Visual Impact Assessment

Wallamore Micro Solar Farm

Prepared for Green Gold Energy Pty Ltd

August 2024

Visual Impact Assessment

Wallamore Micro Solar Farm

Green Gold Energy Pty Ltd

E221117 VIA

August 2024

Version	Date	Prepared by	Reviewed by	Comments
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1 Introduction

1.1 Background

The developer, Green Gold Energy Pty Ltd, proposes to develop the ‘Wallamore Micro Solar Farm’ (the project). The project is situated at Wallamore, near Tamworth, in the Tamworth Regional Council Local Government Area in northern New South Wales (NSW).

A map of the project location and regional context is shown in Figure 1.1.

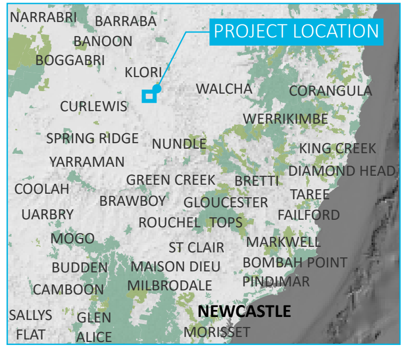
This Visual Impact Assessment (VIA) describes the existing landscape and visual character of the site. It then applies a method to assess the visual sensitivity of the site and to assess the visual impact of the changes resulting from the planned development.

1.2 Project description

The project is located approximately 10 kilometres (km) north-west of the Tamworth Central Business District, and approximately 3.2 km north of Tamworth Airport, at an elevation of approximately 374 metres Australian Height Datum. The project address is Lot 1 / DP 552296 at 821 Wallamore Road, Wallamore, NSW 2340.

The project is a micro-solar farm with a 6.44 megawatts capacity and covers an area of approximately 15 hectares. The facility will include an array of photovoltaic solar panels, battery storage units and will have an overhead connection to the existing Essential Energy network.

The site has historically been cleared of almost all woody vegetation and has been used for grazing and cropping for a number of years. No environmentally or culturally significant vegetation will be impacted by the project.



KEY

Project boundary

Existing environment

Major road

Minor road

Vehicular track

Named watercourse

Named waterbody

INSET KEY

NPWS reserve

State forest

Source: EMM (2024); GGE (2023); ABS (2021); DCSSS (2023); ESRI (2024)

0 1 2 km

GDA2020 MGA Zone 56

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Project location

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Visual Impact Assessment
Figure 1.1

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1.2.1 Project layout

The project consists of approximately 400 rows of photovoltaic panels arranged with a north-south orientation along the northern boundary of the site. The proposed solar arrays are composed of photovoltaic panels approximately 2.4 metres (m) wide and with a maximum height of approximately 2.6 m. The panels will be installed on a tracking system with a north–south axis that aligns the panels with the moving sun for maximum efficiency. The maximum height of the solar panels during operation is 2.7 m high. They will maintain a clearance of 0.5 m off the ground (refer to Figure 1.2). An indicative plan of the site layout is shown in Figure 1.3.

Permanent facilities to be installed at the site include:

- solar array covering most of the 15-hectare site
- one inverter station
- two battery units
- high voltage switchboard
- poles for overhead connection to Essential Energy network
- boundary fence – 1,800-millimetre (mm) high chain mesh with three strands of barbed wire to a total height of 2,250 mm
- perimeter screen planting.

Layout of the above elements avoids the flood zone of Tangaratta Creek, which flows south of the project in a south-west to north-east direction.

1.2.2 Site access

Access to the site will be either from Oxley Highway via existing driveways/private roads on adjoining property south-west of the project site, or via the existing driveway from Wallamore Road. Both access routes are acceptable for the purposes of this VIA and will have no bearing on visual impact findings or recommendations.

1.2.3 Construction

The construction of the project is expected to take approximately 9 months. During this period, there may be noticeable activity within the project site as solar infrastructure components are transported into the site and installed.

During construction, a storage building and an amenities block for the construction workers will be located on the site. These will be removed when construction is complete. No permanent buildings will be located on the site after the construction stage.

