
- trigonometrical stations
- Citizen's band (CB) radio and mobile phones
- wireless internet
- satellite television and internet
- broadcast radio and television.

4 REGULATORY REQUIREMENTS

There are three sets of guidelines that are potentially relevant to the assessment of electromagnetic interference impacts for wind farms in South Australia.

The Draft SA Planning Bulletin [1] states that wind farms *"should be sited, designed and operated in a manner that… minimises the potential for nuisance or hazard to nearby property owners/occupiers, road users and wildlife by way of… interference to television and radio signals"*.

Similarly, the Central SA Guidelines [2] currently state:

> *"The effect of wind turbines on electromagnetic waves will usually be relatively limited. Potential electromagnetic interference effects can be calculated from information about affected telecommunications transmitting or receiving stations, local conditions, turbine design and location. The potential for electromagnetic interference from the generation of electricity from a wind energy facility should be minimised, if not eliminated, through appropriate turbine design and siting. The siting of wind turbines in the 'line of site [sic]' between transmitters and receivers should be avoided."*

Although both the Draft SA Planning Bulletin and Central SA Guidelines describe the importance of assessing EMI related impacts, they do not provide detailed methodologies for these assessments.

The EPHC, in conjunction with Local Governments and the Planning Ministers' Council released a draft version of the National Wind Farm Development Guidelines in July 2010 (Draft National Guidelines) [3]. The Draft National Guidelines cover a range of issues across the different stages of wind farm development.

The main purpose of the Draft National Guidelines is to provide detailed methodologies to assess issues related to wind farms including community consultations, shadow flicker, noise monitoring, EMI, impacts on landscapes, and flora and fauna. Other issues that are covered to a lesser extent in the guidelines include aircraft safety, blade glint, risk of fire and indigenous heritage.

In relation to EMI, the Draft National Guidelines provide advice and methodologies to identify likely affected parties, assess EMI impacts, consult with affected parties and develop mitigation steps to address the likely EMI impacts.

DNV GL considers that the recommendations of the Draft National Guidelines meet, if not exceed, the recommendations of the Draft SA Planning Bulletin and Central SA Guidelines, and therefore the Draft National Guidelines have been used to inform the methodology adopted for this assessment.

5 METHODOLOGY AND RESULTS

If not properly designed, wind farms have the potential to interfere with radiocommunications services. Two services that are most likely to be affected include television broadcast signals and fixed point-to-point microwave signals. Terrestrial broadcast signals are commonly used to transmit domestic television, while microwave links are used for line-of-sight connections for data, voice and video. The interference mechanisms are different for each of these and, hence, there are different ways to avoid interference.

The Customer has asked DNV GL to complete this assessment based upon a layout provided for the Project consisting of 51 wind turbines [6]. A map of the site with the proposed turbine layout is shown in Figure 1, and the coordinates of the proposed turbine locations are presented in Table 5.

Two hundred and eighty-nine houses have been identified in the vicinity of the Project, eight of which belong to associated landholders [4]. The coordinates of these houses are presented in Table 6, and the dwellings and site boundaries considered in this assessment are also shown in Figure 1. DNV GL has assumed that all listed houses are potential inhabited residential locations. It should be noted that DNV GL has not carried out a detailed and comprehensive survey of house locations in the area and is relying on information provided by the Customer.

For the purpose of the EMI study, the Vestas V136-3.45MW turbine with a rotor diameter of 136 m and a tip height of 180 m has been considered. These dimensions represent the maximum tip height and rotor diameter under consideration for the Project. The results generated based on this turbine configuration will be conservative for all turbine configurations with dimensions that remain inside the turbine envelope by satisfying all of the following criteria:

- a rotor diameter of 136 m or less
- an upper tip height of 180 m or less
- a lower tip height of 44 m or greater.

The Draft National Guidelines recommend that a radial distance of 50–60 km from the centre of a wind farm would normally capture all of the potentially affected services in the area. However, the methodology for assessing the potential radiocommunications interference used in this assessment is to locate all of the telecommunication towers within approximately 75 km of the proposed Project site, and then assess the telecommunication licences attached to these towers. This is to reduce the likelihood that telecommunications links crossing the site are inadvertently excluded from the assessment.

In order to conduct the EMI assessment, information regarding radiocommunications licences in the vicinity of the Project has been obtained from the Australian Communication and Media Authority (ACMA) Register of Radiocommunications Licences (RRL) database [5].

Other services with the potential to experience interference from the Project have also been identified, and the potential for interference to those services discussed, including meteorological radars, trigonometrical stations, CB radio and mobile phones, wireless internet, broadcast radio, satellite television and internet, and broadcast television.

The Draft National Guidelines recommend that consultation with the relevant operator be undertaken if a turbine is located within 2 km of a telecommunication site, within the second Fresnel zone of a point-to-point link, or within 250 nautical miles of an aeronautical or meteorological radar site. DNV GL has consulted with organisations operating services that may be impacted by the development and operation of the Project, to disseminate basic information on the Project and request responses from the organisations regarding whether they foresee any potential EMI-related impacts on their operations and services. The organisations that have been contacted and all responses received to date are summarised in Table 14.

It is noted that the responses summarised in Table 14 and discussed throughout this report were based on a previous turbine layout for the Project, as described in DNV GL report 170894-AUME-R-02 Issue A, dated 7 October 2016. Subject to confirmation from the Customer, DNV GL is intending to contact the organisations listed in Table 14 to advise them of the changes to the turbine layout and seek further feedback regarding the potential for interference to their operations and services. However, the revised turbine layout described in this report is not expected to substantially alter the results of the consultation process.

5.1 Telecommunication towers

An image of the ACMA database dated 15 July 2016 was used for this assessment [5]. From the database, there are 1351 telecommunication towers within a nominal 75 km of the Project site boundary. The locations of these telecommunication towers relative to the Project are shown in Figure 2.

5.2 Fixed licences of point-to-point (microwave) type

5.2.1 Diffraction

Wind turbines can potentially cause interference, or diffraction, of point-to-point microwave signals and in some cases, point-to-point UHF signals. It is possible to design around this issue as the path and interference zone of these signals are well known. The frequency of common microwave signals varies from approximately 1 GHz to 30 GHz. For this analysis, DNV GL has used a wider and more conservative frequency range of 0 GHz to 50 GHz. Point-to-point links are often used for line-of-sight connections for data, voice and video. Such links often exist on mobile phone and television broadcast towers.

The criteria used for avoiding diffraction effects of point-to-point signals are normally based on an exclusion zone of circular cross-section around the direct path from the transmitter to the receiver (often called boresight) [3] [7] [8]. This exclusion zone is defined in terms of Fresnel zones. The n^{th} Fresnel zone is comprised of all points for which, if the radio signal travelled in a straight line from the transmitter to the point and then to the receiver, the additional length compared to the straight transmitter-receiver path equals $\frac{n-\lambda}{2}$, where λ = wavelength.

To avoid interference to point-to-point signals, wind turbines, including the blades, should be kept outside the second Fresnel zone. The radius of the second Fresnel zone varies along the length of the signal, and is given by:

$$R_{F2} = \sqrt{\frac{2\lambda d_1 d_2}{D}}$$

Where d_1 is the distance from the transmitter

d_2 is the distance from the receiver

D is the distance from the transmitter to receiver, such that $d_1+d_2 = D$

The registered communications licences for each tower according to the ACMA database were analysed to determine the transmission paths of licenced links that may experience interference from wind turbines.

Each individual link is given a unique identifier or "Assignment ID" so that it can be readily distinguished. This Assignment ID is taken as either the Device Registration ID (for spectrum licences associated with the use of certain frequency band within a particular geographic area) or the EFL ID (for apparatus licences associated with the use of a particular device).

The paths resulting from the towers analysed are shown in Figure 3. It can be seen that not all of the identified transmission towers have a fixed licence of point-to-point type transmission vector. Some towers have no active licences associated with them, and some towers are used solely for point-to-area style transmissions, such as some emergency services towers.

A review of the ACMA database shows that there are three links passing over the proposed Project site (operated by SA Water, W & L Phillips Pty Limited (Flow FM), and NBN Co Limited). The links are shown in greater detail in Figure 4.

References [3] [7] [8] state that turbines should be located outside of either the first or second Fresnel zone in order to avoid interference to that link. For each of the identified links around the site, an exclusion zone has been established based on their operating frequencies, the second Fresnel zone, plus the blade length for turbines with a 136 m rotor diameter. The potential exclusion zones are also shown in Figure 4.

It is common practice to have multiple Assignment IDs for the same physical link to cover practicalities such as licensing for sending and/or receiving signals. Accordingly, the Fresnel zone setback has been calculated on the Assignment ID with the lowest frequency. Details of the links are provided in Table 7.

The turbines located within or near the second Fresnel zone for each point-to-point link crossing the proposed Project site are summarised in Table 1 below. There are no turbines located within the exclusion zones for any of the point-to-point links passing over the proposed Project site.

Table 1 Details of turbines located within or near the second Fresnel zones for point-to-point links crossing the proposed Project

Link no.	Assignment ID's for minimum frequency	Operator	Turbines within exclusion zone[1]
1	752339, 752340	SA Water	None (T24 within 44 m)
2	790526, 790527	W & L Phillips Pty Limited (Flow FM)	None (T1 within 60 m)
3	1401120, 1401121	NBN Co Limited	None

1. Distances between turbine locations and the edges of the calculated exclusion zones have been measured perpendicular to the signal path using a geographic information system (GIS) application.

DNV GL has contacted the operators of these links to determine the likelihood that the proposed Project will cause interference to their operations and services. Responses have been received from all three operators. Both Flow FM and NBN Co have indicated that they do not expect their point-to-point links to be impacted by turbines at the Project.

SA Water have expressed concerns regarding the potential for turbines at the Project to interfere with their point-to-point link crossing the Project site, but have declined to comment on the proposed turbine locations or propose a suitable exclusion zone to avoid interference. SA Water have advised that the Customer proceed at their own risk, and that "any impact on the SA Water point-to-point link post construction will be the responsibility of the wind farm developer/owner to remedy". DNV GL recommends that turbines at the Project be kept outside the second Fresnel zone for the SA Water point-to-point link in order to minimise the potential for interference.

A preliminary assessment was also carried out to determine if the links pass over the Project at a height that is well above the highest point of the turbines (maximum tip height of 180 m). This was achieved by examining the elevation and tower heights at each end of the link, as well as the approximate elevation of the areas within the Project boundaries over which the link crosses. It was determined that the links do cross the site at a height which has the potential to intersect with turbine blades.

5.2.2 Near field effects and scattering

The Draft National Guidelines [3] mention the possibility of interference to point-to-point links from two additional mechanisms, near field effects and scattering.

According to the Draft National Guidelines, near field effects are usually limited to approximately 720 m from a communication tower and it is recommended that consultation is required if a turbine is within 1 km of a telecommunication site. The Draft National Guidelines also state that scattering is best avoided by placing wind turbines more than 2 km from a communication tower.

All telecommunication towers are greater than 2 km from the Project, with the closest communication towers (Site IDs 24226 and 24226) located approximately 2.7 km from the proposed site boundary or 3.5 km east of the nearest wind turbine (turbine T25). It is not expected that these towers will experience interference due to near field effects or scattering.

5.3 Fixed licences of point-to-multipoint type

Fixed licences of the point-to-multipoint type are a variation of the point-to-point type. The difference between them is administrative. A point-to-point licence permits communication between two static sites, where the locations of the sites are detailed in the licence register. A point-to-multipoint licence allows communication between one or more static sites and multiple points or between the points. The point-to-multipoint type is usually licensed for a defined operational area.

Administratively, the ACMA database details the location of the static station for a fixed licence of the point-to-multipoint type. Hence, the location of the transmission vectors is not readily identifiable. A review of fixed licences of point-to-multipoint types was undertaken and 222 Assignment ID's were identified within approximately 75 km of the proposed site. These licences are shown in Figure 5. The details of the licence holders as per the ACMA database are provided in Table 8.

There are seven point-to-multipoint base stations listed in the ACMA database within 20 km of the Project boundary. These stations are operated by Aussie Broadband Pty Ltd (Site ID 9012660), Barossa Valley Golf Club Inc (Site ID 501154), SA Water (Site ID 24263 and 9007183), SA Power Networks (Site ID 24227), Telstra (Site ID 24227), The Barossa Council (Site ID 9011554), and Treasury Wine Estates Vintners Limited (Site ID 138906). It is assumed that the two point-to-multipoint base stations operated by Barossa Valley Golf Club and Treasury Wine Estates Vintners are associated with communication or irrigation system networks that are confined to the property around the station, and so interference with these services is unlikely. Since it is not possible to determine if there are any potential impacts on the services provided by the other five point-to-multipoint base stations without knowing the locations of each station in the network, DNV GL has contacted the operators of these stations as part of the consultation process to seek feedback on whether their services are likely to be affected by the Project. Responses have been received from several operators, as summarised in Table 14.

As a result of the consultation process, SA Power Networks has advised that they operate a fixed link between their point-to-multipoint base station at Mt Rufus (Site ID 24227) and an electrical substation at Kapunda which crosses the Project site. The link details are given in Table 2, and the path of this link is shown in Figure 6. DNV GL has established an exclusion zone for the link based on the minimum operating frequency, the second Fresnel zone, plus the blade length for turbines with a 136 m rotor diameter, as described in Section 5.2.1. The potential exclusion zone is also shown in Figure 6, and it can be seen that there are no turbines located within the exclusion zone for the SA Power Networks link passing over the proposed Project site. SA Power Networks have confirmed that they are satisfied with an exclusion zone based on the second Fresnel zone, and that they do not expect their link to be impacted by turbines located outside this zone.

Table 2 Details of point-to-multipoint link crossing the proposed Project

	Transmitter		Receiver		
Operator	Latitude [GDA94]	Longitude [GDA94]	Latitude [GDA94]	Longitude [GDA94]	Minimum frequency [MHz}
SA Power Networks	-34.315312	139.127007	-34.335294	138.886801	452.344

There are a number of point-to-multipoint stations at a distance of greater than 20 km from the site. Although it is unlikely that stations at this distance will be servicing customers in the vicinity of the site, DNV GL has also contacted the operators of all potentially affected stations within 60 km of the centre of the Project to seek feedback on any potential impact that the Project could have on their services. Responses have been received from several operators, as summarised in Table 14, and no concerns have been raised to date.

5.4 Other licence types

A review of the ACMA database for other licences was conducted. These licences are shown in Table 9 and Figure 7.

Many of the licences identified can be broadly described as base to mobile station style communications, including radio broadcasting and commercial and private mobile telephony. These licence types are generally not affected by the presence of wind turbines any more than other effects such as terrain, vegetation, and other forms of signal obstruction. Should reception difficulty be encountered, the amelioration method consists of the user simply moving to receive a clearer signal.

A number of broadcasting licences have been identified. These are likely to consist of radio and television broadcasting services, and are considered in Sections 5.13 and 5.14.

A number of aeronautical licences, and radiodetermination licences which may be used for aircraft navigation, have been identified. DNV GL understands that potential impacts to these services will be considered as part of an aviation impact study.

5.5 Emergency services

A review of the ACMA database was conducted to identify emergency services with licences for radiocommunications assets operating in the vicinity of the Project. The groups identified are listed in Table 10 along with their contact details. DNV GL has contacted the operators of all stations within approximately 60 km of the centre of the Project to seek feedback regarding any potential impact that the Project could have on their operations and services. Responses have been received from several operators, as summarised in Table 14, and no concerns have been raised to date.

5.6 Aircraft navigation systems and radar

DNV GL understands that a separate aviation impact study will be undertaken to assess the impact of the Project on nearby aviation navigation systems and radar.

5.7 Meteorological radar

The Bureau of Meteorology (BoM) operates a network of weather stations across Australia and uses radar instruments for measuring wind speeds in the upper atmosphere (known as "wind finding" radar), and determining rain and storm activity (known as "weather watch" radar).

The "wind finding" radar uses radar echoes from a target to determine the wind speeds and direction. The radar target is attached to a balloon and tracked by the ground radar. The "weather watch" radar, or "weather surveillance" radar, consists of a rotating antenna located on a building, and kept free from any physical obstruction. The antenna is used to direct a thin beam of radio energy upward into the atmosphere which is then reflected back by a cloud mass. The location of the cloud is then determined by the direction and travel time of the reflected beam.

Wind profile measurements are used to ensure the safe and economical operation of aircraft and provide an important source of data for the BoM's general weather forecasting system. "Weather watch" radars monitor weather situations and are able to indicate the possibility of severe storms out to as distance of 250 km or more. Hence, whilst the uninhibited operation of meteorological radars may not be as critical as aviation radar, there are implications for public safety if severe weather is not predicted or if its approach is masked due to EMI.

The World Meteorological Organisation (WMO) currently states that wind turbines should not be located within 5 km of a meteorological radar site, due to the high risk of interference to the radar signal and subsequent loss of weather data [9]. For wind farms located within 20 km of a radar, the WMO recommends consultation and analysis be undertaken to assess the likelihood of turbines interfering with the radar signals or Doppler velocity measurements. Similarly, the Network of European Meteorological Services (EUMETNET) recommends that, to avoid potential for interference, wind turbines should not be located within 5-10 km of a meteorological radar, depending on the antenna frequency band, and that an impact study should be undertaken for wind turbines located within 20-30 km of a radar site [10].

Wind farms located at distances greater than 5 km from a BoM weather station are unlikely to affect wind finding operations [3]. Generally, the optimal coverage area for "weather watch" radar extends approximately 200 km from the radar installation at a height of approximately 3000 m [11] [12], and approximately 100 km at a height of 1000 m [12]. Theoretically, wind farms can impact upon weather watch radar when located within several hundred kilometres of a radar station, however, due to the curvature of the earth, and intervening terrain, the range at or near ground level is generally less.

According to the Draft National Guidelines, consultations with operators of weather stations within 250 nautical miles (463 km) of the proposed Project should be undertaken [3]. It has been identified that the BoM operates five weather stations within that range with the closest station, "Buckland Park" (Adelaide), located approximately 58 km southwest of the Project site, or 63 km from the nearest turbine location. The locations of these stations are shown in Figure 8 and the details of each station can be found in Table 11.

Given that the distances between the BoM radar installations and the turbine locations are more than twice the distance at which the WMO and EUMETMET recommend that an impact study be undertaken, it is expected that impact on the radar signals will be minimal.

DNV GL has contacted the BoM regarding the Project, in accordance with the recommendations of the Draft National Guidelines, to seek feedback on whether interference to their operations and services is likely. The response received from the BoM indicates that the WMO guidelines are currently under review and that the recommended impact study distances are expected to be doubled. The BoM has therefore expressed concerns regarding the potential for turbines at the Project to interfere with their Buckland Park radar, resulting in clutter and false artefacts. However, noting that all of the turbines at the Project are more than 60 km from the Buckland Park radar site, the BoM has advised that they are satisfied with the proposed turbine locations.

5.8 Trigonometrical stations

A trigonometrical station, also known as a trig point or a trig beacon, is an observation mark used for surveying or distance measuring purposes. Some trig points may host surveying equipment such as Global Positioning System (GPS) antennas and electronic distance measuring (EDM) devices. EDM devices measure the distance from the trig point to the target object by means of a beam of known velocity which is reflected back to the unit from the target object. Most EDM devices require the target object to be highly reflective and, accordingly, a reflective prism is placed on the target object being surveyed. The effective range of EDM devices depends on the wavelength bands used. Light wave and infrared systems have an effective range of 3 to 5 km while microwave systems can measure distances up to 150 km. However, such systems are not limited by the line of sight or affected by visibility [13].

Global navigation satellite system (GNSS) technology is also commonly used for surveying and distance measurements, as it enables users to accurately determine their geographic location using positioning and timing information received from satellite signals. Geoscience Australia currently operates several GNSS networks across Australia, including the Australian Regional GNSS Network (ARGN) and the AuScope GNSS network [14]. The ARGN is comprised of 20 permanent GNSS Continuously Operating Reference Stations (CORS) which provide the geodetic framework for the spatial data infrastructure in Australia and its territories. Eight stations from the ARGN form the Australian Fiducial Network (AFN) [15], through which the Geocentric Datum of Australia (GDA) is defined. The ARGN also provides information for the measurement of geological processes and contributes data to the International GNSS Service. Additional geospatial information aimed at enhancing the accuracy and resolution of the National Geospatial Reference System is provided by the AuScope GNSS network of around 100 CORS strategically distributed across the country. Several Australian states also operate GNSS CORS networks, although DNV GL understands that such a network is not currently available in South Australia. GNSS stations are typically equipped with EDM devices and GPS receivers, and transmit data to Geoscience Australia or the relevant state authority via phone lines, internet, and/or satellite communications.

The closest ARGN or AuScope GNSS station is located approximately 55 km southwest of the Project, at Adelaide [16]. Due to the significant distance between the Project and the GNSS station, it is considered unlikely that the Project will cause interference to the GNSS network.

DNV GL has also undertaken a review of the primary geodetic network of Australia [17] and it has been observed that the Project is located within the first-order triangulation region. First-order triangulation depends on trigonometrical stations of known positions, baselines and heights, with the highest degree of accuracy. Points determined from first-order triangulation are then used for the second-order triangulation network and so forth, with the degree of accuracy decreasing for subsequent networks.

According to Geoscience Australia [16], there are 56 trig points within 20 km of the Project site boundary. Two trig points, Bald Hill and 6729/1004, are located inside the site boundary approximately 2.4 km southwest of the nearest proposed turbine location (turbine T1). The details of all 56 trig points are provided in Table 12 and illustrated in Figure 9.

Although it is unlikely that the trig points in close proximity to the Project host EDM devices or other equipment that may be subject to EMI, DNV GL has contacted Geoscience Australia and the South Australian Land Services Group to inform them of the Project, and seek feedback regarding whether interference to their systems is possible. Responses have been received from both Geoscience Australia and the South Australian Land Services Group, and no concerns have been raised.

5.9 Citizen’s band radio

Citizen’s band radio, also known as CB radio, is a class-licensed two-way, short distance, communication service that can be used by any person in Australia, for private or work purposes. It is commonly used in rural areas for emergency communications, road safety information, communication between recreational travellers, and general conversation. The class licence implies that all users of the CB radio operate within the same frequency range on a shared basis and no individual licence is required.

The CB radio service can be used for voice communications activities, telemetry, and telecommand applications. The radio service operates on two frequency bands, namely the high frequency (HF) band at between 26.965 MHz and 27.405 MHz, and the ultra-high frequency (UHF) band at between 476.425 MHz and 477.400 MHz.

The 27 MHz CB radio service was legalised in Australia in the 1970s as a temporary move to switch to UHF CB over the following five years, and transmits signals in either AM (amplitude modulation) or SSB (single side band) transmission mode. The actual range over which the signal is transmitted depends on the antenna used, the terrain, and the interference levels. Over the last decade, the use of the 27 MHz CB radio service has declined and has been replaced by UHF CB radio service.

The UHF CB radio service is unique in Australia and uses the FM (frequency modulation) transmission mode. It provides clear communication over 5–20 km and is less susceptible to power line noise. However, the UHF CB radio service requires "line-of-sight" and is easily hindered by hilly terrain and forested areas. If located on a hilltop, CB radio signals can be transmitted over at least 50 km. Repeater stations are set up on hilltops by community groups and commercial organisations to transmit signals from one channel to another.

No individual or organisation owns or has the right to use a channel exclusively. However, out of the 40 channels available, some of them will be allocated to emergency, telemetry, or repeater inputs.

Since users of CB radio services do not require a licence, there is no record of users of the service and their locations and the channels are shared among the users and the repeater stations without a right of protection from interference. The impact of the Project on CB radio services is expected to be minimal. In the event of interference from the wind turbines, simple steps such as moving a short distance until the signal strength improves would help to mitigate the impact.

5.10 Mobile phones

Mobile phone networks typically operate at frequencies of either between 700 and 900 MHz, or between 1800 and 2600 MHz, however some new services may operate at up to 3500 MHz. At such frequencies, signals are likely to be affected by physical obstructions such as buildings and wind turbines. However, mobile phone networks are designed to operate in such conditions and in most cases, if there is sufficient mobile network coverage and signal strength, the presence of wind turbines is unlikely to cause any interference.

In rural areas, the mobile network coverage may be more susceptible to physical obstructions due to the large distance between the phone towers and the mobile phone user. In that case, it is theoretically possible that wind turbines could cause some interference to the signal, although there is little evidence of this in the literature.

A review of mobile phone towers in the vicinity of the proposed Project has been carried out. The locations of these towers are shown in Figure 10. The nearest mobile phone tower is located approximately 5 km to the north of the Project boundary.

Mobile phone network coverage maps have been obtained for Optus Mobile, Telstra, and Vodafone.

Figure 11 shows the Optus Mobile network coverage for the Project area [18]. The map shows outdoor 3G coverage at most locations in the vicinity of the Project, with some areas immediately to the east requiring an external antenna to receive 3G coverage. Some locations, particularly to the north, southwest, and southeast of the Project, may receive outdoor 4G coverage.

Figure 12 shows the Telstra network coverage for the Project area [19]. This map also shows 3G coverage in the vicinity of the Project, although an external antenna is required to receive coverage in some areas, and some areas appear to have no coverage. Areas around the Project site may also receive 4G coverage, particularly in the north, west, and southwest, but 4GX coverage is limited in the vicinity of the Project.

Figure 13 shows the Vodafone network coverage for the Project area [20]. Most locations in the vicinity of the Project have only outdoor coverage, although some locations have both outdoor and limited indoor coverage. Areas to the southwest of the Project receive good outdoor and indoor coverage.

In general, for areas with good coverage, interference to mobile phone signals is unlikely. However, for areas where the reception is likely to be marginal, such as those where an external antenna is required, the possibility for interference exists if a wind turbine intercepts the signal between a mobile phone and the tower.

DNV GL has contacted Optus Mobile, Telstra, and Vodafone to inform them of the proposed Project and to seek feedback on any potential impact that the Project could have on their services. Responses have been received from all three operators, and no concerns have been raised.

In cases of marginal network coverage, simple procedures are available to mitigate interference, such as moving a short distance to a new or higher location until the signal improves, or using an external antenna to improve the signal.

5.11 Wireless internet

Agile Communications and Aussie Broadband Pty Ltd hold point-to-multipoint licences in the vicinity of the Project, with base stations located 41 km east of the Project site and 6 km north of the Project site respectively. As the locations of Agile Communications and Aussie Broadband customers are not known, it is not possible to determine whether there is the potential for interference to these services, however it is possible that stations at these distances may be servicing customers in the vicinity of the proposed Project. Agile Communications and Aussie Broadband have been contacted by DNV GL to seek feedback regarding the potential for interference to their services. Responses have been received from both Agile Communications and Aussie Broadband, and no concerns have been raised.

Additionally, residents in the vicinity of the Project are likely to utilise Telstra wireless broadband services. Telstra's wireless broadband service utilises the same network as Telstra's mobile phone service, and therefore the comments made in Section 5.10 are applicable here. Specifically, the presence of wind turbines is unlikely to cause any interference. However should interference occur, the simple mitigation options given in Section 5.10 may be applicable.

The National Broadband Network (NBN) website [21] indicates that the network is currently available as a fixed wireless service and satellite internet service using the NBN SkyMuster satellite in the areas surrounding the Project site. It is therefore likely that some residents are currently accessing the internet via the NBN and that the network will also be available to other residents in the vicinity of the Project in the near future. NBN Co has been contacted as part of the consultation process to seek feedback on whether there is potential for the Project to cause interference to their services. No formal response has been received to date.

The potential for signals from the NBN SkyMuster satellite to be intercepted by wind turbines at the Project has been considered as part of the analysis described in Section 5.12 below.

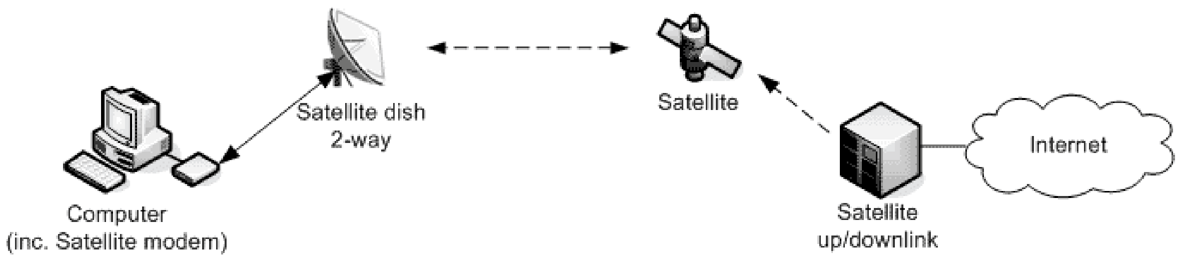
Feedback received from the Customer suggests that residents in the vicinity of the Project currently experience poor wireless internet coverage [22], however it is not clear what service these residents are currently using. Residents who have marginal wireless internet coverage may be more susceptible to interference from the wind farm, depending on the technology type, and the relative positions of the infrastructure of the internet service provider, the wind farm, and the residents.

The Customer has also indicated that some residents may be utilising wireless internet services provided by local company Beam Barossa [22]. DNV GL is intending to contact Beam Barossa to seek further information regarding their services and customers in the vicinity of the Project, and feedback on the potential for interference to their services.

5.12 Satellite television and internet

In some rural or remote areas, television and internet access can be provided through satellite only. Satellite television is delivered via a communication satellite to a satellite dish connected to a set-top box. The satellite transmits television signals to the user's antenna at two frequency bands; the C band at between 4 GHz and 8 GHz, and the Ku band at between 12 GHz and 18 GHz. Signals in the C band are susceptible to interference due to radio relay links, radar systems and other devices operating at a similar frequency while signals in the Ku band are most likely to be affected by rain which acts as an excellent absorber of microwave signals at this frequency. DNV GL understands that there are currently 20 satellites that can provide television to the east coast of Australia [23].

In the case of satellite internet, the user's computer is connected to a satellite modem which is in turn linked to a satellite dish/antenna mounted on the building roof. When the user accesses the internet, a request is sent to the operation centre of the satellite internet provider via the satellite antenna. Data is then sent back to the user's computer via the same path as shown in the figure below.



Two-way connection to the internet via satellite [24]

Due to marginal coverage of some communication services, some residents in the vicinity of the Project may utilise satellite television and internet.

A number of satellites transmit television signals that can be received in Australia. DNV GL has analysed the line-of-sight to dwellings in the vicinity of the Project for satellites which provide any television services to eastern Australia. Although only a small number of satellites are likely to be providing television services intended for Australia (e.g., Optus C1, D1, and D2), all viewable satellites have been considered.

The analysis has shown that no satellite signals to houses in the vicinity of the Project are expected to be intercepted by turbines.

The main satellites for providing satellite internet in Australia are the IPSTAR and Optus D2 satellites, and the NBN SkyMuster satellite. From the Project site, the IPSTAR, Optus D2, and

SkyMuster satellites have elevations of approximately 45.0°, 47.8°, and 50.1° respectively [25]. Therefore it is unlikely that the Project will impact upon the line-of-sight from these satellites to any house.

5.13 Radio broadcasting

Radio stations typically broadcast using one of two forms of transmission: either amplitude modulation (AM) or frequency modulation (FM). In Australia, AM radio operates in the medium wave (MW) band at frequencies between 520 kHz and 1610 kHz, while FM radio operates in the very high frequency (VHF) band between 87.5 MHz and 108 MHz. The locations of AM and FM broadcast transmitters in the vicinity of the Project were determined from the ACMA Broadcast Transmitter Database [26], and are shown in Figure 14.

5.13.1 AM radio

AM radio signals are diffracted by the ground as they propagate, such that they follow the curvature of the earth, and are also reflected or refracted by the ionosphere at night. This means that AM radio waves are able to travel significant distances under the right conditions. Due to their long wavelength, they can readily propagate around physical obstructions on the surface of the earth (such as wind turbines), however they do not propagate easily through some dense building materials such as brick, concrete, and aluminium.

