

# Silverton Wind Farm Modification 3

## VISUAL IMPACT ASSESSMENT

*Prepared for:*



*Prepared by:*

**GREEN BEAN DESIGN**  
*landscape architects*

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

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## DOUCMENT CONTROL

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<b>Author:</b>	<b>Andrew Homewood</b> , Registered Landscape Architect, AILA <i>Graduate Diploma Landscape Management, Bachelor Science (Dual Honours) Landscape Design and Archaeology, National Diploma Horticulture</i>
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**Table 1** Glossary

Term	Definition
<b>Cumulative effects</b>	The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.
<b>Magnitude</b>	A combination of the scale, extent and duration of an effect.
<b>Mitigation</b>	Measures, including any processes, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual effects of a development project.
<b>Residual visual effect</b>	Observable difference between the approved Silverton Wind Farm project and the proposed Silverton Modification 3 amendments.
<b>Sensitivity</b>	Susceptibility of a receiver to a specific type of change.
<b>Swept area</b>	Circular area defined by the rotational path of the rotor blades.
<b>Visibility</b>	A relative determination at which the proposal can be clearly discerned and described.
<b>Visual amenity</b>	The value of a particular area or view in terms of what is seen.
<b>Visual envelope</b>	Extent of potential visibility to or from a specific area or feature.
<b>Visual Impact Assessment</b>	A process of applied professional and methodical techniques to assess and determine the extent and nature of change to the composition of existing views that may result from a development.
<b>View location</b>	A place or situation from which a proposed development may be visible.
<b>Visual receiver</b>	Individual and/or defined groups of people who have the potential to be affected by a proposal.
<b>Visual significance</b>	A measure of the importance or gravity of the visual effect culminating from the degree of magnitude and receiver sensitivity.
<b>Zone of Theoretical Visibility (ZTV; sometimes Zone of Visual Influence)</b>	A map, usually digitally produced, showing areas of land within which a development is theoretically visible.

## Executive summary

Green Bean Design Pty Ltd (GBD) has been commissioned by NGH Environmental Pty Ltd on behalf of Silverton Wind Farm Developments Pty Ltd (the Proponent) to prepare a Visual Impact Assessment (VIA) report for the Silverton Wind Farm (SWF) proposed Modification-3 Application (Mod-3). The Application is for an amendment of development consent in accordance with section 75W of the Environment Planning and Assessment Act 1979. This VIA has been prepared to assess the potential visual effect of the SWF proposed Mod-3 amendments to increase tip height to a maximum 180m against the approved SWF Stage 1 development. The SWF development consent (dated 24th May 2009) permits the construction and operation of up to 282 wind turbines to a 155m tip height.

The Zone of Theoretical Visibility (ZTV) Diagram **Figures 4 and 5** illustrate that the area of land within which the Mod-3 wind turbines would be theoretically visible (as well as number of wind turbines being visible), would be very similar.

This VIA included an assessment of twelve residential dwellings within or proximate to 5 km of a SWF Mod-3 wind turbine. The overall assessment of visual effects associated with the SWF Mod-3 wind turbines is summarised as Low to Negligible. The SWF Mod-3 wind turbine is not considered to be of a magnitude that would significantly increase visual effects associated with the approved SWF development. Key differences in the approved SWF and proposed Mod-3 wind turbines are illustrated in **Figures 6, 7 and 8**.

This VIA incorporates a summary Shadow Flicker and Blade Glint Assessment. This VIA also determined that no non-associated residential dwellings surrounding the SWF wind turbines would experience shadow flicker. This assessment also determined that blade glint would not be an issue subject to the correct surface treatment of wind turbine structures.

Four photomontages have been prepared to illustrate the location and extent of wind turbines within the approved SWF and Mod-3 wind turbine layouts.

As proposed amendments to the approved SWF are considered to result in low level visual effects, and introduce elements which are neither prominent or out of character with the approved SWF, the potential for the proposed Mod-3 wind turbines to result in any additional significant cumulative visual effects is considered to be negligible.

## 1 Introduction

### 1.1 Introduction

The approved Silverton Wind Farm Project includes the construction and operation of 282 wind turbines, and associated infrastructure. Concept Plan Approval was also granted for the construction, operation and decommissioning of up to 598 wind turbines and associated infrastructure. Modifications are now proposed to the Approved Project, to take into account advancements in wind technology since the project was approved. This report assesses proposed modifications to the Approved Project. The key modifications are to decrease the number of turbines from 282 to 172, while increasing the dimensions and capacity of each turbine. The Concept Plan Approval infrastructure would no longer be developed.

The NSW Government Department of Planning and Environment (DoPE) have not issued supplementary requirements in response to the SWF proposed Mod-3 notification; however, DoPE provided comments with regard to the consideration of potential visual impacts for the SWF proposed Mod-3 development. These comments are as follows:

- *‘Undertake a comparative analysis of the visual impacts of the approved vs. modified project, considering also the impact of shadow flicker, blade glint and night lighting from the wind farm*
- *Identify any changes to the visibility of the roject (i.e. will any new areas/on associated residences have views of the project as a result of the proposed modification)*
- *Utilise recognised tools (such as photomontage and wireframes) at representative locations to adequately assess the visual impacts of the proposed modification, particularly for non associated residences within 2km of a proposed turbine*
- *Identify/review any proposed changes/additional mitigation if required.*

### 1.2 Report structure

This VIA report been structured into eleven parts as follows:

**Table 2 – Report structure**

Report section	Description
Section 1 Introduction and report structure	This section provides an introductory section that describes the intent and purpose of the VIA and description of the report structure
Section 2 Project information provided to GBD	Identifies the information provided to, or sourced by, GBD in order to undertake the VIA
Section 3 Methodology	This section sets out the methodology employed in the VIA preparation

**Table 2 – Report structure**

Report section	Description
Section 4 Approved SWF and Mod-3 amendments	This section describes the key differences in wind turbine layout and design criteria between the approved and proposed Mod-3 amendments
Section 5 Zone of Theoretical Visibility (ZTV) diagram	This section identifies the area of land surrounding the wind farm from which wind turbines, or portions of wind turbine structures, may be theoretically visible
Section 6 Ancillary structures	This section describes infrastructure associated with the wind farm other than the wind turbines.
Section 7 Assessment of visual effects	This section describes the assessment and determination of residual visual effects between the approved and proposed Mod-3 amendments
Section 8 Shadow flicker and blade glint	This section describes potential shadow flicker effects.
Section 9 Photomontages	This section describes and presents the photomontages prepared for the SWF Mod-3 VIA
Section 10 Review of Project Approval	This section describes any proposed changes or alternative mitigation measures in addition to those outlined in the Project Approval.
Section 11 Conclusions	Conclusions are drawn on the overall impact of the proposed SWF Mod-3 within the surrounding viewshed

## 2 Project information provided to GBD

GBD confirm the following information has been provided by the Proponent, or procured by GBD, for consideration and/or incorporation into this VIA:

- an amended wind turbine layout, including approved SWF Stage 1 wind turbines removed from the Mod-3 application
- location and description of proposed Mod-3 wind turbines
- ZTV diagram
- Aviation Assessment Report Final 9/7/16
- shadow flicker diagram and
- amended photomontages illustrating the SWF Mod-3 wind turbines.

### 3 Methodology

#### 3.1 Introduction

The SWF Mod-3 methodology included the following activities:

- desktop study reviewing the approved SWF original application, and the approved and proposed Mod-3 wind turbine layout
- preparation of a ZTV diagram
- assessment of significance of residual visual effects and
- preparation of photomontages and illustrative figures.

#### 3.2 Desktop study

A desktop study was carried out to review the approved SWF application and viewsheds. This was carried out by reference to topographic maps as well as aerial photographs of the surrounding landscape. Topographic maps and aerial photographs were also used to verify the locations and categories of potential view locations.

#### 3.3 ZTV diagram

A ZTV Diagram was prepared to illustrate the theoretical visibility of the original Stage 1 and Stage 2 SWF wind turbines (tip height at 155 metres) and the proposed Mod-3 wind turbines (tip height at 180 metres). The ZTV diagrams (north and south) are illustrated in **Figures 4 and 5**.

#### 3.5 Residual visual effects

The SWF Mod-3 residual visual effects on surrounding receiver locations would result from a combination of the Mod-3 wind turbine visibility and the characteristics of the landscape between, and surrounding, the receiver locations and the wind farm. The potential degree of visibility and resultant visual effect would be partly determined by a combination of factors such as:

- category and type of situation from which people could view the wind farm (examples of view location categories include residents or motorists)
- visual sensitivity of view locations surrounding the wind farm
- distance of visual effect (between view locations and the wind farm) and
- duration of time people could view the wind farm from any particular static or dynamic view location.

#### 3.6 Shadow flicker & blade glint

A shadow flicker diagram has been prepared for the SWF Mod-3 amended proposal and is included in this VIA. An overview of the shadow flicker and consideration of potential blade glint impacts are also included in this VIA. The shadow flicker diagram is illustrated in **Figure 9**.

