Landscape Character and Probable Visual Effect Assessment: Appendices

Twin Creek Wind Farm Project

RES Australia Pty Ltd

29 June 2017

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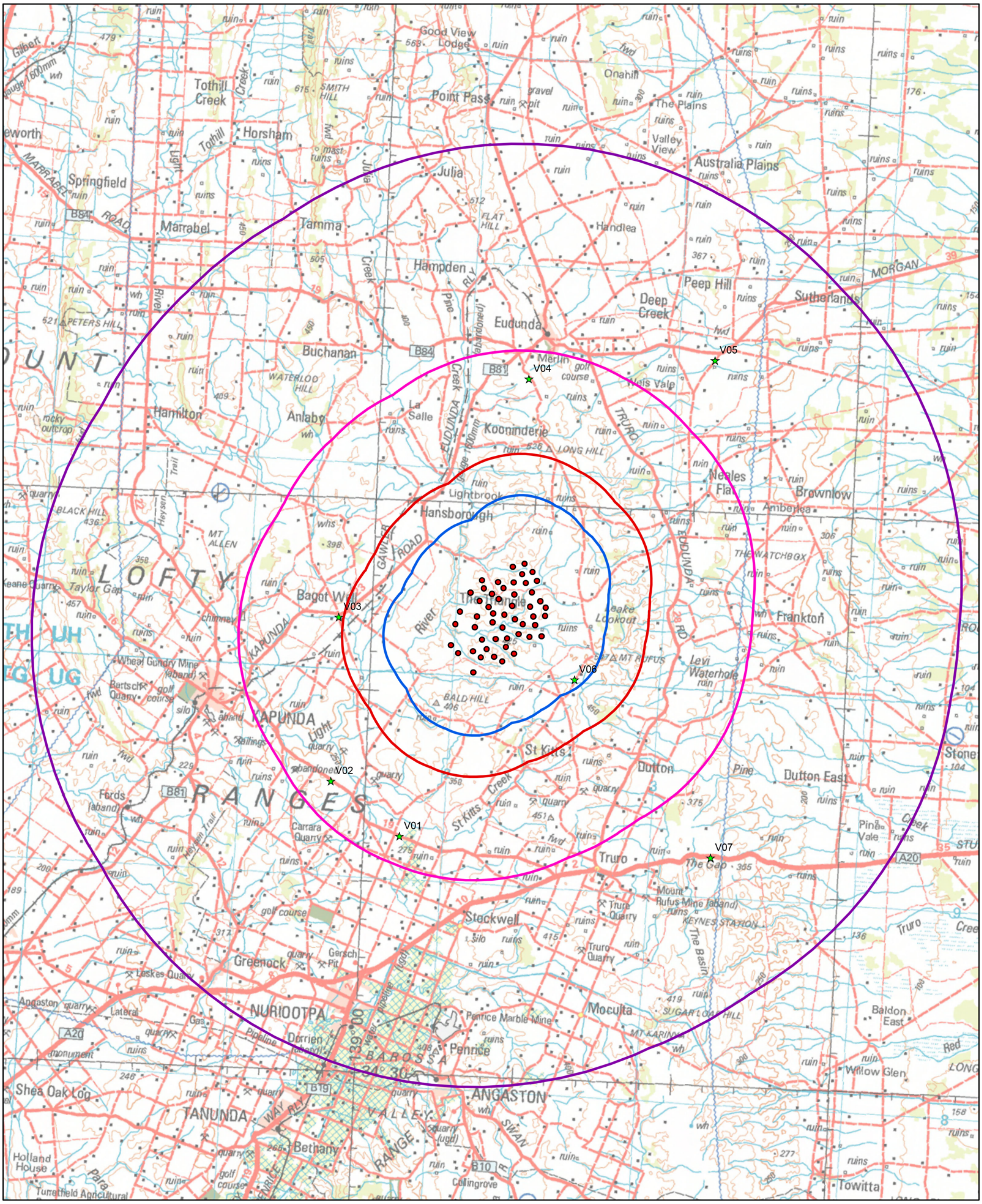
REVISION	DATE	AUTHOR	REVIEWER
V05	27/06/2017	BG/CS/WK	WK
V04	23/06/2017	BG/CS/WK	CS
V03	18/04/2017	BG/CS/WK	CS
V02	15/04/2017	BG/CS/WK	CS
V01	20/03/2017	BG/CS/WK	CS

Appendix A
Assessment Mapping



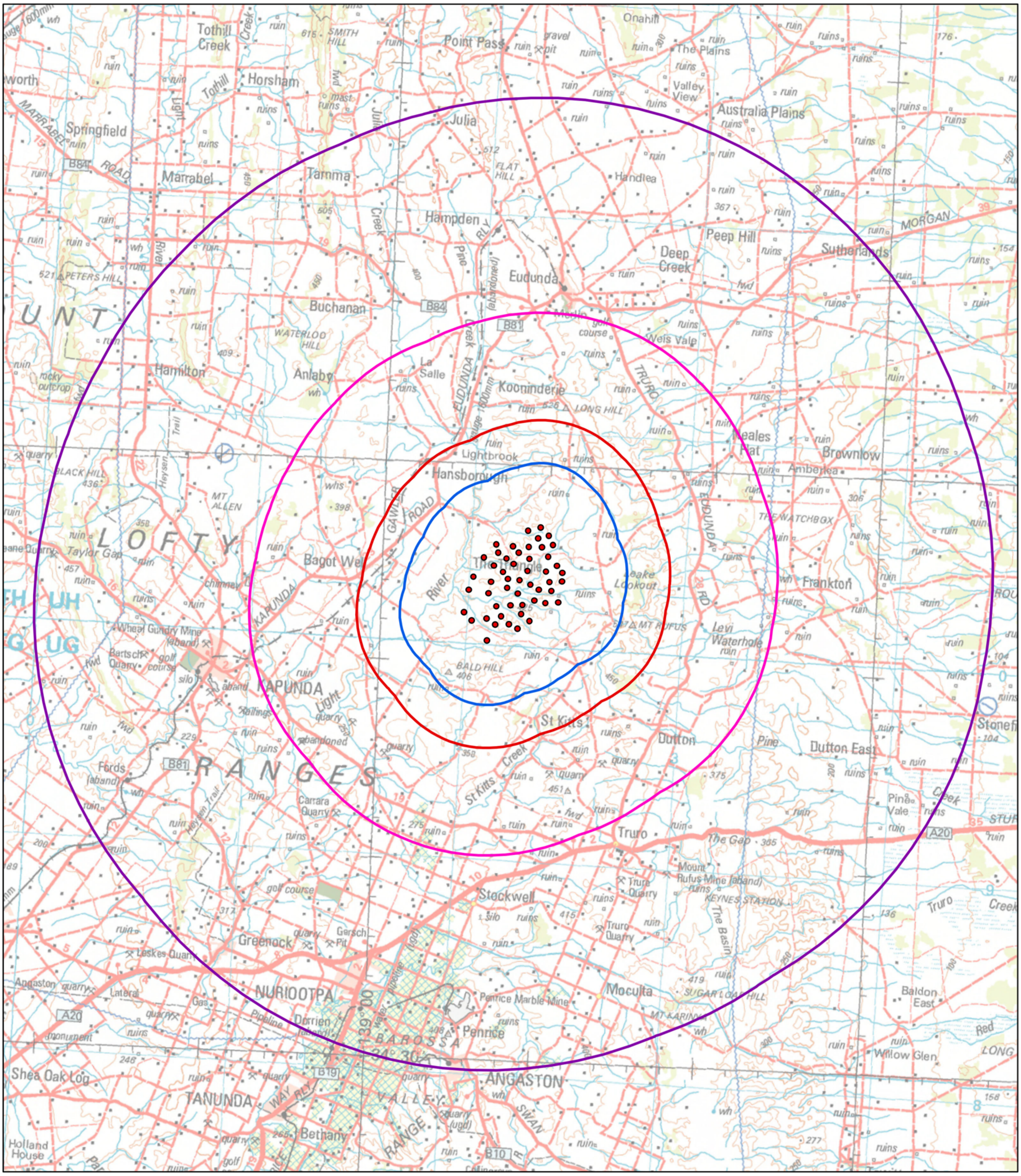
Viewpoints

Legend

- TurbineLayoutPAUStwc025
- Viewpoints_WAX_20160805
- Buffer 3km
- Buffer 5km
- Buffer 10km
- Buffer 20km