The distance over which AM radio signals can travel means that the signal may be weak and susceptible to interference by the time it reaches a receiver. Some of the possible sources of interference to AM radio waves include changes in atmospheric conditions, signals from distant AM broadcasters operating on a similar frequency, electrical power lines, and electrical equipment including electric motors.

As AM radio signals are able to propagate around obstructions such as turbines, it is expected that the Project will not cause significant interference for a receiver. Additionally, due to the long wavelength of the signal, interference is only likely in the immediate vicinity of a turbine [27]. Any interference problems are likely to be easily resolved through the installation of a high quality antenna and/or amplifier.

5.13.2 FM radio

FM radio signals are better suited to short range broadcasting. Unlike lower frequency signals (such as AM signals), they are not reflected or refracted off the ionosphere. The waves are slightly refracted by the atmosphere and curve back towards the earth, meaning they can propagate slightly beyond the visual horizon, however they may be blocked by significant terrain features. FM radio stations therefore tend to have only local coverage, which means that signals are less susceptible to interference from distant FM broadcasters. FM signals are also less susceptible to interference from changes in atmospheric conditions and electrical equipment than AM signals.

FM radio signals are susceptible to interference from buildings and other structures, although they are less vulnerable than higher frequency signals. Interference to an FM signal can occur by two mechanisms: reflection or scattering of the radio waves, or physical obstruction and attenuation of the broadcast signal.

Reflection or scattering of radio waves by physical structures such as wind turbines can reduce the signal strength at a receiver, or can cause multi-path errors through reception of a reflected signal in addition to the primary signal from the transmitter. This can result in hissing, fluttering, or distortion being heard by the listener [28]. However, this type of interference is typically only experienced in the immediate vicinity (within several tens of metres) of a wind turbine, where the signal-to-noise ratio is low [27] [29]. It is unlikely that any permanent FM radio receivers will be located sufficiently close to the Project to be affected.

Wind turbines located close to an FM transmission tower may also present a physical obstruction to the radio signal. If the line-of-sight between the tower and a radio receiver is blocked by a turbine, this can cause a noticeable decrease in signal quality or may lower the signal strength below the threshold of the receiver's sensitivity [28]. In these situations, the attenuation of the signal may be as great as 2.5 dB in the direction of the obstructing wind turbine. However, this type of interference is generally only a problem near the edges of the FM signal coverage area, where the broadcast signal is already weak. For commercial FM broadcast signals, physical obstruction of the signal may occur if the turbines are located within approximately 4 km of the transmission tower [30].

The closest FM broadcast transmission tower is located approximately 2.7 km from the proposed site boundary or 3.5 km east of the nearest wind turbine (turbine T25). Given the relatively small distance between the broadcast tower and the site, it is possible that the FM radio signals from this tower could be influenced by the Project. The location of the broadcast tower in relation to the Project and the sector in which physical obstruction of the signal may occur is shown in Figure 15 and Figure 16. Since the transmission tower is located to the southeast of the proposed turbine locations, the potential interference sector extends to the west and northwest of the Project site. DNV GL has contacted the operator of this tower, Flow FM, to seek feedback on whether interference to their broadcasting services is likely.

The response received from Flow FM indicates that the turbines at the Project have the potential to cause interference to the FM radio signals broadcast from their Kapunda transmission tower, located to the east of the Project site. However, Flow FM has advised that the areas to the west and northwest of the Project site may also receive signals broadcast by their Maitland and Hallett transmission towers. Coverage maps for the radio signals from the Kapunda, Maitland, and Hallett towers have been provided by Flow FM, and have been used to identify the areas with the greatest potential to experience interference to the signal from the Kapunda tower.

The extents of the coverage areas for rural mono reception, assuming a fixed antenna height of 1.5 m, and car radio reception from the Flow FM broadcast towers at Kapunda, Maitland, and Hallett are shown in Figure 15 and Figure 16 respectively. The regions with the highest potential to experience interference to the signal from the Kapunda tower lie at the edges of the signal coverage area to the west and northwest of the Project site, at distances of approximately 35-40 km from the site for fixed antennas and approximately 40-50 km for car radios. Some residents at the edges of the Kapunda rural mono coverage area to the west of the Project are also within the coverage area for the Maitland broadcast tower, which may mitigate any interference experienced in these regions. However, there is no alternative signal available for residents to the northwest of the Project site, around the towns of Saddleworth and Auburn, and so there is increased potential for interference to cause problems in these areas.

Due to the considerable overlap between the car radio coverage areas for the Kapunda, Maitland, and Hallett broadcast towers, it is unlikely that interference arising from the Project will be a problem for car radio reception.

If interference to FM radio signals is experienced, mitigation options include installing high-quality antennas and/or amplifiers at affected residences, increasing the broadcast signal strength from the Kapunda transmitting tower or the nearby Maitland or Hallett towers, moving the Kapunda tower to a new location more than 4 km from any turbine, or installing a signal repeater on the opposite side of the Project. It is understood that the Customer is undertaking further engagement with Flow FM, to establish an understanding of how any impact to the FM radio signal from the Kapunda tower may be mitigated.

5.13.3 Digital radio

Digital radio services were introduced in metropolitan licence areas in Australia in July 2009. The digital radio services offered use an updated version of the digital audio broadcasting (DAB) digital radio standard, DAB+, to broadcast digital radio to Adelaide, Brisbane, Perth, Melbourne, and Sydney [31]. Digital radio broadcasts in Australia operate in the VHF band at frequencies between 174 MHz and 230 MHz, and therefore tend to have only local coverage within the visual horizon. According to the digital radio coverage map available on the ABC website [32], digital radio is currently available in areas to the southwest of the Project.

The UK telecommunications regulator Ofcom [28] states:

> *"In contrast [to FM signals], the signal format used for DAB digital radio is designed to offer high levels of robustness in difficult conditions and it is not materially affected by reflections. FM and DAB reception can be affected where a structure blocks signals and both may cease to function if signals are reduced below a certain threshold"*.

DNV GL has therefore concluded that DAB signals are not affected by reflection or scattering from physical structures in the same way as FM signals, and so digital radio broadcasts are generally not susceptible to interference from wind farm developments. However, interference may be experienced if the line-of-sight between a DAB transmitter and a radio receiver is blocked by a wind turbine.

The locations of the DAB transmitters in the vicinity of the Project have been determined from the Broadcast Transmitter Database [26], and are shown in Figure 14. The nearest DAB transmitter is located at Adelaide, approximately 76 km to the south southwest of the Project site.

Due to the significant distance between the transmitter and the Project, it is considered unlikely that listeners in the vicinity of the Project are receiving digital radio broadcasts. The impact of the Project on digital radio services is therefore expected to be minimal. If interference to DAB signals is encountered, it is likely to be resolved through the installation of a high quality antenna and/or amplifier or by moving the existing antenna to receive a stronger signal.

5.14 Terrestrial television broadcasting

Terrestrial television is broadcast in Australia by a number of networks, both public and commercial. As of December 2013, all television broadcasts in Australia are now digital broadcasts [26]. Digital television (DTV) signals are typically more robust in the presence of interference than analogue television signals, and are generally unaffected by interference from wind turbines. DNV GL has experience in situations where houses were able to receive adequate DTV reception in an area of adequate signal strength where the DTV signal was passing through a wind farm.

The United Kingdom telecommunications regulator Ofcom [28] states the following with regard to interference to DTV reception:

"Digital television signals are much better at coping with signal reflections, and digital television pictures do not suffer from ghosting. However a digital receiver that has to deal with reflections needs a somewhat higher signal level than one that has to deal with the direct path only. This can mean that viewers in areas where digital signals are fairly weak can experience interruptions to their reception should new reflections appear… reflections may still affect digital television reception in some areas, although the extent of the problem should be far less than for analogue television."

DNV GL has drawn two conclusions from this report:

- Firstly, that DTV is very robust and does not suffer from ghosting. In most cases DTV signals are not susceptible to interference from wind farm developments.
- Secondly, that areas of weak DTV signal can experience interruptions to their reception should new reflections appear, such as those from nearby wind turbines.

The ACMA Broadcast Transmitter Database [26] was examined to identify broadcasters nearby to the proposed Project, with those found shown in Figure 14. The main television transmitter used by residents in the vicinity of the Project is the Adelaide transmitter at Crafers. However, it is also possible that residents to the northeast of the site receive television signals from the Eudunda transmitter, while residents to the east of the site may receive television signals from the Renmark/Loxton and Waikerie transmitters.

For television broadcast signals, which are omni-directional or point-to-area signals, interference from wind turbines is dependent on many factors including:

- the proximity of wind turbines to the television broadcast tower
- the proximity of wind turbines to receivers (houses)
- the location of wind turbines in relation to houses and television broadcast towers
- the rotor blade material, rotor speed, and rotor blade direction (always into the wind)
- the properties of the receiving antenna (e.g., type, directionality, and height)
- the location of the television receiver in relation to terrain and other obstacles
- the frequency and power of the television broadcast signal.

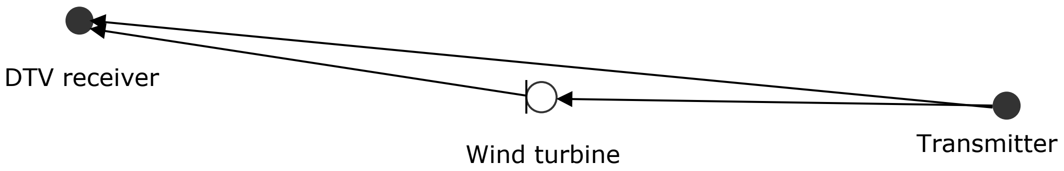
5.14.1 Large scale interference

For broadcast signals, large scale interference can generally be avoided by placing the wind turbines distant from the broadcast tower. Broadcast towers may be either relay or primary transmitters. Relay television transmitters are more commonly found in rural areas. Primary television transmitter towers are higher power and are more commonly located near large urban areas. A clearance of at least 1 km is recommended for relay television transmitters, while a clearance of at least 6 km is recommended for primary television transmitters [8]. The closest digital television transmitter to the Project is the Eudunda transmitter, which is approximately 6 km away from the site boundary and 11 km away from the nearest turbine, and so the Project is not expected to cause large scale interference.

5.14.2 Forward and back scatter

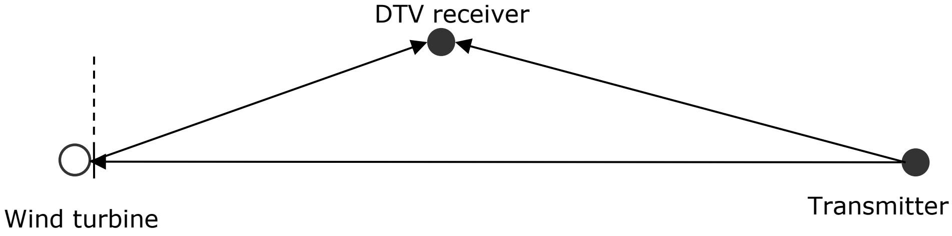
Wind turbines cause interference to television signals by introducing reflections that may be received by the antenna at a dwelling, in addition to the signal received directly from the transmitter, which causes multipath errors. A wind turbine has the potential to scatter electromagnetic waves carrying television signals both forward and back.

Forward scatter can occur when the transmitter, one or more wind turbines, and receiver are almost aligned as shown below. The forward scatter region in this case is characterised by a shadow zone of reduced signal strength behind the turbine, where direct and scattered signals can be received, with the blade rotation introducing a rapid variation in the scattered signal [33]. Both of these effects can potentially degrade the DTV signal quality.



Forward scatter signal path

Back scatter from wind turbines occurs when DTV signals are reflected from turbine towers and turbine blades onto a DTV receiver as shown below. The reflected signals are attenuated, time-delayed and phase-shifted (due to a longer path from transmitter to receiver) compared to the original signal. The reflected signals are also time-varying due to the rotation of the blades and vary with wind direction. The resultant signal at the receiver includes the original signal (transmitter to receiver) and a series of time-varying multipath signals (transmitter-turbine-receiver).



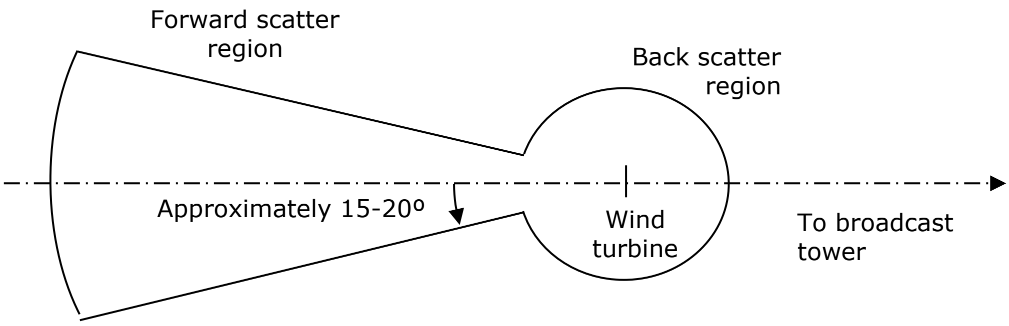
Back scatter signal path

Interference of DTV signals from wind turbine developments can potentially occur in both the forward and backward scatter region. The effect of a wind turbine on a DTV signal can be different depending on the scattering region where the receiver is located [33].

According to Ofcom [28], the forward scatter region does not typically extend further than 5 km for the worst combination of factors [8] [34]. Interference may extend beyond 5 km if the houses are screened from the broadcast tower, but do have line-of-sight to the wind turbines [28]. The shape of this region, assuming a relatively high gain, directional antenna, can be represented by a circular segment with an azimuthal range of approximately ±15° to ±20°, corresponding to the beam width of the antenna. If a lower gain or omni-directional antenna is being used, this region is likely to be larger.

Back scattered signals arrive at the house delayed relative to the source signal from the broadcast tower. The back scatter region generally does not extend further than 500 m [8] [35], assuming a high gain, directional antenna that has a relatively high front-to-back ratio (meaning the signal received by the front of the antenna is much higher than that received from the back). If an antenna with a lower front-to-back ratio, or an omni-directional antenna is used, this region is likely be larger.

The combination of the forward and back scatter regions, as shown in the following figure, resembles a keyhole.



Potential television interference zones around a wind turbine

Television interference mechanisms rely on many factors (as previously mentioned) and are complex to calculate. Previous experience has shown that even after great effort has been put into performing such calculations, they tend to have limited accuracy, and would require field validation after the wind farm is operational.

In Australia, digital television signals are transmitted using the DVB-T (Digital Video Broadcasting – Terrestrial) standard. The International Telecommunication Union (ITU) Recommendation BT.1893 [36] states the following in regards to the forward scatter region for DVB-T signals:

> *"In most of the situations where the impact of a wind farm to DVB-T reception quality was analyzed, the threshold C/N [carrier-to-noise] ratios obtained were similar to those expected in environments with the absence of wind farms. More precisely, in the forward scattering region of the wind turbines, where the transmit antenna, one or more turbines and the receive antenna are lined-up (±60° behind the wind turbine), the DVB-T reception quality may not be affected though further work of analysis is needed in order to confirm this point, especially in the vicinity of 0°."*

In other words, wind turbines are not generally expected to affect DVB-T DTV signals in the forward scatter region. However, the ITU [37] also highlight that in the case where there is significant blockage of the direct signal, but clear line-of-sight to one or more wind turbines, interference to the reception of the DTV signal is possible. Results of studies reported by the ITU also suggest that interference may be more likely in areas where the existing DTV signal is already weak or degraded [37].

With regards to back scattering, the ITU states:

> *"In the case of the backscattering region, in those situations where the scattered signals from wind turbines are significant in amplitude and variability, the threshold C/N ratio necessary for quasi error free (QEF) condition is higher."*

In other words, the C/N ratio needs to be higher in the presence of significant back scatter to achieve the same QEF condition as is the case without the presence of wind turbines, which effectively means that interference is more likely to occur as coverage quality decreases. The implications of this conclusion for dwellings in the vicinity of the Project are discussed in section 5.14.4.

5.14.3 Theoretical models for wind turbine scattering estimation

Various theoretical scatter models to predict scatter of terrestrial television signals have been proposed, some dating back to the late 1970s. A review of these models, as well as a comparison against empirical data has been reported in [38]. This comparison with empirical data found:

> *"…none of the analyzed methods seems to be accurate enough to provide realistic estimations of the signal scattered by the wind turbines. In conclusion, a more complete scattering model is needed in order to provide more practical estimations of the scattered signals and evaluate their potential impact on the broadcasting services."*

Notably, the scattering model proposed by the ITU to specifically address DTV signals [36], was found to be the most inaccurate, and does not provide signal estimations in the forward scattering zone of the blades. Additionally, DNV GL notes that it only applies to a single wind turbine rather than a wind farm as a whole. Due to the lack of an accurate scattering model, DNV GL has not performed detailed scatter calculations to predict DTV interference.

As an alternative, it is common practice to identify those dwellings or areas that are most likely to experience potential television interference based on likely forward and back scatter regions. As introduced above, this is often referred to as the 'keyhole' approach, and is an established technique for predicting where terrestrial television interference is most likely, based on a number of assumptions regarding receiving antenna characteristics. The approach involves combining multiple keyhole shaped areas that are placed over each turbine location [28]. The combination of these areas forms a region where there is an increased likelihood of interference to television signals occurring. The results of using this approach to identify the dwellings that have increased potential to receive scattered signals from a turbine in the Project, and hence have an increased likelihood of experiencing interference to television signals, are described in Section 5.14.4.

5.14.4 Potential impacts for dwellings

According to the Australian Government mySwitch website [35], the area around the Project is able to receive DTV signals from the Adelaide, Eudunda, Renmark/Loxton, and Waikerie broadcast towers. The coverage map reproduced in Figure 17 suggests that coverage from the Adelaide tower is 'variable' to 'good' across the site. Coverage maps reproduced in Figure 18 to Figure 20 suggest that coverage from Eudunda, Renmark/Loxton, and Waikerie towers is 'poor' to 'variable' and only available in the areas to the north and east of the site.

Dwellings that have increased potential to receive back-scattered or forward-scattered signals from a turbine in the Project (assuming an antenna with a sufficiently narrow beam width and sufficiently high front-to-back ratio is being used) have been highlighted using the 'keyhole' approach described above.

The results of the analysis can be seen in Table 13 and Figure 17 to Figure 20. The dwellings that are most likely to be susceptible to interference include those within the possible interference zones, as summarised in Table 3 below. Dwellings located in the potential interference zones for the Eudunda, Renmark/Loxton, and Waikerie broadcast towers are not expected to be able to receive signals from these towers, based on the coverage maps in Figure 18 to Figure 20, and are not included in Table 3 and Table 13. Note that if the signal received at a dwelling from the transmitter is sufficiently weak, or an antenna with insufficient directional discrimination is installed (i.e., a low gain or omni-directional antenna), interference may still occur outside of the identified interference zones.

Table 3 Number of dwellings located within potential interference zones for digital television broadcast towers in the vicinity of the Project site

Digital television broadcast tower	Number of dwellings within potential interference zone
Adelaide (Crafers)	10 (3 dwellings belonging to associated landholders)

Although DTV signals are generally unlikely to be susceptible to interference from wind turbines in areas of adequate coverage, interference could be encountered in areas where coverage is marginal and antennas at dwellings may receive a reflected signal from a turbine that is of sufficient power to interfere with the signal received directly from the transmitter. Based on the coverage maps for the area around the Project, it is possible that some areas could be deemed to have marginal reception, and interference could be encountered. If reception difficulties are encountered, there are a number of mitigation options available, and these are discussed in further detail in Section 5.14.5.

The method used here to assess the potential interference to television signals from the Project represents a simplified approach which is expected to capture locations where interference is most likely to occur. This simplified analysis is deemed appropriate as the implications of potential television interference are reasonably low given the large range of mitigation options available.

5.14.5 Mitigation options

In the event that television interference is an issue during construction or after commissioning of the Project, there are several amelioration options available:

1. Realigning the householder's television antenna more directly towards their existing transmitter.
2. Tuning the householder's antenna into alternative sources of the same television signal or a substitute signal.
3. Installing a more directional and/or higher gain antenna at the affected house.

4. Relocating the antenna to a less affected position.
5. Installing cable or satellite television at the affected house.
6. Installing a television relay station.

In the event of significant interference in the backscatter region, a more directional antenna should ensure a stronger signal from the transmitter since the backscattered signal will originate from a different direction. In the case of forward scatter, the antenna will be pointed towards both the original and scattered signal and hence a more directional antenna may not alleviate a forward scatter issue, however, as noted in [33] DVB-T reception quality may not be substantially affected in the forward scatter region.

The ITU [37] identified that the receiver height can also affect interference. In areas that are relatively flat and free of vegetation, reflections can enhance or decrease the received signal strength relative to the free path signal strength. The ITU found that the received signal strength may not increase monotonically with receiver height. In other words, lowering the receiver height can improve reception in some cases.

In the event that terrestrial DTV reception cannot be improved, satellite television represents another potential amelioration option. Satellite based television comprises of both free to air and subscription based broadcasts. Residents in areas which are unable to receive DTV through their normal television antenna due to local interference, terrain or distance from the transmitter in their area may be eligible to access the Australian Government funded Viewer Access Satellite Television (VAST) service [39].

6 CONCLUSIONS

Broadcast towers and transmission paths around the Project were investigated to determine if EMI would be experienced as a result of the development and operation of the Project. The Project will involve the installation of 51 wind turbine generators. DNV GL has considered a turbine geometry that will be conservative for turbine configurations with dimensions satisfying all of the following criteria: a rotor diameter of 136 m or less and an upper tip height of 180 m or less.

The results of this assessment, including feedback obtained from relevant stakeholders, are summarised in Table 4 on the following pages. It is noted that the Project has the potential to cause interference to digital television signals received at dwellings in the vicinity of the Project, and FM radio broadcasts to the west and northwest of the Project.

DNV GL has assessed potential EMI impacts on point-to-multipoint links, emergency services, and wireless internet services through consultation with service operators. While DNV GL considers that interference to fixed point-to-point links passing over the Project boundaries is unlikely, it is noted that one operator, SA Water, has expressed concerns regarding potential impacts on their link. All other responses received to date indicate that the Project is unlikely to have any impact on the relevant services.

Potential EMI impacts on other services considered in this assessment, including meteorological radar, trigonometrical stations, CB radio, and mobile phones, are either considered to be minor or have been assessed through consultation with the service operators.

Table 4 Summary of EMI assessment results for the proposed Project

Licence/service type	Assessment findings	Stakeholder feedback (to date)
Fixed point-to-point microwave links	Three links crossing Project boundary: *SA Water* No turbines in exclusion zone *W & L Phillips Pty Limited (Flow FM)* No turbines in exclusion zone *NBN Co* No turbines in exclusion zone	 Potential for interference No concerns raised No concerns raised
Fixed point-to-multipoint microwave links	222 assignments within 75 km of Project boundary Seven base stations within 20 km of Project boundary: Aussie Broadband (Site ID 9012660) Barossa Valley Golf Club (Site ID 501154) SA Water (Site ID 24263 and 9007183) SA Power Networks / Telstra (Site ID 24227) The Barossa Council (Site ID 9011554) Treasury Wine Estates Vintners (Site ID 138906)	Potential for interference to SA Power Networks point-to-multipoint link; resolved with proposed exclusion zone
Other licence types	Base to mobile station style communications: unlikely to be affected (see "Emergency services", "Mobile phones", "Radio broadcasting", "Television broadcasting") Aeronautical and radiodetermination: to be considered as part of an aviation impact assessment	-
Emergency services	Point-to-point microwave links: No links crossing boundary Base to mobile station style communications: unlikely to be affected	No concerns raised
Aircraft navigation systems and radar	To be considered as part of an aviation impact assessment	-
Meteorological radar	Nearest station: 'Buckland Park' (Adelaide), 63 km from nearest turbine Unlikely to be affected	Potential for interference to Buckland Park radar; satisfied with proposed turbine locations

Table 4 Summary of EMI assessment results for the proposed Project (continued)

Licence/service type	Assessment findings	Stakeholder feedback (to date)
Trigonometrical stations	56 stations within 20 km of Project boundary Electronic equipment: unlikely to be affected Sight lines to other stations: may be blocked by turbines	No concerns raised
Citizen's band radio	Unlikely to be affected	-
Mobile phones	Fair to good coverage across site Unlikely to be affected, may experience interference in areas with marginal coverage	No concerns raised
Wireless internet	Likely service providers: Agile Communications, Aussie Broadband NBN: currently available in areas surrounding Project May experience interference in areas with marginal coverage	No concerns raised
Satellite television and internet	Services intended for Australia: unlikely to be affected Other services: no signals intercepted	-
Radio broadcasting	AM signals: unlikely to be affected FM signals: may experience interference (low level hiss or distortion) in close proximity to turbines FM signals from nearby Flow FM transmission tower: may experience interference in areas with poor or marginal reception to the north and northeast of the Project Digital radio signals: unlikely to be affected	AM and digital radio signals: no consultation required FM signals: potential for interference to Flow FM signal
Television broadcasting	Digital signals: may experience interference in areas with poor or marginal reception *Adelaide tower: 'variable' to 'good' coverage across site* Ten dwellings (three belonging to associated landholders) in potential interference zone	-
	Eudunda, Renmark/Loxton, and Waikerie towers: 'variable' coverage to north and east of site No dwellings with coverage in potential interference zone	-

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LIST OF TABLES

Table 5 Proposed turbine layout for the Project site [6]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
T1	321026	6200205	388	T27	323772	6203076	437
T2	321360	6200955	376	T28	322719	6203537	442
T3	322403	6200826	438	T29	322046	6203820	423
T4	321993	6201019	435	T30	321713	6204052	406
T5	321620	6201367	412	T31	321308	6204303	421
T6	320952	6201223	374	T32	321201	6204679	384
T7	319882	6201452	349	T33	324338	6203141	454
T8	320250	6201090	329	T34	323586	6203550	425
T9	322950	6201222	432	T35	322782	6204095	455
T10	322538	6201521	436	T36	322249	6204368	453
T11	322022	6201882	412	T37	321973	6204642	418
T12	322572	6201943	406	T38	324342	6203539	480
T13	322322	6202456	380	T40	324060	6203843	446
T14	320971	6202391	349	T42	323325	6204676	427
T15	320036	6202498	341	T43	322719	6204664	453
T16	320224	6203111	350	T44	323646	6204246	425
T17	321816	6202690	392	T45	323837	6204811	439
T18	323643	6202084	428	T46	323611	6205227	447
T19	323292	6202686	425	T47	323205	6205593	470
T20	322886	6202903	407	T48	323115	6205082	462
T21	322371	6203086	426	T49	322641	6205411	423
T22	321826	6203111	392	T50	321133	6203686	364
T23	321590	6203414	404	T51	321050	6202928	347
T24	320666	6204049	353	T52	321374	6201812	356
T25	324225	6202148	432	T53	323112	6202183	415
T26	323887	6202670	451				

1. Coordinate system: MGA zone 54, GDA94 datum

Table 6 Dwellings in the vicinity of the proposed Project [4]

House ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
1	333402	6212941	Non-associated landholder	12.5
2	332889	6208870	Non-associated landholder	9.9
3	317966	6209162	Non-associated landholder	5.5
4	328759	6208684	Non-associated landholder	6.2
5	318425	6204359	Non-associated landholder	2.2
6	317441	6204023	Non-associated landholder	2.9
7	314690	6200064	Non-associated landholder	5.4
8	317532	6197178	Non-associated landholder	4.6
9	324339	6199469	Non-associated landholder	2.2
10	332956	6200681	Non-associated landholder	8.8
11	315260	6200442	Non-associated landholder	4.7
12	332692	6205239	Non-associated landholder	8.5
13	333156	6212589	Non-associated landholder	12.0
14	323507	6197563	Non-associated landholder	3.5
15	321443	6211068	Non-associated landholder	5.8
16	332053	6213021	Non-associated landholder	11.5
17	316653	6209849	Non-associated landholder	6.9
18	326591	6204222	Non-associated landholder	2.3
19	319693	6211627	Non-associated landholder	6.9
20	330489	6211539	Non-associated landholder	9.3
21	321390	6210185	*Associated landholder*	4.9
22	316087	6197701	Non-associated landholder	5.3
23	319090	6211336	Non-associated landholder	6.9
24	331055	6202837	Non-associated landholder	6.7
25	317428	6198149	Non-associated landholder	4.1
26	330378	6205007	Non-associated landholder	6.2
27	316856	6202618	Non-associated landholder	3.2
28	316348	6204184	Non-associated landholder	4.0
29	317896	6207851	Non-associated landholder	4.6
30	316038	6210298	Non-associated landholder	7.6
31	319234	6211695	Non-associated landholder	7.2
32	314980	6201698	Non-associated landholder	4.9
33	318887	6210081	Non-associated landholder	5.9
34	316892	6212587	Non-associated landholder	9.0
35	318683	6213276	Non-associated landholder	8.8
36	320026	6212872	Non-associated landholder	7.9
37	320360	6213355	Non-associated landholder	8.3
38	321846	6212649	Non-associated landholder	7.2
39	323271	6212624	Non-associated landholder	7.0
40	326660	6213122	Non-associated landholder	8.3
41	327250	6212452	Non-associated landholder	8.0
42	331257	6213255	Non-associated landholder	11.1
43	331793	6210204	Non-associated landholder	9.6
44	331902	6209525	Non-associated landholder	9.3
45	330253	6209655	Non-associated landholder	8.0
46	330760	6210910	Non-associated landholder	9.1
47	329548	6210857	Non-associated landholder	8.2
48	328334	6211145	Non-associated landholder	7.6
49	327768	6211498	Non-associated landholder	7.5
50	320263	6212613	Non-associated landholder	7.6
51	320282	6212500	Non-associated landholder	7.5
52	319846	6212278	Non-associated landholder	7.4
53	319737	6212327	Non-associated landholder	7.5
54	314685	6206976	Non-associated landholder	6.7
55	314798	6206455	Non-associated landholder	6.3

Table 6 Dwellings in the vicinity of the proposed Project [4] (continued)

House ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
56	314913	6206182	Non-associated landholder	6.1
57	315169	6206334	Non-associated landholder	5.9
58	314945	6203986	Non-associated landholder	5.3
59	316285	6203701	Non-associated landholder	3.9
60	316133	6202968	Non-associated landholder	3.9
61	315845	6202465	Non-associated landholder	4.2
62	314649	6201555	Non-associated landholder	5.2
63	321440	6211313	Non-associated landholder	6.0
64	329377	6208084	Non-associated landholder	6.4
65	329672	6207896	Non-associated landholder	6.6
66	328249	6207469	Non-associated landholder	5.1
67	329079	6205727	Non-associated landholder	5.2
68	330079	6207149	Non-associated landholder	6.7
69	328912	6206433	Non-associated landholder	5.3
70	327001	6207829	Non-associated landholder	4.3
71	317366	6208478	Non-associated landholder	5.4
72	319006	6208941	Non-associated landholder	4.8
73	319843	6205696	*Associated landholder*	1.7
74	320270	6205615	Non-associated landholder	1.3
75	321830	6206405	*Associated landholder*	1.3
76	324379	6207966	Non-associated landholder	2.7
77	324320	6207653	Non-associated landholder	2.3
78	323818	6210616	Non-associated landholder	5.1
79	323873	6210441	Non-associated landholder	4.9
80	324097	6210418	Non-associated landholder	4.9
81	333163	6204041	Non-associated landholder	8.8
82	332114	6199930	Non-associated landholder	8.2
83	331318	6199253	Non-associated landholder	7.7
84	330876	6199742	Non-associated landholder	7.1
85	330199	6199883	Non-associated landholder	6.4
86	330014	6199830	Non-associated landholder	6.2
87	328452	6199011	Non-associated landholder	5.3
88	330707	6195869	Non-associated landholder	9.0
89	329182	6196326	Non-associated landholder	7.7
90	329251	6196299	Non-associated landholder	7.7
91	329366	6196323	Non-associated landholder	7.8
92	329477	6196741	Non-associated landholder	7.5
93	329375	6196658	Non-associated landholder	7.5
94	329394	6196597	Non-associated landholder	7.6
95	329439	6196657	Non-associated landholder	7.6
96	329316	6196623	Non-associated landholder	7.5
97	329248	6196582	Non-associated landholder	7.5
98	329163	6196530	Non-associated landholder	7.5
99	329163	6196557	Non-associated landholder	7.5
100	329174	6196594	Non-associated landholder	7.4
101	329184	6196620	Non-associated landholder	7.4
102	329214	6196373	Non-associated landholder	7.6
103	328993	6196382	Non-associated landholder	7.5
104	328943	6196320	Non-associated landholder	7.5
105	329118	6196714	Non-associated landholder	7.3
106	329158	6196489	Non-associated landholder	7.5
107	329020	6196732	Non-associated landholder	7.2
108	328227	6196021	Non-associated landholder	7.3
109	328868	6196628	Non-associated landholder	7.2
110	328765	6196749	Non-associated landholder	7.1