#### 3.7 Photomontages

Four photomontages have been prepared from public road corridors. The photomontages illustrate and contrast the approved SWF and the proposed Mod-3 wind turbine layout. The photomontage locations are illustrated in **Figures 10 to 13**.

## 4 Approved SWF development and proposed Mod-3 amendment

### 4.1 Approved SWF development

Project Approval for the Silverton Wind Farm was granted to the Proponent on 24 May 2009, which included the construction and operation of 282 (Stage 1) wind turbines, and associated infrastructure including a 24km transmission line from the site to Broken Hill (NSW Government Department of Planning 2009). Approval was granted under Part 3A of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) and included Concept Approval for the construction, operation and decommissioning of up to 598 (Stage 2) wind turbines and associated infrastructure.

### 4.2 Proposed SWF Mod-3 design

The SWF Mod-3 design would include:

- up to 172 wind turbines (removing the balance of Stage 1 and all Stage 2 wind turbines)
- a hub height increase to 110 metres AHD
- an increase in blade length to a maximum 70 metres
- an increase in rotor diameter up to 140 metres and
- an increase of the blade tip height up to 180 metres.

The following table outlines the differences in the approved SWF and proposed Mod-3 wind turbine design criteria.

**Table 3: Approved SWF and proposed Mod-3 design criteria**

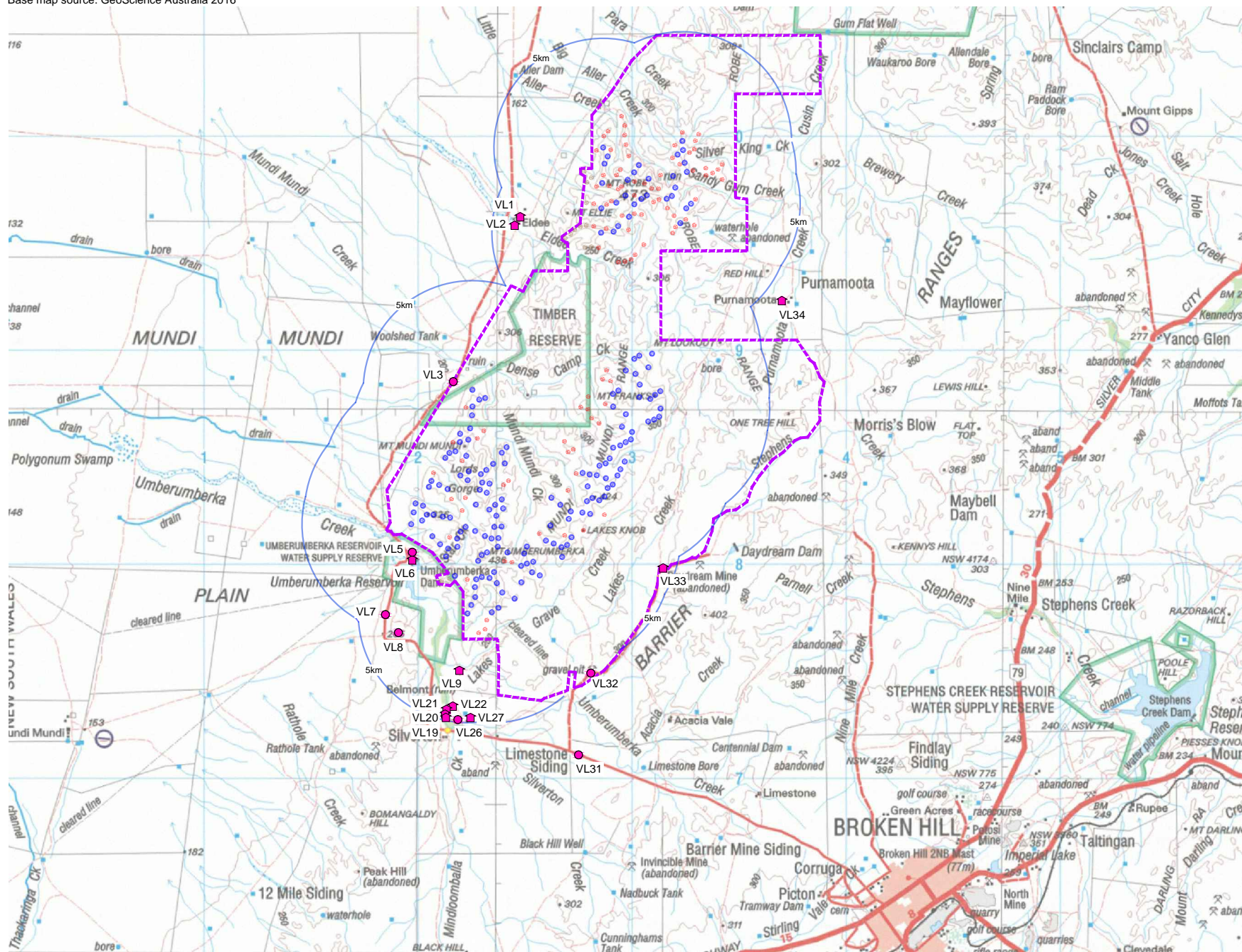
	Hub height	Rotor diameter	Tip height	Total number
Approved SWF wind turbine	100 m	110 m	155 m	282
SWF Mod-3 proposed wind turbine	110 m	140 m	180 m	172
Difference	+10 m	+30 m	+25 m	-110
Percentage difference	+10%	+27%	+16%	-39%

**Table 4: Approved SWF and proposed Mod-3 swept area**

	Rotor diameter	Swept area
Approved SWF wind turbine	110 m	9,498 m <sup>2</sup>
SWF Mod-3 proposed wind turbine	140 m	15,386 m <sup>2</sup>
Difference	+30 m	+6,032 m <sup>2</sup>
Percentage difference	+27%	+62%

The approved SWF and proposed Mod-3 amended wind turbine layouts, including location of wind turbines to be deleted are illustrated in **Figure 1** and detailed in **Figures 2** and **3**.





**Legend**

- Approved SWF wind turbine layout subject to Mod-3 (indicative location)
  - Approved SWF wind turbine not included in Mod-3 application (indicative location)
  - SWF wind farm project boundary
  - 5km distance from SWF wind turbine
  - Residential dwelling within 5km of approved SWF wind turbine
  - Non residential view location within 5km of approved SWF wind turbine
- Note: All house locations are indicative only

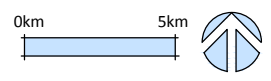
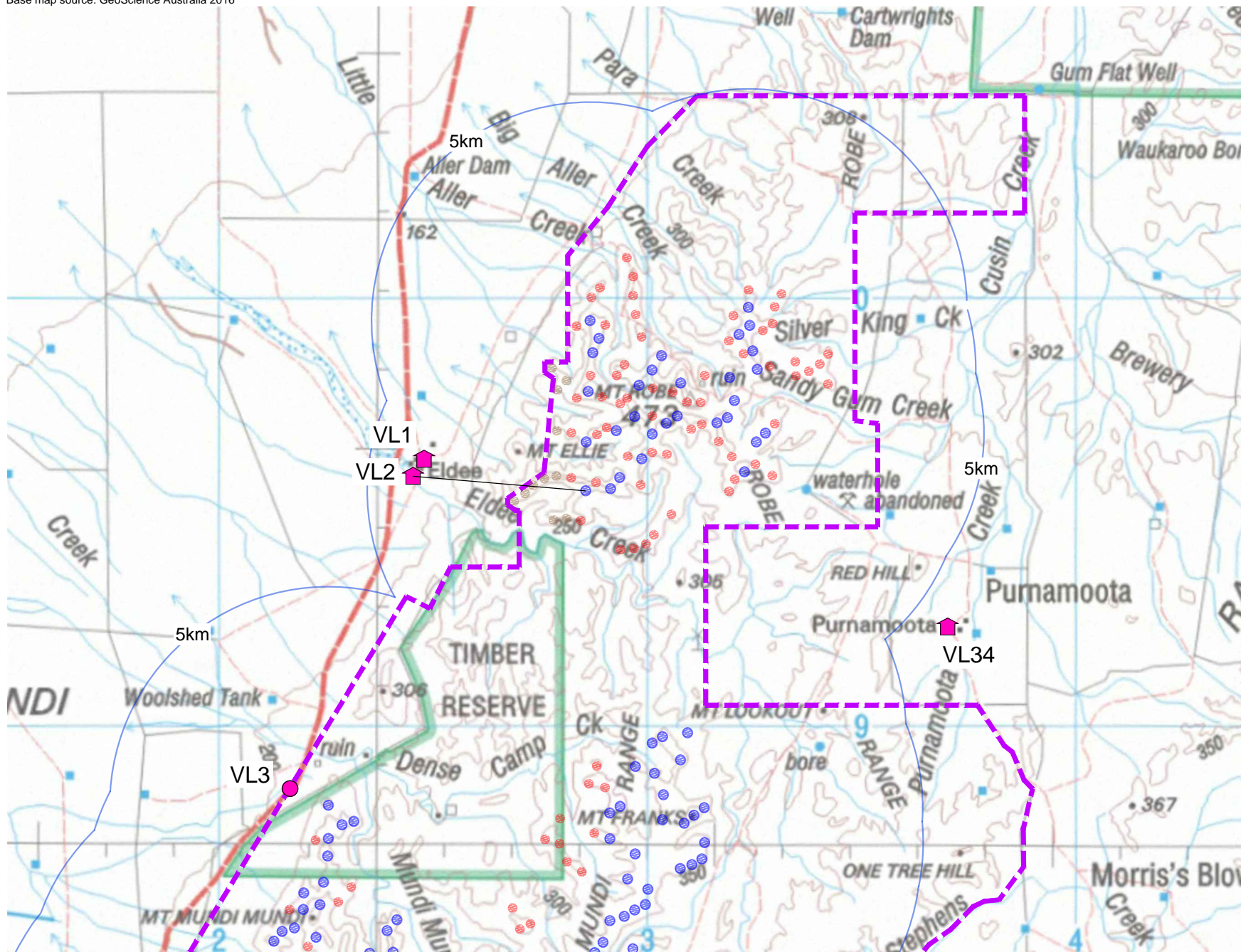