0 2.5 5 10 Kilometers

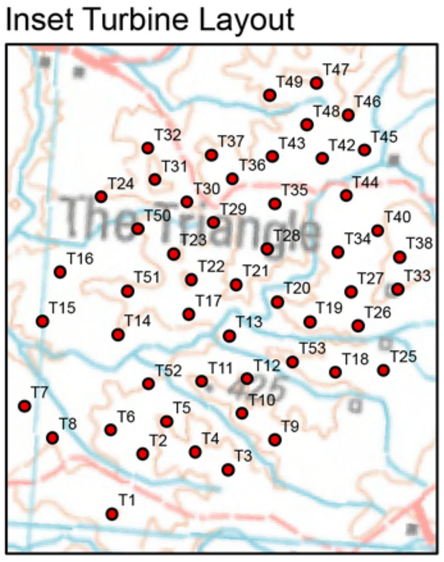
N



Legend

- TurbineLayoutPAUStwc025
- Buffer 3km
- Buffer 5km
- Buffer 10km
- Buffer 20km

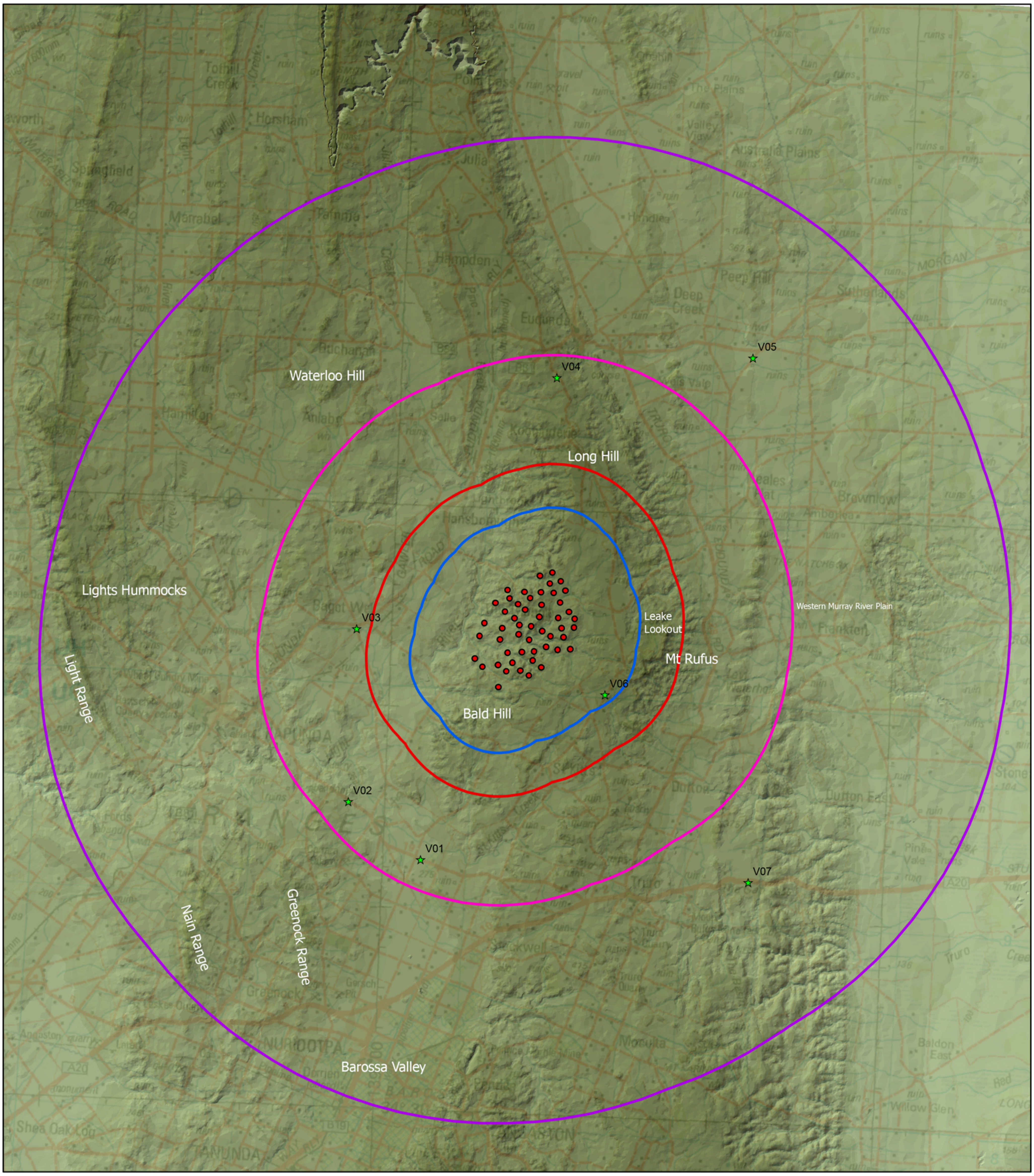
Inset Turbine Layout



Site Location

0 2.5 5 10 Kilometers

N



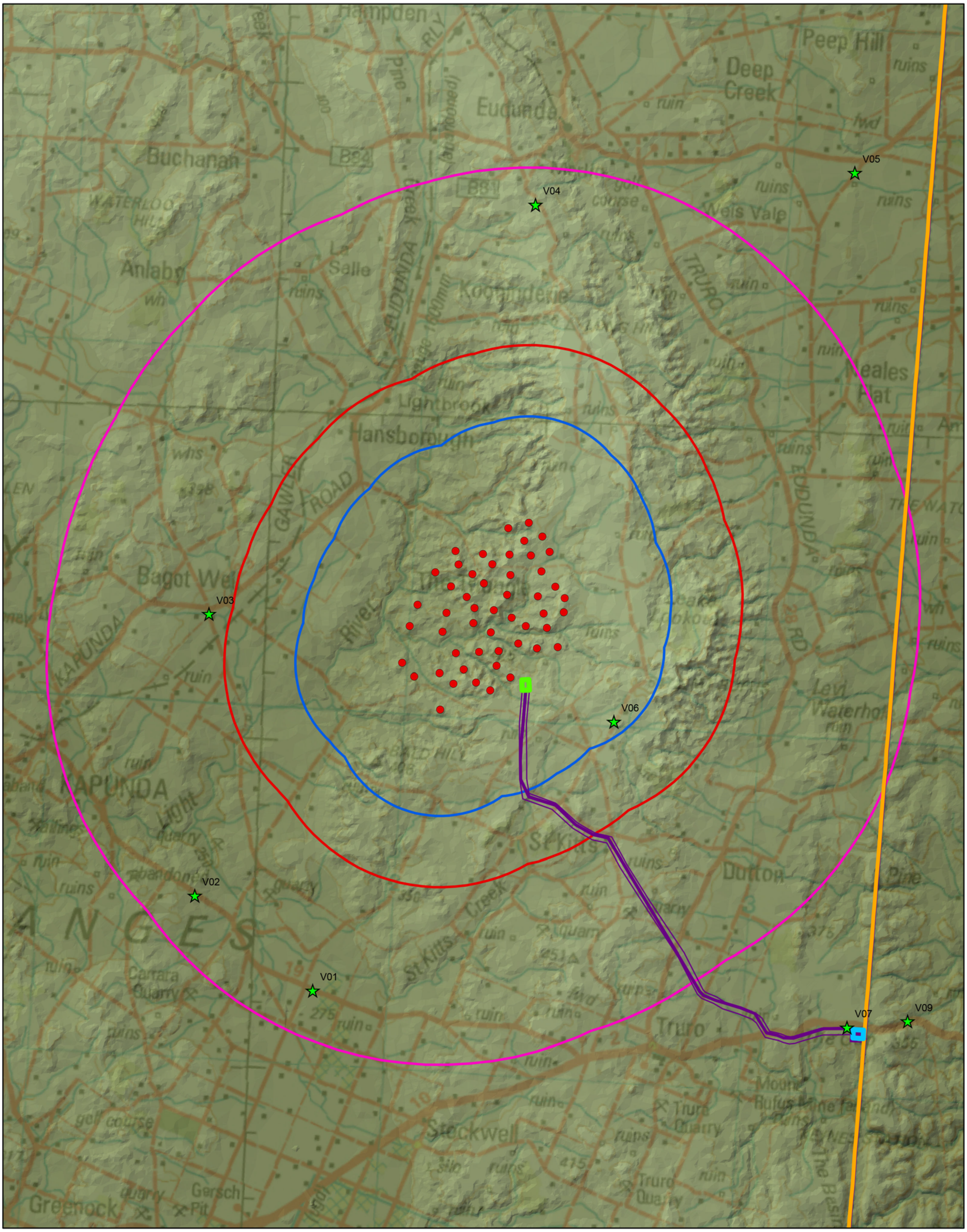
Legend

- TurbineLayoutPAUStwc025
- Viewpoints_WAX_20160805
- Buffer 3km
- Buffer 5km
- Buffer 10km
- Buffer 20km

Topography

0 2.5 5 10 Kilometers

N



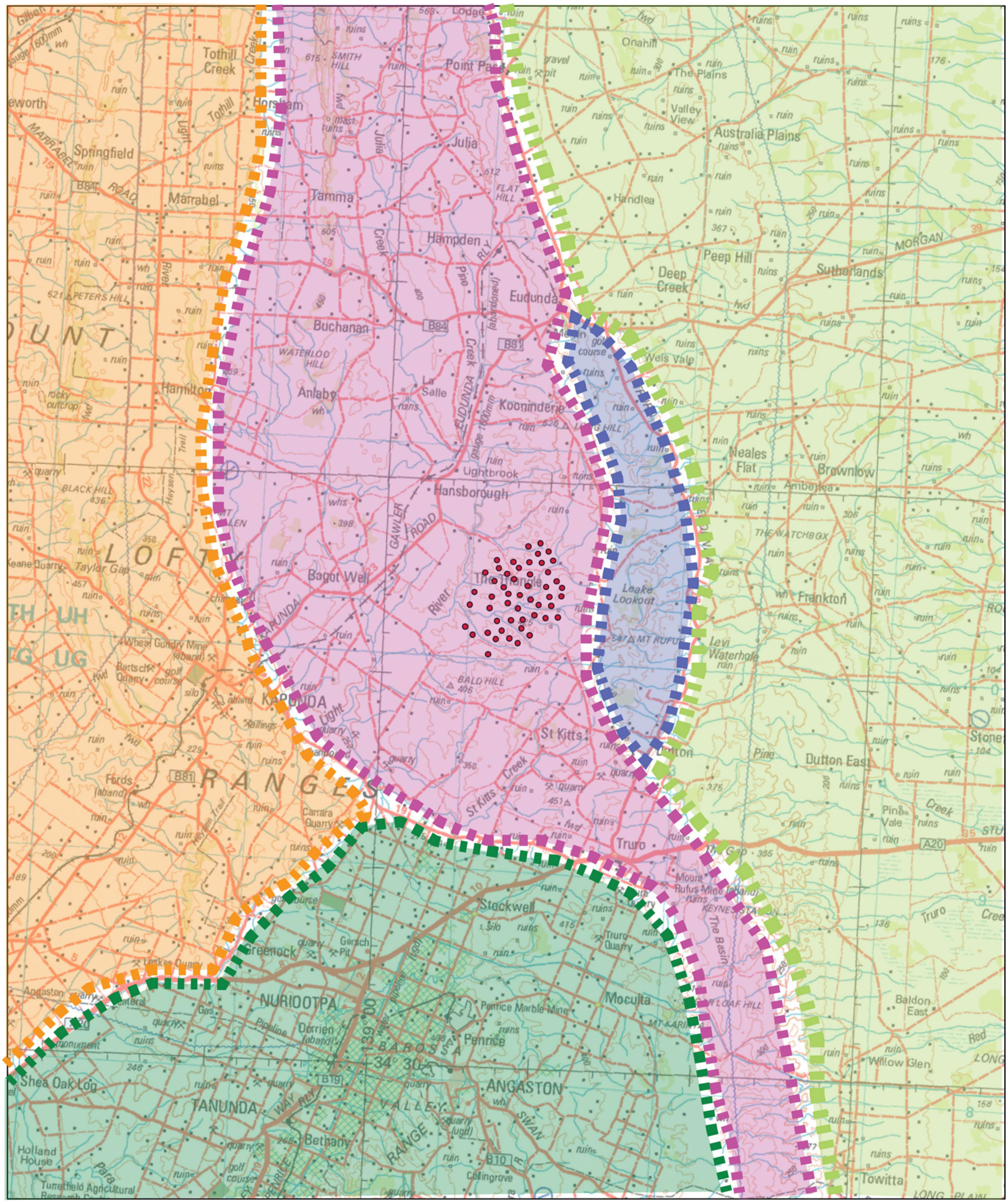
Substations and Transmission Line

Legend

- Viewpoints
- Substation Terminal
- Existing 275kv
- Onsite Substation
- 132kv Proposed Transmission Line Corridor
- Buffer 3km
- Buffer 5km
- Buffer 10km