Table 6 Dwellings in the vicinity of the proposed Project [4] (continued)

House ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
111	327910	6197263	Non-associated landholder	6.1
112	325928	6196512	Non-associated landholder	5.6
113	323876	6195866	Non-associated landholder	5.2
114	316390	6196126	Non-associated landholder	6.2
115	323124	6196480	Non-associated landholder	4.3
116	323256	6196546	Non-associated landholder	4.3
117	321750	6197065	Non-associated landholder	3.2
118	318374	6200027	*Associated landholder*	2.1
119	318462	6200062	*Associated landholder*	2.0
120	318362	6200119	*Associated landholder*	2.0
121	316698	6201396	Non-associated landholder	3.2
122	322874	6198829	Non-associated landholder	2.1
123	324465	6199580	Non-associated landholder	2.2
124	324921	6199805	Non-associated landholder	2.4
125	324704	6200152	Non-associated landholder	2.1
126	331687	6202536	Non-associated landholder	7.4
127	330979	6201508	Non-associated landholder	6.8
128	330871	6203287	Non-associated landholder	6.5
129	330007	6201895	Non-associated landholder	5.8
130	329866	6203188	Non-associated landholder	5.5
131	324533	6197985	Non-associated landholder	3.6
132	324698	6197761	Non-associated landholder	3.8
133	319433	6210179	Non-associated landholder	5.8
134	319393	6209917	Non-associated landholder	5.6
135	319245	6209852	Non-associated landholder	5.5
136	329263	6197269	Non-associated landholder	7.0
137	329442	6197354	Non-associated landholder	7.1
138	329172	6197743	Non-associated landholder	6.6
139	333146	6199476	Non-associated landholder	9.3
140	330772	6211625	Non-associated landholder	9.6
141	331628	6212480	Non-associated landholder	10.8
142	333080	6209399	Non-associated landholder	10.3
143	331996	6204819	Non-associated landholder	7.7
144	326589	6210431	Non-associated landholder	5.9
145	331473	6207476	Non-associated landholder	8.1
146	331945	6207310	Non-associated landholder	8.5
147	319969	6205165	*Associated landholder*	1.3
148	319669	6207310	Non-associated landholder	3.0
149	314445	6202336	Non-associated landholder	5.5
150	316224	6203117	Non-associated landholder	3.9
151	320252	6205722	*Associated landholder*	1.4
152	329320	6196662	Non-associated landholder	7.5
153	329222	6196619	Non-associated landholder	7.5
154	329050	6196585	Non-associated landholder	7.4
155	329084	6196649	Non-associated landholder	7.3
156	329037	6196731	Non-associated landholder	7.2
157	329091	6196837	Non-associated landholder	7.2
158	328914	6196750	Non-associated landholder	7.2
159	328900	6196737	Non-associated landholder	7.2
160	328983	6197055	Non-associated landholder	7.0
161	329223	6197127	Non-associated landholder	7.1
162	329189	6197081	Non-associated landholder	7.1
163	329315	6197629	Non-associated landholder	6.8
164	329376	6197622	Non-associated landholder	6.9
165	329283	6197521	Non-associated landholder	6.9

Table 6 Dwellings in the vicinity of the proposed Project [4] (continued)

House ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
166	329427	6197811	Non-associated landholder	6.8
167	331881	6199249	Non-associated landholder	8.2
168	325069	6195084	Non-associated landholder	6.3
169	324942	6195205	Non-associated landholder	6.2
170	324876	6195388	Non-associated landholder	6.0
171	324384	6194580	Non-associated landholder	6.6
172	322403	6193774	Non-associated landholder	6.6
173	322166	6193978	Non-associated landholder	6.3
174	322377	6195495	Non-associated landholder	4.9
175	321305	6214520	Non-associated landholder	9.1
176	322134	6214224	Non-associated landholder	8.7
177	316423	6203609	Non-associated landholder	3.8
178	319884	6195267	Non-associated landholder	5.1
179	320076	6195303	Non-associated landholder	5.0
180	325159	6199502	Non-associated landholder	2.8
181	323623	6197004	Non-associated landholder	4.0
182	323772	6197057	Non-associated landholder	4.0
183	323773	6196905	Non-associated landholder	4.2
184	322571	6195278	Non-associated landholder	5.2
185	322560	6194278	Non-associated landholder	6.1
186	323539	6196728	Non-associated landholder	4.3
187	326433	6207948	Non-associated landholder	3.9
188	328156	6194319	Non-associated landholder	8.7
189	328827	6193956	Non-associated landholder	9.4
190	327849	6193219	Non-associated landholder	9.4
191	329897	6193600	Non-associated landholder	10.3
192	330243	6194049	Non-associated landholder	10.1
193	329437	6191717	Non-associated landholder	11.5
194	329439	6191654	Non-associated landholder	11.6
195	329883	6191224	Non-associated landholder	12.2
196	329942	6191210	Non-associated landholder	12.2
197	329987	6191376	Non-associated landholder	12.1
198	330371	6191129	Non-associated landholder	12.5
199	330424	6191076	Non-associated landholder	12.6
200	330575	6191066	Non-associated landholder	12.7
201	330532	6191090	Non-associated landholder	12.7
202	330214	6190939	Non-associated landholder	12.6
203	330462	6190513	Non-associated landholder	13.1
204	330420	6190543	Non-associated landholder	13.0
205	330236	6190480	Non-associated landholder	13.0
206	330272	6190519	Non-associated landholder	13.0
207	330182	6190514	Non-associated landholder	12.9
208	330115	6190492	Non-associated landholder	12.9
209	330290	6190746	Non-associated landholder	12.8
210	330599	6193136	Non-associated landholder	11.0
211	328296	6196025	Non-associated landholder	7.4
212	325385	6194799	Non-associated landholder	6.7
213	325861	6194403	Non-associated landholder	7.3
214	325870	6194335	Non-associated landholder	7.4
215	329570	6194498	Non-associated landholder	9.3
216	329530	6194510	Non-associated landholder	9.3
217	329469	6194508	Non-associated landholder	9.3
218	327658	6193293	Non-associated landholder	9.2
219	327302	6192599	Non-associated landholder	9.6
220	327546	6191204	Non-associated landholder	10.9
221	327813	6191195	Non-associated landholder	11.1
222	327884	6191280	Non-associated landholder	11.0
223	327845	6191144	Non-associated landholder	11.1
224	327814	6191146	Non-associated landholder	11.1
225	327926	6191067	Non-associated landholder	11.2
226	327891	6191081	Non-associated landholder	11.2

Table 6 Dwellings in the vicinity of the proposed Project [4] (continued)

House ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
227	328051	6191084	Non-associated landholder	11.3
228	328176	6191074	Non-associated landholder	11.3
229	328105	6191058	Non-associated landholder	11.3
230	328221	6191050	Non-associated landholder	11.4
231	328227	6191071	Non-associated landholder	11.4
232	328289	6191043	Non-associated landholder	11.4
233	328285	6191021	Non-associated landholder	11.4
234	328259	6190995	Non-associated landholder	11.5
235	328202	6191014	Non-associated landholder	11.4
236	328378	6191064	Non-associated landholder	11.5
237	327895	6191019	Non-associated landholder	11.3
238	327736	6191073	Non-associated landholder	11.1
239	327771	6191057	Non-associated landholder	11.2
240	327724	6190994	Non-associated landholder	11.2
241	327772	6190979	Non-associated landholder	11.2
242	327781	6190978	Non-associated landholder	11.2
243	327794	6190972	Non-associated landholder	11.2
244	327806	6190972	Non-associated landholder	11.3
245	327823	6190964	Non-associated landholder	11.3
246	327863	6190961	Non-associated landholder	11.3
247	327800	6191000	Non-associated landholder	11.2
248	327778	6191009	Non-associated landholder	11.2
249	327827	6190995	Non-associated landholder	11.2
250	327751	6191015	Non-associated landholder	11.2
251	327880	6190979	Non-associated landholder	11.3
252	327917	6190967	Non-associated landholder	11.3
253	327918	6190931	Non-associated landholder	11.3
254	327932	6190959	Non-associated landholder	11.3
255	328046	6190889	Non-associated landholder	11.4
256	328050	6190919	Non-associated landholder	11.4
257	328084	6190905	Non-associated landholder	11.4
258	328113	6190894	Non-associated landholder	11.5
259	328141	6190886	Non-associated landholder	11.5
260	328136	6190860	Non-associated landholder	11.5
261	328044	6190850	Non-associated landholder	11.5
262	328057	6190809	Non-associated landholder	11.5
263	328086	6190833	Non-associated landholder	11.5
264	328100	6190829	Non-associated landholder	11.5
265	327999	6190852	Non-associated landholder	11.5
266	327962	6190865	Non-associated landholder	11.4
267	327909	6190891	Non-associated landholder	11.4
268	327878	6190901	Non-associated landholder	11.4
269	327935	6190882	Non-associated landholder	11.4
270	327824	6190926	Non-associated landholder	11.3
271	328179	6190855	Non-associated landholder	11.5
272	328198	6190850	Non-associated landholder	11.6
273	328216	6190866	Non-associated landholder	11.5
274	328416	6190927	Non-associated landholder	11.6
275	328439	6190984	Non-associated landholder	11.6
276	328206	6190972	Non-associated landholder	11.5
277	327791	6191184	Non-associated landholder	11.1
278	329216	6191476	Non-associated landholder	11.6
279	331991	6192334	Non-associated landholder	12.5
280	328154	6190849	Non-associated landholder	11.5
281	329412	6190930	Non-associated landholder	12.1
282	331957	6190500	Non-associated landholder	14.0
283	332111	6190531	Non-associated landholder	14.1
284	332360	6190441	Non-associated landholder	14.3
285	332404	6190454	Non-associated landholder	14.3
286	333877	6192644	Non-associated landholder	13.5
287	332679	6193278	Non-associated landholder	12.3

Table 6 Dwellings in the vicinity of the proposed Project [4] (continued)

House ID	Easting[1] [m]	Northing[1] [m]	Status	Distance to nearest turbine [km]
288	332708	6193251	Non-associated landholder	12.3
289	332743	6193332	Non-associated landholder	12.3

1. Coordinate system: MGA zone 54, GDA94 datum

Dwellings belonging to associated landholders are indicated by *underlined italic text*

Table 7 Details of point-to-point links crossing the proposed Project site

<table>
<tr><th>Link no.</th><th>Assignment ID</th><th>Licence number</th><th>Frequency [MHz]</th><th>Postal address</th></tr>
<tr><td rowspan="2">1</td><td>752337, 752338</td><td>1181233/1</td><td>414.150</td><td rowspan="2">South Australian Water Corporation
SA Water
Adelaide
GPO Box 1751
(C/- Chris Atkinson)
ADELAIDE
SA 5001</td></tr>
<tr><td>752339, 752340</td><td>1181233/1</td><td>404.700</td></tr>
<tr><td>2</td><td>790526, 790527</td><td>1323526/1</td><td>849.400</td><td>W & L Phillips Pty Limited
Flow FM
PO Box 407
KAPUNDA
SA 5373</td></tr>
<tr><td rowspan="2">3</td><td>1401118, 1401119</td><td>9900523/1</td><td>8044.195</td><td rowspan="2">NBN Co Limited
Level 11, 100 Arthur Street
NORTH SYDNEY
NSW 2060</td></tr>
<tr><td>1401120, 1401121</td><td>9900523/1</td><td>7732.875</td></tr>
</table>

Table 8 Details of point-to-multipoint licences within 75 km of the proposed Project

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
825047	501670	1509414/1	-34.859032	138.612163	68	Adelaide Cemeteries Authority PO Box 294 ENFIELD PLAZA SA 5085
825044	501670	1509414/1	-34.859032	138.612163	68	
887641	9010114	1920362/1	-34.669	139.455032	51	Agile Pty Ltd Agile Communications Adelaide Accts Payable Locked Bag 16 CLOISTERS SQUARE WA 6850
887644	9010114	1920362/1	-34.669	139.455032	51	
887652	9010892	1920363/1	-34.353795	139.540136	41	
887649	9010892	1920363/1	-34.353795	139.540136	41	
1175109	9013850	1937806/1	-33.590507	138.948662	71	Aussie Broadband Pty Ltd PO Box 3351 GIPPSLAND MC VIC 3841
1175112	9013850	1937806/1	-33.590507	138.948662	71	
1174839	403816	1926122/1	-34.913975	139.303291	67	
1174842	403816	1926122/1	-34.913975	139.303291	67	
1174835	403816	1926121/1	-34.913975	139.303291	67	
1174838	403816	1926121/1	-34.913975	139.303291	67	
1175001	500947	1930218/1	-33.871023	138.651993	55	
1175004	500947	1930218/1	-33.871023	138.651993	55	
1175008	9012665	1930220/1	-33.931071	138.677158	48	
1175005	9012665	1930220/1	-33.931071	138.677158	48	
1174903	501046	1927157/1	-34.435721	138.509917	47	
1174906	501046	1927157/1	-34.435721	138.509917	47	
1175000	9012663	1930217/1	-34.197677	138.660263	35	
1174997	9012663	1930217/1	-34.197677	138.660263	35	
1174935	9012518	1929261/1	-34.53602	138.750656	32	
1174938	9012518	1929261/1	-34.53602	138.750656	32	
1174993	9012662	1930216/1	-33.990368	138.916622	29	
1174996	9012662	1930216/1	-33.990368	138.916622	29	
1174989	9012661	1930215/1	-34.179009	138.832201	21	
1174992	9012661	1930215/1	-34.179009	138.832201	21	
1174985	9012660	1930214/1	-34.167868	139.067008	6	
1174988	9012660	1930214/1	-34.167868	139.067008	6	
1289159	501781	1142622/1	-34.104047	139.867285	73	Australian Vintage Ltd RMB 3375 PIANGIL VIC 3597
1289162	501781	1142622/1	-34.104047	139.867285	73	
824019	501154	1506275/1	-34.431931	138.968331	10	Barossa Valley Golf Club Inc PO Box 322 NURIOOTPA SA 5355
824016	501154	1506275/1	-34.431931	138.968331	10	
792875	305318	1325983/1	-34.569823	138.64902	42	Barry Farmer Virginia Farm Produce PO Box 38 VIRGINIA SA 5120
792872	305318	1325983/1	-34.569823	138.64902	42	

Table 8 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
1305745	22712	433978/1	-34.921223	138.622149	73	Bureau of Meteorology Network Services Operations Manager GPO Box 1289 MELBOURNE VIC 3001
1305748	22712	433978/1	-34.921223	138.622149	73	
1306043	134199	1148674/1	-34.922189	138.680288	71	
1306040	134199	1148674/1	-34.922189	138.680288	71	
1306484	304390	1322463/1	-34.883287	138.759151	64	
1306481	304390	1322463/1	-34.883287	138.759151	64	
1306874	23452	1505641/1	-34.882778	138.87125	61	
1306871	23452	1505641/1	-34.882778	138.87125	61	
1305749	24472	433980/1	-33.90131	138.61134	55	
1305752	24472	433980/1	-33.90131	138.61134	55	
1305790	23428	434009/1	-34.72427	138.9279	43	
1305787	23428	434009/1	-34.72427	138.9279	43	
1306021	405152	1145023/1	-34.201488	138.596999	40	
1306018	405152	1145023/1	-34.201488	138.596999	40	
1306053	135941	1180111/1	-34.544387	139.192999	26	
1306050	135941	1180111/1	-34.544387	139.192999	26	
824038	501183	1506307/1	-33.820107	138.613472	61	Clare Golf Club Inc PO Box 86 CLARE SA 5453
824041	501183	1506307/1	-33.820107	138.613472	61	
824996	501643	1509217/1	-34.582717	139.610856	56	Condo & Son Pty Ltd & Trustee for Condo Family Trust Swan Produce PO Box 334 BROOKLYN PARK SA 5032
824999	501643	1509217/1	-34.582717	139.610856	56	
1465844	22202	1143151/2	-34.919999	138.60893	74	Department for Health and Ageing eHealth Systems (ICT) Infrastructure GPO Box 11027 c/- Shared Services ADELAIDE SA 5001
1465843	22202	1143151/2	-34.919999	138.60893	74	

Table 8 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
1267625	22971	493558/1	-34.716039	138.534509	60	Department of Defence Director Defence Spectrum Office D DSO APW-GF-173 Anzac Park West PO Box 7953 CANBERRA BC
1267622	22971	493558/1	-34.716039	138.534509	60	
1265221	22971	99850/1	-34.716039	138.534509	60	
1265218	22971	99850/1	-34.716039	138.534509	60	
1267629	52733	493559/1	-34.734195	138.634893	55	
1267626	52733	493559/1	-34.734195	138.634893	55	
1265637	22977	100379/1	-34.732426	138.647818	55	
1267633	22977	493573/1	-34.732426	138.647818	55	
1265644	22977	100389/1	-34.732426	138.647818	55	
1265641	22977	100389/1	-34.732426	138.647818	55	
1265640	22977	100379/1	-34.732426	138.647818	55	
1265653	22977	100394/1	-34.732426	138.647818	55	
1265656	22977	100394/1	-34.732426	138.647818	55	
1267630	22977	493573/1	-34.732426	138.647818	55	
1265636	22977	100378/1	-34.732426	138.647818	55	
1252145	22977	100384/1	-34.732426	138.647818	55	
1265214	22977	99849/1	-34.732426	138.647818	55	
1265217	22977	99849/1	-34.732426	138.647818	55	
1265652	22977	100392/1	-34.732426	138.647818	55	
1265648	22977	100391/1	-34.732426	138.647818	55	
1265645	22977	100391/1	-34.732426	138.647818	55	
1252148	22977	100384/1	-34.732426	138.647818	55	
1265632	22977	100374/1	-34.732426	138.647818	55	
1265649	22977	100392/1	-34.732426	138.647818	55	
1265629	22977	100374/1	-34.732426	138.647818	55	
1265633	22977	100378/1	-34.732426	138.647818	55	
1270336	100206	1136256/1	-34.710839	138.625296	54	
1270333	100206	1136256/1	-34.710839	138.625296	54	
832235	23109	1565401/1	-34.949392	138.715901	72	Direct-Mix Concrete Pty Ltd PO Box 232 TORRENSVILLE PLAZA SA 5031
832232	23109	1565401/1	-34.949392	138.715901	72	
979286	23109	1974920/1	-34.949392	138.715901	72	
979283	23109	1974920/1	-34.949392	138.715901	72	
822822	500354	1501292/1	-34.779834	138.480671	69	Flinders Ports Pty Ltd St Vincent St PORT ADELAIDE SA 5015
822825	500354	1501292/1	-34.779834	138.480671	69	
795677	501003	1329006/1	-34.611677	138.837313	34	Gawler Golf Club PO Box 278 GAWLER SA 5118
795681	501003	1329006/1	-34.611677	138.837313	34	
761640	304555	1191804/1	-34.093624	139.861635	73	GD & AR Bald Pty Ltd ATF Bald Family Trust PO Box 78 WAIKERIE SA 5330
761637	304555	1191804/1	-34.093624	139.861635	73	
824090	501221	1506533/1	-33.8187	138.5972	62	Jim Barry Wines Pty Ltd PO Box 321 CLARE SA 5453
824087	501221	1506533/1	-33.8187	138.5972	62	
791294	304672	1324071/1	-34.052643	138.718536	37	Koonowla Pty Ltd Koonowla Wines PO Box 45 AUBURN SA 5451
791291	304672	1324071/1	-34.052643	138.718536	37	

Table 8 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
1256417	502448	1322427/1	-34.694378	139.657867	66	Oakville Potatoes Pty Ltd PO Box 42 NILDOTTIE SA 5238
1256420	502448	1322427/1	-34.694378	139.657867	66	
827419	502100	1512188/1	-34.694822	139.657315	66	
827422	502100	1512188/1	-34.694822	139.657315	66	
1000005	9023070	1985221/1	-34.098875	139.853532	72	Samuel Smith and Son Pty Ltd Yalumba Winery Oxford Landing Estate PMB 31 WAIKERIE SA 5330
1000002	9023070	1985221/1	-34.098875	139.853532	72	
1311943	54110	9847156/1	-34.940285	138.633422	75	South Australian Water Corporation SA Water Adelaide GPO Box 1751 (C/- Chris Atkinson) ADELAIDE SA 5001
1311940	54110	9847156/1	-34.940285	138.633422	75	
917364	54110	1940402/1	-34.940285	138.633422	75	
917367	54110	1940402/1	-34.940285	138.633422	75	
1311938	22346	9847157/1	-34.865257	138.501625	74	
1311935	22346	9847157/1	-34.865257	138.501625	74	
1706232	22346	10058433/1	-34.865257	138.501625	74	
1706231	22346	10058433/1	-34.865257	138.501625	74	
1311965	500963	9847151/1	-34.994554	138.910898	72	
1311964	500963	9847151/1	-34.994554	138.910898	72	
932093	23114	1950797/1	-34.946926	138.714206	72	
1696541	23114	10054183/1	-34.946926	138.714206	72	
932096	23114	1950797/1	-34.946926	138.714206	72	
1696540	23114	10054183/1	-34.946926	138.714206	72	
971881	305774	1971357/1	-34.874449	138.771582	63	
971878	305774	1971357/1	-34.874449	138.771582	63	
825223	501743	1509915/1	-34.865003	138.774852	62	
825227	501743	1509915/1	-34.865003	138.774852	62	
1400555	134025	9898303/1	-34.769796	138.582586	61	
917380	134025	1940404/1	-34.769796	138.582586	61	
917383	134025	1940404/1	-34.769796	138.582586	61	
917372	134025	1940403/1	-34.769796	138.582586	61	
917375	134025	1940403/1	-34.769796	138.582586	61	
1400554	134025	9898303/1	-34.769796	138.582586	61	
1696533	23452	10054185/1	-34.882778	138.87125	61	
1696532	23452	10054185/1	-34.882778	138.87125	61	
1740362	23452	10065205/1	-34.882778	138.87125	61	
1740361	23452	10065205/1	-34.882778	138.87125	61	
823252	500680	1503652/1	-34.021737	139.684262	60	
823255	500680	1503652/1	-34.021737	139.684262	60	
831194	500680	1564623/1	-34.021737	139.684262	60	
831191	500680	1564623/1	-34.021737	139.684262	60	
749226	502494	1148259/1	-34.83582	138.746881	60	
749223	502494	1148259/1	-34.83582	138.746881	60	
779525	205783	1232338/1	-33.818628	138.646676	59	
779528	205783	1232338/1	-33.818628	138.646676	59	
830888	9004223	1564380/1	-34.832581	138.806886	57	
830891	9004223	1564380/1	-34.832581	138.806886	57	
908994	23437	1935045/1	-34.849854	139.133642	57	
908991	23437	1935045/1	-34.849854	139.133642	57	
825535	501838	1510884/1	-34.761131	138.710789	54	
825532	501838	1510884/1	-34.761131	138.710789	54	
886607	9010753	1919707/1	-34.814866	138.873895	54	
886610	9010753	1919707/1	-34.814866	138.873895	54	
868770	9008662	1906921/1	-34.756795	138.71602	53	
868767	9008662	1906921/1	-34.756795	138.71602	53	
825221	501742	1509914/1	-34.753714	138.719076	53	
825218	501742	1509914/1	-34.753714	138.719076	53	

Table 8 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
779517	24293	1232337/1	-33.932219	138.676867	48	
779520	24293	1232337/1	-33.932219	138.676867	48	
824704	501499	1508463/1	-34.052467	138.600476	46	
824701	501499	1508463/1	-34.052467	138.600476	46	
864043	137591	1901960/1	-34.733186	139.080779	43	
864046	137591	1901960/1	-34.733186	139.080779	43	
970858	23422	1970916/1	-34.726063	138.927309	43	
970852	23422	1970916/1	-34.726063	138.927309	43	
781543	23422	1235783/1	-34.726063	138.927309	43	
781546	23422	1235783/1	-34.726063	138.927309	43	
825410	501790	1510402/1	-34.602938	138.760769	37	
825413	501790	1510402/1	-34.602938	138.760769	37	
957733	501790	1964490/1	-34.602938	138.760769	37	
957730	501790	1964490/1	-34.602938	138.760769	37	
911061	9002222	1936788/1	-34.27461	138.686434	30	
911058	9002222	1936788/1	-34.27461	138.686434	30	
752368	24275	1181237/1	-33.964823	139.06284	29	
752365	24275	1181237/1	-33.964823	139.06284	29	
1311959	9002223	9847152/1	-34.392418	138.71854	27	
1311962	9002223	9847152/1	-34.392418	138.71854	27	
752356	24182	1181235/1	-34.571804	139.00583	25	
752353	24182	1181235/1	-34.571804	139.00583	25	
1311921	9007183	9847149/1	-34.489054	139.18397	20	
1311924	9007183	9847149/1	-34.489054	139.18397	20	
752362	24263	1181236/1	-34.184752	139.071928	4	
752357	24263	1181236/1	-34.184752	139.071928	4	
806149	304331	1423692/1	-33.995414	139.732308	65	Spark Infrastructure SA (No2) Pty Limited SA Power Networks GPO Box 77 (C/- Geof Axon) ADELAIDE SA 5001
806152	304331	1423692/1	-33.995414	139.732308	65	
1725438	23530	10062782/1	-34.929104	139.034726	65	
1725435	23530	10062782/1	-34.929104	139.034726	65	
829201	23530	1515470/1	-34.929104	139.034726	65	
829198	23530	1515470/1	-34.929104	139.034726	65	
810662	23530	1430093/1	-34.929104	139.034726	65	
810665	23530	1430093/1	-34.929104	139.034726	65	
829177	35742	1515225/1	-34.735937	138.71334	51	
904908	35742	1931977/1	-34.735937	138.71334	51	
904905	35742	1931977/1	-34.735937	138.71334	51	
955379	35742	1963427/1	-34.735937	138.71334	51	
955376	35742	1963427/1	-34.735937	138.71334	51	
829174	35742	1515225/1	-34.735937	138.71334	51	
806488	35742	1424275/1	-34.735937	138.71334	51	
806485	35742	1424275/1	-34.735937	138.71334	51	
914766	24293	1938723/1	-33.932219	138.676867	48	
914763	24293	1938723/1	-33.932219	138.676867	48	
993465	24293	1982086/1	-33.932219	138.676867	48	
993462	24293	1982086/1	-33.932219	138.676867	48	
1004794	24227	1987208/1	-34.315311	139.127007	3	
1004797	24227	1987208/1	-34.315311	139.127007	3	

Table 8 Details of point-to-multipoint licences within 75 km of the proposed Project (continued)

Assignment ID	Site ID	Licence no.	Latitude [GDA94]	Longitude [GDA94]	Distance to Project [km]	Licence owner
823364	500752	1503777/1	-33.660182	139.441125	72	Telstra Corporation Limited Radio Transport Engineering Locked Bag 810 (Attn Tom Fairbrother) ADELAIDE
823367	500752	1503777/1	-33.660182	139.441125	72	
823359	24468	1503775/1	-33.849035	138.595627	60	
823356	24468	1503775/1	-33.849035	138.595627	60	
707371	24205	90628/1	-34.669208	139.454395	51	
707374	24205	90628/1	-34.669208	139.454395	51	
790742	24205	1323924/1	-34.669208	139.454395	51	
790745	24205	1323924/1	-34.669208	139.454395	51	
707365	24227	90627/1	-34.315311	139.127007	3	
707368	24227	90627/1	-34.315311	139.127007	3	
895132	9011554	1924213/1	-34.476202	138.985256	15	The Barossa Council PO Box 867 NURIOOTPA SA 5355
895129	9011554	1924213/1	-34.476202	138.985256	15	
764733	136864	1194316/1	-34.912209	138.588613	74	The Corporation Of The City Of Adelaide City of Adelaide GPO Box 2252 ADELAIDE SA 5001
764730	136864	1194316/1	-34.912209	138.588613	74	
793880	305748	1327131/1	-33.954162	138.653486	48	Treasury Wine Estates Vintners Limited Annies Lane at Qelltaler PO Box 10 WATERVALE SA 5452
793883	305748	1327131/1	-33.954162	138.653486	48	
889272	138906	1921484/1	-34.497473	138.991953	17	
889269	138906	1921484/1	-34.497473	138.991953	17	
828764	502346	1513794/1	-34.155936	139.89588	74	Waikerie Golf Club Inc PO Box 643 WAIKERIE SA 5330
828767	502346	1513794/1	-34.155936	139.89588	74	
823703	500886	1504946/1	-34.870885	138.50047	75	West Lakes Golf Club Incorporated 26 Lochside Drive WEST LAKES SA 5021
823706	500886	1504946/1	-34.870885	138.50047	75	

Table 9 Details of other licences identified within 75 km of the proposed Project

Licence type	Licence category	Number of instances
1800 MHz Band	Spectrum	6583
2 GHz Band	Spectrum	9818
2.3 GHz Band	Spectrum	1050
2.5 GHz Band	Spectrum	352
2.5 GHz Mid Band Gap	Spectrum	112
27 GHz Band	Spectrum	2
700 MHz Band	Spectrum	2294
800 MHz Band	Spectrum	3481
Aeronautical Assigned System	Aeronautical	55
Amateur Beacon	Amateur	8
Amateur Repeater	Amateur	72
Ambulatory - Initial	Land Mobile	28
Ambulatory System	Land Mobile	348
CBRS Repeater	Land Mobile	2
Commercial Radio	Broadcasting	8
Commercial Television	Broadcasting	18
Community Broadcasting	Broadcasting	4
Earth Receive	Earth Receive	17
Fixed Earth	Earth	6
Fixed Receive	Fixed Receive	4
HF Domestic Service	Broadcasting	1
Land Mobile System - > 30MHz	Land Mobile	1988
Land Mobile System 0-30MHz	Land Mobile	146
Limited Coast Assigned System	Maritime Coast	24
Limited Coast Marine Rescue	Maritime Coast	15
Narrowband Area Service station(s)	Broadcasting	10
Narrowcasting Service (Fixed Tax)	Broadcasting	3
Narrowcasting Service (LPON)	Broadcasting	40
Narrowcasting Service Station(s)	Broadcasting	1
National Broadcasting	Broadcasting	12
PABX Cordless Telephone Service	Land Mobile	4
Paging System - Exterior	Land Mobile	39
Paging System - Interior	Land Mobile	15
PMTS Class B	PTS	300
Point to Multipoint	Fixed	208
Point to Multipoint - Land Mobile Spec	Fixed	12
Radiodetermination	Radiodetermination	36
Retransmission	Broadcasting	33
Sound Outside Broadcast	Fixed	4
Television Outside Broadcast	Fixed	1

Table 10 Emergency services with radiocommunication assets in the vicinity of the proposed Project