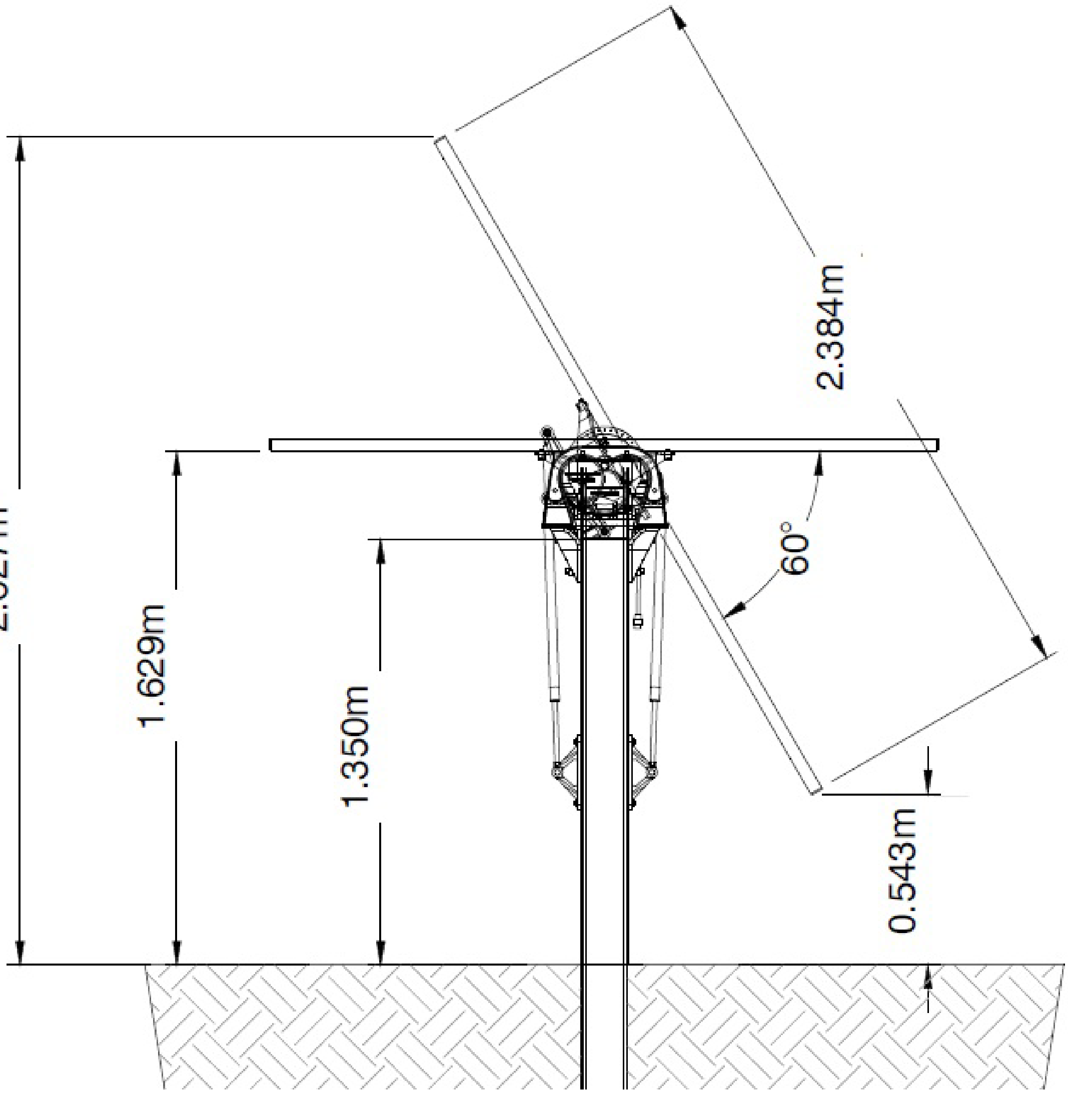
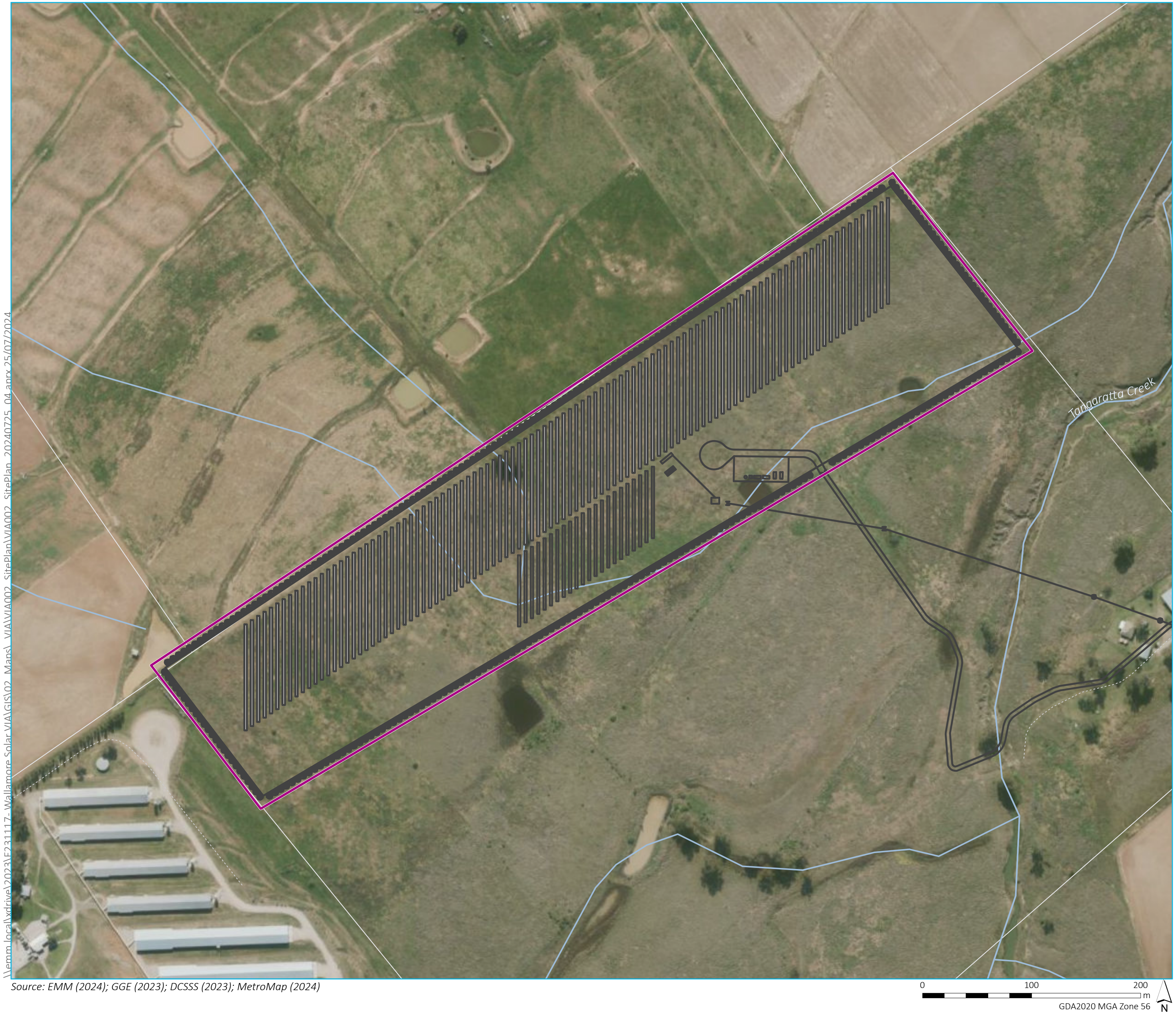