0 2 4 8 Kilometers

N



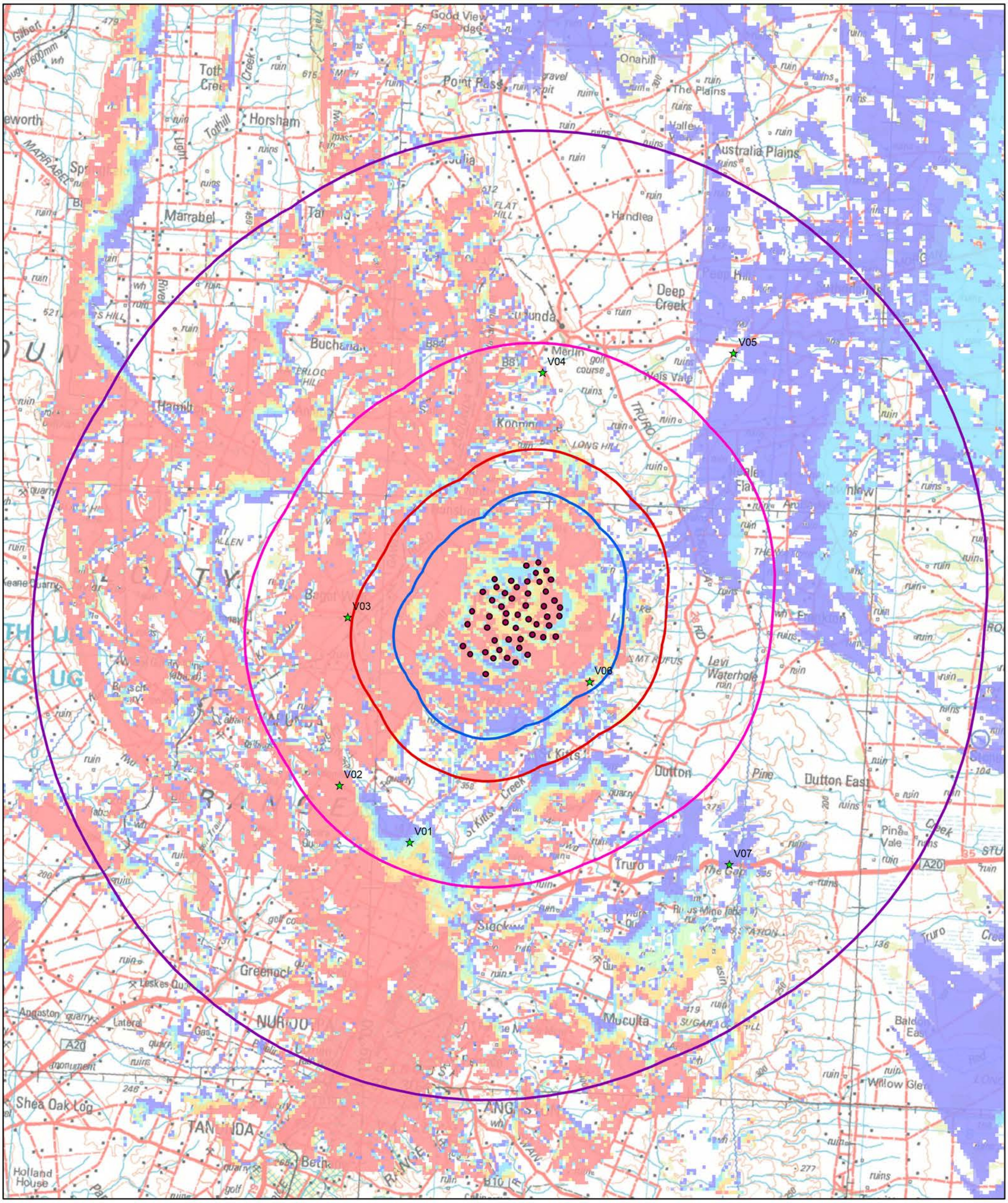
Landscape Character Units

Legend

- TurbineLayoutPAUStwc025
- Western Pastoral Lands and Ridgelines
- Northern Barrosa Valley
- Central Tablelands
- Mount Rufus Ridgeline
- Western Murray River Plain

0 2.5 5 10 Kilometers

N



Zone of Theoretical Visual Influence_Hub Height (112m)

ZTVI represents 'worst case scenario'
it is based on 10m contour data and
does not take into account vegetation or
built form screening or localised ridgelines

Legend

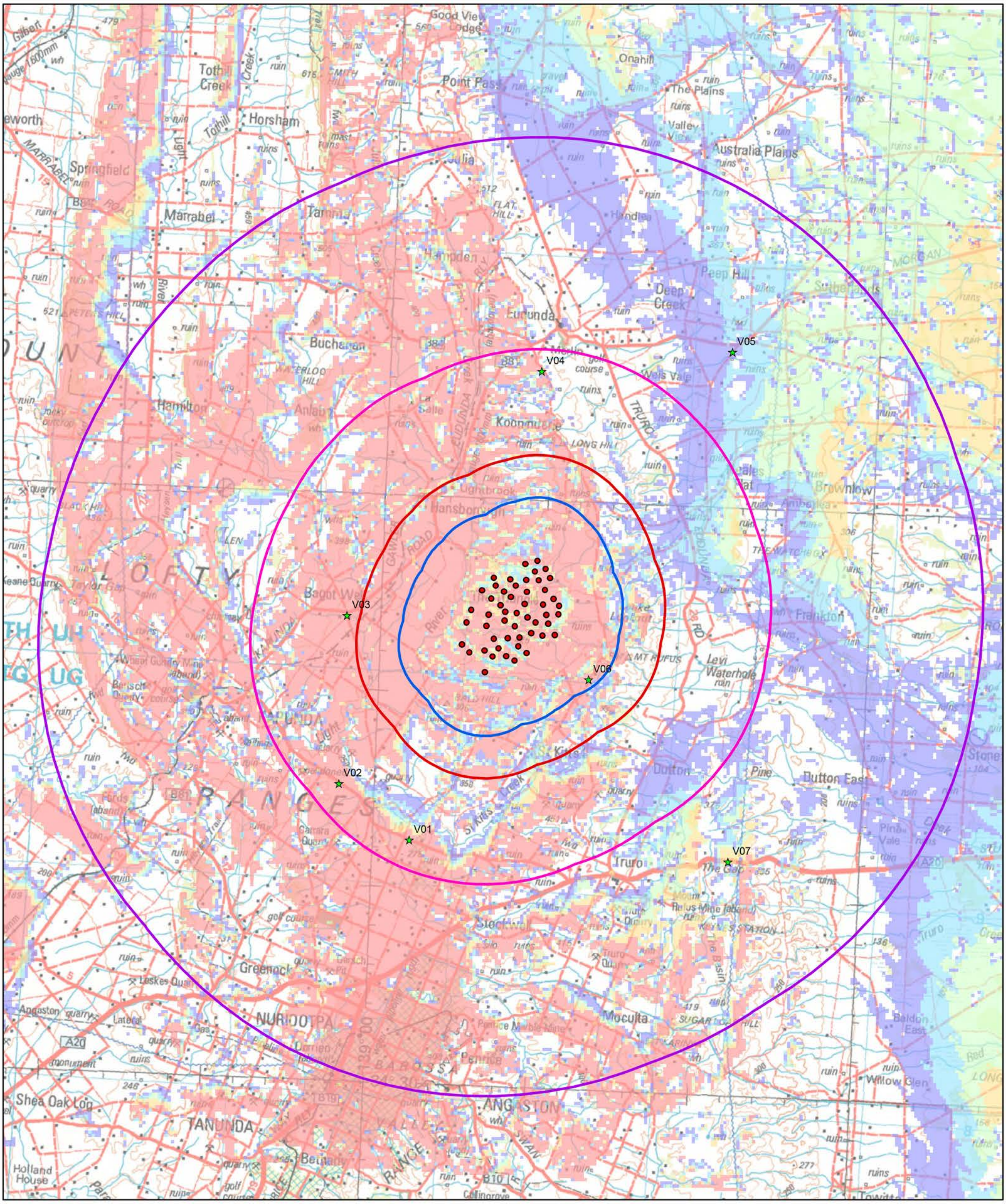
- ● TurbineLayoutPAUStwc025
- ★ Viewpoints_WAX_20160805
- Buffer 3km
- Buffer 5km
- Buffer 10km
- Buffer 20km

No. Turbines Visible

- 1 - 11
- 12 - 21
- 22 - 31
- 32 - 41
- 42 - 51

0 2.5 5 10 Kilometers

N



Zone of Theoretical Visual Influence_Tip of Blade (180m)