Emergency service	Contact details	Distance from closest site to Project boundary [km]
Australian Federal Police	Australian Federal Police Attn: T&I Eileen Ferber PO Box 401 CANBERRA ACT 2601	55
South Australia Police	South Australia Police GPO Box 1539 ADELAIDE SA 5001	72
South Australian Country Fire Service	South Australian Country Fire Service GPO Box 2468 ADELAIDE SA 5001	42
South Australian State Emergency Service	South Australian State Emergency Service GPO Box 2706 ADELAIDE SA 5001	69
St John Ambulance Australia (N.S.W.)	St John Ambulance Australia (N.S.W.) 9 Deane Street BURWOOD NSW 2134	75
St John Ambulance Australia Incorporated	St John Ambulance Australia Incorporated Attn: Paul Stein 170 Forster Road MOUNT WAVERLEY VIC 3149	18
Surf Life Saving South Australia Inc	Surf Life Saving South Australia Inc PO Box 117 WEST BEACH SA 5024	86
The Australian Volunteer Coast Guard Association Inc	The Australian Volunteer Coast Guard Association Inc SA Squadron PO Box 60 SEMAPHORE SA 5019	69
The South Australian Sea Rescue Squadron Inc	The South Australian Sea Rescue Squadron Inc PO Box 267 GLENELG SA 5045	73
Visionstream Australia Pty Limited	Visionstream Australia Pty Limited 962 South Road EDWARDSTOWN SA 5039	75

Table 11 BoM radar sites in the vicinity of the proposed Project

BoM Radar site	Location[1]		Distance to Project [km]
Buckland Park (Adelaide)	S34.65°	E138.47°	58
Sellicks Hill	S35.33°	E138.50°	119
Mildura	S34.23°	E142.08°	274
Woomera	S31.16°	E136.80°	401
Mt Gambier	S37.75°	E140.77°	409

1. Coordinate system: Lat/Long WGS84 datum

Table 12 Trigonometrical stations in the vicinity of the proposed Project

Station name	Datum	Latitude	Longitude	Distance to Project [km]
Bald Hill	AGD66	S34°20' 21.71"	E139°2' 2.83"	0
Belvidere	GDA94	S34°25' 40.47"	E138°54' 14.18"	14
	AGD84	S34°25' 45.75"	E138°54' 9.30"	
	AGD66	S34°25' 45.76"	E138°54' 9.35"	
Brownlow	AGD84	S34°12' 35.44"	E139°14' 37.43"	15
	GDA94	S34°12' 30.14"	E139°14' 42.28"	
Julia	GDA94	S34°50' 52.46"	E139°1' 23.28"	15
	AGD84	S34°5' 57.754"	E139°1' 18.43"	
Light	AGD66	S34°18' 7.38"	E138°50' 8.31"	16
	GDA94	S34°18' 2.09"	E138°50' 13.14"	
	AGD84	S34°18' 7.37"	E138°50' 8.27"	
Penrice	AGD84	S34°29' 26.42"	E139°2' 28.39"	16
	GDA94	S34°29' 21.13"	E139°2' 33.26"	
	AGD66	S34°29' 26.43"	E139°2' 28.44"	
Rufus	AGD84	S34°18' 59.84"	E139°7' 33.73"	3
	GDA94	S34°18' 54.55"	E139°7' 38.59"	
	AGD66	S34°18' 59.84"	E139°7' 33.78"	
Smith Hill	AGD84	S34°40' 30.54"	E138°57' 27.36"	19
	GDA94	S34°40' 25.25"	E138°57' 32.21"	
Waterloo	AGD66	S34°12' 12.11"	E138°57' 52.22"	9
	GDA94	S34°12' 6.82"	E138°57' 57.03"	
	AGD84	S34°12' 12.11"	E138°57' 52.17"	
6628/23502	GDA94	S34°29' 56.76"	E138°57' 3.69"	18
6628/47819	GDA94	S34°30' 28.54"	E138°58' 50.24"	18
6629/ 1083	GDA94	S34°14' 53.93"	E138°50' 51.70"	17
6629/ 1085	GDA94	S34°15' 2.98"	E138°57' 1.68"	9
6629/ 1086	GDA94	S34°14' 44.95"	E138°59' 54.27"	5
6629/ 1088	GDA94	S34°14' 56.43"	E139°00' 4.47"	4
6629/ 1111	GDA94	S34°29' 49.00"	E138°59' 55.63"	17
6629/ 1112	GDA94	S34°29' 51.71"	E138°56' 34.55"	18
6629/ 1113	GDA94	S34°29' 51.04"	E138°56' 42.35"	18
6629/ 1114	GDA94	S34°29' 48.64"	E138°54' 18.22"	20
6629/ 1139	GDA94	S34°15' 10.07"	E138°52' 59.62"	14
6629/ 1357	GDA94	S34°17' 21.60"	E138°59' 59.60"	3
6629/ 1358	GDA94	S34°17' 24.49"	E138°59' 58.45"	3
6629/ 1359	GDA94	S34°16' 39.78"	E138°58' 9.91"	6
6629/ 1360	GDA94	S34°16' 46.19"	E138°58' 2.66"	6
6629/ 1361	GDA94	S34°15' 42.49"	E138°57' 51.65"	7
6629/ 1362	GDA94	S34°14' 52.00"	E138°53' 54.99"	13

Table 12 Trigonometrical stations in the vicinity of the proposed Project (continued)

Station name	Datum	Latitude	Longitude	Distance to Project [km]
6629/ 1363	GDA94	S34°15' 9.49"	E138°53' 1.41"	14
6629/ 1364	GDA94	S34°14' 53.74"	E138°51' 0.03"	17
6629/ 1381	AGD66	S34°21' 17.85"	E138°52' 18.60"	13
	GDA94	S34°21' 12.56"	E138°52' 23.43"	
	AGD84	S34°21' 17.84"	E138°52' 18.55"	
6629/ 1382	GDA94	S34°21' 12.44"	E138°52' 24.60"	13
6629/ 1383	GDA94	S34°26' 14.04"	E138°55' 31.67"	13
6629/ 1384	GDA94	S34°26' 12.66"	E138°55' 31.43"	13
6629/ 1385	GDA94	S34°28' 46.63"	E138°58' 21.01"	15
6629/ 1386	GDA94	S34°28' 46.54"	E138°58' 20.31"	15
6629/ 1387	GDA94	S34°15' 0.89"	E138°57' 2.70"	9
6629/ 1389	GDA94	S34°29' 51.76"	E138°56' 33.94"	18
6629/ 1391	GDA94	S34°29' 51.00"	E138°56' 42.87"	18
6629/ 1392	GDA94	S34°29' 38.79"	E138°53' 43.46"	20
6629/ 1660	GDA94	S34°28' 59.35"	E138°59' 27.59"	15
6629/ 3418	GDA94	S34°29' 51.23"	E138°57' 30.29"	17
6629/ 3462	GDA94	S34°27' 40.42"	E138°58' 52.83"	13
6728/ 1817	GDA94	S34°30' 24.75"	E139°10' 43.04"	18
6728/ 3365	GDA94	S34°30' 50.98"	E139°20' 38.76"	19
6728/ 3416	GDA94	S34°30' 36.53"	E139°30' 30.40"	18
6729/ 1003	AGD66	S34°13' 35.95"	E139°50' 17.49"	2
	GDA94	S34°13' 30.65"	E139°50' 22.30"	
	AGD84	S34°13' 35.95"	E139°50' 17.45"	
6729/ 1004	AGD66	S34°20' 21.66"	E139°20' 2.63"	0
	AGD84	S34°20' 21.68"	E139°20' 2.58"	
	GDA94	S34°20' 16.37"	E139°20' 7.45"	
6729/ 1005	GDA94	S34°23' 8.10"	E139°50' 53.95"	6
	AGD84	S34°23' 13.39"	E139°50' 49.09"	
	AGD66	S34°23' 13.39"	E139°50' 49.14"	
6729/ 1104	GDA94	S34°28' 31.93"	E139°10' 17.27"	14
6729/ 1191	GDA94	S34°22' 23.72"	E139°00' 15.96"	3
6729/ 1192	GDA94	S34°22' 19.54"	E139°00' 10.44"	3
6729/ 1193	GDA94	S34°19' 56.02"	E139°00' 7.54"	1
6729/ 1196	GDA94	S34°27' 24.58"	E139°00' 7.35"	12
6729/ 1197	GDA94	S34°27' 28.16"	E139°00' 7.84"	12
6729/ 1532	GDA94	S34°27' 56.58"	E139°10' 33.33"	13
6729/ 1951	GDA94	S34°29' 9.49"	E139°10' 49.47"	15
6729/ 1970	GDA94	S34°29' 21.62"	E139°30' 19.90"	16

Table 13 Houses with increased potential to experience EMI to DTV from television broadcast towers

House ID	Easting[1] [m]	Northing[1] [m]	Located in potential interference zone Adelaide
70	327001	6207829	X
74	320270	6205615	X
75	*321830*	*6206405*	*X*
76	324379	6207966	X
77	324320	6207653	X
79	323873	6210441	X
80	324097	6210418	X
147	*319969*	*6205165*	*X*
151	*320252*	*6205722*	*X*
187	326433	6207948	X

1. Coordinate system: MGA zone 54, GDA94 datum
Dwellings belonging to associated landholders are indicated by *underlined italic text*

Table 14 Summary of service operators contacted by DNV GL and responses received to date

	Licence/service type	Distance of closest site [km]	Operator	DNV GL reference	Response received to date
1	Fixed point-to-point, fixed point-to-multipoint	Point-to-point: no turbines in exclusion zone set by DNV GL Fixed point-to-multipoint: 4 km	South Australian Water Corporation (SA Water)	170894-AUME-L-01	Response received by email on 10 November 2016: *"It would appear that this could impact our PTP link between Mt Kitchener & Eudunda bases (site ID 24263) If we were to have interference, approx 4 critical pump station/tank sites would be impacted."* Response received by email on 17 November 2016: *"…we are concerned that the proposed installation of wind turbines at the proposed location may adversely impact our PTP radio link between our radio facilities at Mt Kitchener and Eudunda. Upon reviewing the Google Earth data originally submitted to us, it would appear that our radio path will be dissected by the turbines.* *As a ACMA radio licence holder, we are entitled to operate on our allocated frequencies unimpeded and without interference. We are not in a position to suggest whether or not the proposed development of the wind farm could or would impact our operations with any degree of certainty. Therefore it is our position that… [the developer] must engage a subject matter expert in the field of RF propagation to provide an expert opinion and report into this. This report should document opinion on the likelihood of interference posed to our allocated frequencies and recommend any mitigating measures that should take place to prevent interference. The completed report should then be submitted to SA Water for further review."* Response received by email on 24 January 2017 (following submission of draft EMI Assessment report): *"…whilst we acknowledge your EMI Assessment draft report and the conclusions you have drawn from the findings, SA Water normally do not provide approvals or acceptance on locations of wind turbines in relation to SA Water infrastructure.* *We advise that you proceed at your own risk, and any impact on the SA Water point to point link post construction will be the responsibility of the wind farm developer/owner to remedy."*

Table 14 Summary of service operators contacted by DNV GL and responses received to date (continued)

	Licence/service type	Distance of closest site [km]	Operator	DNV GL reference	Response received to date
2	Fixed point-to-point, FM broadcasting	Point-to-point: no turbines in exclusion zone set by DNV GL FM transmission tower: 3 km	W & L Phillips Pty Limited (Flow FM)	170894-AUME-L-02	Response received by email on 17 November 2016: *"I've had a look at the proposal for the wind farm and agree that there is sufficient Fresnel zone clearance for out (sic) 850MHz studio-to-transmitter link. So this shouldn't be a problem with the our STL link…* *Not sure as to how much the 99.5MHz signal will be affected… but this still may not be a problem as the wind tower may or may not have a sufficient surface area to reflect enough signal to cause a problem at 99.5MHz it may only be minor if any."* Response received by email on 2 December 2016: *"I think as you suggest that coverage in some of the weaker areas from Mt Rufus [Kapunda] will get coverage from one of the other transmitters in most cases."*
3	Fixed point-to-point, wireless internet	Point-to-point: no turbines in exclusion zone set by DNV GL Wireless internet: 9 km	NBN Co Limited	170894-AUME-L-03	Response received by telephone on 11 November 2016: No concerns regarding fixed network No formal response regarding wireless services received to date
4	Fixed point-to-multipoint, wireless internet	41 km	Agile Pty Ltd	170XXX-AUME-L-04	Response received by email on 28 October 2016: *"I have reviewed your brief and found there to be minimal interference risk arising from the wind farm proposal."*
5	Fixed point-to-multipoint, wireless internet	6 km	Aussie Broadband Pty Ltd	170894-AUME-L-05	Response received by email on 14 November 2016: *"We don't have any concerns regarding the proposed wind farm."*

Table 14 Summary of service operators contacted by DNV GL and responses received to date (continued)

	Licence/service type	Distance of closest site [km]	Operator	DNV GL reference	Response received to date
6	Fixed point-to-multipoint, meteorological radar	Point-to-multipoint: 6 km Meteorological radar: 58 km	Bureau of Meteorology	170894-AUME-L-06	<u>Response received by email on 14 December 2016:</u> *"Noting that:* *No Bureau radar is within 20 to 30 km of the proposed Twin Creek wind farm. The closest Bureau radars to the proposed wind farm is approximately 58km away at Buckland Park (S-band), at least 2x the range at which the WMO suggests an impact study is required. However a WMO working group is currently revising these guidelines and will recommend that these avoidance distances be doubled.* *Recommendation* *Given that Buckland Park radar is within 2x the range of the proposed WMO guidelines and straight-line propagation puts the wind farm at about 0.2 degrees above the horizon (the effective angle will actually be higher due to atmospheric refraction). Buckland Park radar will observe clutter at higher elevation angles due to the wind farm and radar side-lobe scatter. Buckland Park radar will most likely be affected by the location of the proposed Twin Creek wind farm. The Bureau would prefer if this wind farm is located at a greater distance from Buckland Park radar in order to mitigate interference, namely clutter and Doppler mode false artefacts."* <u>Response received by email on 2 February 2017 (following confirmation that all proposed radar locations are more than 60 km from the Buckland Park radar):</u> *"The Bureau is rather cautious regarding the wind farm's location and the effect it will have on Buckland Park radar's contiguous performance beyond the wind farm, towards the border region. …whilst the proposed site meets WMO recommendations The Bureau strives to provide the best possible performance of our radar network for all stakeholders throughout the country.* *…The Bureau would be happy with the proposed turbine locations as it now stands."*

Table 14 Summary of service operators contacted by DNV GL and responses received to date (continued)

	Licence/service type	Distance of closest site [km]	Operator	DNV GL reference	Response received to date
7	Fixed point-to-multipoint	54 km	Department of Defence	170894-AUME-L-07	None received to date
8	Fixed point-to-multipoint	3 km	Spark Infrastructure SA (No2) Pty Limited (SA Power Networks)	170894-AUME-L-08	Response received by email on 18 November 2016: *"Based on our radio designers review they have plotted some of the turbines on a map and have found that they are in the path of our link between Mt Rufus to Kapunda substation. They are located roughly 6 km along the path and they have run a path calculation (attached) showing the effect of the proposed 180m turbines on our path. The obstruction will attenuate the radio considerably and the actual path effect is very hard to predict since the rotational obstruction is impossible to model.* *Bottom line is that we expect this will impact the reliability of the path between Mt Rufus and Kapunda substation. Which is critical to our operation of the Electricity Distribution business."* Response received by email on 9 January 2017 (following suggestion that an exclusion zone based on the second Fresnel zone be applied): *"Thanks for your response to our concerns regarding our path between Mt Rufus and Kapunda.* *I have had a look through your proposal and an exclusion zone of the second Fresnel zone would be adequate to ensure the reliability of our path."*

Table 14 Summary of service operators contacted by DNV GL and responses received to date (continued)

	Licence/service type	Distance of closest site [km]	Operator	DNV GL reference	Response received to date
9	Fixed point-to-multipoint, PTMS/spectrum (mobile phone)	Point-to-multipoint: 3 km PTMS/spectrum: 5 km	Telstra Corporation Limited	170894-AUME-L-09	<u>Response received by email on 23 November 2016:</u> *"...a desk top study has been undertaken of the area and nearby telecommunications infrastructure.* *Based on the provided information relating to the proposed wind farm on rural land in the Twin Creek area South of Eudunda, between Kapunda and Frankton, SA, results of Radio rayline analysis investigation reveals that there is no potential for undue interference from the proposed wind farm.* *Also, results of Optic & Copper cable investigation reveals that there is no cable within 1.22Km of any of the proposed location of the Wind Turbines.* *Telstra has no objection to this development in relation to the proposed wind farm subject to [the developer] confirming its agreement to the conditions and matters set out in this letter.* *Telstra requires [the developer] to notify of any additional turbines, or any change to the proposed location of the Wind Turbine, so that impacts on Telstra's Network can be re-assessed.* *Telstra will require the protection of/relocation of its fixed telecommunications infrastructure that may be impacted by activities on this site. To minimise risk of liability due to any damage, the DialBeforeYouDig 1100 Inquiry number should be contacted to obtain location of Telstra plant before commencement of construction work."*
10	Fixed point-to-multipoint	15 km	The Barossa Council	170894-AUME-L-10	None received to date

Table 14 Summary of service operators contacted by DNV GL and responses received to date (continued)

	Licence/service type	Distance of closest site [km]	Operator	DNV GL reference	Response received to date
11	Emergency service, fixed point-to-point, land mobile system	Point-to-point: no links crossing the Project Land mobile: 55 km	Australian Federal Police	170894-AUME-L-11	None received to date
12	Emergency service, land mobile system	42 km	South Australian Country Fire Service	170894-AUME-L-12	Response received by email on 28 October 2016: *"I have reviewed the proposal, CFS doesn't see any potential issue pertaining to the HF site, Para Wirra National Park, site ID 23048."*
13	Emergency service, land mobile system	46 km	St John Ambulance Australia Incorporated	170894-AUME-L-13	Response received by email on 10 November 2016: *"…we have reviewed it and could not identify any obvious impact to St John assets."*
14	Trigonometrical stations, Global Navigational Satellite System (GNSS) stations	Within Project boundaries	Geoscience Australia	170894-AUME-L-14	Response received by email on 5 December 2016: *"Geoscience Australia does not see foresee any impact to our trigonometrical stations, Global Navigational Satellite System stations, equipment, facilities or services associated with the proposed Twin Creek Wind Farm."*

Table 14 Summary of service operators contacted by DNV GL and responses received to date (continued)

	Licence/service type	Distance of closest site [km]	Operator	DNV GL reference	Response received to date
15	Trigonometrical stations	Within Project boundaries	South Australia Land Services Group	170894-AUME-L-15	Response received by email on 25 October 2016: *"Departmental Trig Points and Permanent Survey Marks are non-communicative assets and so will not be affected at all by electromagnetic interference...* *The marks you have listed are generally outside of the proposed wind farm boundary and so will be unaffected by potential construction works and the one inside the boundary appears to be sufficiently clear of the proposed turbine localities.* *There are four survey marks along Ben Lomond Rd that runs through the centre portion of the site. The mark numbers are 6729/1606, 6729/1607, 6729/2060 and 6729/2059, although I have estimated that the turbine locations are just south of Ben Lomond Rd so these marks may not be affected either. However, if these marks are to be disturbed in any way by construction of the wind farm turbines, please arrange for my office to be contacted before they are moved or destroyed."*
16	PTMS/spectrum (mobile phone)	5 km	Optus Mobile Pty Ltd	170894-AUME-L-16	Response received by email on 31 November 2016: *"We have reviewed this proposal and conclude it will not impact either our mobile network or microwave link network."*
17	PTMS/spectrum (mobile phone)	8 km	Vodafone Australia Pty Limited	170894-AUME-L-17	Response received by email on 14 November 2016: *"Having spoken with both our radio access and transmission teams Vodafone confirm that we have no plant in the area of interest and as a result would not expect the Twin Creek development to impact our network operation."*

LIST OF FIGURES

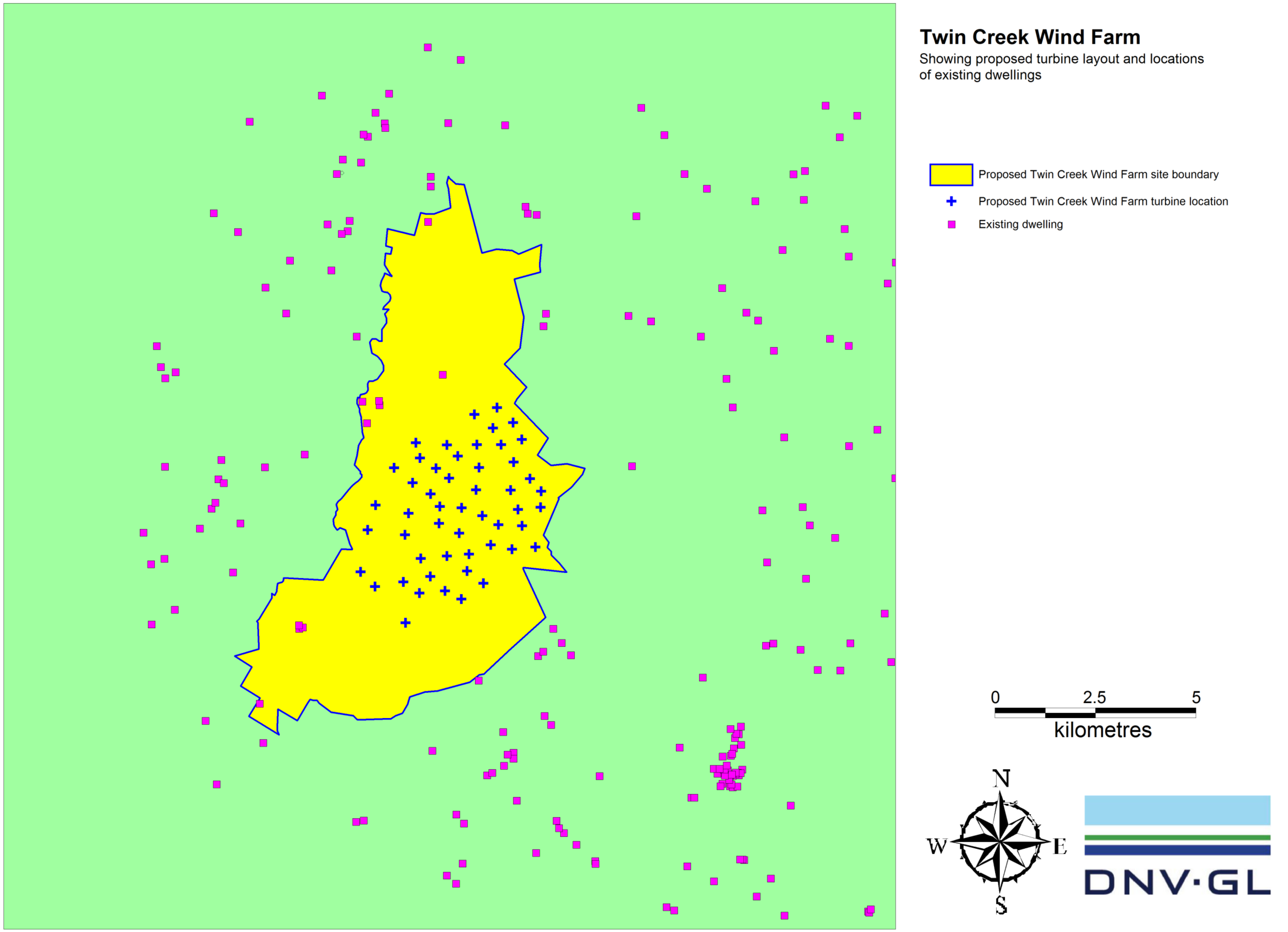

Figure 1 Map of the proposed Project, showing site boundaries, turbine locations, and locations of nearby dwellings

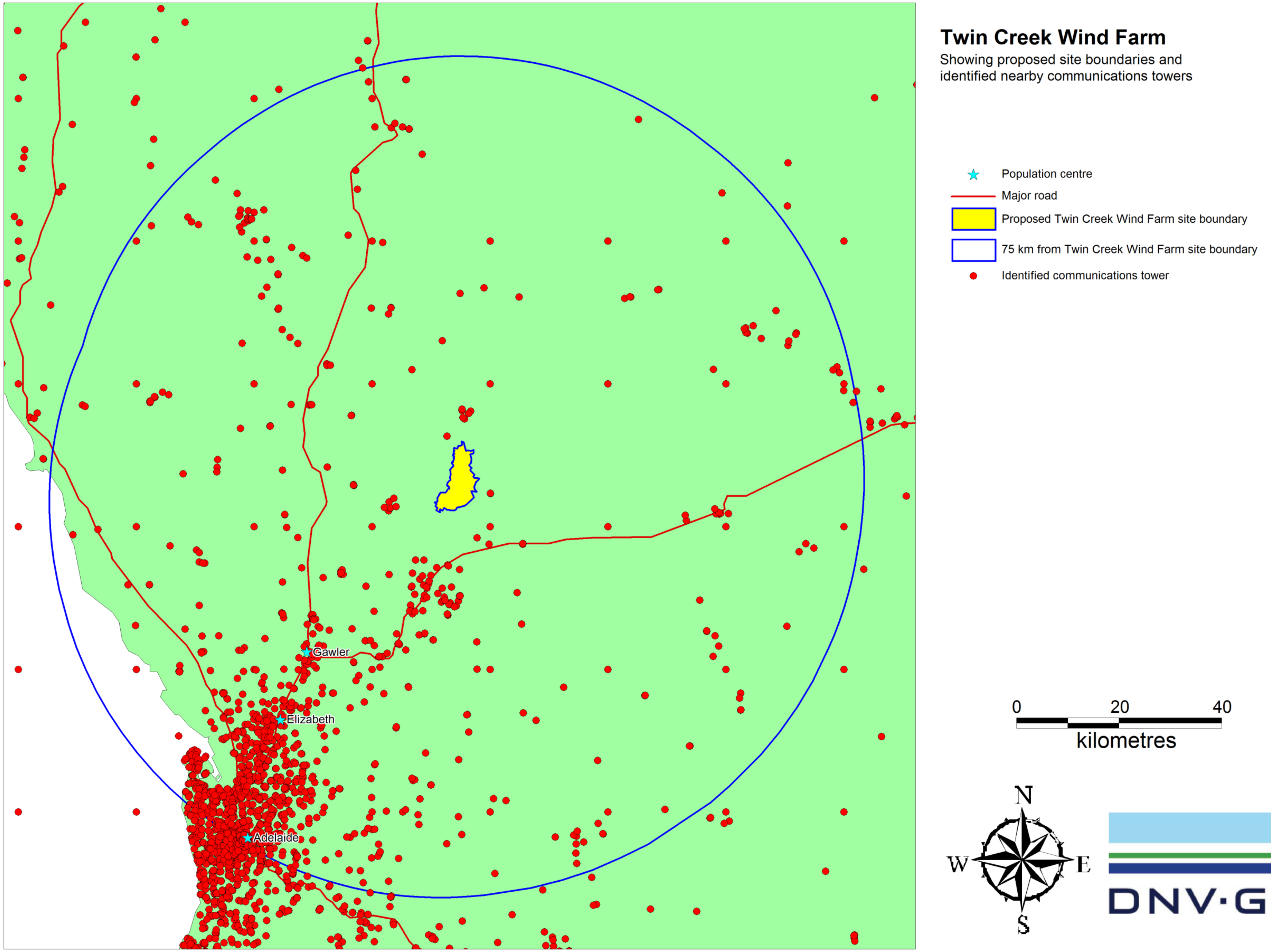

Figure 2 Location of the proposed Project and identified proximate radiocommunication sites

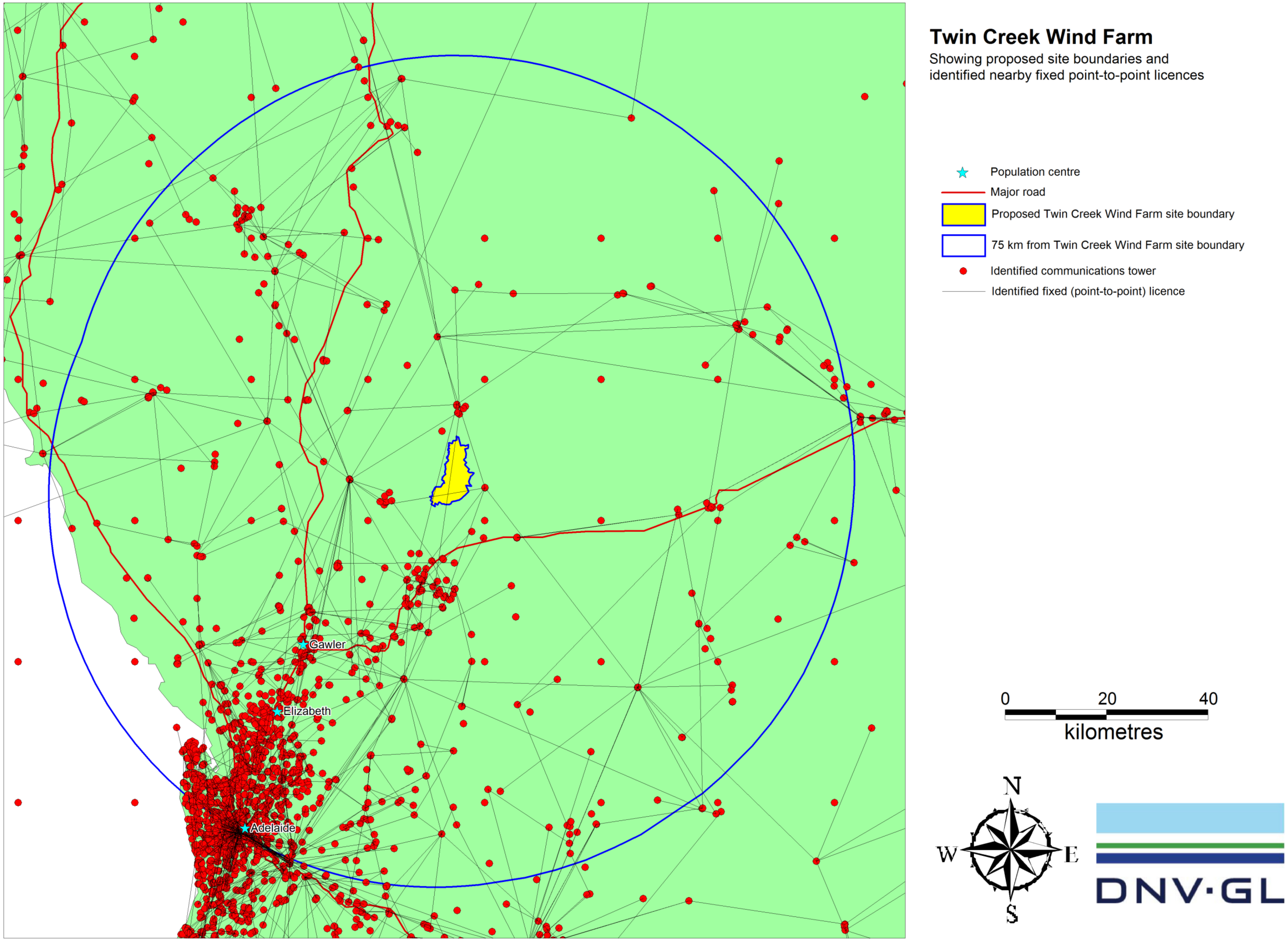

Figure 3 Identified transmission vectors for fixed licences of point-to-point type in the vicinity of the proposed Project