Figure 1.2 Typical solar panel on tracking system



Source: EMM (2024); GGE (2023); DCSSS (2023); MetroMap (2024)

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KEY

Project boundary

Site plan

Existing environment

Vehicular track

Watercourse/drainage line

Cadastral boundary

Site plan

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Figure 1.3

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2 Assessment methodology

The method used in this visual impact assessment is based on established practices and policies. Documents used for broad guidance include:

- *Guideline for Landscape Character and Visual Impact Assessment*, EIA-N04, Version 2.2 (2020), Transport for NSW Centre for Urban Design
- *Guidelines for Landscape and Visual Impact Assessment* Third Edition (2013) (the GLVIA), prepared by the Landscape Institute and Institute of Environmental Management and Assessment.

EMM employs a system that enables the evaluation of the visual impact in rural and urban environments. The study method for the VIA follows four key steps outlined below:

- Existing visual environment:
  - review proposal and extents of the development
  - landscape character description
  - visual catchment area defined through reviewing maps and satellite imagery to identify where the site is visible from
  - site visit – undertake inspections from viewpoints, including photographs of the site from each location and verifying the visual catchment.
- Assessment of the visual impact by applying the visual sensitivity and visual effect criteria:
  - superimpose the visual model into the viewpoints (photo-montages)
  - review against baseline information (impact of change from proposal).
- Acceptability of the visual impact against relevant considerations:
  - drawing conclusion and recommendations.
- Glint and glare analysis
  - specialised software is used to analyse potential glint and glare impacts from light reflecting off the proposed solar array.

2.1 Assessment criteria

The potential visual impact of the planned development is measured through the combination of two factors:

- visual sensitivity of the development to the viewer
- visual effect of the development on the landscape.

To measure the visual sensitivity and the visual effect of the site, specific locations known as ‘viewpoints’ are chosen as representative views (refer to Section 5.2). These are then assessed to determine the overall visual impact. Visual sensitivity and visual effect are defined below.

2.1.1 Visual sensitivity

Visual sensitivity is a measure of the extent to which activities or components of a proposal may change the landscape and be visible from surrounding areas. This takes into account the relative number of viewers, the period of view, viewing distance and context of view.

The rationale for the assessment is that if a proposal is not visible the impact is nil and if the number of people who would potentially see the proposal is low, then the visual impact would be lower than if a potentially large number of people had the same view.

For the purpose of this study, the general category of visual sensitivity has been divided into two elements. The first, viewing location, is a rating based on distance from the site and the landscape type as shown in Table 2.1. The second, viewer experience, is based on the number of people affected and the duration of the impact as indicated in Table 2.2.

Table 2.1 Visual sensitivity rating – location

Viewing location	Distance from site (km)				
Landscape type	**0–0.5**	**0.5–1.0**	**1.0–2.5**	**2.5–4.0**	**>4.0**
Townships	High	Moderate	Moderate	Moderate	Low
Recreation reserve	High	Moderate	Moderate	Moderate	Low
Residence	High	Moderate	Moderate	Low	Low
Rural township	High	Moderate	Low	Low	Nil
Main highway	Moderate	Low	Low	Low	Nil
Local roads	Moderate	Low	Low	Low	Nil
Farm roads	Low	Low	Low	Nil	Nil
Agricultural land	Low	Low	Low	Nil	Nil

Table 2.2 Visual sensitivity rating – experience

Viewer experience	Number of viewers		
Duration of view	**Large**	**Moderate**	**Small**
Long (>10 minutes)	High	High	Moderate
Moderate (1–10 minutes)	High	Moderate	Low
Short (<1 minute)	Moderate	Low	Low

The two sensitivity ratings above are combined to form the visual sensitivity rating as indicated in Table 2.3. The resulting combined rating is applied to the visual impact rating shown in Table 2.4.

Table 2.3 Visual sensitivity rating

Visual sensitivity rating		Viewing location		
Viewer experience		High	Moderate	Low
	High	High	High	Moderate
	Moderate	High	Moderate	Low
	Low	Moderate	Low	Low

2.1.2 Visual effect

Visual effect is an estimation of the capacity of the landscape to absorb development without creating significant visual change. The capacity to absorb development is primarily dependent on landform, vegetation cover and the presence of other development.