ZTVI represents 'worst case scenario'
it is based on 10m contour data and
does not take into account vegetation or
built form screening or localised ridgelines

Legend

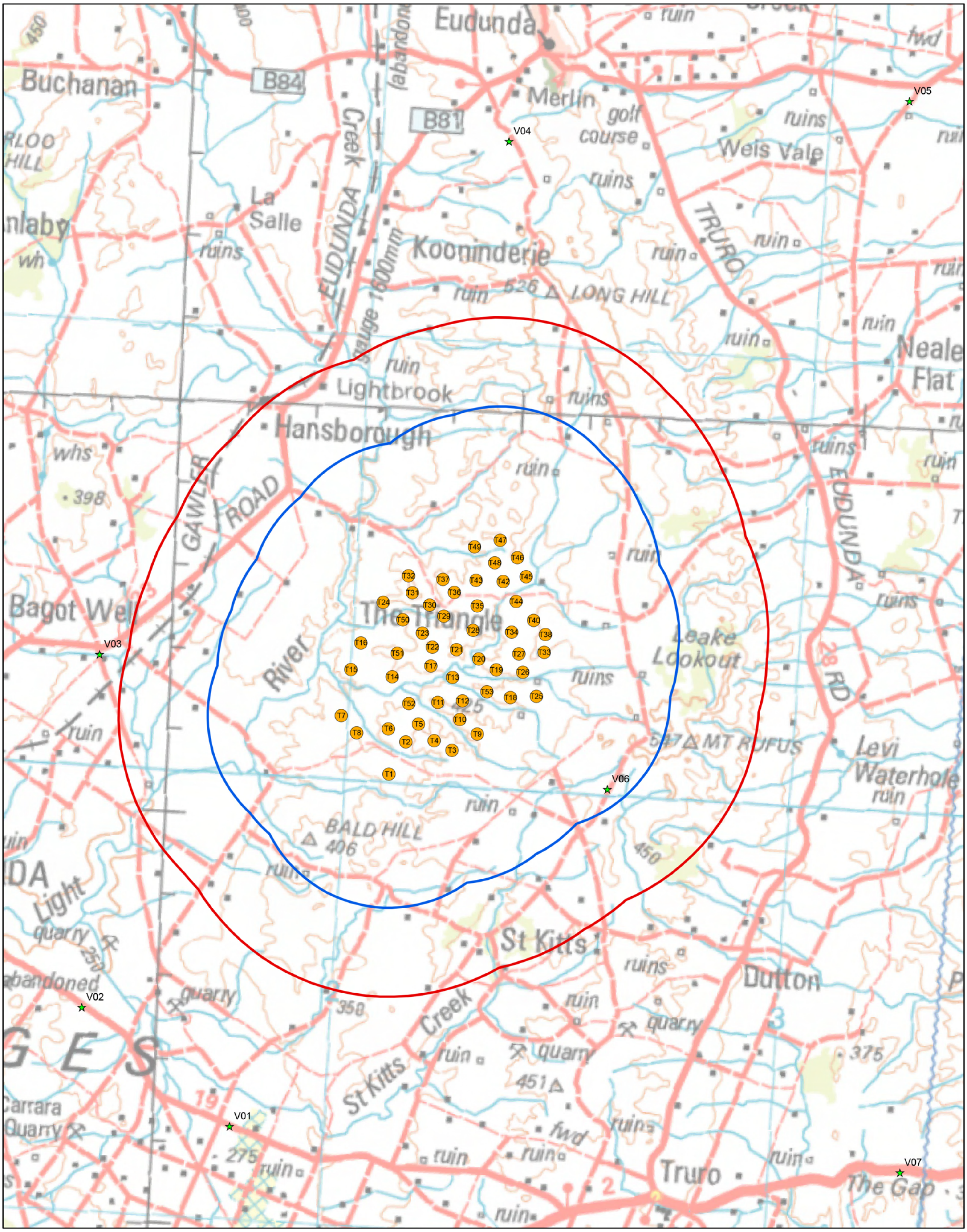
- TurbineLayoutPAUStwc025
- Viewpoints_WAX_20160805
- Buffer_3km
- Buffer_5km
- Buffer_10km
- Buffer_20km

No Turbines Visible

- 1 - 11
- 12 - 21
- 22 - 31
- 32 - 41
- 42 - 51

0 2.5 5 10 Kilometers

N



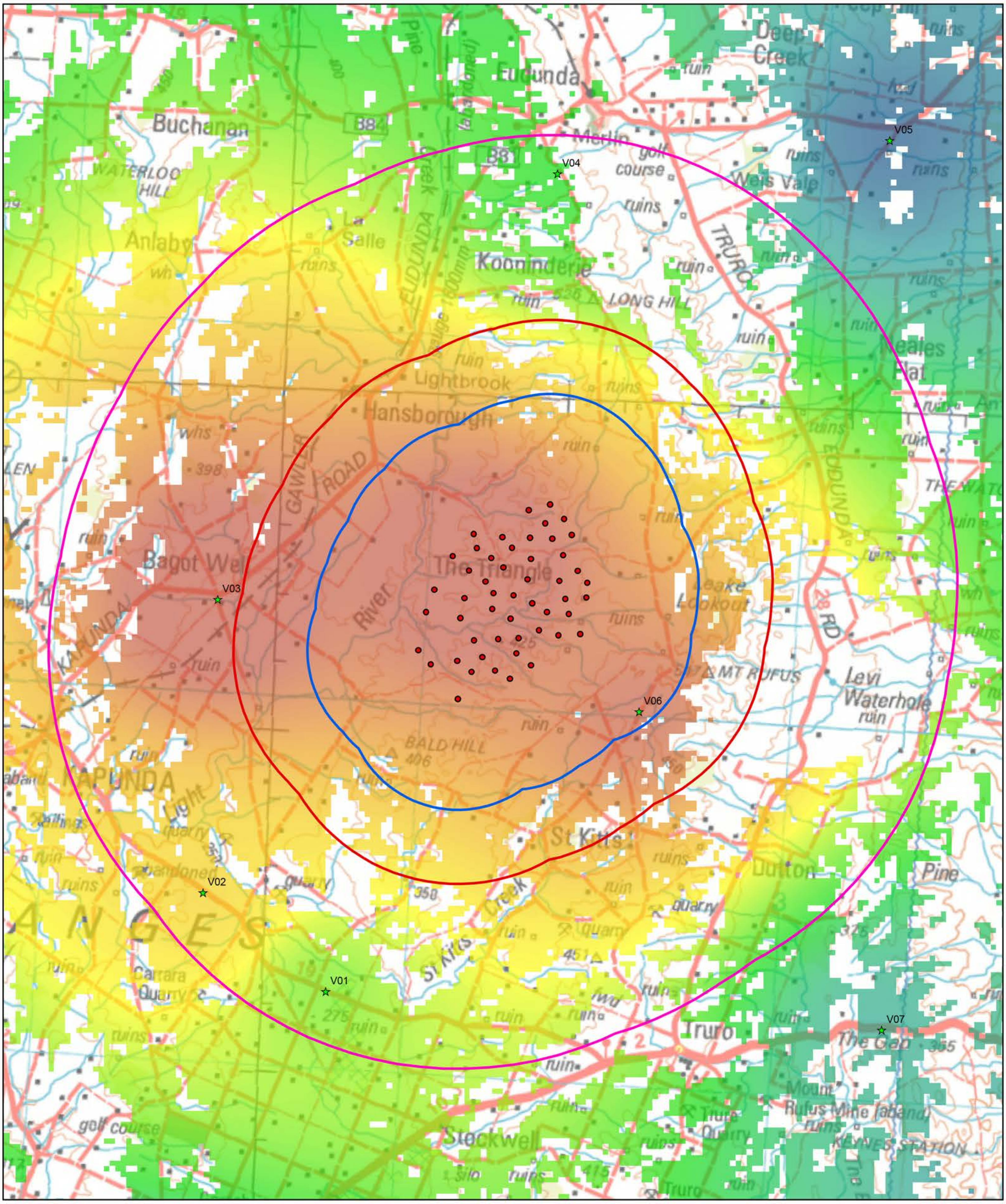
Legend

- TurbineLayoutPAUStwc025
- Viewpoints_WAX_20160805
- Buffer 3km
- Buffer 5km

Turbine layout

0 1.25 2.5 5 Kilometers

N



Visual Effect Interpolation

This figure illustrates the regional visual effect calculated within GIS as a distance weighted interpolation between the detailed assessment viewpoints. Furthermore it describes the potential impact with reference to the GimKe Matrix detailed assessment values. Consequently this figure needs to be interpreted as a relative regional visual effect of the potential transient experience. This does not take into account vegetation screening which would reduce the potential effect in some localities.

Legend

- TurbineLayoutPAUStwc025
- Viewpoints_WAX_20160805
- Buffer 3km
- Buffer 5km
- Buffer 10km

Visual Effect % Chnage

- Substantial
- Moderate
- Slight

0 1.5 3 6 Kilometers

N

Appendix B

Photographic Methodology (produced by Convergen)

The method consists of 6 stages. The following summarises the stages;

1. Viewpoints are identified using a Zone of Theoretical Visibility map, site assessment and in consultation with the client and residents in the area. The viewpoints are selected to represent the worse case scenario i.e. the maximum number of turbines visible within the field of view. The locations of viewpoints are typically representative of the regional landscape character units or identified by residents. The locations represent a diverse range of views from around the wind farm at a variety of directions and distances.

2. Photos are taken onsite using a 32mm lens digital SLR camera (50mm equivalent analogue). Numerous research papers have concluded that this is most representative of the human eye for depth of field. Photos are taken on a mounted tripod and the height recorded to eye level. In addition the elevation of the viewpoint is recorded Above Sea Level (ASL) using the barometric measure on a handheld GPS device. The weather and time of day are also recorded to enable computer model rectification in stage 4 and 6 of the process.