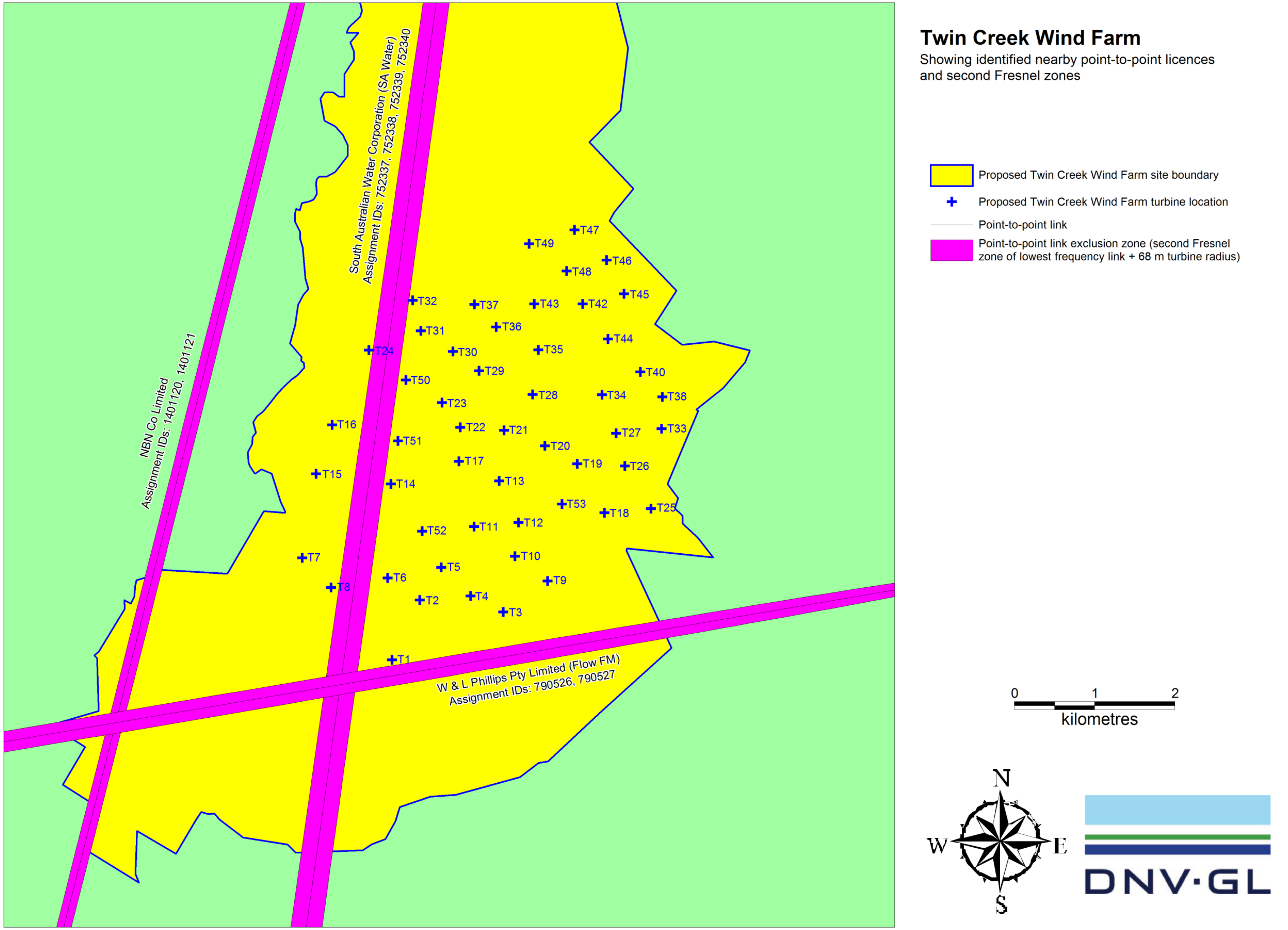

Figure 4 Identified telecommunication vectors and second Fresnel zones plus 68 m buffer for the proposed Project

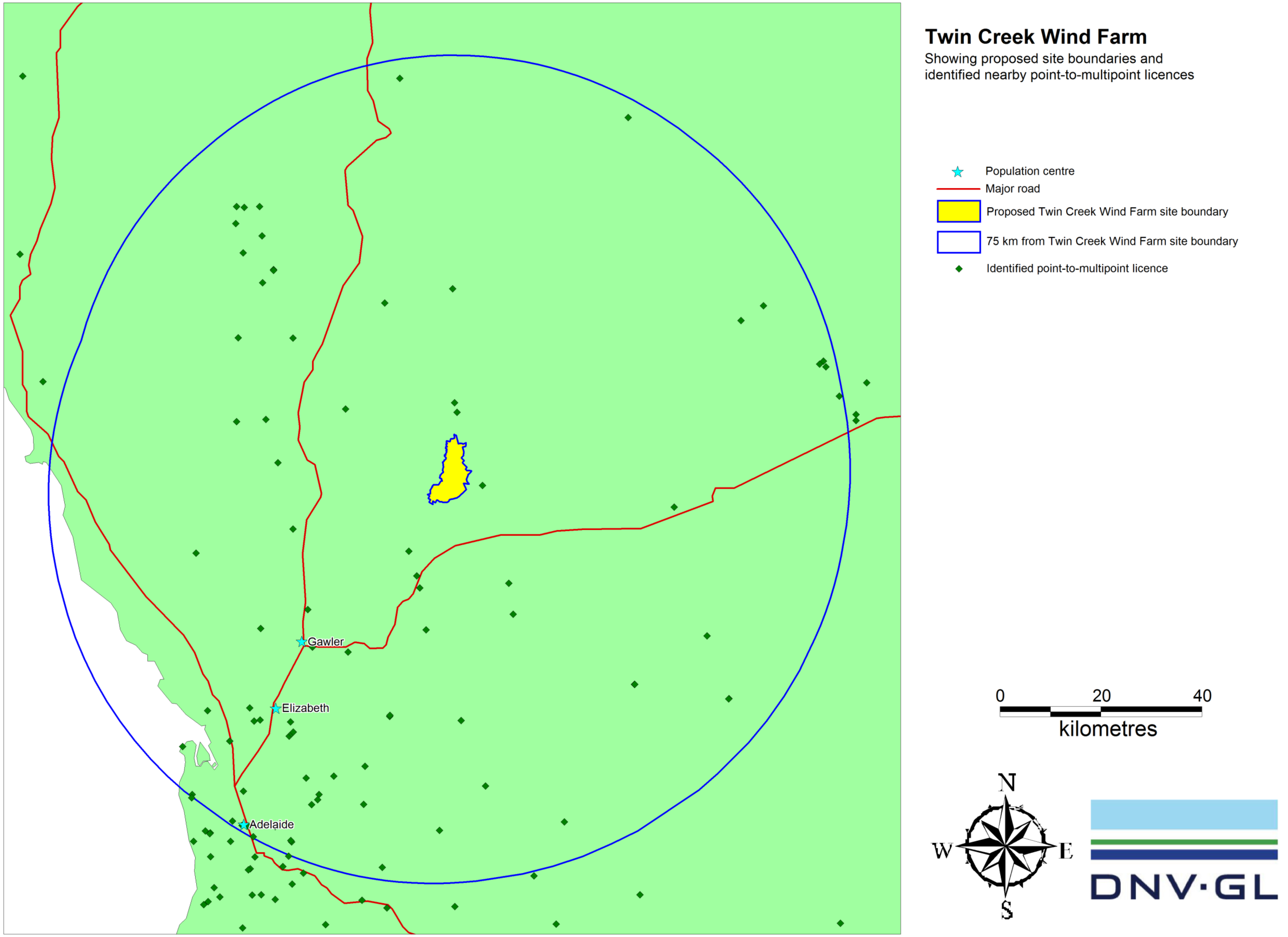

Figure 5 Location of point-to-multipoint licences in the vicinity of the proposed Project

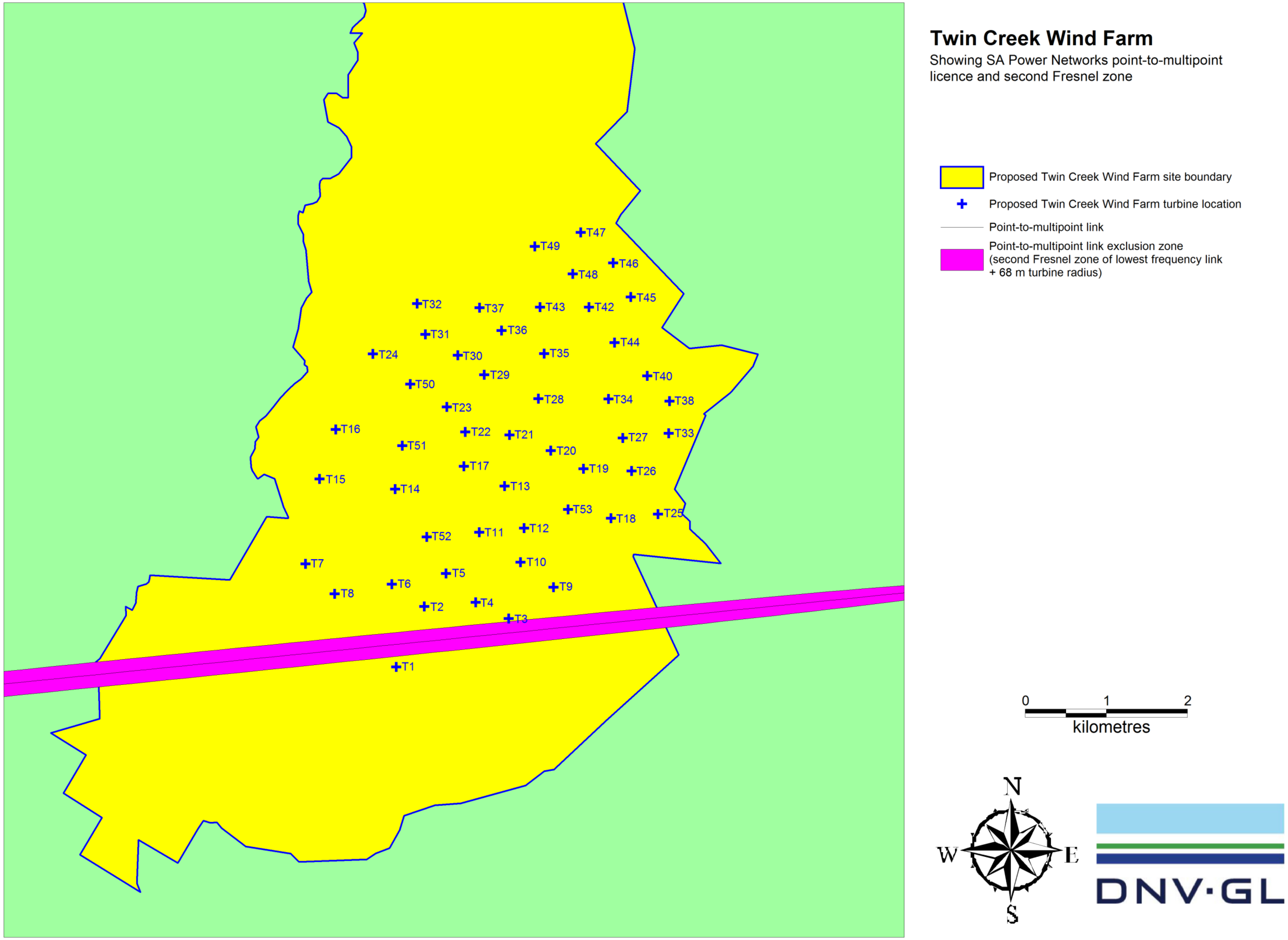

Figure 6 Identified SA Power Networks link and second Fresnel zone plus 68 m buffer

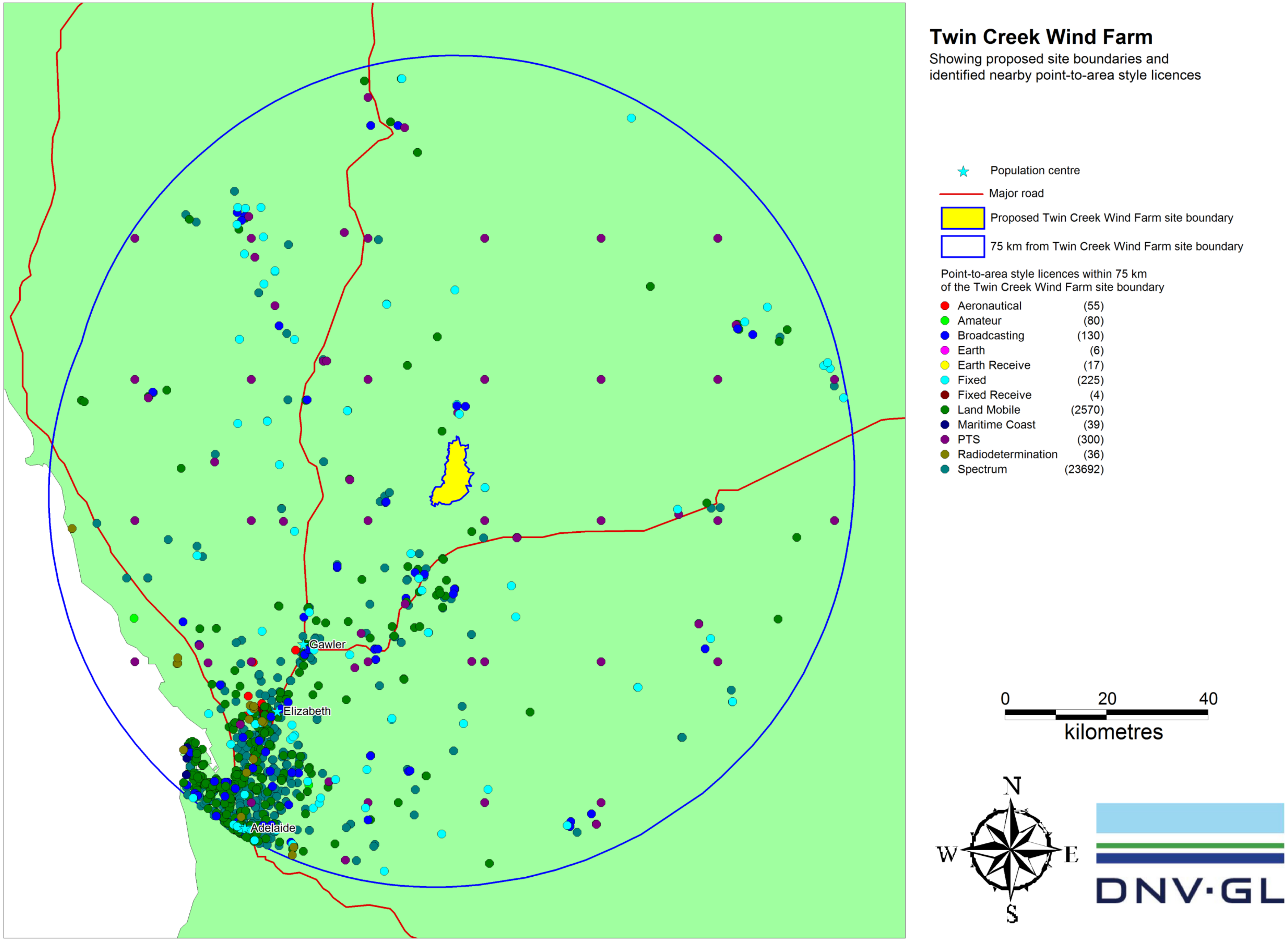

Figure 7 Location of general point-to-area style licences within 75km of the proposed Project

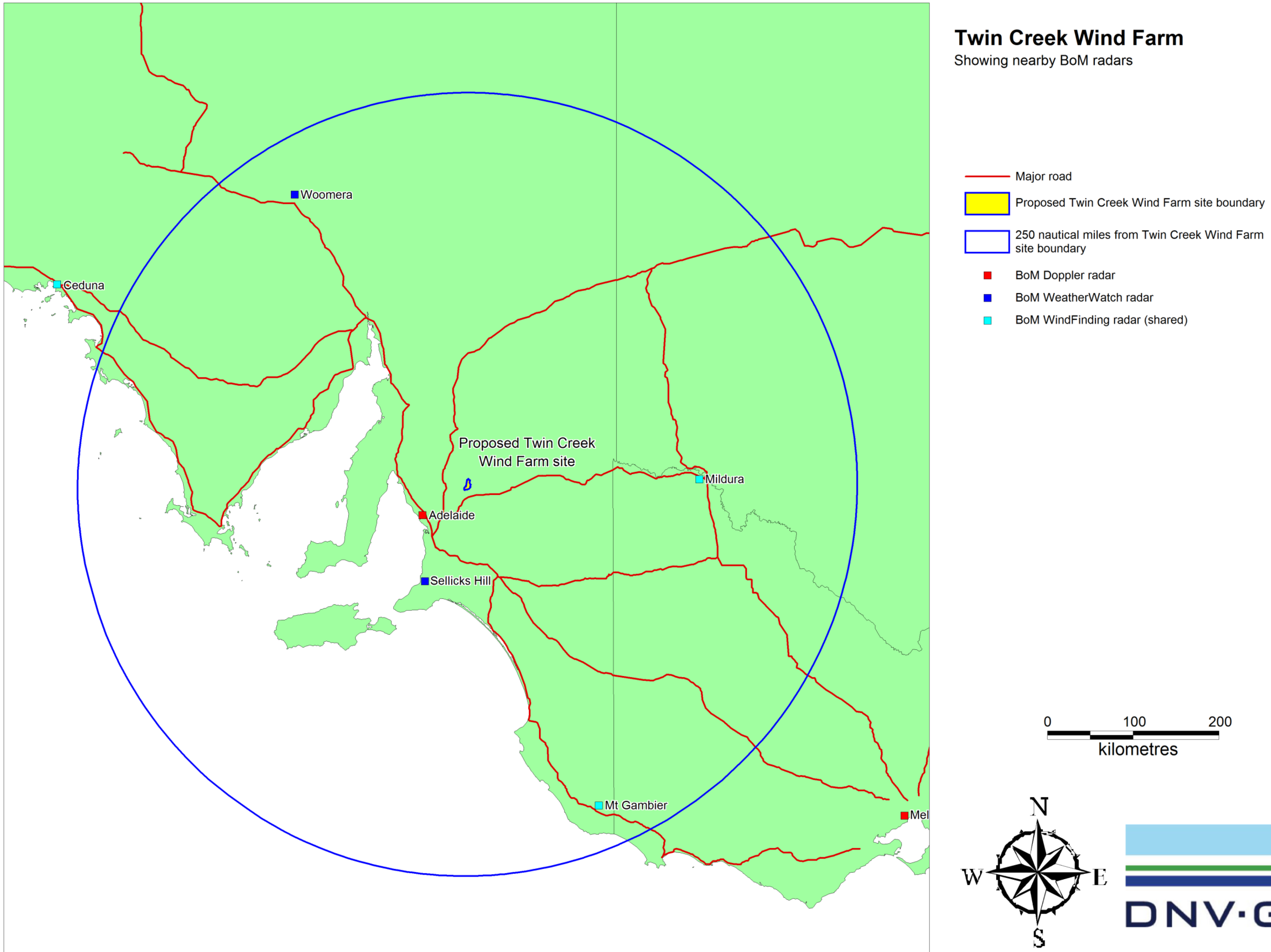

Figure 8 Location of meteorological radar sites within 250 nautical miles of the proposed Project

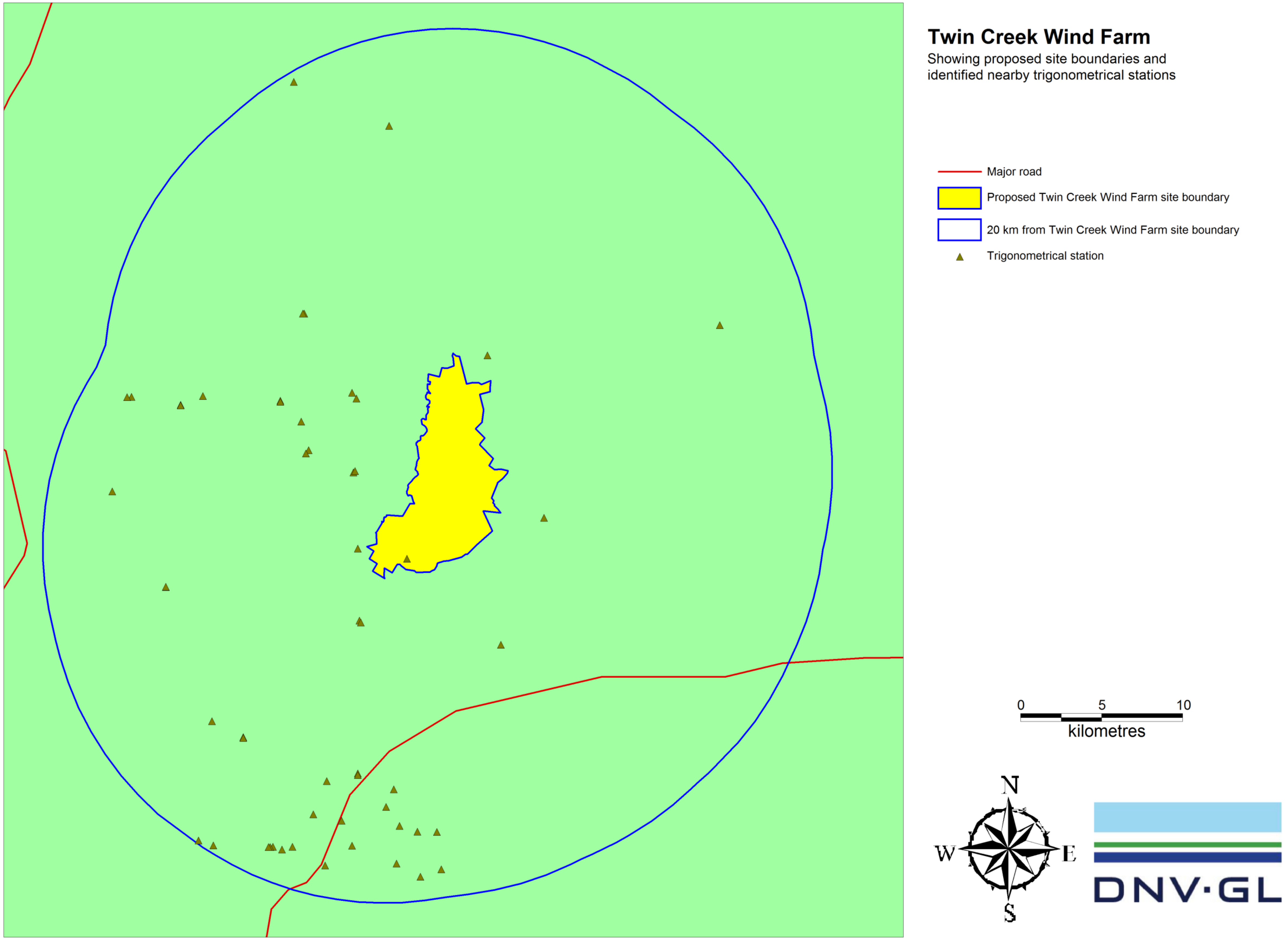

Figure 9 Location of trigonometrical stations within 20 km of the proposed Project

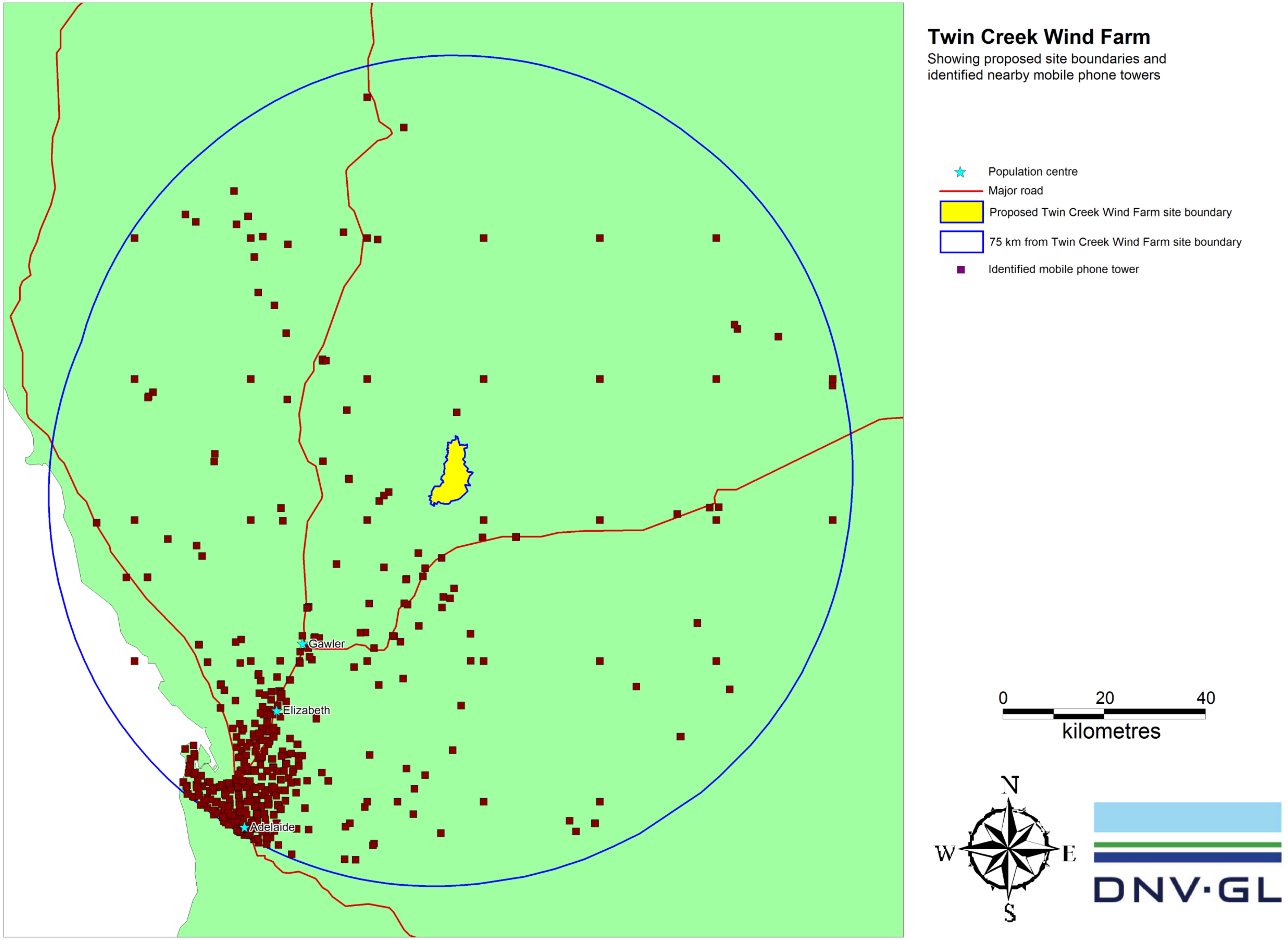

Figure 10 Location of mobile phone towers within 75 km of the proposed Project

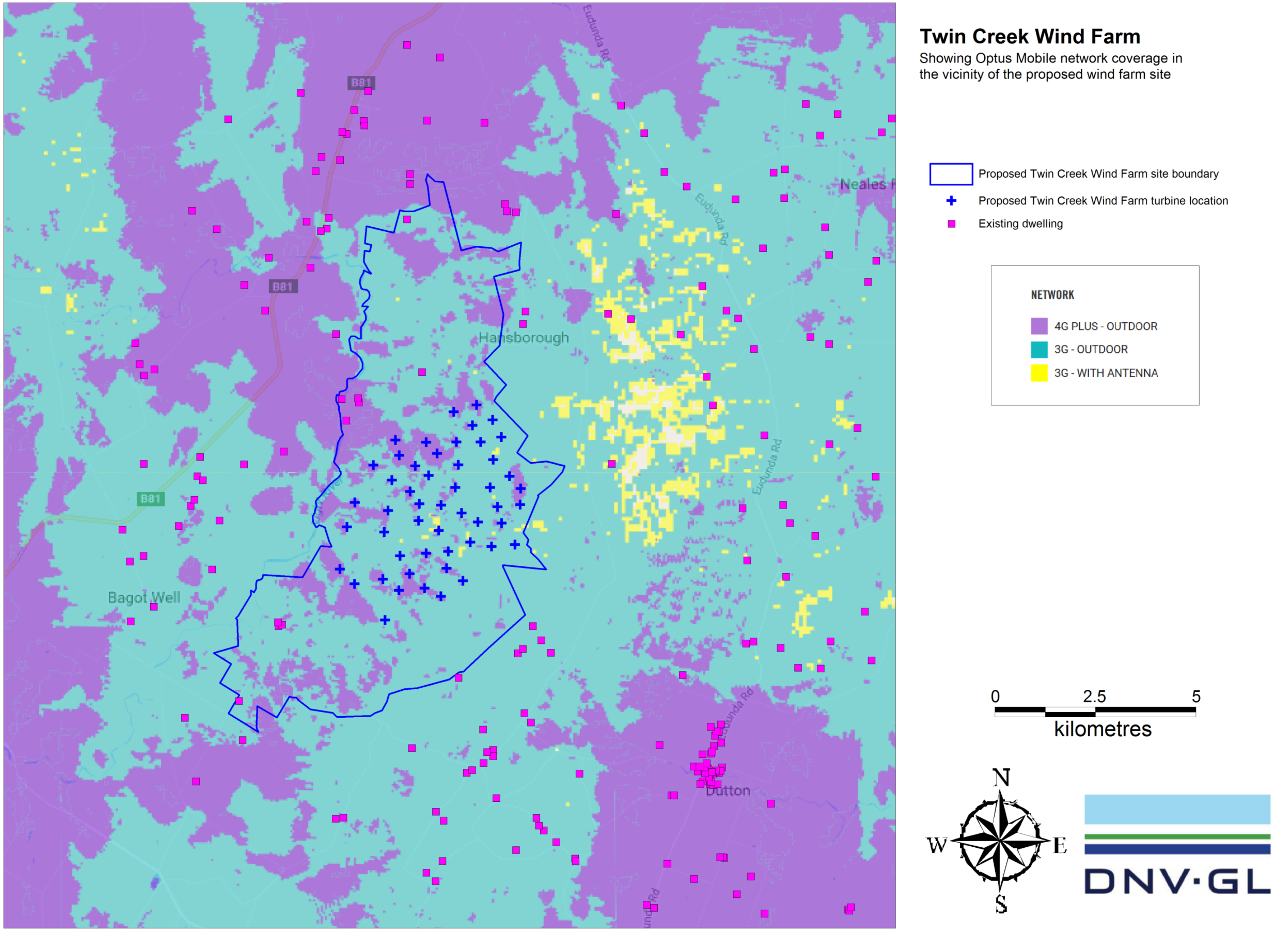

Figure 11 Optus Mobile network coverage (Samsung Galaxy S7 handset) for the proposed Project