The extent to which portions of the site can potentially absorb development without reducing the scenic quality of the area is assessed under these criteria (Table 2.4). Generally, an urban context is able to absorb buildings and structures with low impact to the scenic value, while erecting structures in a natural or agricultural setting may impact the scenic quality significantly.

The level of contrast is also strongly influenced by the nature of the backdrop against which development is viewed. In particular, structures that are viewed above the skyline will potentially create a higher degree of contrast than the same elements viewed against a backdrop of similar structures or a landscape of similar colour/textures as the building or structure.

The degree of contrast between proposed development and the existing landscape (buildings and vegetation) can be reduced by careful attention to the colour, scale, texture, and reflectivity of building materials and by avoiding development that breaks the height of the existing tree canopy. Where possible, these considerations are to be incorporated into the design and locations of buildings, roads and other structures.

Table 2.4 Visual effect criteria

Criteria	Definition
High	A substantial or obvious change to the landscape due to a total loss or change to characteristic elements or features of the landscape. Existing landscape is unable to absorb the change/development and a high degree of visual contrast is apparent. There is little, or no screening or integration with the vegetation, topography or existing urban context.
Moderate	Discernible changes to the landscape due to partial loss or change to elements or features that are characteristic of the landscape. The changes may be partly mitigated, but will leave an adverse, recognisable change to the landscape. Existing landscape is able to visually absorb some of the development, but there is some visual contrast and the development is visible.
Low	Minor loss or change to key landscape elements or features that may alter the landscape but still maintain the existing landscape character. Existing landscape or built environment is able to visually absorb the development. There is a low degree of visual contrast and effective use of screening.

2.1.3 Visual impact rating

Visual impact refers to the change in the appearance of the landscape because of development. Table 2.5 provides a matrix that combines the visual sensitivity rating with the visual effect rating to determine the visual impact rating. This rating is applied to each viewpoint as a way to measure the impacts of a development from particular locations.

Table 2.5 Visual impact rating matrix

Visual impact rating		Visual effect		
		High	Moderate	Low
Visual sensitivity	High	High	High	Moderate
	Moderate	High	Moderate	Low
	Low	Moderate	Low	Low

3 Existing visual environment

3.1 Land zoning and surrounding land use

The site is on land zoned RU1 – Primary Production under Tamworth Regional Local Environmental Plan 2010. The objectives of this zone are listed in Table 3.1 below. Land with this zoning in this region is characterised by diverse agricultural uses on large blocks of land. This leads to a diverse mix of structures, including private dwellings, sheds, silos and large agricultural buildings that are often clustered within the landscape. The project site is adjoined by a large poultry farm to the south-west and is otherwise surrounded by cropping and grazing land uses. The mix of land uses, including pasture, irrigated cropping and intensive poultry sheds can be seen on Figure 1.1 and Figure 1.3.

The Oxley Highway runs west of the site and contributes to the local visual context, as shown in Photograph 3.1 below.

Table 3.1 Zone RU1 objectives (Tamworth Regional Local Environmental Plan 2010)

Objectives
To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
To encourage diversity in primary industry enterprises and systems appropriate for the area.
To minimise the fragmentation and alienation of resource lands.
To minimise conflict between land uses within this zone and land uses within adjoining zones.
To permit subdivision only where it is considered by the Council to be necessary to maintain or increase agricultural production.
To restrict the establishment of inappropriate traffic generating uses along main road frontages.
To ensure sound management of land which has an extractive or mining industry potential and to ensure that development does not adversely affect the extractive industry.
To permit development for purposes where it can be demonstrated that suitable land or premises are not available elsewhere.

Photograph 3.1 The Oxley Highway and intensive poulty sheds near the project site

3.2 Topography and landform

The site is located centrally in the broad Peel River valley, with high, forested ridges visible to the north-east and south-west. The project site and surrounds are part of a landscape of undulating hills, with local relief approximately 40–60 m. The site is generally flat, sloping gently down to the south and east toward Tangaratta Creek, which crosses the property flowing northeast toward the Peel River.

The local landform and distant ridges are visible in Photograph 3.2 below.

Photograph 3.2 View from the Oxley Highway looking NE across the site

3.3 Vegetation

The type and extent of vegetation on land surrounding the project has a significant impact on both the visual character of the area and the on the potential visibility of the project. For this project, the dominance of open farming land in the surrounding area, including a mix of irrigated and non-irrigate cropping and pastures provides broad views and a sense of openness.

In contrast to the openness of crop and grazing land, the landscape surrounding the site is frequently punctuated by stands of native trees that occur in linear bands along fences and property boundaries, and as bands or clumps along roads and drainage lines. Individual trees are scattered sparsely through the landscape. Denser planting of native and exotic trees occurs around widely separated farm dwellings.

The project site has almost no woody vegetation or trees, having been used as pasture for a number of years.

Most of the vegetation types described above can be seen in Photograph 3.2 above.