Figure 1 SWF Approved and proposed Mod-3 wind turbine layouts

# Silverton Wind Farm Mod-3 Visual Impact Assessment







Legend

- Approved SWF wind turbine layout subject to Mod-3 (indicative location)
  - Approved SWF wind turbine not included in Mod-3 application (indicative location)
  - SWF wind farm project boundary
  - 5km distance from SWF wind turbine
  - Residential dwelling within 5km of approved SWF wind turbine
  - Non residential view location within 5km of approved SWF wind turbine
- Note: All house locations are indicative only

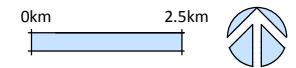
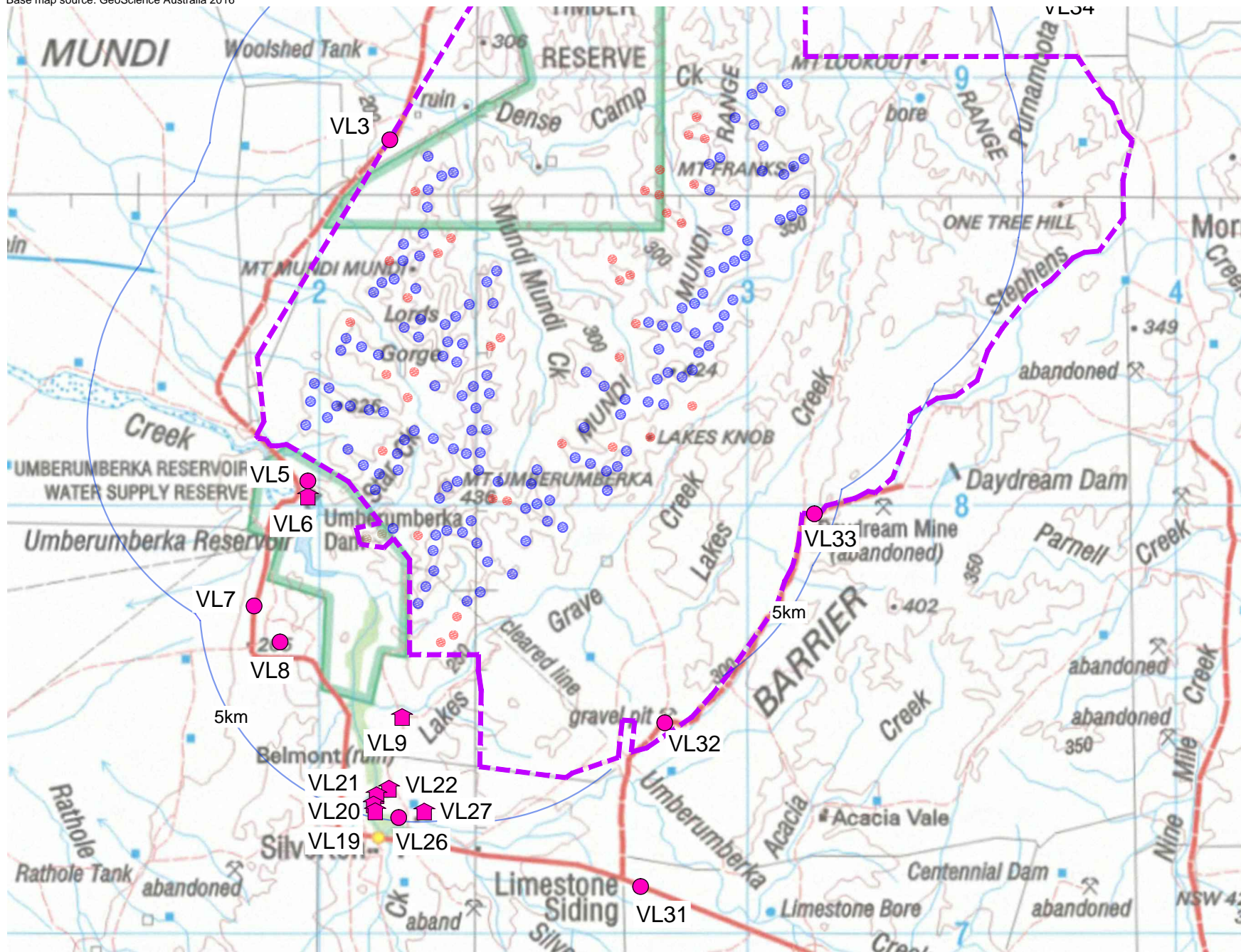


Figure 2 SWF Approved and Mod-3 wind turbine layout - detail north

# Silvertown Wind Farm Mod-3 Visual Impact Assessment







Legend

- Approved SWF wind turbine layout subject to Mod-3 (indicative location)
  - Approved SWF wind turbine not included in Mod-3 application (indicative location)
  - - - SWF wind farm project boundary
  - 5km distance from SWF wind turbine
  - 🏠 Residential dwelling within 5km of approved SWF wind turbine
  - Non residential view location within 5km of approved SWF wind turbine
- Note: All house locations are indicative only

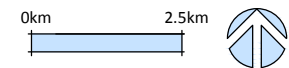


Figure 3 SWF Approved and Mod-3 wind turbine layout

# Silverton Wind Farm Mod-3 Visual Impact Assessment



## 5 Zone of Theoretical Visibility Diagram

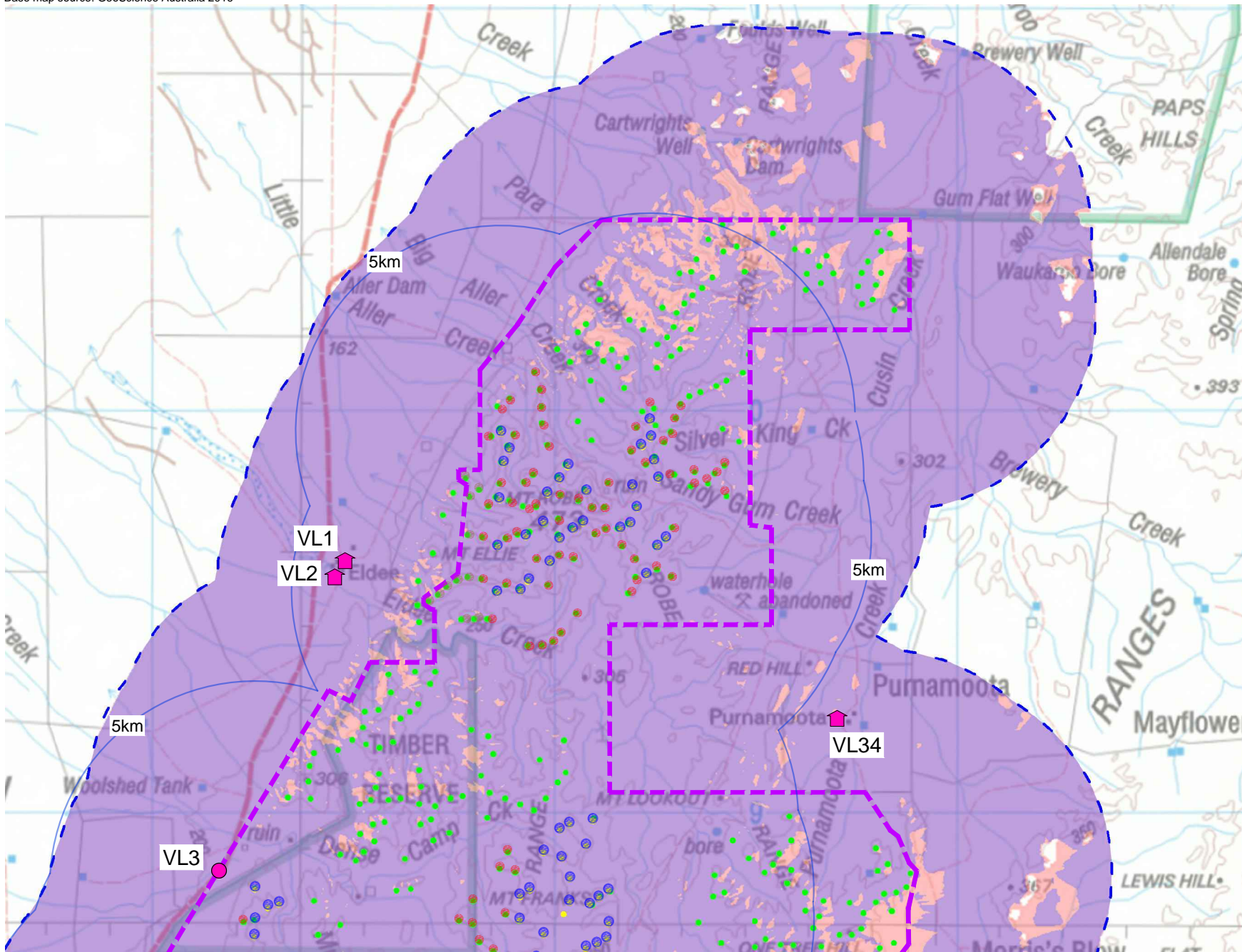
### 5.1 Introduction

Within the recognised limitations of Zone of Theoretical Visibility (ZTV) diagrams, the overall extent of approved SWF and proposed Mod-3 wind turbine visibility covers a similar extent within 5km of the landscape surrounding the approved SWF development. **Figures 4 and 5** illustrate the theoretical visibility of the approved SWF (at 155 m tip height) and proposed Mod-3 (at 180m tip height) wind turbines.