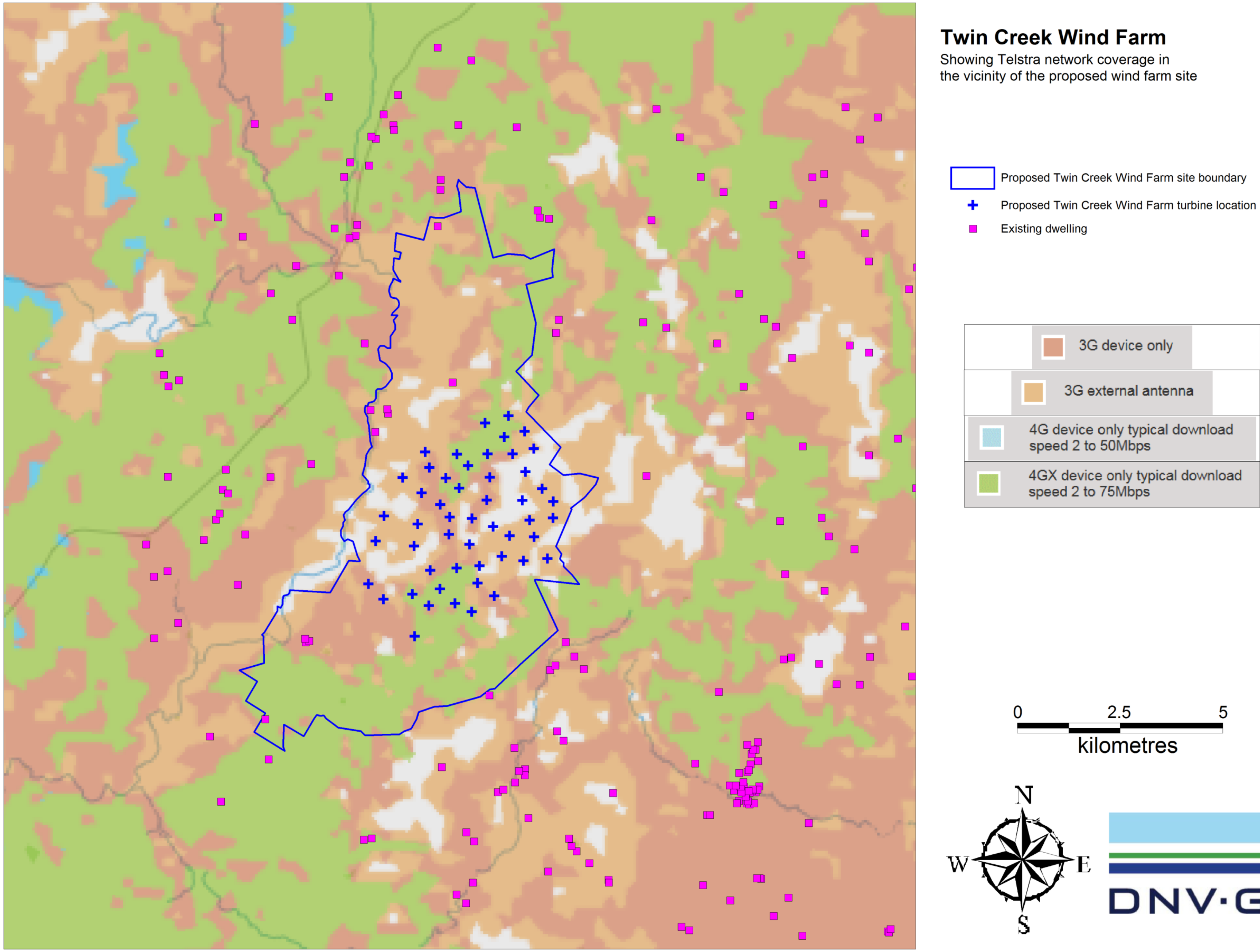

Figure 12 Telstra network coverage for the proposed Project

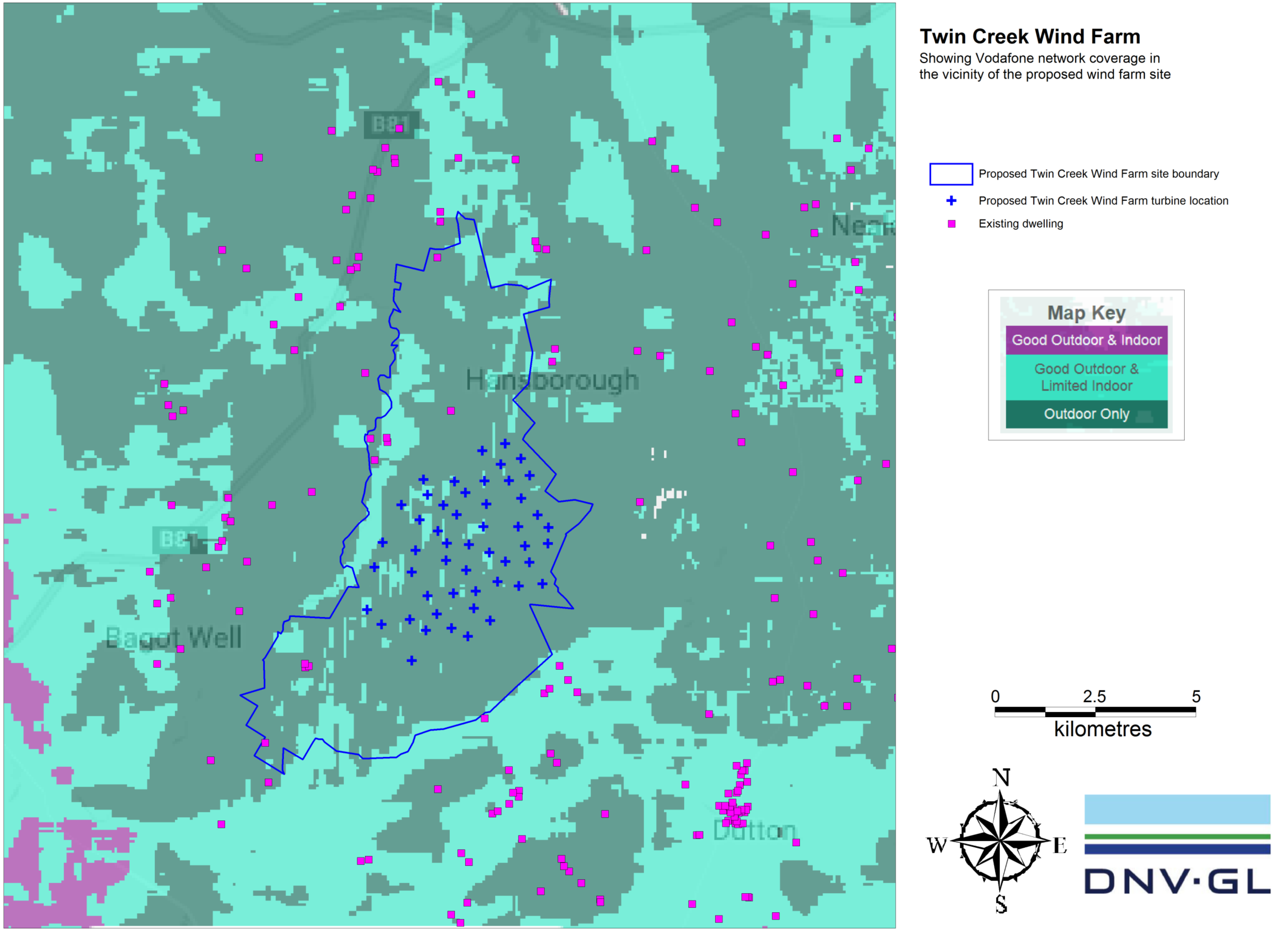

Figure 13 Vodafone network coverage for the proposed Project

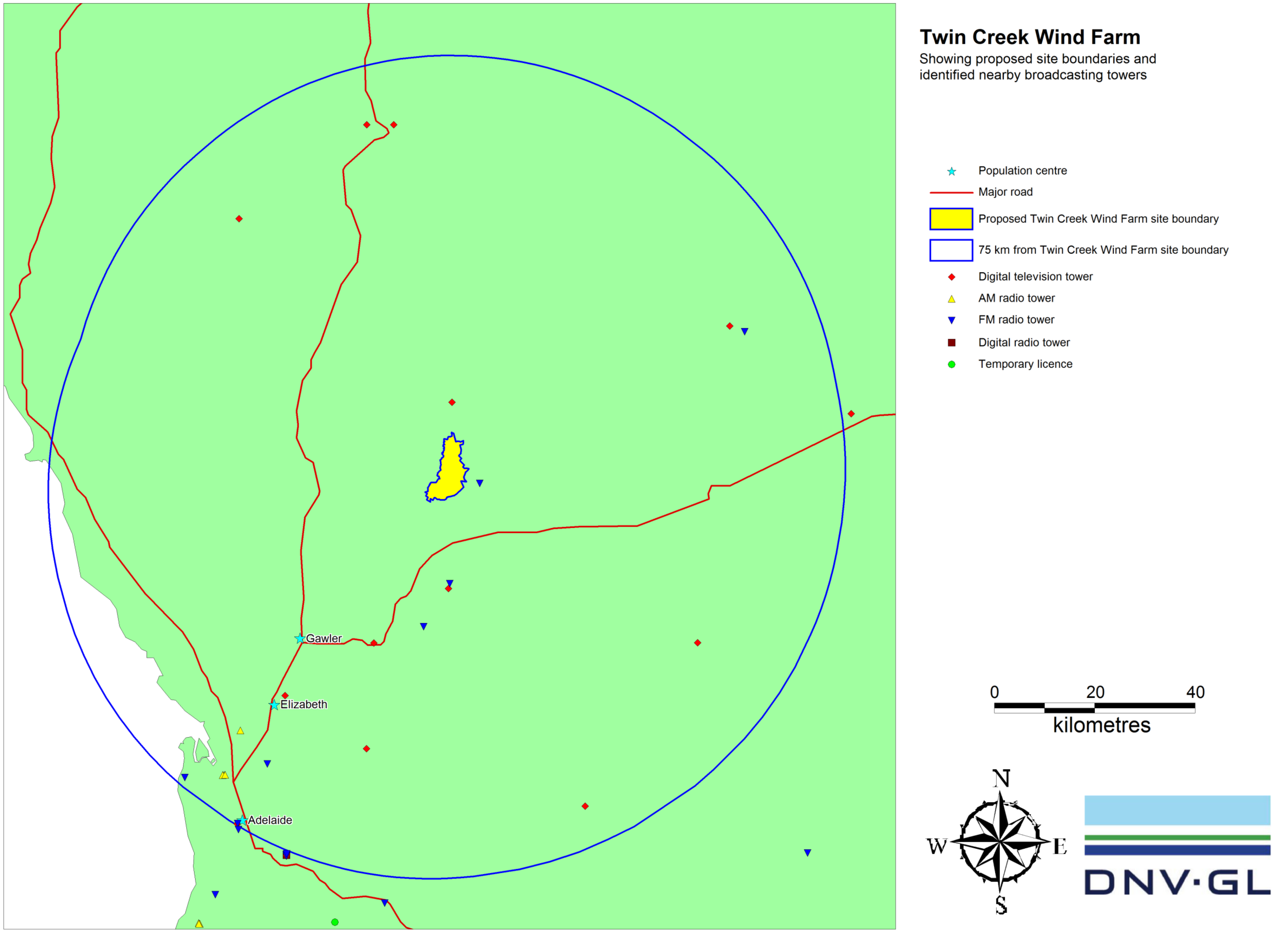

Figure 14 Location of broadcast transmitters in the vicinity of the proposed Project

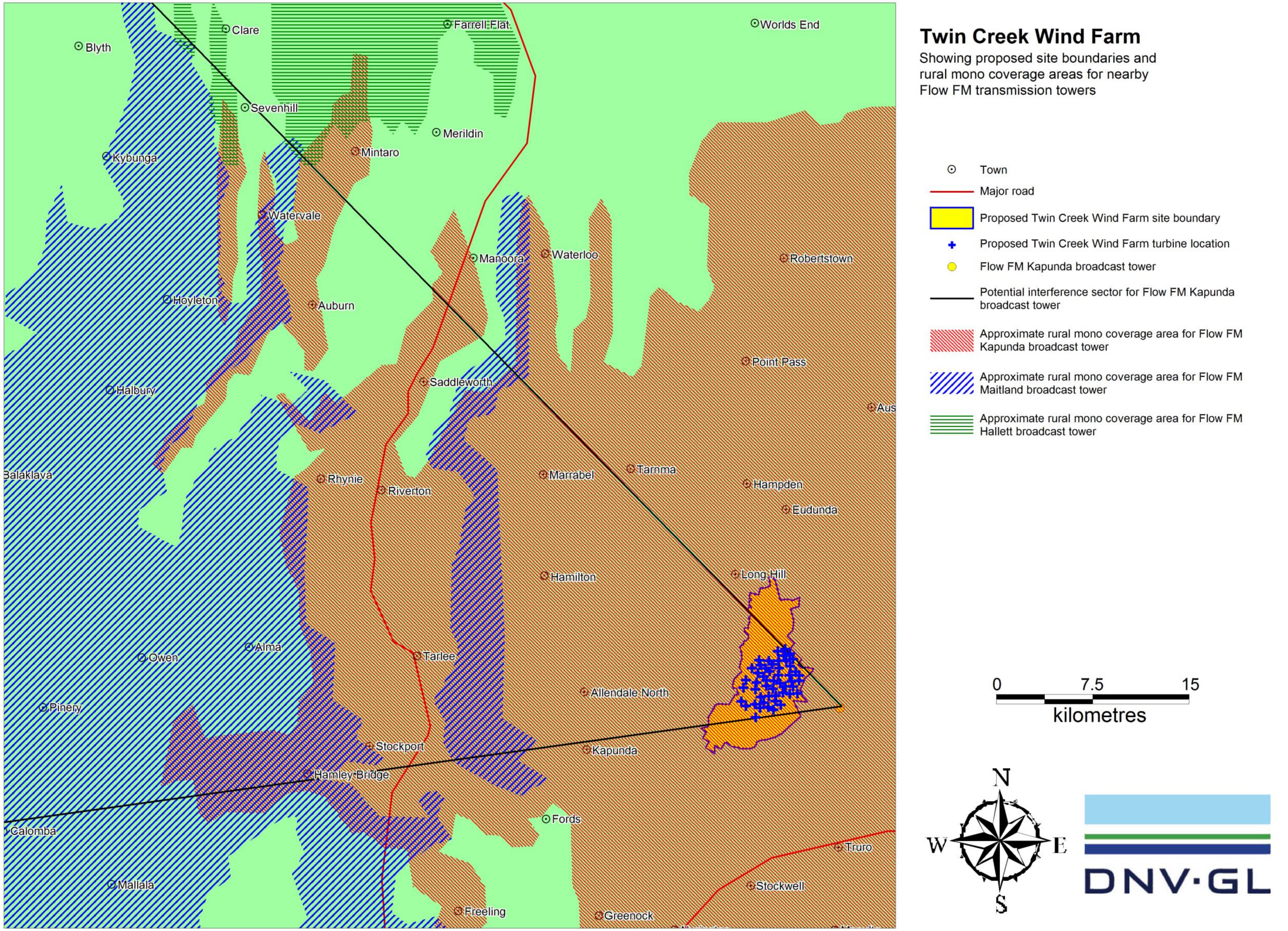

Figure 15 Flow FM signal coverage (rural mono reception) for the proposed Project

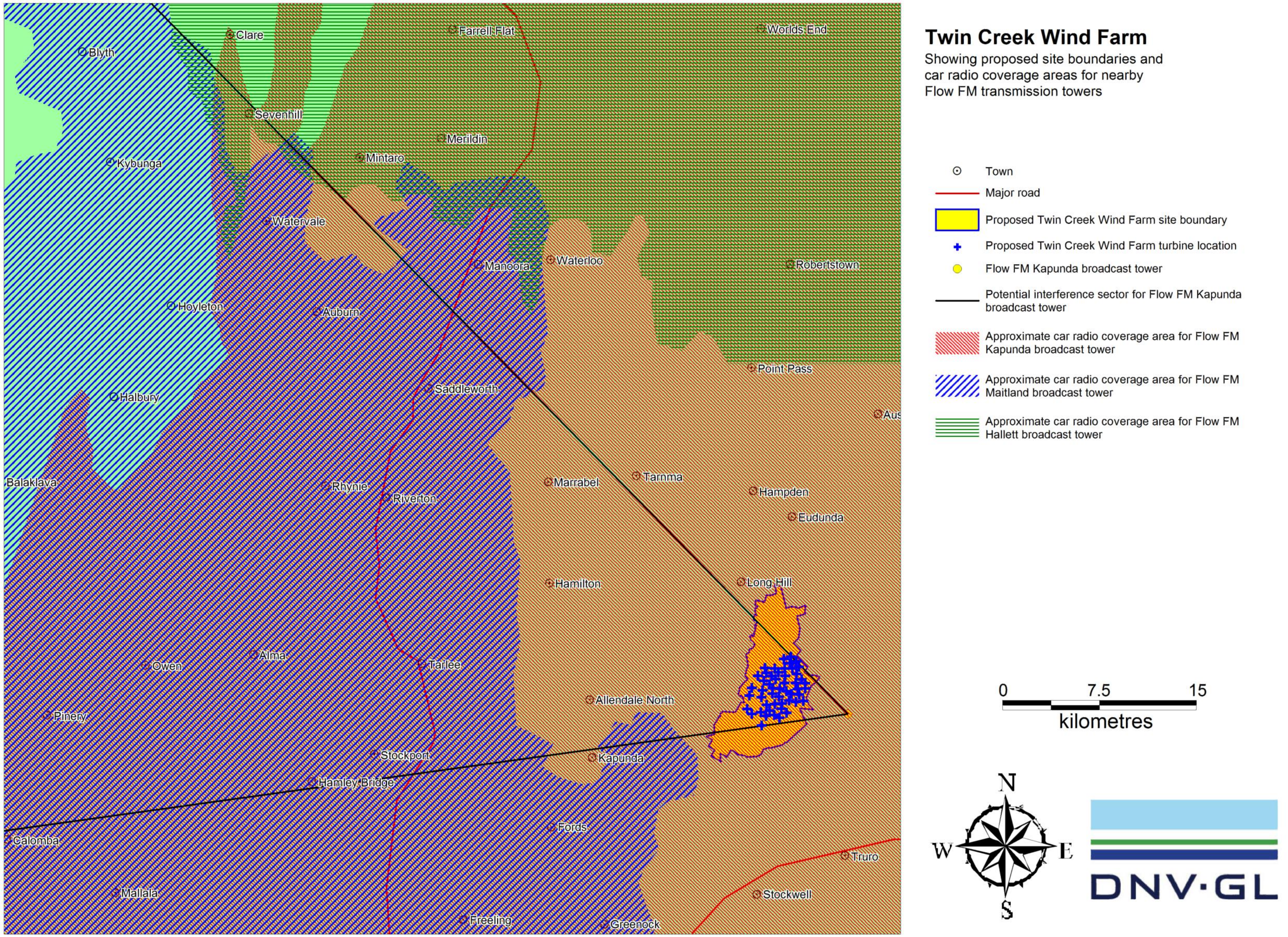

Figure 16 Flow FM signal coverage (car radio reception) for the proposed Project

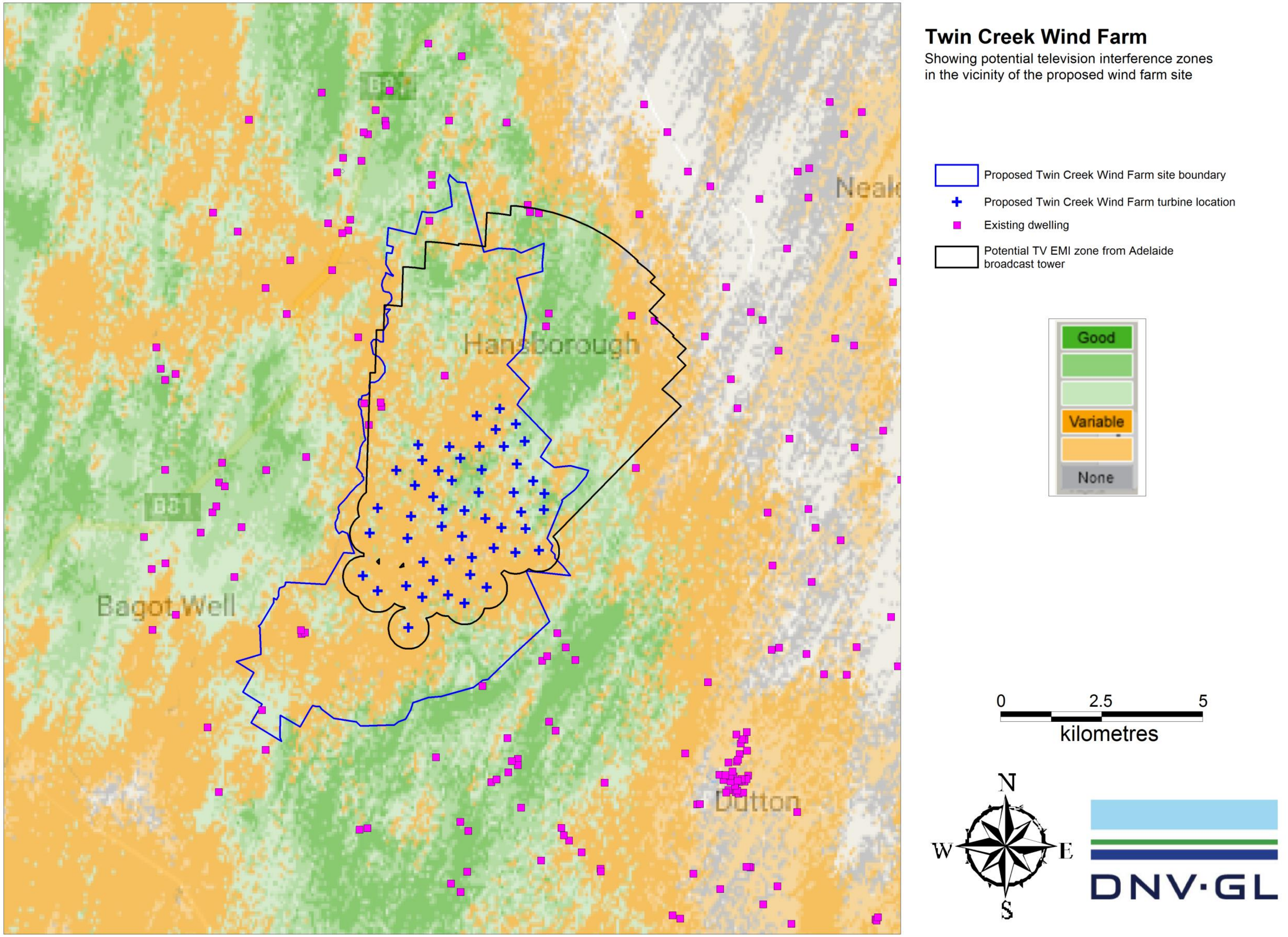

Figure 17 Potential television EMI zones from the Adelaide broadcast tower for the proposed Project

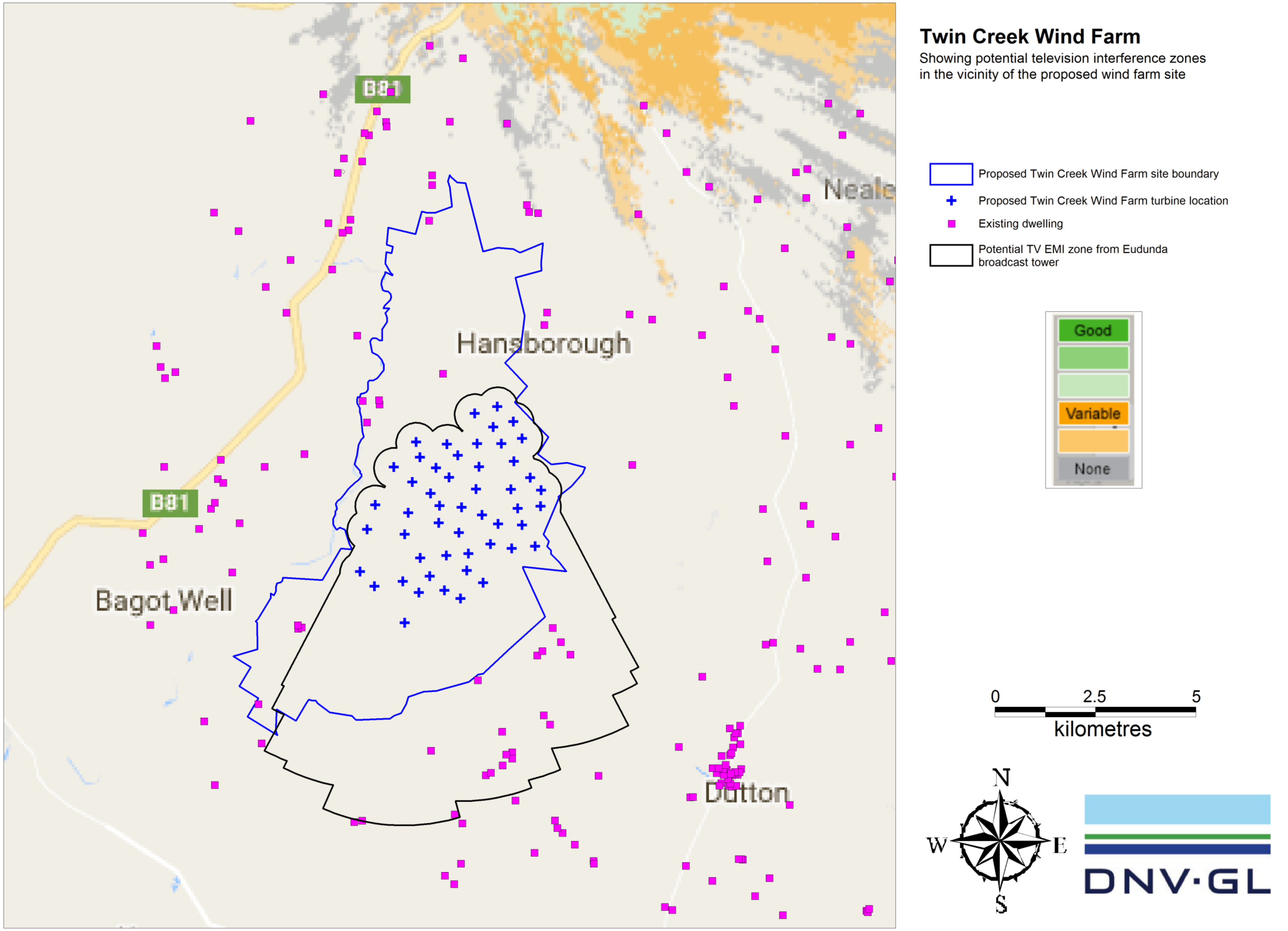

Figure 18 Potential television EMI zones from the Eudunda broadcast tower for the proposed Project

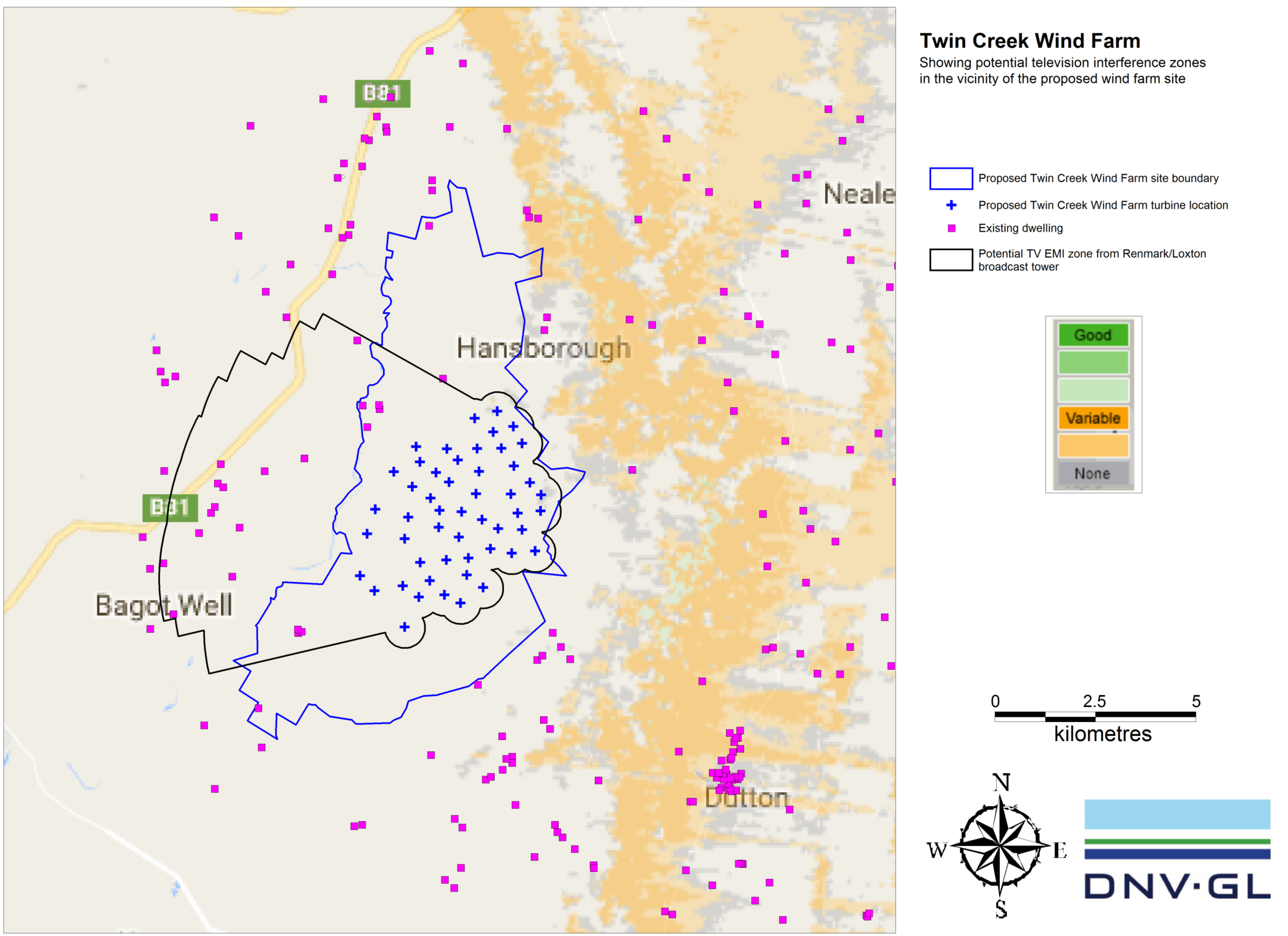

Figure 19 Potential television EMI zones from the Renmark/Loxton broadcast tower for the proposed Project

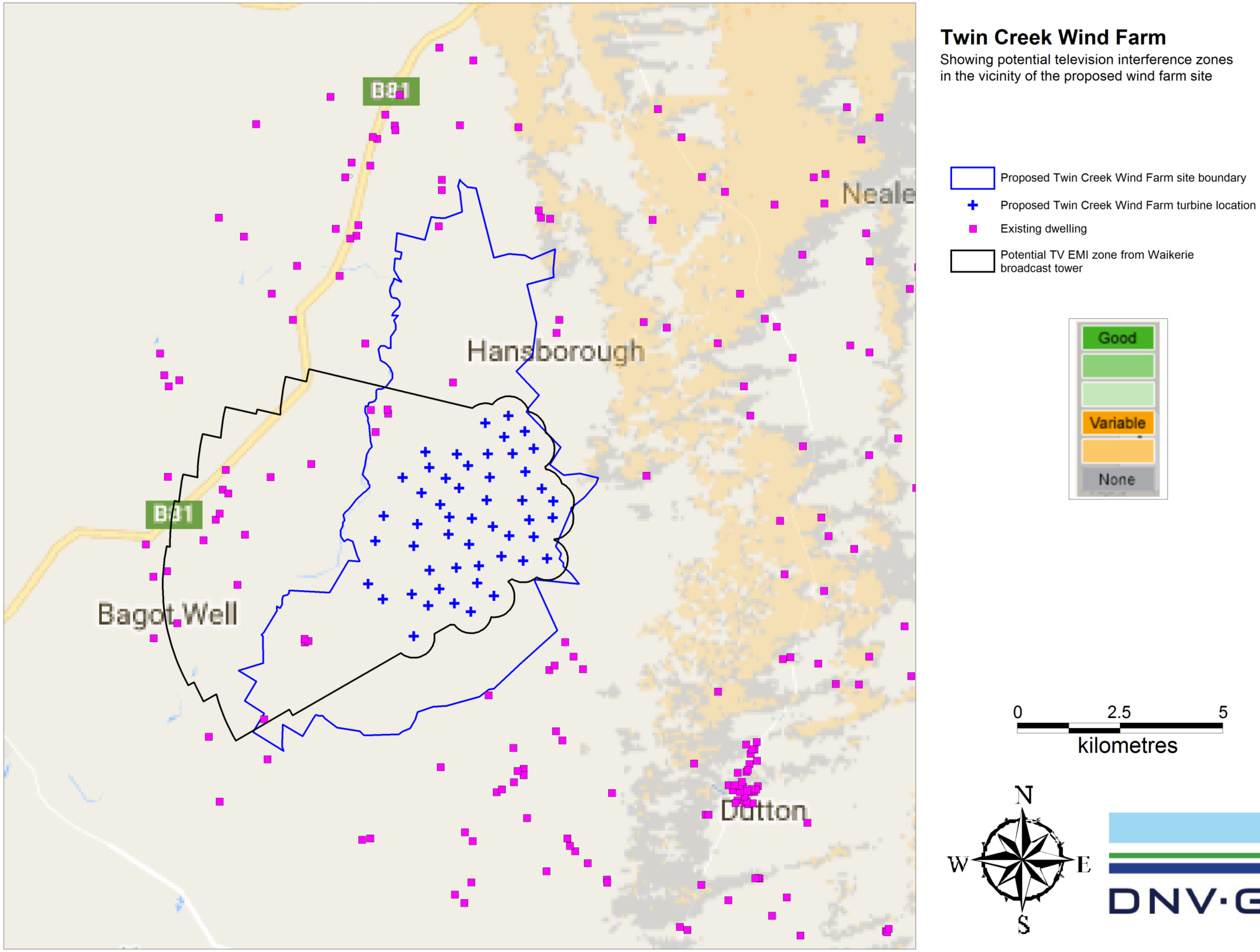

Figure 20 Potential television EMI zones from the Waikerie broadcast tower for the proposed Project

About DNV GL

FINAL REPORT

AVIATION IMPACT STATEMENT
QUALITATIVE RISK ASSESSMENT
OBSTACLE LIGHTING REVIEW

TWIN CREEK WIND FARM

J0475

Copy No.: v1.0

Report to:

RES Australia Pty Ltd

17 March 2017

Melbourne, Australia

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Name: Ian Jennings

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V1.0	Final Report	17 March 2017	IJ	BWS

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EXECUTIVE SUMMARY

The proposed Twin Creek Wind Farm (TCWF) comprises 51 turbines with a tip height of 180m above ground level (AGL) situated approximately 11km east north east of Kapunda and 84km north east of Adelaide International Airport.