3. The centre of the field of view is equated onsite using a bearing compass and GPS to the projected centre of the development. A field of view of 60 degrees to either side of centre is established onsite to provide the full 120 degrees. The extent of the field of view is recorded and evaluated onsite using the GPS and bearing compass. 6 photos are taken for each viewpoint with 1/3 overlap of each to enable photo stitching. The bearing to centre of each photo is recorded to enable cross reference to the next phase of developing a computer model. During the site photography numerous fixed known visual markers are recorded with a GPS location and bearing from the viewpoint. These markers provide reference points within the computer modelling for due diligence.

4. To generate the panoramic photographs the individual photographs are stitched together using PTGui software.

5. The next stage of the process involves the computer generation of a wire frame perspective view of the wind farm, which incorporates the topography from each viewpoint. Using the Wind Farmer™ software the wire frame is produced using a digital terrain model with 10 metre contour intervals. This creates the topography and positions the turbines at the correct coordinates and elevation within the wire frame. The correct field of view is established by matching the viewing centre of the view angle to the camera and lens used for the photography with the wire frame. This ensures that the image size and angle of view of the wire line matches the photos taken. The wire line is then superimposed on the stitched panoramic photograph and matched in accordance to reference markers and landscape features.

6. A second site visit is conducted with the preliminary wire lines to certify the correct locations of the turbines using a GPS and bearing compass. Minor alterations are marked up on the drafts to mitigate the effects of photographic warping to the periphery of the stitched panorama. Ground truthing the turbine locations, provides rigour to the process. Typically if any amendments are required they are within 1-5 degrees.

7. Once the wire frame and photograph have been lined up the rendered image of the turbines are created. The rendered model is created in Wind Farmer™ using the correct sun angle for the date and time of the day that the photograph was taken. The rendered model is exported to Photoshop™ for final matching with the photograph. The rendered image is edited, masking

turbines or parts their off that are screened by vegetation and other elements to the foreground. Additional visual effects are applied to match the lighting effects of shadow imposed by vegetation etc.

Viewing of Photomontages

Given that the objectives of photography and photomontage are to produce printed images of a size and resolution sufficient for use in assessment work in the field, the exact dimensions of these images will depend on the characteristics of the field of view.

All photographs, whether printed or digitally displayed, have a unique, correct viewing distance - that is, the distance at which the perspective in the photograph correctly reconstructs the perspective seen from the point at which the photograph was taken. The correct viewing distance is stated for all printed or digitally displayed photographs and photomontages, together with the size at which they should be printed.

The viewing distance and the horizontal field of view together determine the overall printed image size.
Photographs and photomontages should be printed or published digitally at an appropriate scale for comfortable viewing at the correct distance, noting the limitations of the printing process particularly with regards to colour and resolution. Guidance is provided on viewing the image in order to best represent how the proposal would appear if constructed, such as the required viewing distance between the eye and the printed image. Panoramic images should be curved so that peripheral parts of the image are viewed at the same intended viewing distance. The 'before' photograph and the 'after' photomontage should be presented on the same page and/or at the same scale to allow comparison if practicable.

References

Landscape Institute Photography and photomontage in landscape and visual impact assessment (March 2011)

Landscape Institute and IEMA (2002) Guidelines for landscape and visual impact assessment (2nd ed). London: Spon.

Scottish Natural Heritage (2006) Visual representation of windfarms: good practice guidance. Inverness: Scottish Natural Heritage. SNH report no. FO3 AA 308/2

Appendix C

Photomontages and Turbine Locations

Used in the GrimKe visual assessment and referred to in sections 5.2 – 5.9 of the Landscape Character and Probable Visual Effect Report

Twin Creek Wind Farm Photomontage:
Viewpoint 1 Kapunda-Truro Road, Ebenezer

Longitude	Latitude	Distance to nearest WTG	View Direction
317919	6192096	8.41km	25º

Twin Creek Wind Farm Photomontage:
Viewpoint 2 Kaunda-Truro Road, Koonunga

Longitude	Latitude	Distance to nearest WTG	View Direction
314453	6194570	8.62km	40º

Viewpoint 2 Kaunda-Truro Road, Koonunga

Viewpoint 2 Photomontage

Viewpoint 2 Digital Overlay with All Turbines Visible

Twin Creek Wind Farm Photomontage:
Viewpoint 3 Intersection of Bagot Well Road and Kapunda-Eudunda Road, Bagot Well

Longitude	Latitude	Distance to nearest WTG	View Direction
314383	6202506	5.22km	85°

Viewpoint 3 Intersection of Bagot Well Road and Kapunda-Eudunda Road, Bagot Well

Viewpoint 3 Photomontage

Viewpoint 3 Digital Overlay with All Turbines Visible

Twin Creek Wind Farm Photomontage:
Viewpoint 4 Tablelands Road, south of Eudunda

Longitude	Latitude	Distance to nearest WTG	View Direction
322870	6214541	8.9km	180º

Viewpoint 4 Tablelands Road, south of Eudunda

Viewpoint 4 Photomontage

Viewpoint 4 Digital Overlay with All Turbines Visible

Twin Creek Wind Farm Photomontage:
Viewpoint 5 Von Reiben Road, east of Eudunda

Longitude	Latitude	Distance to nearest WTG	View Direction
331788	6215965	13.3km	220°

Twin Creek Wind Farm Photomontage: Excluding Infrastructure
Viewpoint 6 Tablelands Road, south of Mount Rufus

Longitude	Latitude	Distance to nearest WTG	View Direction
325931	6200154	2.64km	300º

Twin Creek Wind Farm Illustrative image: Including Infrastructure
Viewpoint 6 Tablelands Road, south of Mount Rufus

Longitude	Latitude	Distance to nearest WTG	View Direction
325931	6200154	2.64km	300°

Twin Creek Wind Farm Photomontage: Excluding Infrastructure
Viewpoint 7 Sturt Highway, east of Truro

Longitude	Latitude	Distance to nearest WTG	View Direction
332988	6191953	13.6km	310º

Twin Creek Wind Farm Illustrative image: Including Infrastructure
Viewpoint 7 Sturt Highway, east of Truro

Longitude	Latitude	Distance to nearest WTG	View Direction
332988	6191953	13.6km	310°

Twin Creek Wind Farm Illustrative image: Including Infrastructure
Viewpoint 9 Sturt Highway, east of Proposed Transmission Substation

Longitude	Latitude	Distance to Substation	View Direction
333817	6191881	379m	290º

Viewpoint 9 Sturt Highway, east of Proposed Transmission Substation

Viewpoint 9 Illustrative Image

Viewpoint 9 Digital Overlay with All Turbines and Infrastructure Visible

Twin Creek Wind Farm Illustrative Image: Potential Landscape Treatment
Viewpoint 9 Sturt Highway, east of Proposed Transmission Substation

Longitude	Latitude	Distance to Substation	View Direction
333817	6191881	379m	290º

Appendix D

Supplementary Photomontages with Substations and Transmission Line

Additional photomontages produced to discuss the probable visual effect of the associated infrastructure and referred to in sections 5.11 – 5.16 of the Landscape Character and Probable Visual Effect Report

Appendix E

GrimKe Assessment Matrix

The GRIMKE Matrix has been based on the WAX (2006) and HASSELL Matrix (2005), and with reference to The Visual Management System (VMS) produced by Litton (1968) primarily used for the U.S. Forest Service (1973) and the US Bureau of Land Management (1980). These models are based on a professional consultant (Landscape Architect) quantifying potential changes to landscape composition through "forms, lines, colours and textures and their interrelationships"1. Other factors such as compositional qualities, dominance, variety, animation and sensitivity to potential receptors are also considered.

The extent of visual impact was identified on site, using a GPS with a Wide Area Augmentation System (WAAS) that provides positional accuracy to within 3 metres.i Using the GPS, the location and extent of the development was plotted as 'waypoints', using longitude and latitude, elevation and distances to provide geographic referenced data. The surrounding area was then surveyed with the GPS and a SILVAii bearing compass to calculate the bearing and distance between the viewpoint and the subject area. This methodology was used to assess where the development is in the landscape and whether it is visible.

The GrimKe Matrix considers two key aspects in terms of understanding visual impact and the resulting visual assessment. The initial assessment is a quasi-objective measurement, where a landscape architect considers the landscape character of the site and particularly in relation of this landscape to the viewpoints that have been selected as part of the assessment criteria. Each viewpoint is then assessed in terms of:

— Relief (the complexity of the land that exists as part of the underlying landscape character)
— Vegetation Cover (the extent to which vegetation is present and its potential to screen and filter views)
— Infrastructure and Built Form (the impact of development on landscape and visual character)
— Cultural and Landscape Value (quantification of recognised planning overlays)

Assessing each viewpoint and the regional context (cultural and landscape value) a quantified value is generated for landscape character. This value then forms the baseline assessment value, which will be modified by the impact of the development within the landscape, which in turn will be measured as part of the visual assessment.

This two-tiered assessment methodology ensures the degree of visual impact is assessed against a quantified landscape character value enabling, the GrimKe Matrix to accurately quantify the degree of visual impact that is experienced as a result of implementing the development.

The assessment considers the landscape as three distinct zones based on the distance from the proposed development. The three zones were defined as; local (0-1km), sub-regional (1-5km) and regional (5-30km). (Planning South Australia, 2002). Specific landscape characters are also identified to provide a complete assessment of the landscape context.

[1] *Daniel, T C & Vining, J (1980) p49*

1. Landscape Character Assessment

1.1 Relief

This is an assessment of the landscape complexity in terms of the underlying topography. The relationship of relief assists in defining the landscape and the visual character of an area. This is relevant in terms of the position and elevation of a proposed development within the landscape and the viewpoint.

The topography is assessed both on site (from each viewpoint) and as part of a desktop review (topography mapping). The assessment considers the topographical complexity in terms of local, sub-regional and regional. Within each zone an assessment is made of the topography and the complexity of landscape features.

The assessment is concerned with landscape complexity and how it impacts on the visual character. The assessment considers landform patterns, dominant elements and other distinguishing topographical features that will impact on the visual context.