4 Site visibility and viewpoints

4.1 Project visibility

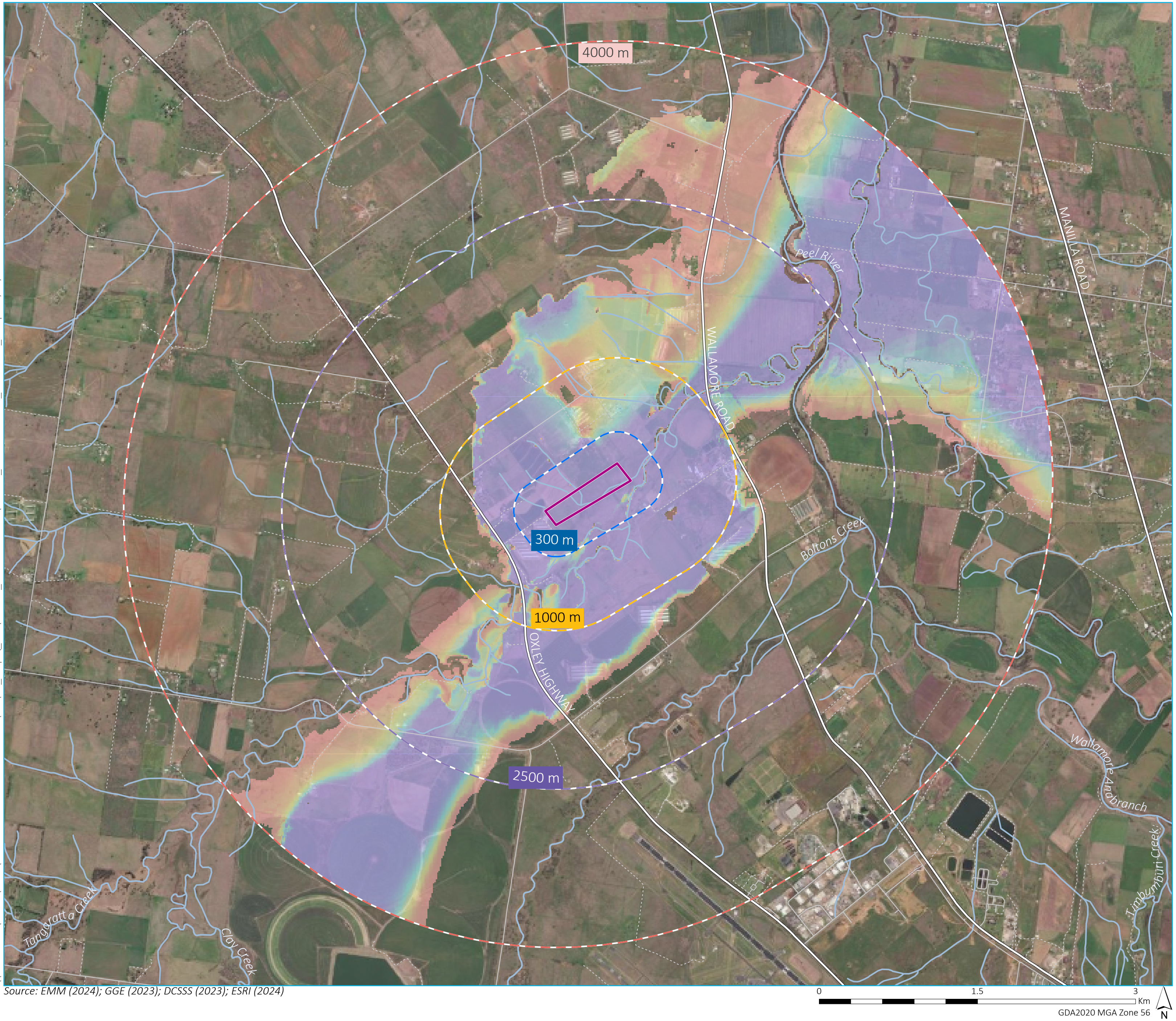
Site visibility helps to determine where the site can be seen from. This is important in mapping out the visual catchment of the site and determining viewing zones and viewpoint locations. A zone of visual influence (ZVI) represents the area over which a development can theoretically be seen. A ZVI was generated for the project using a digital elevation model, which is representative of the bare earth surface and only considers the topography of the landscape without considering vegetation or buildings. It is common practice to use only a digital elevation model for the theoretical viewsheds, as this ensures the worst-case scenarios are identified for further evaluation. During site visits, it was observed that views into the site are limited by topography, vegetation and built structures.

The ZVI modelling used a 3D geodesic viewshed, where points were placed on structural features of the project, such as along the top of the solar panels. GIS software uses these points to simulate whether the points will be visible from the surrounding landscape. This simulates a person's view from the surrounding area (assuming an eye-level of 1.6 m).

It is important to note that the ZVI does not consider the diminishing size of the project elements as the viewer moves further away. It only indicates where the project elements may be visible. To account for the diminishing effect of distance on the project elements, distance bands are marked on the ZVI. These provide a general indication of relative size based on the characteristics of the human eye.

The areas from which the site can potentially be seen from are illustrated in the ZVI shown in Figure 4.1. The ZVI shows the project will be most visible from nearby locations within approximately 1 km of the site. High ground prevents views beyond 1 km in most directions. There are two narrow bands of potential visibility running south-west and north-east out to distances beyond 4 km.

During the site visit, views of the site were available from the Oxley Highway and Wallamore Road. A small number of farm dwellings scattered to the north and north-west of the project were noted to potentially have views of the project.



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Source: EMM (2024); GGE (2023); DCSSS (2023); ESRI (2024)

KEY

- Project boundary
- 300 m- Site context
- 1 km- Immediate vicinity
- 2.5 km- Local area
- 4 km- District area

Visibility of new development

- Highly visible
- Not very visible

Existing environment

- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line

Zone of visual influence

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Figure 4.1

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4.2 View locations

Viewing zones are areas outside the site that have potential views into the site. These are categorised by distance (site context, immediate vicinity, local area, district area and regional area), since visibility diminishes with distance. After the viewing zones are determined, viewpoints are selected. Viewpoints are locations from which photographs are taken that will illustrate the views from that area. These are then tested through field investigations and photography to determine if the site is visible and how much of the site can be seen from the viewpoint.