The tallest turbine has a tip height of 660.22m (2166ft) above the Australian Height Datum (AHD). At this height the TCWF does not interfere with any airspace procedures or aviation related communications, navigation or surveillance facilities for both civil or military aerodromes and airspace.

In accordance with the National Airports Safeguarding Framework (NASF) Guideline D, Ambidji conducted a Qualitative Risk Assessment that concluded that the TCWF is not a hazard to aircraft safety. Given that the location of the TCWF will be marked on aeronautical charts and that by day the size and color of the turbines makes them conspicuous, no further hazard marking is required. At night the hazard to aircraft operations is negligible because pilots are required to flight plan to be a minimum of 1000ft above the highest obstacle on the terrain, or be above the promulgated Lowest Safe Altitude (LSALT). Consequently, in accordance with NASF Guideline D paragraph 34, there is no requirement for aviation obstruction lighting to be fitted to the turbines.

CASA cannot mandate the fitting of obstruction lighting to obstacles ñnot in the vicinity of an aerodrome.ò In accordance with the NASF, CASA may only recommend obstruction lighting on wind turbines.

The TCWF is not a hazard to aircraft safety and does not: -

- Interfere with any military or civil airspace procedures;
- Impact on the operation of any military or civil communications, navigation or surveillance facilities; and
- Require aviation obstructing lighting.

1. INTRODUCTION

RES Australia Pty Ltd has engaged Ambidji, a division of Landrum and Brown Worldwide to prepare an Aviation Impact Assessment (AIA), Aviation Impact Statement (AIS), Qualitative Risk Assessment (QRA) and an Obstacle Lighting Review (OLR) for the proposed Twin Creek Wind Farm (TCWF) north east of Kapunda and approximately 84km north east of Adelaide, South Australia.

1.1 Location

The TCWF is located approximately 11km (6nm) north east of Kapunda in South Australia. The wind farm is approximately 84km (45nm) north east of Adelaide International Airport.

The TCWF comprises 51 turbines with a tip height of 180m Above Ground Level (AGL). The highest ground is at turbine T38 and gives a tip height of 660.22 m (2166ft) above the Australian Height Datum (AHD). Figure 1.1.1 below provides the general location of the wind farm.

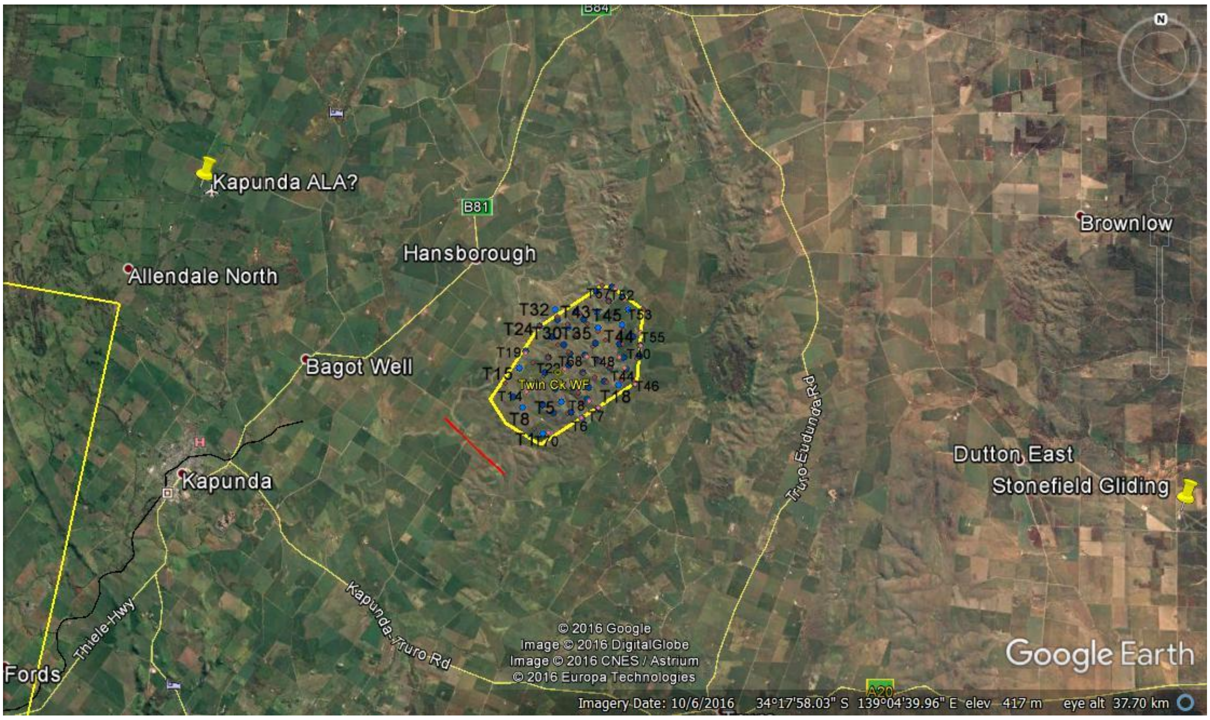

Fig 1.1.1 General Location of the Proposed Twin Creek Wind Farm

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, and Port Augusta 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 Renmark 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 no military, certified or registered aerodromes within 30nm (56km) of the TCWF.

The nearest aerodrome is the Edinburgh Military base (YPED) 31nm (57.4km) south west of the TCWF.

1.4 Air Routes in the Area

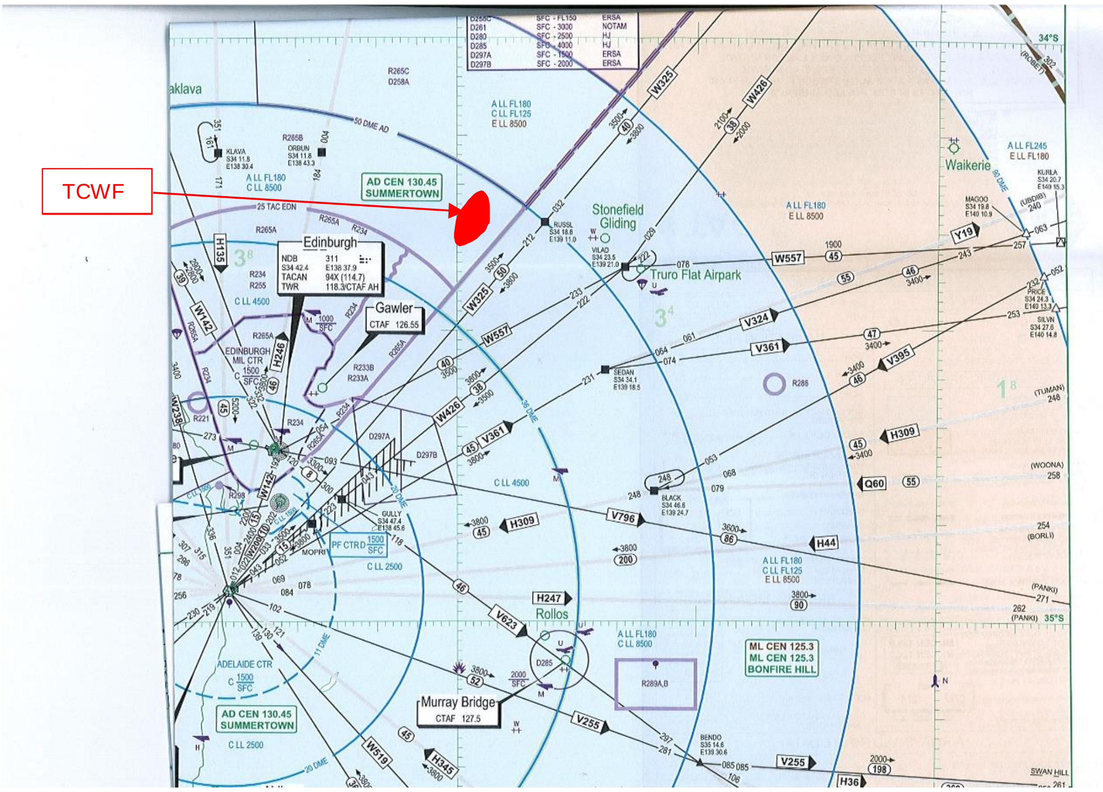

Figure 1.4.1 Air routes in the vicinity of the Twin Creek Wind Farm (approximate boundaries)[3]

[3] AIP Terminal Area Chart 5 (Adelaide) effective 26 May 2016

1.4.1 Relevant Air Routes

There are two significant air routes in the vicinity of the TCWF as shown in Figure 1.4.1. above.

Air Route	Segment	Lowest Safe Altitude LSALT
GRID		3400
W325	AD ï RUSEL	3500
H426	AD - ORBUN	3800

Table 1.4.1 Relevant Air Routes and LSALT

1.5 Airspace

The TCWF is situated in Class G airspace, beneath Class E airspace with a lower limit of 8500ft.

As can be seen from Figure 1.4.1, the TCWF is located within the lateral boundaries of Military Restricted Area R265B.

R265B has: -

- A Lower Limit of 3500ft;
- Hours of operation notified by NOTAM; and
- A Conditional RA1 status meaning that when it is active a pilot may flight plan through the Restricted Area and under normal circumstances expect a clearance from Air Traffic Control (ATC)[4]

The maximum tip height of the TCWF is 660.22m (2166ft) AHD at turbine T38 and is below the Lower Limit of this Restricted Area.

[4] AIP Designated Airspace Handbook p PRD ï 1 Effective 26 May 2016

2. SCOPE

To meet RES Australiaœ requirements, the study required Ambidji to examine the proposed MWWF 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 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 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.
- An assessment of the need, against the outcomes of the Qualitative Risk Assessment, for obstacle lighting of the wind farm.

2.3 Obstacle Lighting Review

The OLR reviews the outcome of the QRA to determine the need or otherwise for aviation obstruction lighting of turbines in the wind farm.

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 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 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 31000-2009 *Risk Management – Principles and Guidelines.*

The QRA investigates the risk posed to aviation activity in the area by the wind farm.

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 surveyed to ascertain the extent of local aviation activity in the vicinity of the proposed wind farm. 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;

- 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.

3.3 Obstacle Lighting Review

The Obstacle Lighting Review investigates the current International and 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: -

- Summarise current International standards and regulatory requirements;

- 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

4.1 Location

The location of the proposed TCWF is shown in Figure 1.1.1

4.2 Obstacles

A list of the proposed wind turbine locations is shown in Appendix B.

4.3 Drawings

A drawing of the proposed TCWF is shown at Figure 4.3.1 below.

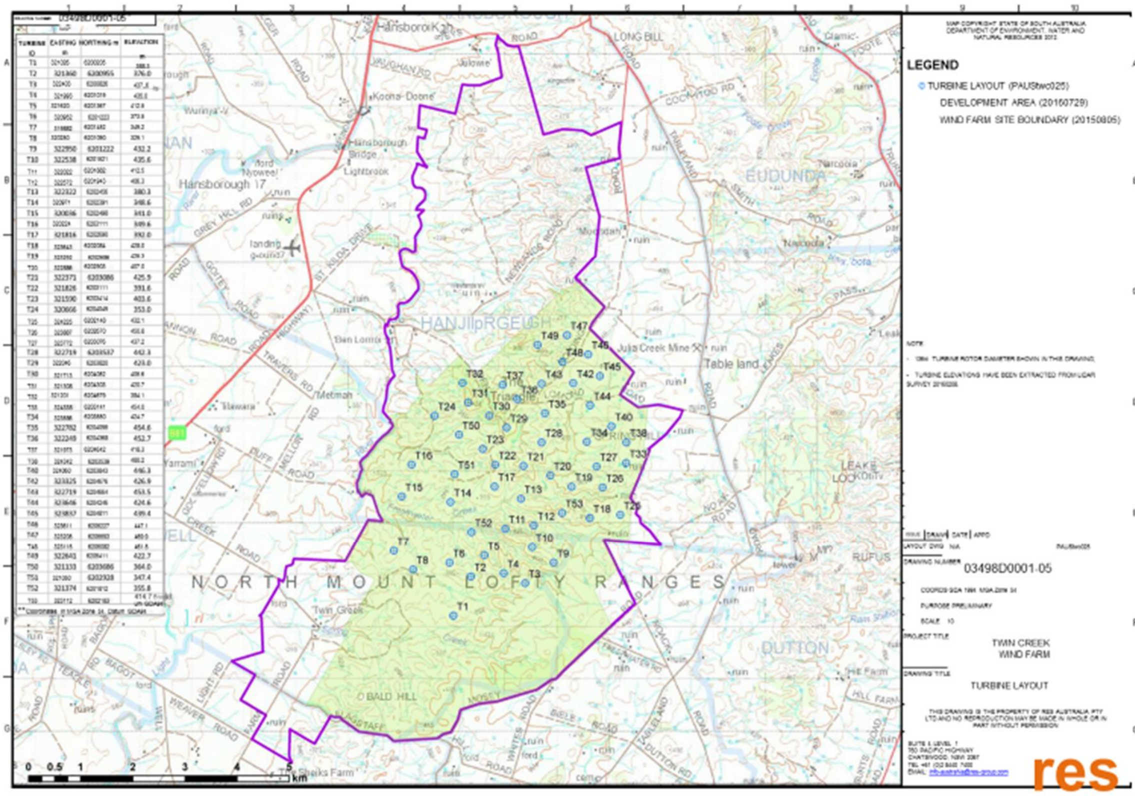

Figure 4.3.1 Layout of the Twin Creek Wind Farm showing turbine locations

A Google Earth (GE) image showing the identification and location of each turbine site is shown at Figure 4.3.2.

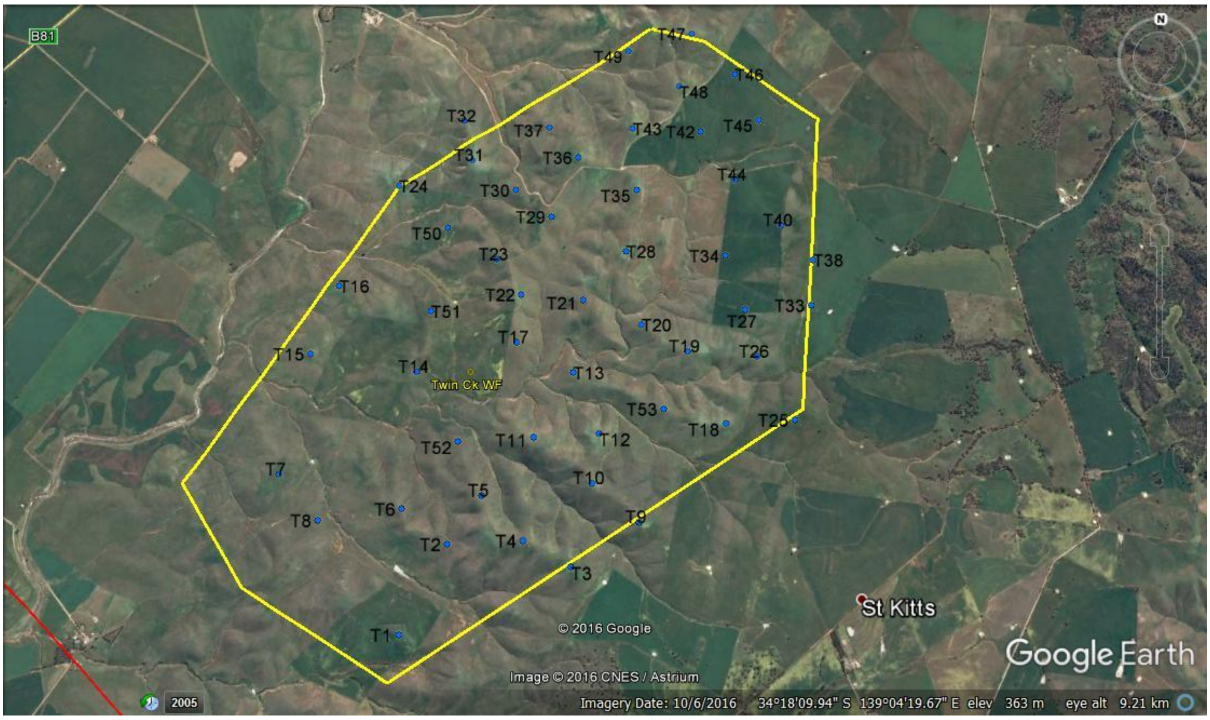

Figure 4.3.2 GE image of the Twin Creek Wind Farm showing turbine locations

4.4 Aerodromes with 30nm

There are no Military, certified or registered aerodromes within 30nm (56km) of the TCWF.

4.5 Obstacle Limitation Surfaces

The TCWF does not impact any Obstacle Limitation Surfaces (OLS).

4.6 PANS – OPS Surfaces

The TCWF does not impact any PANS-OPS surfaces.

4.7 Air Routes and Lowest Safe Altitudes

There are two significant air routes in the vicinity of the TCWF as shown in Figure 1.4.1 above.

These are shown in table 1.4.1:

Air Route	Segment	Lowest Safe Altitude LSALT
GRID		3400
W325	AD ï RUSEL	3500
H246	AD ï ORBUN	3800

Table 1.4.1 Relevant Air Routes and LSALT

The highest turbine tip is 2165ft, and when the MOC of 1000ft is applied the result is 3165ft which is below the Grid LSALT of 3400ft.

The TCWF does not impact the LSALTs in the area.

4.8 Airspace

As noted in paragraph 1.5 above the TCWF is situated in Class G airspace, beneath Class E airspace with a lower limit of 8500ft.

As can be seen from Figure 1.4.1 the TCWF is located within the lateral boundaries of Military Restricted Area R265B.

R265B has: -

- A Lower Limit of 3500ft;
- Hours of operation notified by NOTAM; and
- A Conditional RA1 status meaning that when it is active a pilot may flight plan through the Restricted Area and under normal circumstances expect a clearance from ATC[5]

The TCWF does not impact R265B as the maximum tip height of 2166ft (660.22m) AHD at turbine T40 is below the lower limit of 3500ft.

[5] AIP Designated Airspace Handbook p PRD ï 1 Effective 26 May 2016

4.9 Communications, Navigation and Surveillance Facilities

4.9.1 Communications

There are no AsA communications facilities located at or within 30nm of the TCWF.

The TCWF will not impact on the performance of any communication facilities.

4.9.2 Navigation Aids

There are no Radio Navigation Aids (NAVAIDs) in the vicinity of the TCWF.

4.9.3 Surveillance (Radar)

The nearest AsA Radar installations are at Adelaide Airport, 84km to the south west, and Summerton, 75.5km to the south south west of the TCWF.

Both of these radars are too far from the TCWF for the wind turbines to have any impact on radar performance.

4.10 AIS Conclusions

The AIS for the Twin Creek Wind Farm has made the following conclusions:

The TCWF will NOT impact upon the following:-

- The OLS and PANS-OPS surfaces published for any military, registered or certified aerodrome;
- The LSALTs for Air Routes and Grid in the vicinity;
- Any civil or military airspace; and
- The operation of any CNS facilities.

4.11 AsA Response to the AIS

AsA provided the following response: -

- With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 660.22m (2166ft)

AHD, the wind farm will not affect any air route, sector or circling altitude, nor any instrument approach or departure procedure at any airport

- The wind farm proposal as defined in the AIS with turbines to a maximum height of 660.22m (2166ft) AHD and in locations within +/- 100m of those provided, will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

- *Note: There are no instrument approach or departure procedures designed by organisations other than Airservices within 30nm of the wind farm.*

The AsA response to the AIS is shown at Appendix C.

4.12 Department of Defence Response to the AIS

Department of Defence advises they have no objection to the proposed TCWF.

The Department of Defence request that any LED obstruction lighting should be within the frequency range of wavelengths 655 to 930 nanometres in order to be compatible with the use of night vision devices.

The Department of Defence response to the AIS is shown at Appendix D.

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 or Registered aerodromes

There are no Military, certified or registered aerodromes within 56km (30nm) of the proposed TCWF.

5.2 Aeroplane Landing Areas

There are a number of ALA identified within 30km of the TCWF as shown in table 5.2.1 below.

ALA	Direction From	Distance (km/nm)	Use
Truro Flat	110	29/16	Sport Aviation
Stonefield	100	20/10.75	Gliding
Kapunda	295	13/7.3	Private [rarely used]

Table 5.2.1 – ALA within 30km of TCWF

Note: The Gawler ALA is 42km south west of the TCWF and is used extensively for gliding and sport aviation activity. Whilst it is beyond the 30km distance it was considered due to the amount of aviation activity taking place.

5.3 Airspace

The TCWF is situated in Class G airspace below Military Restricted airspace R265B.

R265B has: -

- A Lower Limit of 3500ft;
- Hours of operation notified by NOTAM; and
- A Conditional RA1 status meaning that when it is active a pilot may flight plan through the Restricted Area and under normal circumstances expect a

clearance from ATC[6]

The maximum tip height in the TCWF is 660.22m (2166ft) AHD at turbine T38. Applying the MOC of 1000ft provides a safe height of 3165ft AHD.

A VFR flight can transit safely above the TCWF at 3500ft and remain clear of R265B. In order to comply with the CAR the minimum transit altitude of 2666ft, (rounded up to 2700ft) would be necessary to remain 500ft above the highest turbine tip.

[6] AIP Designated Airspace Handbook p PRD ï 1 Effective 26 May 2016

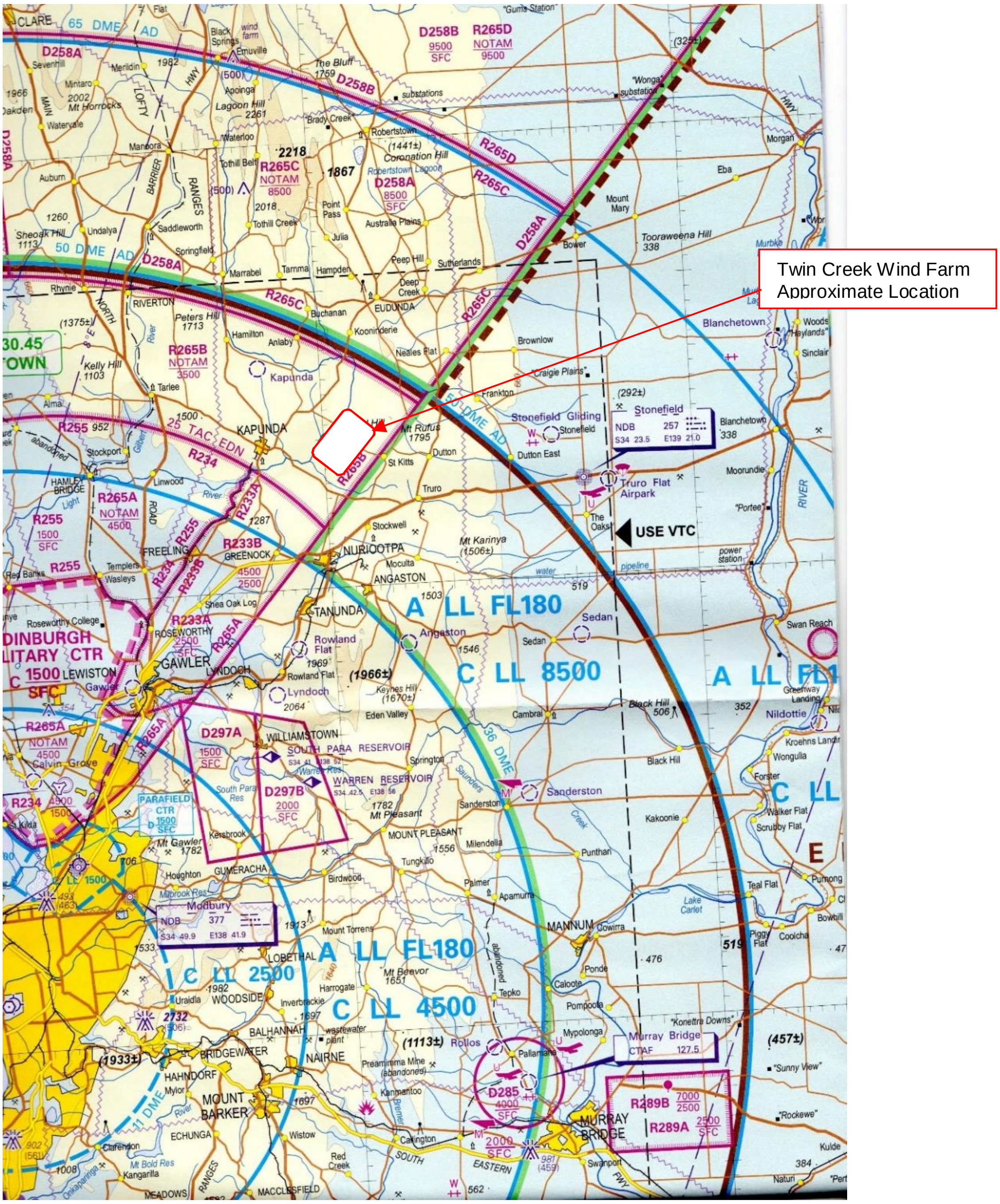

Figure 5.3.1 Approximate Location of TCWF shown on VNC Adelaide[7]

[7] Visual Navigation Chart ï Adelaide effective date 12 November 2015

5.4 Relevant Air Routes

The published Air Routes and Lowest Safe Altitudes relevant to the TCWF are tabulated below in Table 5.4.1.

Air Route	Segment	Lowest Safe Altitude LSALT
GRID		3400
W325	AD ï RUSEL	3500
H246	AD ï ORBUN	3800

Table 5.4.1 – Air Routes in vicinity and LSALTs

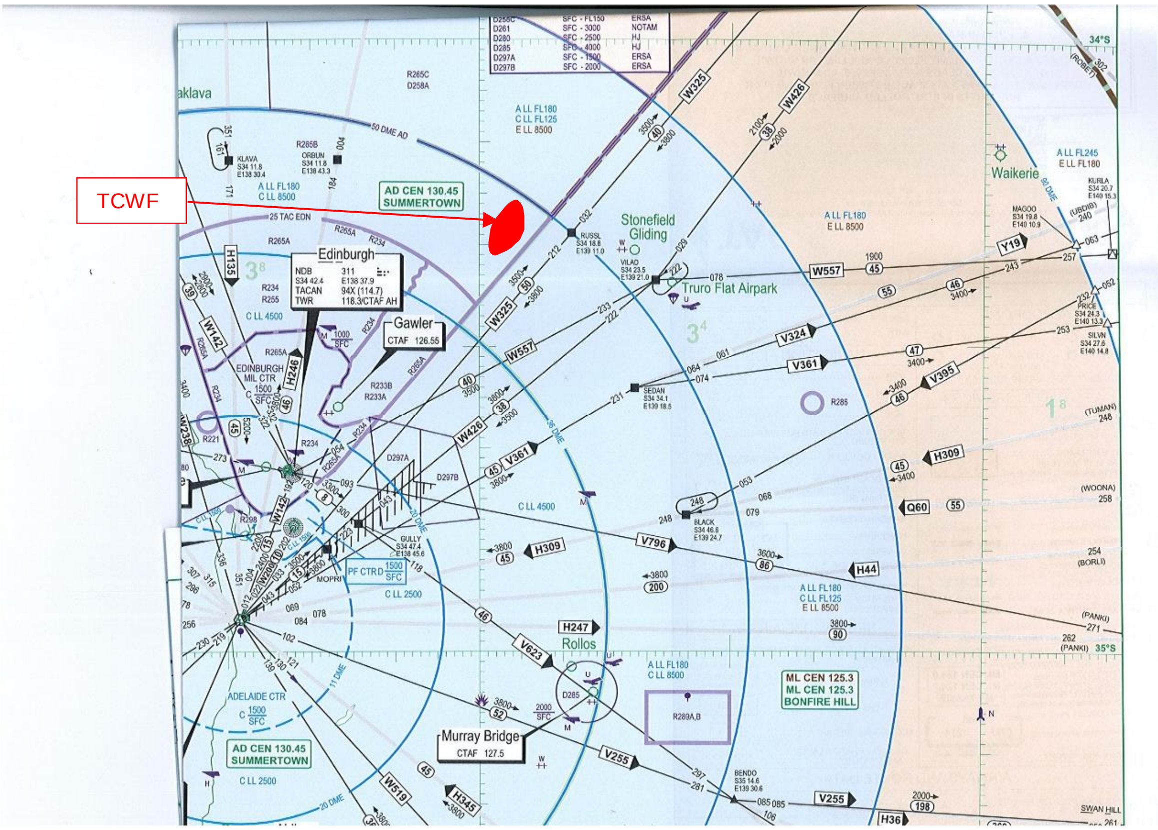

Figure 5.4.1 Approximate Location of TCWF shown on TAC 5[8]

5.5 Night Flying

Aircraft flying at night under either IFR or VFR are protected by published or calculated LSALT and descent below the LSALT is restricted to within 3nm (5.4km) of the aerodrome for a visual approach to land. Where an IFR aircraft is using a published

[8] AIP Terminal Area Chart 5 (Adelaide) effective 26 May 2016

instrument approach it is protected by PANS-OPS surfaces.

There are no Military, certified or registered aerodromes within 30nm of the TCWF. Consequently any night flight into an aerodrome closer to the TCWF must be conducted in accordance with the VFR as there is no published Instrument Departure or Approach Procedures for such aerodromes.

5.6 General Aviation Flying Training

All ab-initio flying training is conducted in accordance with the Visual Flight Rules (VFR) as defined in Division 3 of the Civil Aviation Regulations 1988 (CAR). VFR operations may be flown in accordance with CAR 157 *Low Flying*, which states, in part, that an aircraft must not be flown lower than 500ft (152m) above the highest terrain or obstacle thereon or within a radius of 600m for fixed wing aircraft and 300m for helicopters. This requirement does not apply if the aircraft is engaged in approved low flying activity.

There are a number of flying training organisations at Parafield aerodrome that use the area to the north of Edinburgh for training flights. Discussions with these organisations indicates that to avoid the Edinburgh Restricted Airspace they generally fly east to the Barossa Valley before turning north or they use the western lanes out of Parafield toward the coast and then fly north. From the stakeholder interviews the TCWF is not considered to have any undue effect on the flying training of these organisations.