Relief (expressed as percentage)	Value	Description of Landscape Relief
80-100%	5	Substantial landscape relief. The landscape possesses significant topographic variations, features and prominent elements creating a dynamic landscape context.
60-79%	4	Increasing relief. Due to the scale of the topography and frequency of features.
40-59%	3	Moderate relief. Medium level of change to the landscape. Occasional landscape features and topographic variation.
20-39%	2	Limited relief. Small amount of topographic variation in the landscape.
0-19%	1	No or minor relief within the landscape. The landscape is considered feature less, without noticeable elements or patterns.

1.2 Vegetation Coverage

Vegetation coverage is a measurement of the extent, character and frequency of vegetation that exists at each viewpoint and within the local, sub-regional and regional zones. The extent of vegetation provides the potential for screening and to reduce the visual effect of development. Conversely, a lack of vegetation results in an increase in the visual significance of a development.

This measurement responds to the potential visual absorption of the landscape as measured by the visual matrix. Again, this assessment considers the dominant vegetation patterns within each zone and in relation to each viewpoint.

Vegetation Coverage (expressed as percentage)	Value	Description of Vegetation Coverage
80-100%	5	Natural or non-harvested commercial forests. Significant areas of treed vegetation creating an arboreal landscape.
60-79%	4	Bushland or woodlands. Major areas of vegetation that define the landscape character of an area
40-59%	3	Tree groups, copse, screens, shelter belts. Defined areas of vegetation creating a layered landscape character.
20-39%	2	Sporadic trees producing a punctuated vegetation character.
0-19%	1	No trees scrub or low ground cover. Limited vegetation cover.

1.3 Infrastructure and Built Form

This assessment considers the interrelationship of landscape character and human development. The assessment considers how development and infrastructure can create a counterpoint to the existing landscape character (vegetation and topography). Alternatively, development within the landscape may assist with the assimilation of development.

Infrastructure and Built Form (expressed as percentage)	Value	Description of Infrastructure and Built Form
0-19%	5	No objects within the landscape. The landscape has a high natural or remote rural character.
20-39%	4	Isolated objects in the landscape. Single elements with limited visual impact on the landscape. Small farm building, telephone towers or houses.
40-59%	3	Small clusters of development. Increasing presence of development within the landscape.
60-79%	2	Medium scale linear infrastructure or development. More significant development within the landscape. Minor roads, culverts, warehouses, transmission lines and residential areas.
80-100%	1	Large scale infrastructure. The landscape is significantly affected by development. Freeways, power stations and opencast mining

1.4 Cultural Sensitivity Value

The cultural and landscape value assessment is a survey of the regional area around the development up to 20 kilometres. The measurement considers the recognised cultural, heritage, natural and social overlays that exist within the landscape. This assessment is predominantly a desktop survey and only measures recognised designations.

The measurement is then represented as a percentage based of the area of designation compare to the area occupied by the regional zone.

The landscape value is the aggregate value from each of the assessment criteria. Either, as a value for each viewpoint or as a baseline value for the landscape surrounding the development. This Landscape Value in then used to assess the percentage of visual change created by the introduction of development within the landscape.

Cultural and Landscape (expressed as percentage)	Value	Description of Cultural and Landscape Value
80-100%	5	Majority of regional zone is affected by planning designations or overlays. Highly valued culture, natural and social landscape.
60-79%	4	Planning designations impacts a significant area of the regional zone. Valued culture, natural and social landscape
40-59%	3	Moderate impact from planning designations. Valued community or social landscape
20-39%	2	Limited effect
0-19%	1	None to negligible effect of planning designations

1.5 Landscape Character Assessment

The aggregate of relief, vegetation, infrastructure and cultural sensitivity values determines the base line landscape character value. The following table summarises the definition of Landscape Character Values

Landscape Character Value	Value	Description of Landscape Relief
16-20	High	Landscape quality is of high value with significant areas of scenic quality provided by varied topography, large areas of natural beauty and obvious presence of cultural sensitivity to change.
12-16	Moderate to increasing	Moderate to increasing landscape character value experienced through a layered landscape of natural

		qualities, scenic beauty and cultural sensitivity.
8-12	Moderate	Moderate landscape character value experienced by small clusters of natural landscape and cultural sensitivity.
4-8	Limited	Limited landscape character value experienced. The landscape is monotonous with little visual interest through topography or vegetation and heavily modified.

2. Visual Assessment

Each viewpoint was then assessed with respect to the following aspects of visual effect

- Percent of landscape absorption (the landscape's ability to absorb and screen the development form).
- Horizontal visual effect (percentage spread of the development in the field of view).
- Vertical visual effect (height of the development as a percentage of the field of view).
- Distance of visual effect (distance between viewpoint and development).

Using the following GRIMKE matrix formula, the development was quantified and aggregated to provide an assessment of the visual effect for each viewpoint.

2.1 Percent of Visual Absorption (PVA)

This is an assessment of the landscape's ability to absorb or screen the visual effect. Due to the comprehension of the landscape and wind farm development being holistic, the area that is visually affected includes the space between the turbines.

Using photomontages of the proposed development and Adobe Photoshop™ the amount to which the landscape screens the development is described as a percent of pixel absorption. Foreground contrasting pixels are selected within the vertical and horizontal extents of the development (area A), figure 6. This area is divided by the total area occupied by the development within the active field of view (area B) and expressed as a percentage of visual absorption. The assessment takes into consideration, visual sky lining and screening from existing vegetation and other physical forms.

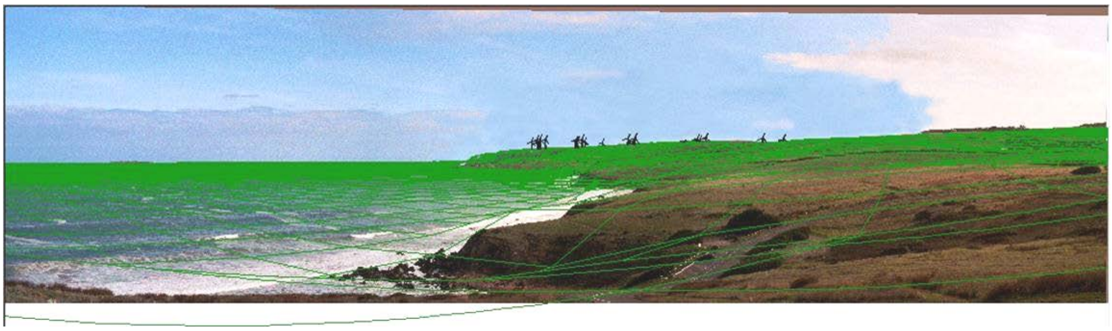


Figure 1 Photo with wire line model draped on top. Courtesy Wind Farm Developments (2004)

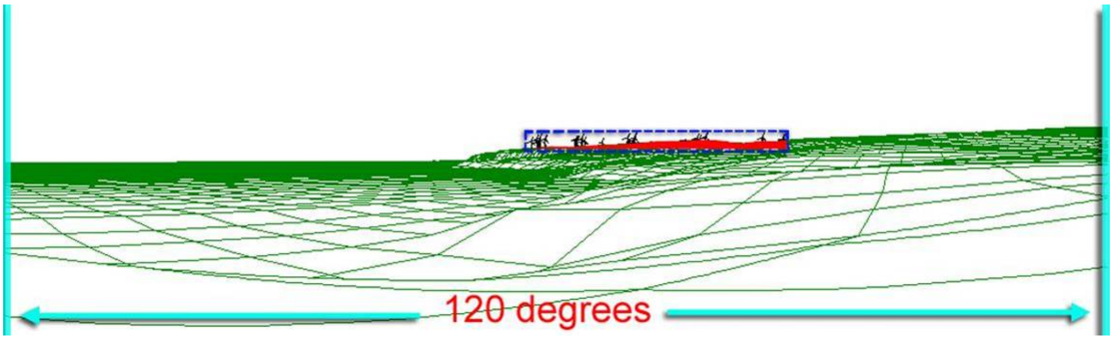


Figure 2 Wire line of showing extent of photomontage. Adapted from Wind Farm Development (2004)

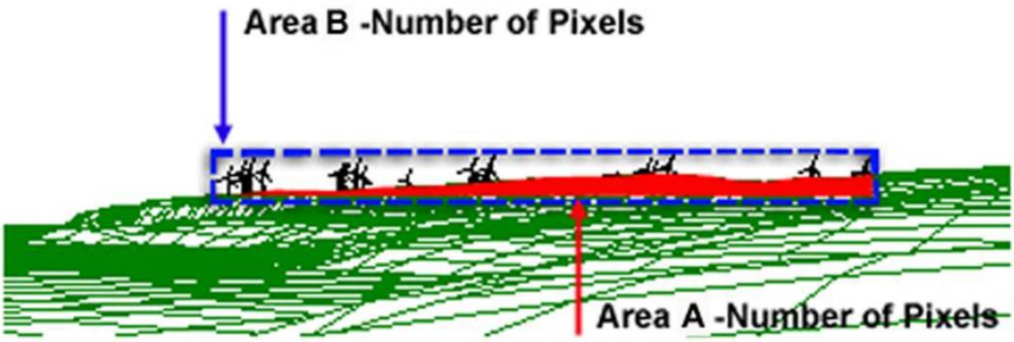


Figure 3 Detailed view of the landscape absorption (area A) and development extents (area B). Adapted from Wind Farm Development (2004)

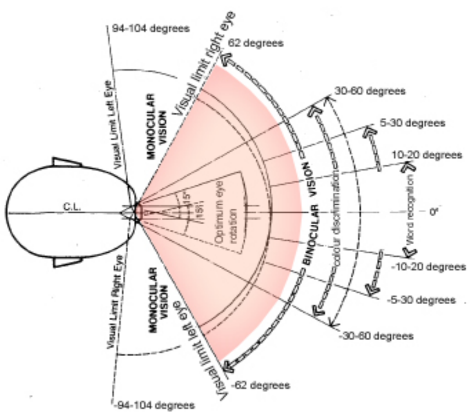
Percent of Visual Absorption (expressed as percentage of change)	Value	Description of Visual Absorption
80-100%	1	Substantial landscape absorption capacity. The landscape possesses sufficient vegetation and topography to screen any effect of the development,

		maintaining the visual character.
60-79%	2	Increasing absorption capacity. Due to the scale of the topography and density of vegetation the landscape is able to screen the development.
40-59%	3	Moderate absorption capacity. Medium level of change to the landscape. The landscape is less able to absorb change due to the scale, distance and extent of the development.
20-39%	4	Limited absorption. The development is noticeable within the landscape; however through vegetation and topography the landscape fragments and filters views of the development.
0-19%	5	No or minor absorption within the landscape. The development is considered to be prominent within the visual landscape.