The similarity in theoretical wind turbine visibility demonstrates the influence of local topographical features on views toward the approved SWF and proposed Mod-3 wind turbines. The ZTV diagram also illustrates that the proposed Mod-3 wind turbines would have a very limited increase in visual effects across the approved SWF viewshed.

Whilst the overall extent of wind turbine visibility would be influenced by topography for both the approved SWF and the proposed Mod-3 wind turbines, the number of wind turbines visible from surrounding receiver locations within the wind farm viewshed is likely to decrease given the overall reduction in the number of wind turbines.





### Legend

- Area from which the original LVIA (Stage 1 and 2) wind turbines will be visible
  - Area from which the SWF Mod-3 wind turbines will not be visible
  - Approved SWF wind turbine layout subject to Mod-3 (indicative location)
  - Approved SWF wind turbine not included in Mod-3 application (indicative location)
  - SWF wind farm project boundary
  - SWF original LVIA (2008) Stage 1 wind turbine
  - SWF original LVIA (2008) Stage 2 wind turbine
  - 5km distance from SWF wind turbine
  - Residential dwelling within 5km of approved SWF wind turbine
  - Non residential view location within 5km of approved SWF wind turbine
- Note: All house locations are indicative only

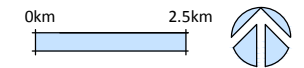
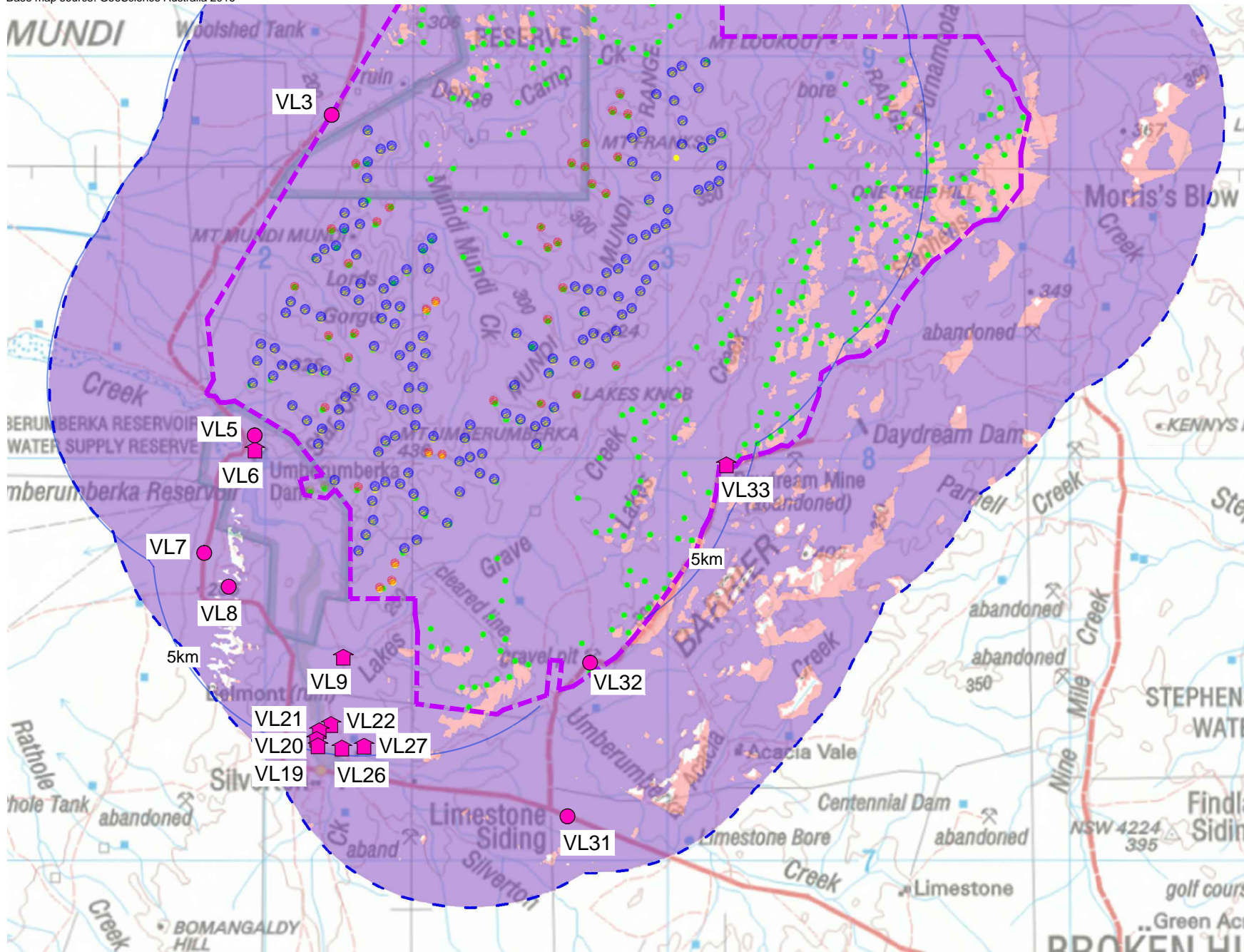


Figure 4 SWF Mod-3 ZTV Diagram north detail

# Silverton Wind Farm Mod-3 Visual Impact Assessment







Legend

- Area from which the original LVIA (Stage 1 and 2) wind turbines will be visible
  - Area from which the SWF Mod-3 wind turbines will not be visible
  - Approved SWF wind turbine layout subject to Mod-3 (indicative location)
  - Approved SWF wind turbine not included in Mod-3 application (indicative location)
  - SWF wind farm project boundary
  - SWF original LVIA (2008) Stage 1 wind turbine
  - SWF original LVIA (2008) Stage 2 wind turbine
  - 5km distance from SWF wind turbine
  - Residential dwelling within 5km of approved SWF wind turbine
  - Non residential view location within 5km of approved SWF wind turbine
- Note: All house locations are indicative only

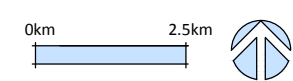


Figure 5 SWF Mod-3 ZTV Diagram south detail

# Silverton Wind Farm Mod-3 Visual Impact Assessment



## 6 Ancillary structures

### 6.1 Introduction

The approved SWF development incorporates a range of ancillary structures which include:

- wind monitoring masts
- on-site access tracks
- overhead powerline and
- control and operation facilities building.

The proposed SWF Mod-3 wind turbines would not result in any fundamental change to the approved SWF ancillary structures and would not result in any additional visual impacts to those outlined in previous landscape and visual impact assessments.

## 7 Visual effects

### 7.1 Introduction

Whilst the SWF Mod-3 wind turbines would extend above the approved SWF wind turbine height, this VIA has determined that the overall scale of the proposed Mod-3 wind turbines at a 5 kilometre (and over) view distance would not result in an order of visual magnitude that is significantly above the visual magnitude of the approved SWF wind turbines. A comparison of the approved SWF and proposed Mod-3 wind turbine is illustrated in **Figure 6**.

It is also noted that the proposed Mod-3 wind turbines would be consistent with the approved SWF wind turbines with regard to their visual form, design, pattern and colour. The extent of the magnitude of effect would also be reduced by the reduction of 110 SWF wind turbines from the project. The location of non-associated residential dwellings within 5 kilometres of the proposed Mod-3 wind turbine layout is illustrated in **Figure 1**.

The degree of magnitude effect is illustrated in **Figures 7** and **8**. **Figure 7** illustrates the elevated angle of view (toward tip height) for the approved SWF and proposed Mod-3 amended wind turbines from a view distance of 2 kilometres and 5 kilometres respectively.

**Figure 8** illustrates that the proposed SWF Mod-3 wind turbine would include an additional and approximate half degree view angle above the approved SWF with a 155 metre tip of blade wind turbine from a 2 kilometre view distance. The additional view angle from a view distance of 5 kilometres would be an additional and approximate one quarter of one degree (15 minutes) increase in view angle.