An inspection of the Wallamore site considered the existing landscape and how it is seen from various points in the surrounding region. Identification of potentially impacted viewpoints that are publicly accessible was performed prior to the site visit and the viewpoints most impacted were confirmed during the site visit. Five representative viewpoints were selected on the basis of where the development would appear to be most prominent, either based on degree of exposure or the number of people likely to be affected. One viewpoint (VP03) was not selected for further assessment following a site visit, as ground-truthing showed no view would be possible.

The viewing zones selected (by distance category) are as follows:

- Site context (0–0.3 km): due to the scale and location of the development, no viewpoints have been selected in this zone.
- Immediate vicinity (0.3–1.0 km): three viewpoints (VP-01, VP-05 and VP-06) have been identified in this viewing zone.
- Local area (1.0–2.5 km): one viewpoint has been identified in this viewing zone (VP-02).
- District area (2.5–4.0 km): no viewpoints have been identified in this viewing zone.
- Regional area (>4.0 km): one viewpoint has been identified in this viewing zone (VP-04).

Each view is addressed separately in Chapter 5 of this report.

Source: EMM (2024); GGE (2023); DCSSS (2023); ESRI (2024)

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KEY

- Project boundary
- 300 m- Site context
- 1 km- Immediate vicinity
- 2.5 km- Local area
- 4 km- District area
- Viewpoint location

Existing environment

- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line

Viewing zones and viewpoint locations

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Visual Impact Assessment
Figure 4.1

creating opportunities

5 Visual impact assessment

5.1 Viewpoint assessment

The following viewpoint worksheets provide photographs and analysis data from each of the viewpoints identified in Figure 4.2 above.

The images were taken using a digital camera with a focal length equal to a standard 50 mm for a conventional 35 mm camera. This focal length is widely accepted as closely approximating the vision of the human eye. At the time of the site visits, the weather varied from overcast/stormy to clear and sunny.

5.1.1 Site visit

Site visits were undertaken on 29–30 November 2023 by a registered landscape architect with substantial experience analysing and mitigating visual impacts on the landscape. During the site visits, viewpoints were confirmed, and an assessment was made of each potential public viewpoint against the extent of the project.
Assessment criteria

Viewpoint 1 - Oxley Highway (B56)

Visual assessment table	
Landscape type (table 2.1)	Main highway
Distance from site	750 m
Visual sensitivity rating - location (table 2.1)	Low
Number of viewers	Large
Duration of view	Short
Visual sensitivity rating - experience (table 2.2)	Moderate
Visual sensitivity rating (table 2.3)	Low
Visual effect criteria (table 2.4)	Low
Visual impact rating (table 2.5)	**Low**

Description:

View from the western side of Oxley Highway, looking north east toward the proposed development.

Comments:

This view is available to a high number of north bound travellers for a very short duration. Travellers heading south toward Tamworth will not have a forward-facing view of the project from any point on the Oxley Highway.

For motorists heading north the project will be briefly visible between the exising poultry sheds and the trees in the right mid-ground of this image.

Viewpoint 1 photomontage - Oxley Highway (B56)

Extent of project visibility

Viewpoint 2 - Old Winton Road

Visual assessment table	
Landscape type (table 2.1)	Local road
Distance from site	2,200 m
Visual sensitivity rating - location (table 2.1)	Low
Number of viewers	Small
Duration of view	Short
Visual sensitivity rating - experience (table 2.2)	Low
Visual sensitivity rating (table 2.3)	Low
Visual effect criteria (table 2.4)	Low
Visual impact rating (table 2.5)	**Low**

Description:

View from beside Old Winton Road, looking north toward the proposed development.

Comments:

This view is from over 2 km away from the project, on a lightly trafficked local road.

Distance, and the small scale of the visible project will make any visual impact minimal from this location.

Viewpoint 2 photomontage - Old Winton Road

Extent of project visibility

Viewpoint 4 - Manilla Rd (B95)

Visual assessment table	
Landscape type (table 2.1)	Main highway
Distance from site	5,000 m
Visual sensitivity rating - location (table 2.1)	Low
Number of viewers	Large
Duration of view	Short
Visual sensitivity rating - experience (table 2.2)	Moderate
Visual sensitivity rating (table 2.3)	Low
Visual effect criteria (table 2.4)	Low
Visual impact rating (table 2.5)	**Low**

Description:

View from an elevated vantage point on the western side of Manilla Road, looking west toward the proposed development.

Comments:

This view illustrates the negligable visual impact of the project from regional viewpoints. The broad landscape occupied by the project contains many different land uses that are absorbed by the dominant pasture and cropping land use and the estensive tree canopy cover.

Viewpoint 4 photomontage - Manilla Road (B95)

Extent of project visibility

Viewpoint 5 - Byamee Lane

Visual assessment table	
Landscape type (table 2.1)	Local road
Distance from site	680 m
Visual sensitivity rating - location (table 2.1)	Low
Number of viewers	Small
Duration of view	Short
Visual sensitivity rating - experience (table 2.2)	Low
Visual sensitivity rating (table 2.3)	Low
Visual effect criteria (table 2.4)	Low
Visual impact rating (table 2.5)	**Low**

Description:

View from southern side of Byamee Lane, looking south toward the proposed development.