2.3 Horizontal Visual Effect (HVE)

The field of vision (FOV) experienced by the human eye is described as an angle of 200-208 degrees horizontally[iii]. This field of view includes the peripheral (monocular) vision, which is described as 40 degrees to each eye; within this zone colour and depth of field are not registered. For the purposes of the assessment the angle of peripheral vision has been subtracted from the field of view producing a binocular, 'active field of view' of 120 degrees.

Using this fixed visual reference, an assessment of the possible impact of development within this measurable area is undertaken. The centre of the development is established and an angle of 60 degrees each side is defined. The overall assessment is made of the entire development, rather than of the individual objects that may form the proposal. The angle is measured using a GPS and a bearing compass with known waypoints (geographic coordinates). Using GPS the extent of the horizontal visual field is calculated by the difference in bearing between the widest waypoints from a particular viewpoint. This measurement of effect is then described as a percentage of the 120 degrees active field of view



VISUAL FIELD IN HORIZONTAL PLANE

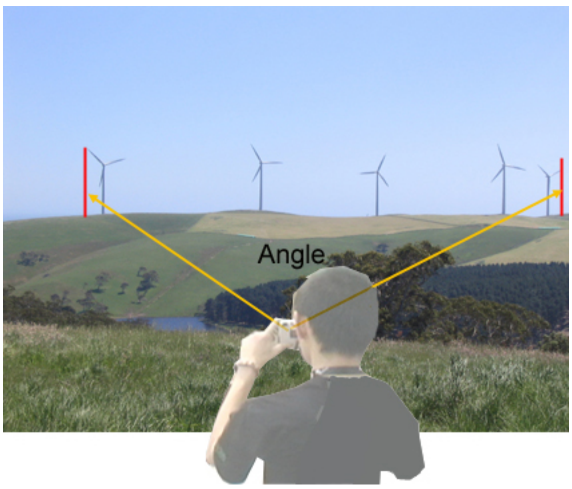


Figure 4 Active field of view is defined as the binocular field equating to 120-124 degreesiv. On the right is an illustration of horizontal measured angle as percent of active field 120 degrees. Photo Brett Grimm

Degree of Horizontal Visual Impact (expressed as an angle of impact and percentage of change)	Value	Description of Visual Modification
80-100% of the panorama measure at 120˚FOV)	5	Substantial horizontal visual impact. Visual impact throughout the entire active field of view.
60-80% of the panorama measure at 120˚FOV)	4	Increasing visual effect. A large proportion of the active field of view is affected.
40-60% of the panorama Measure at 120˚FOV	3	Moderate visual effect.
20-40% of the panorama measure at 120˚FOV)	2	Limited effect. The visual impact is a small part of the active field of view.
0-20% of the panorama measure at 120˚FOV)	1	No or minor visual effect.

2.4 Vertical Visual Effect (VVE)

The vertical visual effect evaluates the proportional scale of the development with reference to the vertical character of the existing landscape, as seen within the field of view of the assessed viewpoints.

The process of assessment is undertaken in 3 stages:

Stage 1:

The first stage of the process is to determine the vertical scale of the existing landscape. The baseline landscape scale is calculated using the photomontage viewpoint elevation (A) as a known reference height. The elevation of the viewpoint is recorded using a GPS. Using contour data, a second value (B) is recorded representing the highest topographic elevation within the field of view. Finally, the horizontal distance (C) between the viewpoint and the highest topographic feature is recorded. The vertical angle of view α_1 is then given as:

$\alpha_1 = \tan^{-1}((B-A)/C)$

as shown in Figure 6 below.

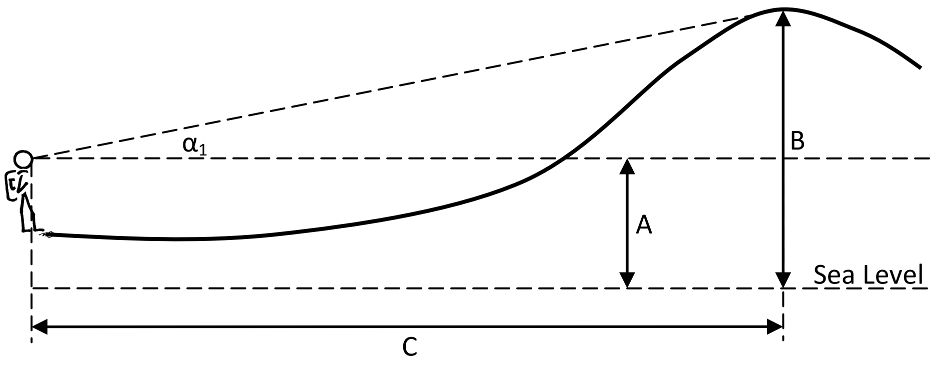


Figure 6: Vertical Scale of Existing Landscape

Stage 2:

The second stage of the process is to determine the vertical scale of the landscape modification, namely that of the apparent maximum turbine tip height as viewed from the viewpoint. Using the known turbine height (E), ground elevation (F) and its distance from the viewpoint (G), the vertical angle of view α_2 is then given by:

$\alpha_2 = \tan^{-1}((E+F - A)/G)$

as shown in Figure 7 below.

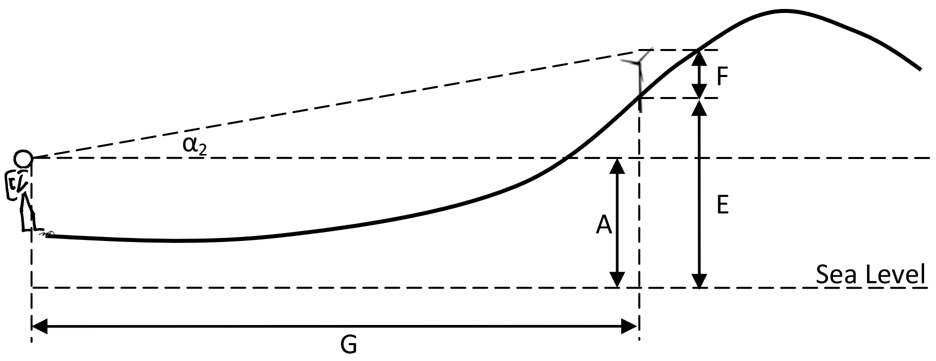


Figure 7: Vertical Scale of Landscape Modification

Stage 3:

The final stage of the process is to determine the overall proportion of the vertical scale of the development with reference to the existing landscape scale by taking the ratio of the two angles α_2 and α_1. Depending on the relative size of the vertical angles of view occupied by the existing and modified landscapes respectively, the ratio α_2 / α_1 will determine the nature and scale of the visual impact.

Depending on the relative scale of the angle of view occupied by the landscape and/or the development, the two vertical angles will depict whether there will be an increase in vertical visual impact created by the development ($\alpha_2 / \alpha_1 > 1$) or conversely the visual effect will be experienced as a vertical visual effect relative to the existing landscape scale ($\alpha_2 / \alpha_1 < 1$).

The vertical visual effect assessment will result in one of the following conditions:

- an increase in the overall vertical visual effect experienced from the viewpoint as a result of the combined vertical visual effect of the existing landscape character and the proposed development, or;

- a limited vertical visual effect as a result of the scale of the development being less than the existing landscape vertical scale when assessed from a viewpoint. This may be created by backdrop landforms or large ravines, valleys depicting a scale that within the field of view is greater than the development.

Either, the turbines or parts of the turbines are seen above ridgelines or landforms within the field of view and the effect will result in an increase in vertical visual effect, or the viewpoint contains large escarpments or deep valleys within the field of view and the vertical scale of the proposed wind turbines are likely to be seen as a proportion of the existing landscape scale resulting in a limited vertical visual effect.

In the first case (i.e. where $\alpha_2 / \alpha_1 > 1$), the proportional vertical visual impact should be assessed using Table 1 below. In the second case, the proportional vertical visual impact is considered minor and is assigned a value of 1.

Table 1 Proportional Vertical Visual Effect in existing landscape scale ($\alpha_2 / \alpha_1 > 1$)

Vertical Visual Impact (expressed as percentage increase (α_2 / α_1 - 1) x 100)	Value	Description of Visual Modification
80-100%	5	Substantial visual impact.
60-80%	4	Increasing visual impact
40-60%	3	Moderate visual impact.
20-40%	2	Limited impact
0-20%	1	No or minor visual impact within the landscape.

2.5 Distance of Visual Effect

This is a measurement of how visual impact is modified by distance. The effect of scale, topography, vegetation and weather, changes with distance, and in turn changes the degree of visual effect. The distance to the development from each viewpoint is recorded using the GPS. Standing onsite at each viewpoint the exact distance can be calculated by selecting the closest waypoint function (all the turbine locations are stored as waypoints in the GPS).

The distance categories outlined in the table below have been based on empirical research University of Newcastle (2002), Sinclair (2001), Bishop (2002).