**Figure 8** illustrates the perceived and relative height difference between the approved SWF 155 metre tip height wind turbine and the proposed Mod-3 180 metre tip height wind turbine. The relatively small increase in view angle toward the proposed Mod-3 wind turbine tip height, at a view distance of 2 and 5 kilometres (and beyond) is considered unlikely to result in a level of visual magnitude greater than the approved SWF wind turbines.

Within the parameters of normal human vision, the proposed Mod-3 wind turbines are not considered to give rise to an increased level of visual magnitude over and above that determined for the approved SWF development.

### 7.2 Magnitude of visual effects

The determination of residual visual effects resulting from the SWF proposed Mod-3 wind turbines would result primarily from observable differences between the approved SWF and the proposed Mod-3 wind turbines. Observable differences may include:

- Views toward wind turbines where previously screened by landform or vegetation and
- Change in distance between a receiver location and wind turbine (note: a change in distance would only increase where wind turbines are removed, all other wind turbines remain in the approved SWF location).



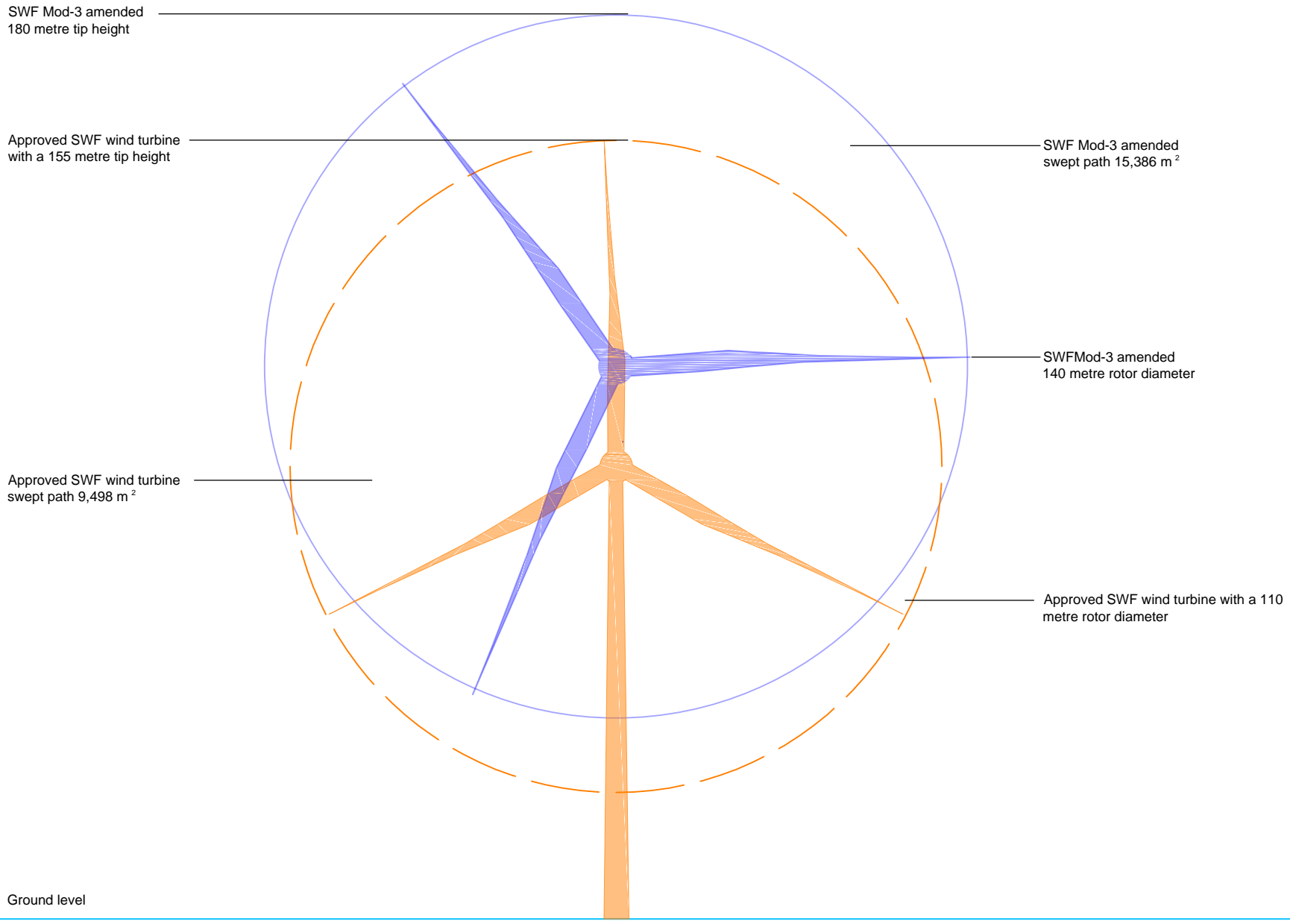
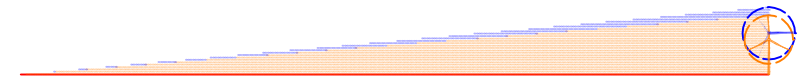
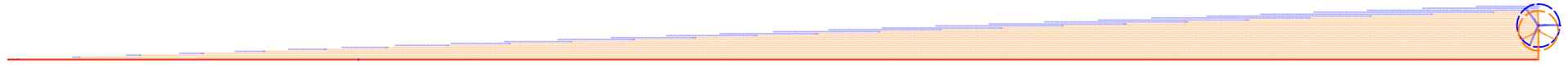


Figure 6 - Approved SWF and Mod-3 wind turbine comparison

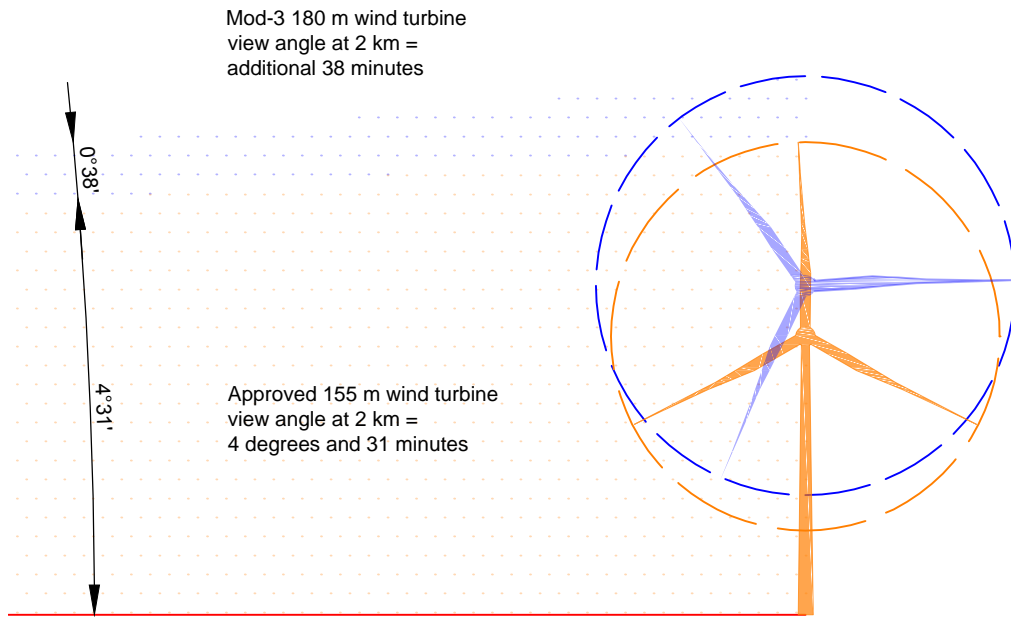
Orange line = view line toward tip height of approved SWF wind turbine (155 metres)  
 Blue line = view line toward tip height of SWF Mod-3 wind turbine (180 metres)



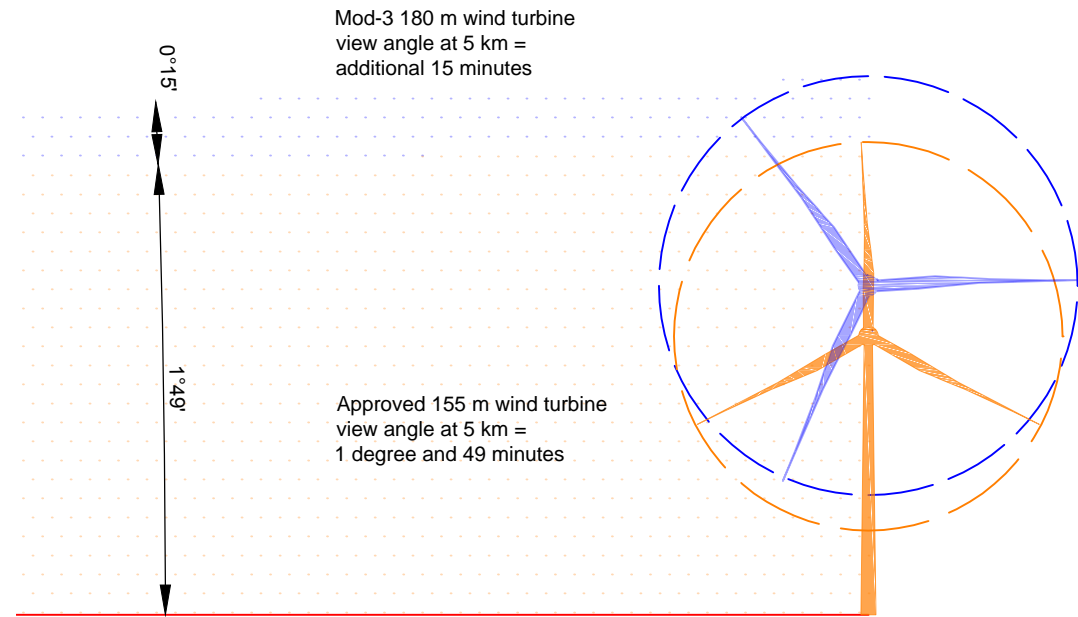
Comparative height of approved SWF and SWF Mod-3 wind turbine from a 2 km view distance