5.7 Recreational and Sport Aviation

Recreational and Sport aircraft 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. These aircraft are generally excluded from flight within controlled airspace. There are a number of airfields, such as Truro Flat that cater for recreational and sport aircraft. The TCWF is not considered to have any effect on the flights conducted by these aircraft. One stakeholder, whilst discussing the possible impact on recreational aircraft of the TCWF made a comment about wind farms in general, limiting the low level airspace available for flight.

5.8 Gliding

Glider flying is limited to daytime flight in accordance with the Visual Flight Rules (VFR). Modern gliders are high performance aircraft that can glide long distances with minimal loss of height.

The Gliding Federation of Australia advises that wind farms are considered in a similar manner to forests; a glider cannot be landed safely in either so the pilot will stay well away from them.

Stakeholder interviews with gliding organisations at Gawler and Stonefield indicate that gliders stay away from wind farms as they are not suitable places to land. Both stakeholders advise that in the normal course of their flying activities they operate in areas well away from the proposed TCWF and therefore it will not impact on their flying activity.

5.9 Approved Low Flying Activities

There are no promulgated flying training areas depicted on the relevant aeronautical charts that will impact the Twin Creek Wind Farm.

As noted in 5.2 above, Military Restricted Area R265B sits above the TCWF. This Restricted Area is designated for Military Flying operations and flights would not operate below 4500ft. A civil aircraft is permitted to transit at the lower limit of 3500ft for R265B when it is active.

5.10 Aerial Agricultural Aviation Activities

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.[9]

[9] http://www.aerialag.com.au/ResourceCenter/Policies.aspx

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[10]."*

One operator expressed the view that there is very little aerial applications undertaken in that area.

5.11 Known Highly Trafficked Areas

There are no known highly trafficked areas in the vicinity of the wind farm.

5.12 Emergency Services Flying

5.12.1 Police Air Wing

The South Australian Police utilise the services of the MAC Helicopters (see 5.12.2 below) for police operations.

5.12.2 Air Ambulance

The MAC Air Ambulance uses helicopter aircraft 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 undertaken using night vision goggles (NVG) and at the destination the ñnight sunò searchlight is used to illuminate the operational area. It was also noted that LED type obstacle lights need to be within a specific wavelength spectrum for successful use of NVG. The TCWF will not have any undue effect on the operations of the MAC helicopters.

5.13 Firefighting

"It is important to remember that aircraft alone do not extinguish fires."[11]

[10] Expert opinion obtained by the author during previous QRA work

[11] NSW Rural Fire Service submission to the Senate Select Committee on Wind Turbines, 6 March 2015, page 2

Concern about the inability to utilise aerial firefighting in the wind farm area was expressed by some stakeholders. From previous work undertaken by Ambidji 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 ‘just another hazard’ that has to be considered in the risk management process associated with aerial firefighting[12].

The State rural firefighting agencies made submissions to the recent 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. A copy of this paper is at Appendix E.

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."*[13]

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) comments:

> *"… … 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 considered in the incident action plan."*[14]

The South Australian Country Fire Service (CFS) 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*

[12] Expert opinion formed by the author from previous QRA work

[13] AFAC *Wind Farms and Bushfire Operations Position version 2.0 30 October 2014, page 2*

[14] CFA Emergency Management Guidelines for Wind Energy Facilities May 2015 section 2

> *and fire appliance for the vast majority of instances are the primary and only method of controlling bushfires.[15]"*

A further point made by the CFS is that firefighting aircraft are a limited resource and are not routinely allocated to every fire. A copy is at Appendix F.

From previous work done 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 will 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.

5.14 Topography and Marginal Weather Considerations

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 LSALTõs that are designed to keep the aircraft above obstacles and terrain.

Otherwise 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 stress of weather or any other avoidable 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.

[15] SA CFS Fact Sheet 10-01, *Understanding Aerial Firefighting,* March 2015

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[16]) 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 ñpressed onò 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.

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:

> *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.*

The TCWF is more than 30km from the nearest military, certified or registered aerodrome.

There is no military or civil CNS infrastructure, OLS, PANS-OPS, LSALT or Restricted Airspace that will be impacted by the TCWF.

The turbines and meteorological monitoring towers used in the TCWF must be reported to CASA and the RAAF in accordance with AC 139-08(1) *Reporting of Tall Structures*.

The turbines are greater than 150m so could be considered as a hazardous obstacle.

[16] 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.

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.*
>
> Stakeholder consultation concerning the proposed TCWF has not raised any risks to aviation 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.*

The risk assessment for the TCWF indicates that the overall risk to aviation is LOW. A risk assessment of LOW indicates that the wind farm is ónot a hazard to aircraft safetyô The TCWF is not a hazard to aircraft safety; therefore there is no need to install additional obstacle marking or obstacle lighting.

5.15.3 Lighting of wind turbines not in the vicinity of an aerodrome, with a height of 150m or more

> *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 risk assessment for the TCWF indicates that the overall risk to aviation is LOW. A risk assessment of LOW indicates that the wind farm is ónot a hazard to aircraft safetyô The TCWF is not a hazard to aircraft safety; therefore there is no need to install additional obstacle marking or obstacle lighting.

5.16 QRA Findings

The Twin Creek Wind Farm will not be a hazard to aircraft safety as shown in table 5.16.1 below.

The wind farm must be reported to aviation authorities in accordance with AC 139-08(1) *Reporting of Tall Structures* and marked on the appropriate aeronautical charts.

Risk Element	Assessed Level of Risk	Comment
Airport Operations	LOW	
Aircraft Landing Area Operations	LOW	
Known Highly Trafficked Routes	LOW	
Published Air Routes	LOW	
Restricted Airspace	LOW	
Promulgated Flying Training Areas	LOW	
Night Flying	LOW	
Emergency Services Flying	LOW	
Commercial Flying	LOW	
Recreational and Sport Aviation	LOW	
Recreational Pilot Training (RA-AUS)	LOW	
GA Flying	LOW	
GA Pilot Training	LOW	
Gliding	LOW	
Weather and Topographical Issues	LOW	

Table 5.16.1 – Risk Summary

Additionally, formal notification of the location and height of the TCWF should be made to:-

- Local aviation operators at Gawler, Stonefield and Truro Flat;
- Local Aerial Agricultural Applications Operators;
- MAC Helicopter;
- RFDS;
- Aerial Agricultural Association of Australia (AAAA);
- Gliding Federation Australia (GFA) and
- Recreational Aviation Australia (RA-Aus).

It is considered that the risk to aircraft safety is acceptable and the TCWF will *not be a hazard to aircraft safety* and therefore ñnot of operational significanceò to aircraft operations.

6. OBSTACLE LIGHTING REVIEW

6.1 Summary of International Standards for Obstacle Lighting of Wind Farms

6.1.1 International Civil Aviation Organisation

The relevant International Civil Aviation Organisation (ICAO) recommendations regarding wind farms are detailed in *Annex 14 – Aerodromes*.[17]

ICAO has recommended that a wind turbine shall be marked and/or lit if it is determined to be an obstacle. Section 4.3 of the Annex refers to *"Objects outside the Obstacle Limitation Surface"* and Section 4.3.2 in particular states inter-alia: -

> *4.3.2* **Recommendation** – *In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150m or more above ground level should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.*
>
> *Note – This study may have regard to the nature of operations concerned and may distinguish between day and night operations.*
>
> *6.2.4* ***Wind Turbines***
>
> ***Markings***
>
> *6.2.4.1 A wind turbine shall be marked and/or lit if it is determined to be an obstacle.*
>
> *Note – See 4.3.1 and 4.3.2*
>
> *6.2.4.2* ***Recommendation*** – *The 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.*
>
> ***Lighting***
>
> *6.2.4.3* ***Recommendation*** – *When lighting is deemed necessary, medium-intensity obstacle lights should be used. In the case of a wind farm, i.e. a group of 2 or more wind turbines, it should be regarded as an extensive object and the lights should be installed*
>
> *a) to identify the perimeter of the wind farm;*
>
> *b) respecting the maximum spacing, in accordance with*

[17] ICAO Annex 14 Aerodromes Vol 1 Aerodrome Design and Operations Sixth Edition 14 November 2013

6.2.3.15, between the lights along the perimeter, unless a dedicated assessment shows a greater spacing can be used;*

c) so that, where flashing lights are used, they flash simultaneously; and

d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located.

6.2.4.4 ***Recommendation*** *– The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.*

**6.2.3.15 recommends medium intensity lights be spaced at longitudinal intervals not exceeding 900m.*

6.1.2 Other International Aviation Regulatory Authorities

A review of the standards and recommendations regarding wind farms as obstacles from several countries, including the US FAA, CAA UK, CAA NZ, Transport Canada and the Irish Aviation Authority shows that wind turbines shall be painted white or off-white so that they contrast with the surrounding landscape unless a risk assessment indicates a different colour should be used.

The review also shows there is a wide variation as to the determining criteria related to the location, height and spacing of wind turbines that should be lit. A number of countries are now taking into account the *visual amenity* associated with required obstacle lighting of wind farms by assessing the hazard to aviation safety posed by its *nature and location*. In essence, a wind farm is required to be lit unless a risk assessment shows that it is not a hazard to aviation safety.

Several countries, including Canada, Norway and the USA have approved the use of radar based Obstacle Collision Avoidance Systems (OCAS)[18] to activate obstacle lighting in the presence of an aircraft. This system allows the obstacle lighting to be in a quiescent state until activated by the system sensing the presence of an aircraft.

Throughout the world the accepted obstacle marking for wind turbines is to paint them white or off-white so that they contrast to the surrounding landscape and where a risk assessment considers them to be a hazard to aviation they shall be lit at night.

6.2 Australian regulatory framework for Obstacle Lighting of Wind Farms

CASA is Australia's aviation safety regulator and is responsible for setting standards applicable to the protection of airspace and the safety of aircraft and airport operations. Australia, as a member state, applies the ICAO Standards and Recommended Practices

[18] OCAS technology is now owned by Vestas; see http://www.ocas-as.no/us/

to Australian aviation except where it formally lodges a "difference."

CASA issued Advisory Circular AC139-18 (0) *Obstacle Marking of Wind Farms* in July 2007. CASA withdrew this AC in October 2008 after consideration of its legality and complaints to CASA's Industry Complaints Commissioner.

CASA has very limited jurisdiction over obstacles beyond the vicinity of a certified or registered aerodrome. This is outlined in a letter from CASA Airways and Aerodromes Branch dated February 2103. See Appendix G.

CASA can only make recommendations regarding the lighting of wind farms, and not determinations/directives mandating lighting of wind farms which are not in the vicinity of an aerodrome,. It is noted that in the Senate Select Committee on Wind Turbines (2015) CASA provided the following 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 that 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. That is the extent of our power.*[19]

6.2.1 Civil Aviation Safety Regulations

The Civil Aviation Safety Regulations (CASR) Part 139 Section E contains the regulations governing obstacles in the vicinity of a certified or registered aerodrome, i.e. within the confines of the OLS or PANS-OPS surfaces of the aerodrome. These regulations are for 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.

6.3 Obstacle Lighting Summary

The Twin Creek Wind Farm does not penetrate the OLS or PANS-OPS for any military, certified or registered 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.

[19] Senate Select Committee on Wind Turbines, Final Report, August 2015, paragraph 5.38.

The NASF Guideline D recommends that any structure of 150m or taller AGL be notified to CASA.

CASR 139.365 requires any structure 110m or taller AGL to be notified to CASA.

The TCWF turbines have a tip height of 180m 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 above risk assessment shows that the TCWF poses a low risk and is therefore not a hazard to aircraft safety. Consequently it does not require additional obstacle marking or obstacle lighting.

The size and colour of the turbines is considered suitable marking by day. At night, aircraft operations are required by regulation to be at or above the LSALT for IFR flight or be at least 1000ft above the highest obstacle within a 10nm radius of the aircraft for VFR at night flights. Given the location of the TCWF and the limited aircraft traffic in the area the risk to aircraft safety is LOW, therefore obstacle lighting is not considered necessary.

7. CONCLUSIONS

7.1 AIS

The Twin Creek Wind Farm development will NOT impact upon the following:

- The OLS published for any military, registered or certified aerodrome;
- The operation of any Navigation Aids and Communication facilities; and
- The operation of any Airspace Surveillance facility.

7.1.1 AsA Response to AIS

AsA provided the following response: -

- With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 66022m (2166ft) AHD, the wind farm will not affect any air route, sector or circling altitude, nor any instrument approach or departure procedure at any airport
- The wind farm proposal as defined in the AIS with turbines to a maximum height of 660.22m (2166ft) AHD and in locations within +/- 100m of those provided, will not adversely impact the performance of any Airservices

Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

- *Note: There are no instrument approach or departure procedures designed by organisations other than Airservices within 30nm of the wind farm.*

7.1.2 Defence Response to AIS

Department of Defence advises they have no objection to the proposed TCWF.

The Department of Defence request that any LED obstruction lighting should be within the frequency range of wavelengths 655 to 930 nanometres in order to be compatible with the use of night vision devices.

7.2 Risk Assessment

The risk assessment of the TCWF shows that, it will *not be a hazard to aircraft safety* and therefore ñnot of operational significanceò to aircraft operations.

7.3 Obstacle Lighting

This QRA indicates that, the TCWF is ñnot a hazard to aircraft safety.ò

At night, aircraft operations are required by regulation to be at or above the LSALT for IFR flight or be at least 1000ft above the highest obstacle within a 10nm radius of the aircraft for VFR at night flights. Given that the location of the TCWF will be marked on aeronautical charts and the limited aircraft traffic in the area obstacle lighting is not required. The risk to aircraft safety is LOW and therefore no further risk mitigation is necessary.

7.4 Reporting of Tall Structures

CASR 139.365 requires the turbines and the meteorological monitoring masts to be reported as tall structures in accordance with AC 139-08(0) for inclusion on appropriate aeronautical charts.

8. 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 8.1 below shows a Meteorological Monitoring Mast as seen from the ground.

Figure 8.1 – A Meteorological Monitoring Mast photographed from the ground

8.1 NASAG Guideline – Marking of Meteorological Monitoring Masts

The NASF Guideline D 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.*

8.2 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.[20]

8.3 Recommendation

It is recommended that RES ensure the wind monitoring towers used in the TCWF are:

- Appropriately marked, preferably using high visibility balls on the guy wires;
- Reported as tall structures in accordance with AC139-08(1); and
- Are notified to the
  - Aerial Agricultural Association of Australia; and
  - Operators of Gawler, Stonefield and Truro Flat ALA's.

[20] NAAA (US) website http://www.agaviation.org/content/faa-releases-guidance-marking-met-towers accessed 27/05/2014

9. Duty of Care

As a part of corporate responsibility and duty of care, it is appropriate for the proponent to formally advise all relevant stakeholders of:

- the locations and heights of the turbines and meteorological masts and when they would be constructed or decommissioned; and
- the developer's intentions regarding marking and lighting of the wind farm turbines and meteorological monitoring masts.

RES Australia's attention is also drawn to the following determination of the New South Wales Court of Appeal, in the case of Sheather vs Country Energy, where, inter-alia, the court determined the following.[21]

> *"Mr Sheather, the owner of the helicopter which crashed into a Country Energy owned spur line while flying well below the mandatory height regulations for aircraft, appealed an earlier decision on the grounds that Country Energy had failed to provide sufficient warning of the spur line. Despite Country Energy observing all legal compliance requirements, the NSW Court of Appeal held that Country Energy owed a duty of care to pilots and aircraft owners and had breached its duty of care."*

Due cognisance of this decision should be taken by RES Australia and its legal and insurance advisors in considering this report.

.

[21] Sheather v Country Energy [2007] NSWCA 179

APPENDIX A

Airservices Australia
Aviation Assessments for Wind Farm Developments
19th August 2014

APPENDIX A

Corporate & International Affairs
25 Constitution Avenue
(GPO Box 367)
CANBERRA ACT 2600

t 02 6268 5101
f 02 6268 4233

www.airservicesaustralia.com

ABN 59 698 720 886

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

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AIS Criteria

The AIS must provide a detailed analysis covering, as a minimum:

<u>Airspace Procedures:</u>

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.

<u>Navigation/Radar:</u>

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

Twin Creek Wind Farm
Site Identification, Coordinates and Elevations

PAUStwc025

Coordinate System		MGA ZONE 54, DATUM GDA94
Layout Locked		Yes
Turbine Count		51

Turbine ID	X	Y	Z [m]	Z [ft]	Longitude DECDEG	Latitude DECDEG	Tip AHD (m)	Tip AHD (ft)
T1	321026.00	6200205.00	388.27	1274	139.054677589	-34.323999978	568.27	1864
T2	321360.00	6200955.00	376.05	1234	139.058461831	-34.317297639	556.05	1824
T3	322403.00	6200826.00	437.63	1436	139.069765306	-34.318639499	617.63	2026
T4	321993.00	6201019.00	434.99	1427	139.065351333	-34.316829635	614.99	2017
T5	321620.00	6201367.00	412.46	1353	139.061371602	-34.313628924	592.46	1943
T6	320952.00	6201223.00	373.55	1226	139.054085519	-34.314811730	553.55	1816
T7	319882.00	6201452.00	349.18	1146	139.042510521	-34.312562442	529.18	1736
T8	320250.00	6201090.00	329.08	1080	139.046432219	-34.315889059	509.08	1670
T9	322950.00	6201222.00	432.24	1418	139.075788965	-34.315163747	612.24	2008
T10	322538.00	6201521.00	435.58	1429	139.071375162	-34.312398346	615.58	2019
T11	322022.00	6201882.00	412.46	1353	139.065844822	-34.309056130	592.46	1943
T12	322572.00	6201943.00	406.28	1333	139.071831471	-34.308600532	586.28	1923
T13	322322.00	6202456.00	380.34	1248	139.069221869	-34.303933904	560.34	1838
T14	320971.00	6202391.00	348.61	1144	139.054534830	-34.304287535	528.61	1734
T15	320036.00	6202498.00	340.96	1119	139.044401971	-34.303161368	520.96	1709
T16	320224.00	6203111.00	349.63	1147	139.046571813	-34.297668854	529.63	1737

T17	321816.00	6202690.00	392.04	1286	139.063774488	-34.301738016	572.04	1876
T18	323643.00	6202084.00	427.99	1404	139.083493516	-34.307512268	607.99	1994
T19	323292.00	6202686.00	425.30	1395	139.079804567	-34.302026479	605.30	1985
T20	322886.00	6202903.00	407.00	1335	139.075439592	-34.300001356	587.00	1925
T21	322371.00	6203086.00	425.92	1397	139.069884022	-34.298263887	605.92	1987
T22	321826.00	6203111.00	391.61	1285	139.063970198	-34.297945128	571.61	1875
T23	321590.00	6203414.00	403.64	1324	139.061469885	-34.295173551	583.64	1914
T24	320666.00	6204049.00	353.03	1158	139.051567357	-34.289290891	533.03	1748
T25	324225.00	6202148.00	432.08	1418	139.089828193	-34.307034182	612.08	2008
T26	323887.00	6202670.00	450.84	1479	139.086263674	-34.302271851	630.84	2069
T27	323772.00	6203076.00	437.16	1434	139.085097720	-34.298592875	617.16	2024
T28	322719.00	6203537.00	442.34	1451	139.073756328	-34.294258362	622.34	2041
T29	322046.00	6203820.00	423.05	1388	139.066505974	-34.291592420	603.05	1978
T30	321713.00	6204052.00	405.61	1331	139.062937710	-34.289444189	585.61	1921
T31	321308.00	6204303.00	420.66	1380	139.058591716	-34.287112217	600.66	1970
T32	321201.00	6204679.00	384.06	1260	139.057507804	-34.283704794	564.06	1850
T33	324338.00	6203141.00	453.96	1489	139.091258152	-34.298102961	633.96	2079
T34	323586.00	6203550.00	424.67	1393	139.083174711	-34.294288911	604.67	1983
T35	322782.00	6204095.00	454.60	1491	139.074555292	-34.289239653	634.60	2081
T36	322249.00	6204368.00	452.70	1485	139.068823539	-34.286687882	632.70	2075
T37	321973.00	6204642.00	418.30	1372	139.065883040	-34.284170936	598.30	1962
T38	324342.00	6203539.00	480.22	1576	139.091382761	-34.294516279	660.22	2166
T40	324060.00	6203843.00	446.25	1464	139.088382267	-34.291728425	626.25	2054
T42	323325.00	6204676.00	426.91	1401	139.080571094	-34.284095408	606.91	1991

T43	322719.00	6204664.00	453.47	1488	139.073988202	-34.284100279	633.47	2078
T44	323646.00	6204246.00	424.59	1393	139.083968784	-34.288025758	604.59	1983
T45	323837.00	6204811.00	439.37	1441	139.086158411	-34.282965584	619.37	2032
T46	323611.00	6205227.00	447.06	1467	139.083789472	-34.279177624	627.06	2057
T47	323205.00	6205593.00	469.90	1542	139.079456102	-34.275809671	649.90	2132
T48	323115.00	6205082.00	461.50	1514	139.078374063	-34.280400207	641.50	2104
T49	322641.00	6205411.00	422.73	1387	139.073294913	-34.277353955	602.73	1977
T50	321133.00	6203686.00	364.01	1194	139.056563298	-34.292643282	544.01	1784
T51	321050.00	6202928.00	347.40	1140	139.055504463	-34.299461039	527.40	1730
T52	321374.00	6201812.00	355.79	1167	139.058791785	-34.309575681	535.79	1757
T53	323112.00	6202183.00	414.73	1361	139.077746230	-34.306529540	594.73	1951

APPENDIX C

Airservices Australia Response to the AIS

APPENDIX C

From: **Airport Developments** Airport.Developments@AirservicesAustralia.com
Subject: AIRSERVICES RESPONSE: Twin Creek Wind Farm AIS (SA-WF-017) [SEC=UNCLASSIFIED]
Date: Today at 16:16
To: Ian Jennings ijennings@ambidji.aero

Good afternoon Ian,

I refer to your request for an Airservices assessment of the Twin Creek Wind Farm Aviation Impact Statement (AIS) located approximately 10km north east of Kapunda, SA.

Airspace Procedures
With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a maximum height of 659.96m (2166ft) AHD, the wind farm will not affect any air route, sector or circling altitude, nor any instrument approach or departure procedure at any airport.

Note that procedures not designed by Airservices at any airport were not considered in this assessment.

Communications/Navigation/Surveillance (CNS)
This wind farm proposal as defined in the AIS with turbines to a maximum height of 659.96m (2166ft) AHD and locations within ±100m of those provided, will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

Regards,

Tony Aiezza
Asset Lifecycle
Air Navigation Services
T: 02 6268 4331 / M:0409 143 120

From: Ian Jennings [mailto:ijennings@ambidji.aero]
Sent: Monday, 11 July 2016 1:14 PM
To: Airport Developments <Airport.Developments@AirservicesAustralia.com>
Subject: RE: Twin Creek Wind Farm AIS [SEC=UNCLASSIFIED]

Carly,
Some people want everything…
OR OOPS forgot!
Ian

Ian Jennings

APPENDIX D

Department of Defence Response to the AIS

APPENDIX D

Australian Government
Department of Defence
Estate and Infrastructure Group

Mr David Harrison
A/Director Land Planning & Regulation
Estate Planning Branch
Brindabella Business Park (BP26-1-A053)
PO Box 7925
Department of Defence
CANBERRA BC ACT 2610
☎: (02) 6266 8138
🖳: david.harrison10@defence.gov.au

ID-EP-DLP&R/OUT/2016/AF25644349

Mr Ian Jennings
Principal Consultant
The Ambidji Group
Suite 11, 622 Ferntree Gully Road
WHEELERS HILL VIC 3150

Dear Mr Jennings

RE: AVIATION IMPACT STATEMENT TWIN CREEK WIND FARM

Thank you for your correspondence of 11 July 2016 referring the abovementioned Aviation Impact Statement of the Twin Creek wind farm to the Department of Defence (Defence) for comment. I understand that the proposed wind farm will comprise 50 wind turbines to be located approximately 10km north east of Kapunda, SA and some 30nm to the north east of RAAF Base Edinburgh. The wind turbines will have a maximum blade tip height of 180m Above Ground Level (AGL).

Defence has conducted an assessment of the proposed Twin Creek wind farm for potential impacts on the safety of military flying operations as well as possible interference to Defence communications and radar.

The proposed 180m AGL turbines meet the requirements for reporting of tall structures. There is an ongoing need to obtain and maintain accurate information about tall structures so that this information can be marked on aeronautical charts. Marking tall structures on aeronautical charts assists pilot navigation and enhances flight safety. Airservices Australia (AsA) is responsible for recording the location and height of tall structures. The information is held in a central database managed by AsA and relates to the erection, extension or dismantling of tall structures the top of which is above:

a. 30 metres AGL, that are within 30 kilometres of aerodrome, and
b. 45 metres AGL elsewhere.

The proposed structure will meet the above definition of tall structure. Defence therefore requests that the applicant provide AsA "as constructed" details. The details can be emailed to AsA at the following email address: vod@airservicesaustralia.com.

At a height of 180m AGL the turbines will protrude into navigable airspace. I note, that the *National Airports Safeguarding Framework Guideline D - Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* recommends that where a wind turbine 150 metres or taller in height is proposed away from aerodromes, the proponent should conduct an aeronautical risk assessment. It also recommends that the

Defending Australia and its National Interests risk assessment be submitted to the Civil Aviation Safety Authority (CASA) to determine whether the proposal is a hazard to aircraft safety and requires approved lighting or marking. Defence supports this requirement and believes that in this instance, it would be prudent for the risk assessment of this proposal to be sent to CASA for consideration.

If CASA determines that LED obstruction lighting is to be provided, it should be compatible with persons using night vision devices and that the frequency range of the LED light emitted should be within the range of wavelengths 655 to 930 nanometers.

The proposal has also been assessed as having a negligible impact on existing Defence communications and radar in the region.

My point of contact in relation to this matter is Mr Timothy Hogan on (02) 6266 8193 or email on DSRGIDEP.ExecutiveSupport@defence.gov.au.

Yours sincerely

David Harrison
A/Director
Land Planning and Regulation
Estate Planning Branch

12 August 2016

Defending Australia ***and its National Interests***

APPENDIX E

Australian Fire and Emergency Services Authorities Council Wind Farms and Bushfire Operations

APPENDIX E

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

Australasian Fire and Emergency Service Authorities Council Limited (ABN 52 060 049 327)
Level 5, 340 Albert Street
East Melbourne Victoria 3002
Telephone: 03 9419 2388
Facsimile: 03 9419 2389

Email: afac@afac.com.au
Internet: http://www.afac.com.au

Disclaimer:

This document is constructed from consultation and research between Australasian Fire and Emergency Service Authorities Council Limited (**AFAC**), its member agencies and stakeholders. It is intended to address matters relevant to fire, land management and emergency services across Australia and New Zealand.

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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 F

South Australian Country Fire Service Understanding Aerial Firefighting

APPENDIX F

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 G

CASA Letter February 2013

Current Civil Aviation Safety Authority (CASA) approach to the impact of tall structures, including wind turbines and wind monitoring masts on aviation

CASA has no specific authority to require action for the obstacle marking and lighting of tall structures, including Wind Turbines and Monitoring Masts, located away from certified, registered or certain other aerodromes (regulated aerodromes). CASA cannot impose a requirement for the provision of obstacle lights, nor can CASA comment on the location or design of tall structures that are located away from the vicinity of a regulated aerodrome.

Notwithstanding CASA's regulatory authority, owners of structures which could be hazardous to aviation may have a duty of care to aviators. Wind monitoring masts erected as part of the wind farm development are normally tall slender skeletal structures which can be near invisible to pilots of low flying aircraft.

The proponent should undertake, at least, the following consultation to assess the potential hazard posed to aviation by the proposed development:

- Identify any regulated aerodrome within 30 nm of the boundaries of the proposed wind farm and consult with the aerodrome operator to determine any impact on Obstacle Limitation Surfaces (OLS) and designated flight procedures at such aerodromes. Penetration of these surfaces is likely to pose a hazard to normal aviation operations at the aerodrome. Please contact the aerodrome operators to discuss possible infringements of the OLS.

- Consult with Airservices Australia to have them assess any potential impact on enroute lowest safe altitude, instrument approach procedures at aerodromes, navigational aids, communications facilities or surveillance facilities. The Airservices Australia contact for assessment is Mr Joe Doherty on (02) 6268 5101;

- Contact Mr Phil Hurst of the Aerial Agriculture Association of Australia on (02) 6241 2100 to advise him of the proposal and to seek comment on the potential hazards to aerial application and related operations in the area; and

- Contact operators of any non-certified or non-registered aerodromes, i.e. privately owned landing areas, also termed aeroplane landing areas (ALA), which may be located in the vicinity of the proposed wind turbines and temporary or permanent wind monitoring masts erected prior to the construction of the wind farm . Please consult with the owner and users of the ALAs to ascertain if they consider the wind turbines or wind monitoring masts to be a hazard to their operations. If the wind turbines are considered to be a hazard to their operations you may have a duty of care to provide obstacle lighting or adopt other risk mitigating measures as necessary.

- Contact Royal Flying Doctor Service (RFDS) to advise of the proposal and obtain comment on any impact it may have on RFDS operating at aerodromes located near the tall structures.

Aircraft are permitted to fly as low as 500 ft. (152 m), and certain operations are permitted to fly below this height. Wind turbines with a maximum blade tip height of 150 m or more above ground level could be a hazard to aircraft traversing the area. It is recommended that you take this into consideration when assessing your duty of care in deciding whether or not the wind farm should be obstacle lit or otherwise marked.

Use of obstacle marking to provide better conspicuity to pilots for day operations is not considered essential as the wind turbines are conspicuous by their size.

Work done overseas, particularly by the UK Civil Aviation Authority (CAA) recognises turbulence from wind turbines as having the potential to impact negatively on aviation. It is recognised that aircraft wake vortices can be hazardous to other aircraft, and that wind turbines produce wakes of similar, but not identical, characteristics to aircraft. Although there are independent bodies of knowledge for both of the above, currently, there is no known method of linking the two. Published research shows turbulence effects are still noticeable at 16 rotor diameters downstream of the wind turbine. Verification and validation processes are still ongoing. Whilst being a consideration for all aircraft (particularly in critical stages of flight), turbulence is of particular concern to those aircraft involved in very light sport aviation such as gliding, parachuting, hang-gliding, paragliding or microlight operations.

If the proponent should choose to provide obstacle lighting to indicate the presence of the wind turbines or wind monitoring masts at night or during periods of low visibility, to ensure consistency and avoid any confusion to pilots, the obstacle lighting installation should conform with CASA Manual Of Standards (MOS) Part 139, Chapter 9. The MOS is available on our Web Site, http://casa.gov.au/wcmswr/_assets/main/rules/1998casr/139/139mfull.pdf

If the proposal is approved details of the wind turbines and wind monitoring masts should be reported for inclusion in the national database of tall structures maintained by the Royal Australian Air Force (RAAF). Information on reporting of tall structures may be found in advisory circular issued by CASA, "AC 139-08(0) *Reporting of Tall Structures*" http://www.casa.gov.au/wcmswr/_assets/main/rules/1998casr/139/139c08.pdf

If the proposal is approved, and before construction commences, a temporary Notice to Airmen (NOTAM) will need be issued to cover the construction period of the wind farm. Please advise the Airservices Australia Aeronautical Information Service (AIS) at docs.amend@airservicesaustralia.com of the turbine location and height AHD data of the wind turbines so that pilots can be warned of the construction activity. A permanent NOTAM will need to be issued on completion of the Wind farm at which point you will be required to provide final location and height AHD details of the wind turbines.

Any requirements placed on developers by planning authorities, insurers, or financiers, are beyond CASA's control.

The Department of Infrastructure and Transport currently chairs two groups that have associated roles in this topic area:

1. The National Airspace Safeguarding Advisory Group (NASAG); and
2. The Airports Protection Taskforce (APT).

The NASAG has produced draft guidelines for State building and planning authorities. The APT is reviewing current legislative arrangements that are in place which protect airports and aerodrome operations.

Airways and Aerodromes Branch
February 2013

APPENDIX H

Aeronautical Study Glossary

APPENDIX H

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,ò such 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