Location of Development (from viewpoint)v	Value	Description
0 to 4 km (80-100%)	5	Adjacent: Dominant impact due to large scale, movement, proximity and number
4 to 8 km (60-80%)	4	Foreground: Major impact due to proximity: capable of dominating landscape
8 to 13 km (40-60%)	3	Middle ground: Clearly visible with moderate impact: potentially intrusive
13 to 18 km (20-40%)	2	Distant middle ground: Clearly visible with moderate impact becoming less distinct
18 km and greater (0-20%)	1	Background: Less distinct: size much reduced

2.6 Landscape Absorption Assessment

The aggregate of landscape absorption, horizontal and vertical effects and distance values determines the base visual impact value form the viewpoint. The following table summarises the definition of Visual Impact values

Visual Impact Value	Value	Description of Landscape Relief
16-20	High	High visual impact within the field of view
12-16	Moderate to increasing	Moderate to increasing visual impact within the field of view
8-12	Moderate	Moderate visual impact within the field of view
5-8	Limited	Limited visual impact within the field of view

3. Degree of Visual Impact (Percentage of Visual Change)

Degree of Visual Impact

The degree of Visual Impact is expressed as a coefficient of visual change to the baseline Landscape Value (general or viewpoint specific). This calculation directly expresses the effect of the development on the landscape, the change to the visual character and the reciprocal visual impact.

- Baseline Landscape Character : express as a value between 4 and 20)
- Coefficient of Visual Impact : calculated as the 20 divided by visual assessment value

Calculation of degree of Visual Impact

Coefficient x landscape character value expressed as a percentage = Visual Impact on Landscape Character

Example:

(a) *Visual Impact Assessment*

Horizontal visual effect	3
Vertical visual effect	1
Absorption capacity	3
Distance	2
Total visual effect	9 (0.45)

*9/20 equated to a coefficient of **0.45***

(b) *Landscape Character Assessment*

Relief	3
Vegetation coverage	3
Infrastructure built form	2
Cultural landscape overlays	2
Total landscape character	10

(c) *10 x 0.45 = 4.5*

(d) *4.5/20 = 0.225*

(e) *0.225 x 100 = 22.5% Visual Change to the Landscape*

3.1 Final Aggregated Visual Effect

Percentage Value of Visual Change	Descriptive Qualification of Visual Effect	Comments
80-100%	Extreme	Extreme change in view: change very prominent involving total obstruction of existing view or change in character and composition of view through loss of key elements or addition of new or uncharacteristic elements which significantly alter underlying landscape visual character and amenity
60-80%	Severe	Severe change in view involving the obstruction of existing views or alteration to character through the introduction of new elements. Change may be different in scale and character from the surroundings and the wider setting. Resulting in a perceived increase in proportional change to the underlying landscape visual character.
40-60%	Substantial	Substantial change in view: which may involve partial obstruction of existing view or alteration of character and composition through the introduction of new elements. Composition of the view will alter. View character may be partially changed through the introduction of features.
20-40%	Moderate	Moderate change in view: change will be distinguishable from the surroundings whilst composition and underlying landscape visual character will be retained.
0-20%	Slight	Very slight change in view: change barely distinguishable from the surroundings. Composition and character of view substantially unaltered.

Appendix F

Glossary[2]

[2] *Visual Analysis of Windfarms Good Practice Guidance, Scottish Natural Heritage (2005)*

Active Field of View:	The field of view excluding peripheral vision, which is described as 40° to each eye, within this zone colour, shapes and forms are not registered. The active field of view removes the angle of peripheral vision from the field of view producing an angle of 120 - 160°
Assessment (landscape):	An umbrella term for description, classification and analysis of landscape.
Depth of Field:	The distance between the nearest point (viewpoint) and farthest objects (visual envelope) which is visible within the field of view.
Element:	A component part of the landscape or visual composition.
Effect (landscape or visual):	These occur as a broad culmination of one or more impacts, incorporating professional judgement to extrapolate and/or generalise on the nature of these.
Horizontal Visual Effect:	This term is used to describe the field of view occupied by the visible part of a wind farm.
Impact (landscape or visual):	Impacts occur to a particular element of the environment and they can be described factually by the nature and degree of change.
Landscape:	Human perception of the land conditioned by knowledge and identity with a place.
Landscape character:	The distinct and recognizable pattern of elements that occurs consistently in a particular type of landscape, and how people perceive this. It reflects particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape.
Landscape feature:	A prominent eye-catching element, for example, wooded hilltop, isolated trees or grain silo.
Mitigation:	Measures, including any process, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual impacts of a development project.
Panorama:	A view, covering a wide field of view.
Photomontage:	A visualisation based on the superimposition of an image onto a photograph for the purpose of creating a realistic representation of proposed or potential changes to a view. These are now mainly generated using computer software.
Sensitivity:	The extent to which a landscape or visual composition can accommodate of a particular type and scale without adverse effects on its character or value.
Visual Amenity:	The value of a particular area or view in terms of what is seen.
Visual Envelope:	Extent of potential visibility to or from a specific area, viewpoint or feature.

Appendix G
Relevant Experience

WAX

WARWICK KEATES
Director
Landscape Architecture and Urban Design

Warwick Keates is a Director of WAX Design. With over twenty years landscape architectural experience, he has developed a diverse range of skills, working on major projects in the United Kingdom, Middle East and Australia. This experience has allowed Warwick to develop a detailed understanding the complex requirements associated with landscape assessment and design.

Warwick has been involved in the development of Objective Base Assessment Criteria for measuring the visual impact of various developments, including Open Cast Mines, Wind Farms, Mobile Phone Towers, Significant Trees and Road Corridors. He has also been called as an expert witness at Planning and Parliamentary Hearings.

Warwick has worked in all aspects of the profession, including large scale master plans, urban and civic spaces and small scale projects. This, coupled with his collaborative approach to other design professionals, provides Warwick with complete understanding of landscape and urban design, in respect of the assessment (physical and visual), design and creation of exceptional places.

Qualification

Graduate Diploma in Landscape Architecture, Leeds Polytechnic (United Kingdom) 1990
Bachelor of Arts (Hons) in Landscape Architecture, Leeds Polytechnic (UK) 1988

Professional Affiliations

Associate of the Australian Institute of Landscape Architects
Member of the Landscape Institute (UK) 1995

Specialist Expertise

Visual Impact Assessment
Environmental Impact Assessment
Expert Witness
Urban design
Large scale master planning

Previous Experience

WAX DESIGN
Area 55 Oxide Mine, Darwin NT
Waubra North Wind Farm VIC
Robertstown & Stony Gap Wind Farms SA
Gulnare Wind Farm SA
Mobile Carriers Forum Design Innovation and Visual Assessment Programme
The Sisters Wind Farm VIC
Kanmantoo Copper Mine SA
Woolsthorpe Wind Farm VIC
Olympic Dam Mine Expansion Visual Impact Assessment
Berrimal Wind Farm VIC
Telstra Telephone Tower Visual Assessment

HASSELL
Taralga Wind Farm Peer Review NSW
Naroghid Wind Farm Assessment VIC
Waitpinga Wind Farm VIA
Myponga Wind Farm VIA
IKEA Totem Visual Assessment
Hutchinson 3G Phone Tower Visual Impact Assessment

ANTHONY WALKER & PARTNERS (UK)
Picton-Shipton Nation Grid Powerline EIS
A1/M1 Link Road EIA
M6 Widening Visual Assessment

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Bellevue Heights
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Dr Brett Grimm
Director

PhD, B.Land Arch,
B.Design Studies U.Adel
Registered Landscape Architect AILA

<u>Qualifications</u>

2009	PhD, The University of Adelaide
2002	Bachelor Landscape Architecture, The University of Adelaide, First Class Honours
2000	Bachelor Design Studies, The University of Adelaide

<u>Professional Affiliations</u>

- Australian Institute of Landscape Architects (AILA)
- Lecturer and tutor Adelaide University School of Architecture, Landscape Architecture and Urban Design
- AILA Education Accreditation Panel (Chair)

<u>Experience</u>

2011	Director BGLA
	City of Marion
	Landscape Architect
2007- 2010	Swanbury Penglase, Associate
2006-2007	Hassell, Landscape Architect
2005-2006	Overseas Travel (PhD Scholarship exchange / Insite Environments, UK), Landscape Architect
2002-2005	Hassell, Graduate Landscape Architect

<u>Conference Papers</u>

IFLA World Congress 2005, Edinburgh
Australian Wind Energy Association annual conference 2004, “Best Research Paper”

<u>Project Experience Visual Assessment</u>

- Port Augusta Energy Park VA
- Palmer Wind Farm VA
- Seppeltsfield Visual Assessment
- Residential Visual Assessment Fullarton
- Significant Tree Visual Assessment
- Buckland Park Visual Assessment, SA
- Keyneton Wind Farm
- Crystal brook Wind Farm
- Allendale Wind Farm Appeal Hearing (in association with Wax)
- Mt Bryan ERD Wind Farm Appeal Hearing (in association with Wax)
- Willogoleche Wind Farm Extension (in association with Wax)
- Waubra North Wind Farm Visual Assessment (in association with Wax)
- Carmodies Hill Wind Farm Visual Assessment (in association with Wax)
- Tampakan Mine Phillipines Peer Review
- Area 55 Mine Assessment, Darwin (NT)
- Sisters Wind Farm Visual Assessment (in association with Wax)
- Olympic Dam EIS Visual Assessment
- Buckland Park Visual Assessment
- Project Bulla Visual Assessment
- Witton Bluff Visual Assessment
- Various urban development ERD Expert Witness cases
- Drysdale Wind Farm Visual Assessment
- Kanmantoo Mine Expansion Visual Assessment
- Naroghid Wind Farm Visual Assessment

Appendix H
Endnotes

[i] The GPS used was a Garmin X12 which differential-ready 12 parallel channel receiver continuously tracks and uses up to twelve satellites to compute and update a position

[ii] The SILVA precision M80 with a parallax free prismatic magnification-bearing compass. A magnetic bearing compass with a $\pm$ 0.5° from true magnetic course.

[iii] Pirenne, M.H. (1967). Vision and the Eye. London: Chapman and Hall

[iv] Panero, J. & Zelnik, M. (1979) Human Dimension & Interior Space- A source Book of Design Reference Standards. The Architectural Press Ltd. London.

[v] The distance zones have been developed Sinclair Thomas Matrix, which has cited field observations of the visual extents. The classification zones have been based on projected 90-100m high turbines.