Comparative height of approved SWF and SWF Mod-3 wind turbine from a 5 km view distance



View angle toward approved SWF and SWF Mod-3 wind turbine tip of blade from a 2 km view distance



View angle toward approved SWF and SWF Mod-3 wind turbine tip of blade from a 5 km view distance

Figure 7 - Approved SWF and Mod-3 wind turbine view angle comparison

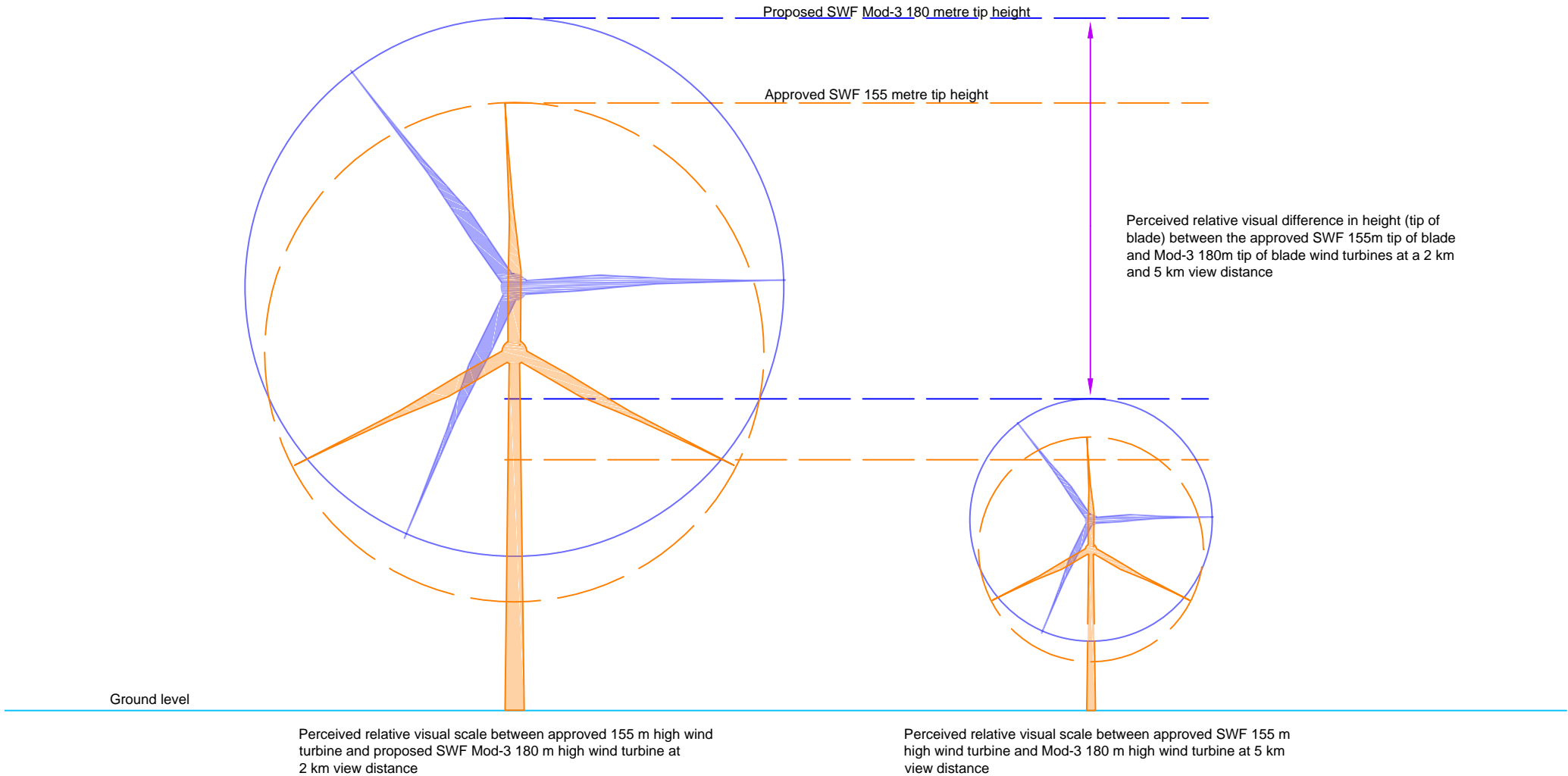


Figure 8 - Approved SWF and Mod-3 wind turbine comparison at 2 km and 5 km view distance

For the purpose of this VIA the magnitude of visual effect takes account of the scale of the change in the view with respect to the loss or addition of features in the view and changes in its composition or contrast with the landscape, including the proportion of the view occupied by the proposed Mod-3 wind turbine relative to the approved SWF wind turbine.

For the purpose of this VIA the following table sets out ratings and definitions associated with the magnitude of visual effects.

**Table 5 – Magnitude of visual effect**

Visual effect	Magnitude
Amendments to the approved SWF would result in a major and prominent visual effect and introduce elements that contrast, or are not in character with the approved SWF development.	High
Amendments to the approved SWF would result in a partial visual effect and introduce elements which may be prominent, but not completely out of character with the approved SWF development.	Medium
Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development.	Low
Amendments to the approved SWF would result in a very minor visual effect and introduce elements which are not prominent or uncharacteristic of the approved SWF development. There would likely be 'no change' to the approved SWF visual effect.	Negligible

### 7.3 Visual effect matrix

**Table 6** sets out the assessment of visual effects from view locations up to 5 km from the approved SWF development. The locations of residential dwellings included in this VIA are illustrated in **Figures 2 and 3**.

**Table 6** includes the original LVIA (2008) assessment and GBD determination of visual impact for the Stage 1 and Stage 2 wind farm development. As GBD did not prepare or undertake any additional assessment with regard to the revised Stage 1 Preferred Project Report, our assessment for proposed SWF Mod-3 has been limited to the original Stage 1 and Stage 2 wind turbine layouts. The original LVIA (2008) included a 'worse case' scenario for the assessment of up to 600 wind turbines.

It is important to note that **Table 6** does not present a re-assessment of potential visual impact for view locations within 5 km of a SWF Mod-3 wind turbine. **Table 6** considers the potential for the SWF Mod-3 development to change the magnitude of visual effect associated with the original LVIA assessment.

Whilst the assessment includes a determination of visual effects from dwellings, it also takes into account any curtilage surrounding each dwelling which may be considered an extension to the dwelling for domestic or social activities. The criteria set out in **Table 5** are noted against each dwelling, with a visual effect rating determined against the matrix in **Table 6**.

The professional judgement and determination of visual effects are also informed by previous site inspection works, photographic records and figures prepared for this VIA. **Table 6** identifies individual residential dwellings, as well as groups of dwellings, where the determination of visual effect is expected to be the same.