Comments:

Byamme Lane is an unsealed, dead-end road providing access to a small number of farm properties. This view will be available to a very small number of travellers.

There are several rural dwelling dwellings in this vicinity that may have similar views to this location. Although this was not confirmed during fieldwork, visual impacts at these locations will likely be mitigated by existing vegetation and structures.

Viewpoint 5 photomontage - Byamee Lane

Extent of project visibility

Viewpoint 6 - Wallamore Road

Visual assessment table	
Landscape type (table 2.1)	Local road
Distance from site	990 m
Visual sensitivity rating - location (table 2.1)	Low
Number of viewers	Moderate
Duration of view	Short
Visual sensitivity rating - experience (table 2.2)	Low
Visual sensitivity rating (table 2.3)	Low
Visual effect criteria (table 2.4)	Low
Visual impact rating (table 2.5)	**Low**

Description:

View from elevated (disused) railway embankment on the western side of Wallamore Road, looking west toward the proposed development.

Comments:

This view illustrates the low visibility of the project from Wallamore Road. It may be similar to fleeting views available to motorists from other parts of Wallamore Road, and serves to illustrate the minimal visual impact of the project to travellers along Wallamore Rd.

Viewpoint 6 photomontage - Wallamore Road

Extent of project visibility

5.2 Viewpoint analysis

Of the five viewpoints assessed, all received a visual impact rating of low. No viewpoints were identified that would receive a moderate or high visual impact rating. The project will be difficult to see from any public locations such as roads, and there are no nearby parks or rest areas.

Two viewpoints (VP-01 and VP-04) received ratings of moderate for visual sensitivity – experience (Table 2.2). This rating is attributable to the fact both are located on highways and will be passed by many motorists each day. The visual impact from VP-01 will be small and barely glimpsed as travellers pass by, and from VP-04 the project will be very difficult to see from such a great distance.

One viewpoint, VP-05, received a moderate rating for visual effect due to its proximity to the project; however, from this viewpoint the overall visual impact rating was low.

The view obtained for VP-06 was from the elevated rail line beside the road. It is unlikely that there will be any views from the road.

Table 5.1 Viewpoint visual impact summary

Viewpoint	Visual sensitivity	Visual effect	Visual impact rating
VP 1	Low	Low	**Low**
VP 2	Low	Low	**Low**
VP 4	Low	Low	**Low**
VP 5	Low	Low	**Low**
VP 6	Low	Low	**Low**

5.3 Visual impact from Byamee Lane and nearby residences

Approximately eight private residences on Byamee Lane and the Oxley Highway just south of Byamee Lane may be impacted by visual aspects of the project. Access to the residences has not been obtained and the visual impact on each residence has therefore not been assessed. However, based on the analysis of VP-05, and analysis of aerial photos, the following points can be made:

- The nature of any visual effect (Table 2.4) will be similar in scale to that shown in VP-05 and would likely be rated as low.
- The visual sensitivity – location (Table 2.1) would be rated as moderate for residences, as all these dwellings are between 300 m and 1 km from the project.
- The visual sensitivity – experience (Table 2.2) would be rated as moderate for a long duration view by a small number of viewers.
- Based on the above, the likely visual impact rating for all these dwellings would be low.
- It is also likely that existing vegetation and structures between these dwellings and the project would significantly reduce visual access to the project.

It is also important to note that, while in plan view, the proposed solar panels would be more extensive than existing structures in the vicinity, when viewed from ground level the proposed solar panel modules will be less visually intrusive than structures such as chicken sheds and silos that exist in the area. The visibility of the proposed solar panels will be further mitigated by the proposed screen planting to the perimeter of the project.

6 Glint and glare analysis

6.1 Reflectivity and glare

Glint and glare are potential impacts of sunlight reflecting off the proposed solar project elements. When sunlight is reflected off a smooth, reflective surface, it can result in glint or glare. Glint refers to short, momentary periods of intense levels of exposure to reflection. Glare refers to sustained or continuous periods of exposure to excessive brightness, but at a reduced level of intensity. Glint is a quick reflection or flash of light, while glare is experience for a longer period of time. Both of these can be annoying and dangerous in certain situations by causing momentary blindness.

Reflection in the form of glint and glare will only be possible when direct sunlight occurs. Therefore, in those instances where glint and glare from the project elements may occur, people will also likely experience direct sunlight, which will be a significantly brighter and more intense source of light than reflections. Nonetheless, glint and glare may result from the project and may have an impact on receptors, such as dwellings within proximity of the development, motorists travelling along the local road network and pilots landing at or taking off from Tamworth Airport.

6.1.1 Reflectivity

Generally, the light reflected is diminished by first hitting the substrate that reflected it. Since solar cells are designed to absorb light energy to create electrical currents, they will only reflect a portion of the sunlight that falls on them.

Typically, solar panels are constructed from a treated glass that is designed to minimise reflection and maximise the amount of light transmitted through the glass to the receptor. Typical treated glass that is used for solar cells reflects about 4% of the light that hits the cell. This is equivalent to a water body (pond or lake), which is considered to be a fairly low amount of reflection.

6.1.2 Angle of reflection

The angle of reflection of light off a reflective surface is directly related to the angle of incidence of the light from the source. In the case of a photovoltaic array, the sunlight will reflect off the panel at the same angle as it arrives from the sun. If the panel is stationary, the sun's angle relative to the solar panel will vary by time of day and therefore reflect toward the west in the morning and eastward in the evening.