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
<b>Receiver location within 5 km of Silverton Wind Farm Mod-3 turbine</b>				
VL2a	Non residential location	3.8 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>Open and extensive views from exterior areas surrounding Eldee woolshed toward series of hills along western edge of Barrier Range. Views take in Eldee Station buildings and tree lines along Eldee Creek.</p> <p>Stage 1 Visual Impact: Nil</p> <p>Stage 2 Visual Impact: Medium</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. Views toward the approved SWF Mod-3 would be altered by the removal wind turbines within the cluster closest to the view location. There would be limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
VL2	Non associated residential dwelling	4.0 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>View east from homestead and guest accommodation toward series of hills along the west edge of the Barrier Range.</p> <p>Stage 1 Visual Impact: Nil</p> <p>Stage 2 Visual Impact: High</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. Views toward the approved SWF Mod-3 would be altered by the removal wind turbines within the cluster closest to the dwelling. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).</p>
VL3	Motorist	900 m	<p><b>Original LVIA (2008) assessment:</b></p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			<p>View north east or south west from vehicles travelling to, or beyond, Eldee Station on section of unsealed road for approximately 10km north of the Umberumberka Reservoir.</p> <p>Road corridor takes in views along the west edge of the Barrier Range and across the Mundi Mundi Plain.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Low</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	which are not prominent or out of character with the approved SWF development).
VL5	Visitors at Umberumberka reservoir car park and	1.3 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>View north and east from lower car park and amenities building across portions of reservoir and dam. Views generally contained by landform</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements</p>



**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
	amenities building.		<p>rising to the east of the reservoir and by tree planting around the car park area.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Low</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	which are not prominent or out of character with the approved SWF development).
VL6	Non associated residential dwelling	1.5 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>View south and east from residence across water body to hills fringing reservoir.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Low</p> <p><b>Amended Mod-3 assessment:</b></p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.	
VL7	Motorist	2.7 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>View east to north east from road corridor toward hills south of reservoir, as well as views west to north west across the Mundi Mundi Plain.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Low</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
VL8	Lookout - visitor	3.2 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>Extensive and open views from the Mundi Mundi lookout west across the Mundi Mundi Plain.</p> <p>Views to the north, north east and south of the lookout are generally contained by undulating hills in the south portion of the Mundi Mundi Range and low hills to the west and south of Silverton.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Medium</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).</p>
VL9	Non associated residential dwelling	2.7 km	<p><b>Original LVIA (2008) assessment:</b></p>	<p>Low</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			<p>View north to north east from homestead generally contained within vicinity of homestead by undulating landform and vegetation.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Low</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. Views toward the approved SWF Mod-3 would be altered by the removal wind turbines within the cluster closest to the dwelling. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).
VL19 – VL22	Non associated residential dwellings	4.4 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>View north to north east from residence toward Silverton Wind Farm generally blocked by a combination of vegetation and surrounding structures. Potential view north to north east toward Silverton Wind</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			<p>Farm from exterior residential areas including access track to residences.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Medium</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. Views toward the approved SWF Mod-3 would be altered by the removal wind turbines within the cluster closest to the dwelling. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	which are not prominent or out of character with the approved SWF development).
VL26	Non residential location , cemetery	2.9 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>View north and north east from cemetery toward Stage 1 and Stage 2 turbine locations.</p> <p>Stage 1 Visual Impact: Low</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			<p>Stage 2 Visual Impact: Low</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	of character with the approved SWF development).
VL27	Non associated residential location	5.0 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>Generally extensive and open view north and north east from adjoining residences.</p> <p>Medium distance views extent to Stage 1 and Stage 2 wind turbine locations, with potential for views from residence.</p> <p>Residence to north offers some screening of views for residence to the south.</p> <p>Stage 1 Visual Impact: Medium</p> <p>Stage 2 Visual Impact: High</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			<p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. Views toward the approved SWF Mod-3 would be altered by the removal wind turbines within the cluster closest to the dwelling. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p> <p>The removal of Stage 2 wind turbines would reduce the level of visual impact from High to a Medium.</p>	
VL31	Motorist	7.9 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>View north west from Silverton Road corridor for around a 10km section of road.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Low</p> <p><b>Amended Mod-3 assessment:</b></p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.	
VL32	Motorist location	5.0 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>Indirect view toward Stage 1 wind turbines from access track running north east toward Day Dream Mine.</p> <p>Very short distance view toward a small number of Stage 2 wind turbines located adjacent to the track to the Day Dream Mine.</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	Low
VL33	Visitors	4.5 km	<p><b>Original LVIA (2008) assessment:</b></p>	Low



**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			<p>Views west to north west toward Stage 1 wind turbines from car park and mine surface areas are partially blocked by undulating landform.</p> <p>Generally direct and very short distance views to a small number of Stage 2 wind turbines located to the east of the Mundi Mundi Range.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Medium</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p>	(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out of character with the approved SWF development).
VL34	Non associated residential dwelling	6.0 km	<p><b>Original LVIA (2008) assessment:</b></p> <p>Views toward Stage 1 wind turbines from residence are generally screened by landform rising to the west of the residence.</p>	<p>Low</p> <p>(Amendments to the approved SWF would result in minor visual effects and introduce elements which are not prominent or out</p>

**Table 6 – Visual Effects Matrix (Refer Figures 2 and 3 for receiver locations)**

Receiver location/s	Category of receiver location	Approximate distance to amended Mod-3 wind turbine	Original Stage 1 LVIA (2008) Description/visual impact and amended Mod-3 assessment	Magnitude of SWF Mod-3 amended visual effect
			<p>Indirect and medium distance views toward Stage 2 wind turbines to the south from exterior areas around the residence, as well as very short distance views from sections of the Purnamoota access track.</p> <p>Stage 1 Visual Impact: Low</p> <p>Stage 2 Visual Impact: Medium</p> <p><b>Amended Mod-3 assessment:</b></p> <p>The observable scale of change would be limited by distance between the location and closest approved SWF Mod-3 wind turbine. Views toward the approved SWF Mod-3 would be altered by the removal wind turbines within the cluster closest to the dwelling. There would be very limited change in the composition or contrast between the approved SWF and proposed Mod-3 development and the surrounding landscape.</p> <p>The removal of Stage 2 wind turbines would reduce the level of visual impact from Medium to Low.</p>	of character with the approved SWF development).

#### 7.4 Summary of visual effects

The Visual Effects Matrix includes ten residential dwellings within 5 km of a SWF proposed Mod-3 wind turbine. The overall assessment of visual effects associated with the SWF proposed Mod-3 wind turbines is summarised as Low to Negligible. The scale of change in the wind turbine structures, whilst noticeable from proximate residential view locations would not result in a degree of change significantly above the visibility of the approved SWF wind turbines.

#### 7.5 Cumulative visual effects

As proposed amendments to the approved SWF development are considered to result in a very low level visual effects, and introduce elements which are not prominent or out of character with the approved SWF development, the potential for the proposed Mod-3 wind turbines to result in any additional significant cumulative visual effects is considered to be negligible.

#### 7.6 Night time obstacle lighting

The Proponent commissioned an aviation assessment for the SWF Mod-3 amendment. The aviation assessment has determined that the risk to civil aviation operation in the vicinity of the wind farm is very low. The aviation assessment considers that the installation of obstacles lights is not required in accordance with CASA MOS 139.

## 8 Shadow flicker and blade glint

### 8.1 Shadow flicker

Due to their height, wind turbines can cast shadows on surrounding areas at a significant distance from the base of the wind turbine tower. Coupled with this, the moving blades create moving shadows. When viewed from a stationary position, the moving shadows appear as a flicker giving rise to the phenomenon of 'shadow flicker'. When the sun is low in the sky the length of the shadows increases, increasing the shadow flicker affected area around the wind turbine. A shadow flicker assessment may over estimate the actual number of annual hours of shadow flicker at a particular location due to a number of reasons including:

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

The SWF proposed Mod-3 shadow flicker diagram illustrates that none of the non-associated residential dwellings surrounding the proposed Mod-3 wind turbines would experience shadow flicker in excess of 30 hours per year.

### 8.2 Blade glint

Blade glint is not generally a problem for modern wind turbines, provided the blades are coated with a non-reflective paint.

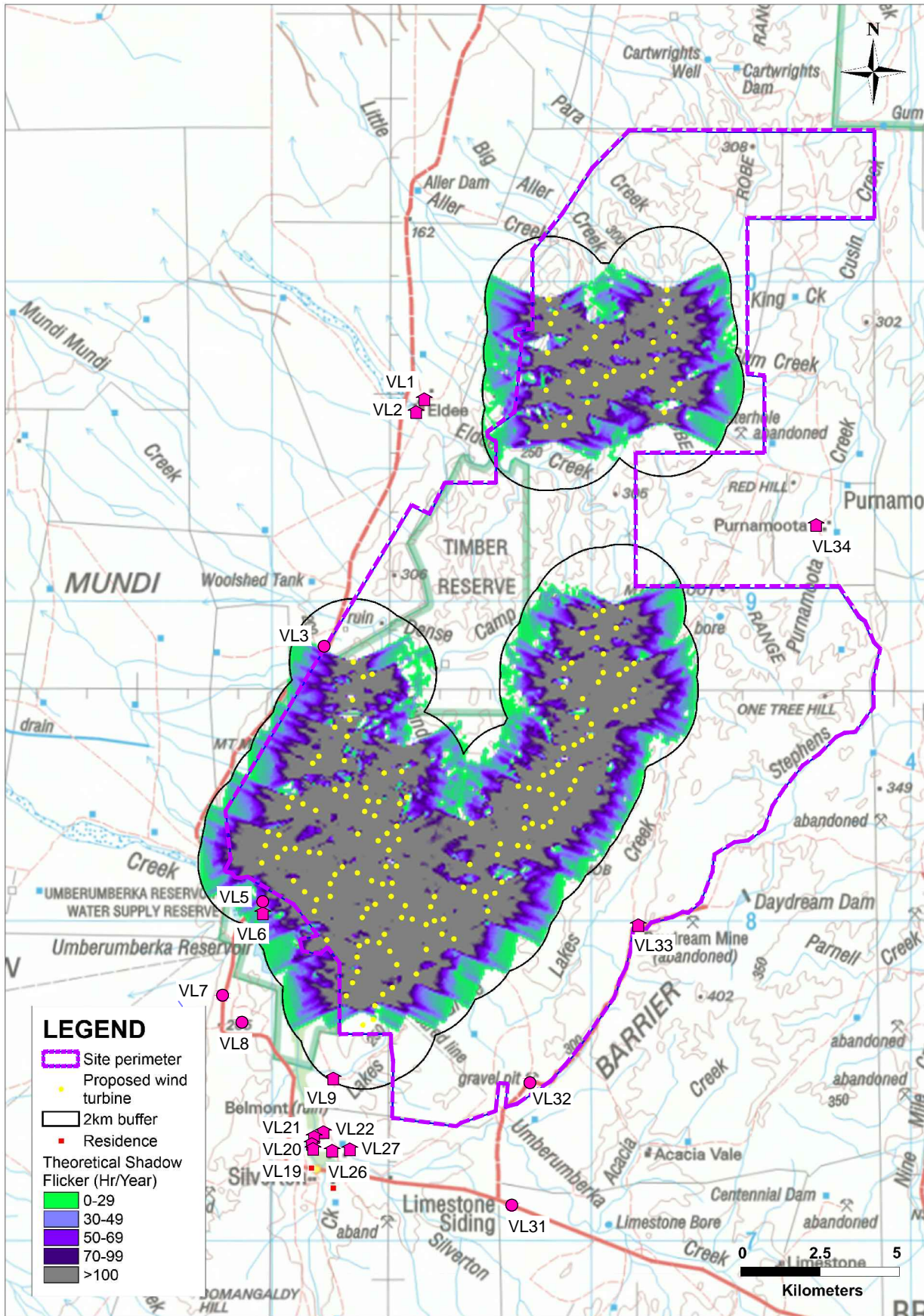


Figure 9 SWF Mod-3 Shadow Flicker Diagram

## 9 Photomontages

### 9.1 Introduction

The photomontage locations have been selected to illustrate a range of key viewpoints from public roads with views toward the approved SWF. Whilst there are no non associated residential dwellings located within 2 km of an approved SWF wind turbine, a photomontage has been prepared from the Eldee Station residential dwelling curtilage to illustrate views toward wind turbines along the western edge of the Barrier Range.

The four photomontages are presented in **Figures 10 to 13**.

The photomontage locations include:

- Photomontage 1 (Figure 10) from Eldee Station
- Photomontage 2 (Figure 11) from the Mundi Mundi Lookout
- Photomontage 3 (Figure 12) from Layard Street, Silverton
- Photomontage 4 (Figure 13) from north Silverton.

### 9.2 Photomontage preparation

The photomontages have been prepared with regard to the general guidelines set out in the Scottish Natural Heritage (2006) Visual representation of windfarms: good practice guidance and British Landscape Institute Advice Note 01/11 (March 2011). Following site photography the photomontages were generated through the following steps:

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





Photomontage 1 - Eldee Station Homestead. View toward the original LVIA (2008) Stage 2 Silverton Wind Farm layout



Photomontage 1 - Eldee Station Homestead. View toward the Mod-3 wind turbine layout.

Figure 10 - Photomontage 1 from view location VL1





Photomontage 2 - Mundi Mundi Lookout. View toward the LVIA (2008) Stage 1 Silverton Wind Farm layout



Photomontage 2 - Mundi Mundi Lookout. View toward the Mod-3 wind turbine layout.

Figure 11 - Photomontage 2 from view location VL8





Photomontage 3 - Layard Street, Silverton. View toward the LVIA Stage 1 Silverton Wind Farm layout



Photomontage 3 - Layard Street, Silverton. View toward the Mod-3 wind turbine layout.

Figure 12 - Photomontage 3 from view location VL15





Photomontage 4 - North Silverton. View toward the LVIA Stage 1 Silverton Wind Farm layout



Photomontage 4 - North Silverton. View toward the Mod-3 wind turbine layout.

Figure 13 - Photomontage 4 from view location VL19

## 10 Administrative Conditions

### 10.1 Introduction

The SWF original application and Administrative Conditions have been reviewed as part of this VIA to determine the type and extent of additional mitigation measures that would be required, or should be modified as a result of the proposed Mod-3 amendments.

### 10.2 Review of Administrative Conditions

The following Table outlines the existing Administrative Conditions relevant to mitigate the potential visual effects of the SWF proposed Mod-3. The conditions are sourced from the NSW Department of Planning Project Approval and Concept Approval for Stage 1 (both dated 24 May 2009), and the NSW Department of Planning Modification 1 Project and Concept Approvals (both dated 11 April 2014).

**Table 7** Administrative Conditions

Condition	Description	Comment
Condition 2, Specific Environmental Conditions - Visual Amenity Impacts		
2.1	The Proponent shall, at the request of any owners of residential dwellings or businesses with views of a turbine(s) located within 6 kilometres of their dwellings, provide and bear the full cost of reasonable landscaping treatments to visually screen these dwellings. Such a request may be made in writing by the owner of the dwelling or business within 6 months from the commencement of operation of the project, and landscaping treatments agreed between the parties must be implemented and completed within 2 months of such an agreement. Should the parties not be able to reach agreement on the scope of landscaping treatments, then either party may refer the matter to the Director-General for resolution. The Director-General's decision on such a referral shall be final and binding on the parties.	These conditions remain valid.
2.2	The Proponent must ensure that all residents, business owners or public authority, whose dwelling, business or public area respectively, may be subject to moderate or high visual impact, is consulted regarding impact minimisation measures and the outcomes of this consultation process are	These conditions remain valid.

**Table 7** Administrative Conditions

Condition	Description	Comment
	used to inform the Design and Landscaping Plan required under condition 5.3 c) of this approval.	
2.2A	Prior to the construction of turbines, the Proponent shall submit a plan of the final turbine number and layout for the approval of the Director-General. The plan must be developed in consultation with Trade & Investment – Crown lands, leaseholders and the CCC. The plan must include photomontages and demonstrate the satisfaction of the Director-General how the visual impacts have been reduced, including by maximising the distance from dwellings, tourist development and other sensitive receivers.	This condition remains valid.
2.3	The WTGs shall be painted matt off-white/grey. The blades shall be finished with a surface treatment than minimises any potential for glare or reflection.	This condition remains valid.
2.4	No advertising, signs or logos shall be mounted on the turbines, except where required for safety purposes.	This condition remains valid.
2.5	The Proponent shall maximise the use of building materials and treatments for associated infrastructure which visually complement the surrounding environment.	This condition remains valid.
2.6 Lighting	No external lighting other than low intensity security night lighting of infrastructure associated with the project, including wind turbine generators is permitted; unless otherwise agreed or directed by the Director-General and/or safety requirements.	This condition remains valid. Note: The aviation assessment states that the installation of obstacle lights is not required in accordance with CASA MOS 139.
Condition 5, Environmental Management		
5.3 c)	A Design and Landscaping Plan to detail the landscape screening measures at the residences situated in close proximity to the project site and alongside roadsides to screen potential moderate	This condition remains valid.

**Table 7** Administrative Conditions

Condition	Description	Comment
	<p>to significant views of the project. The Plan must be prepared by a qualified landscape architect and where relevant meet the requirements of Council and the RTA. The Plan must include design treatments for the WTGs, substations and ancillary infrastructure, detailing:</p> <ul style="list-style-type: none"> <li>(i) landscape elements and built elements, including proposed treatments, finishes and materials of exposed surfaces (including colour specifications)</li> <li>(ii) lighting</li> <li>(iii) a schedule of species to be used in landscaping</li> <li>(iv) details of the timing and progressive implementation of landscape works and</li> <li>(v) procedures and methods to monitor and maintain landscape areas.</li> </ul>	

This VIA has not identified any additional mitigation measures, or mitigation measures to be modified, in addition to the Administrative Conditions set out in the Project Approval.

## 11 Conclusion

The determination for a potential increase to visual effects associated with the approved SWF has been based upon a professional judgement in consideration of:

- the proposed amendments to the SWF wind turbine layout
- the removal of up to 110 approved SWF Stage 1 wind turbines
- the removal of the proposed SWF Stage 2 wind turbines
- the blade length (and tip height difference) between approved SWF and proposed Mod-3 wind turbines
- the overall visibility and visual scale of the SWF Mod-3 wind turbines and
- the SWF Mod-3 magnitude of visual effect compared to the approved SWF wind turbines.

This VIA has illustrated the approved SWF development against the proposed SWF Mod-3 wind turbine layout and concludes that the removal of up to 110 approved SWF Stage 1 wind turbines, including wind turbines within proximity to the Silverton township, would result in an overall reduction in wind turbine visibility for key non associated residential dwellings surrounding the SWF development and for motorists travelling along local roads.

The removal of up to 110 approved SWF Stage 1 and proposed Stage 2 wind turbines would also reduce the visual density of wind turbines, as well as levels of visual complexity created by multiple overlapping rotor blades when viewed from key surrounding view locations.

The proposed increase in wind turbine tip height would be partially discernible from some surrounding and proximate view locations where views toward the approved SWF wind turbines exist. The SWF Mod-3 wind turbine is not considered to be of a magnitude that would significantly increase visual effects associated with the approved SWF development.