The solar arrays proposed for this solar project will track the sun's movement across the sky to maximise exposure to the sun. They are also designed to minimise the shadow cast from one solar panel to an adjacent one. To do this, the panels will begin to rotate back to horizontal as the sun lowers toward the horizon. When the sun is rising or setting, the panels will be in a horizontal position with the potential to reflect sunlight in the opposite direction. This means there is potential for glare west of the solar arrays in the morning, and east of the arrays in the evening.

The seasonal change of the sun's movements will vary the refection angles as well. As the sun move southward in the summer months, the reflection will move northward, and vice versa in the winter months (when the sun is north of the equator). This movement changes the reflection angle in a north–south direction.

6.2 Analysis

Knowing the characteristics of reflected light helps us determine where glare is likely to be an issue. In the case of the Wallamore Micro Solar Farm project, trackers will be used to maximise the sunlight absorbed by the cells. The trackers are designed to keep the panel perpendicular to the sun. We can therefore assume that the sunlight reflected will reflect perpendicular to the cell and directly back toward the sun for most of the daylight hours. When the sun is low in the sky, the solar arrays rotate to minimise shading and can introduce potential for glare. The glare analysis below has been performed to identify the location that might experience glint or glare.

A glare analysis was performed using specialised software (ForgeSolar). The calculations were based on the solar array properties outlined in Section 1.2. Further parameters include:

- photovoltaic cells extend to 2.6 m above ground level with solar glass that has an anti-reflection surface treatment
- single axis tracking rotation aligned on a north-south axis, with a range of +/- 60^0 from vertical
- panels will not use backtracking.

The software calculates the minutes of potential glare predicted at each location every day through the course of a year. The results indicate the number of minutes predicted at each location along with the type of glare expected. The classifications of glare from the software are:

- Green glare – glare is present with only a low potential for temporary after-image or flash blindness
- Yellow glare – glare has a moderate potential for temporary after-image or flash blindness
- Red glare – glare with high potential for permanent eye damage.

The glare analysis produced by the software does not account for physical obstructions between the solar arrays and the residences and motorists. This includes the presence of buildings, trees and other structures. It also assumes the weather is sunny each day for the duration of daylight hours. Therefore, a worst-case scenario is calculated.

Glare impacts were assessed from surrounding residence locations, from the Oxley Highway, Wallamore Road and Byamee Lane, and from Tamworth Airport.

A separate glare assessment for the battery units and other structures has not been done. It is assumed that since these elements are centrally located close to the solar array and the solar panels reach a height of 2.4 m, any glint and glare from these components would be shielded or represented by the glint and glare from the solar panels.

Table 6.1 summarises the findings of the glare assessment. Refer to Appendix B for the full ForgeSolar glare analysis results.

Table 6.1 Glare analysis results

Location	Location name assigned by software	Green glare (minutes per year)	Yellow glare (minutes per year)	Red glare (minutes per year)
Byamee Lane	Byamee Lane	0	0	0
Oxley Highway	Oxley Highway	0	0	0
Wallamore Road	Wallamore Road	0	0	0
Tamworth Airport Flight Path 06	FP 06	0	0	0
Tamworth Airport Flight Path 12 L	FP 12 L	0	0	0
Tamworth Airport Flight Path 12 R	FP 12 R	0	0	0
Tamworth Airport Flight Path 18	FP 18	0	0	0
Tamworth Airport Flight Path 24	FP 24	0	0	0
Tamworth Airport Flight Path 30 L	FP 30 L	0	0	0
Tamworth Airport Flight Path 30 R	FP 30 R	0	0	0
Tamworth Airport Flight Path 36	FP 36	0	0	0
Tamworth Airport Air Traffic Control Tower	1-ATCT	0	0	0
Nearby residences	OP2 – OP11	0	0	0

Note: Duration of "glare from solar arrays" may include duplicate times of glare from multiple solar array areas.

Based on the glare analysis, the project will not produce glare at any of the assessed receptors. No locations, residences or flight paths will have potential glare impacts.

Table 6.1 summarises the locations and durations that glare is expected. In this case no glare is predicted at any location.

7 Mitigation measures

7.1 Recommendations

The visual assessment in Chapter 5 of this report assigns either a high, medium or low visual impact rating when viewed from the site context, immediate vicinity, local area, district area and regional views. The visual impact rating for all viewpoints for this project was low. For visual impact ratings of low, mitigation measures are not required; however, the following mitigation measures will have a beneficial result by further reducing the low visual impacts of the project.

7.1.1 Visual character

To maintain the visual character of the area around the site, the following recommendations are suggested:

- perimeter planting of native trees and shrubs as shown in Appendix A.

7.1.2 Infrastructure, materials, and colours

To minimise the visual impact of infrastructure on the landscape, the following are recommended:

- materials, textures and colour selection should relate to the palette of the surrounding environment to minimise visibility and potential for visual impact
- reflective surfaces and bright, contrasting colours should be avoided.

References

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Transport for NSW (2020), *Guideline for Landscape Character and Visual Impact Assessment*, EIA-N04, Version 2.2, Centre for Urban Design.

The Landscape Institute with the Institute of Environmental Management and Assessment (2013), *Guidelines for Landscape and Visual Assessment*, Third Edition, Newport, Lincoln.

Appendix A
Planting plan

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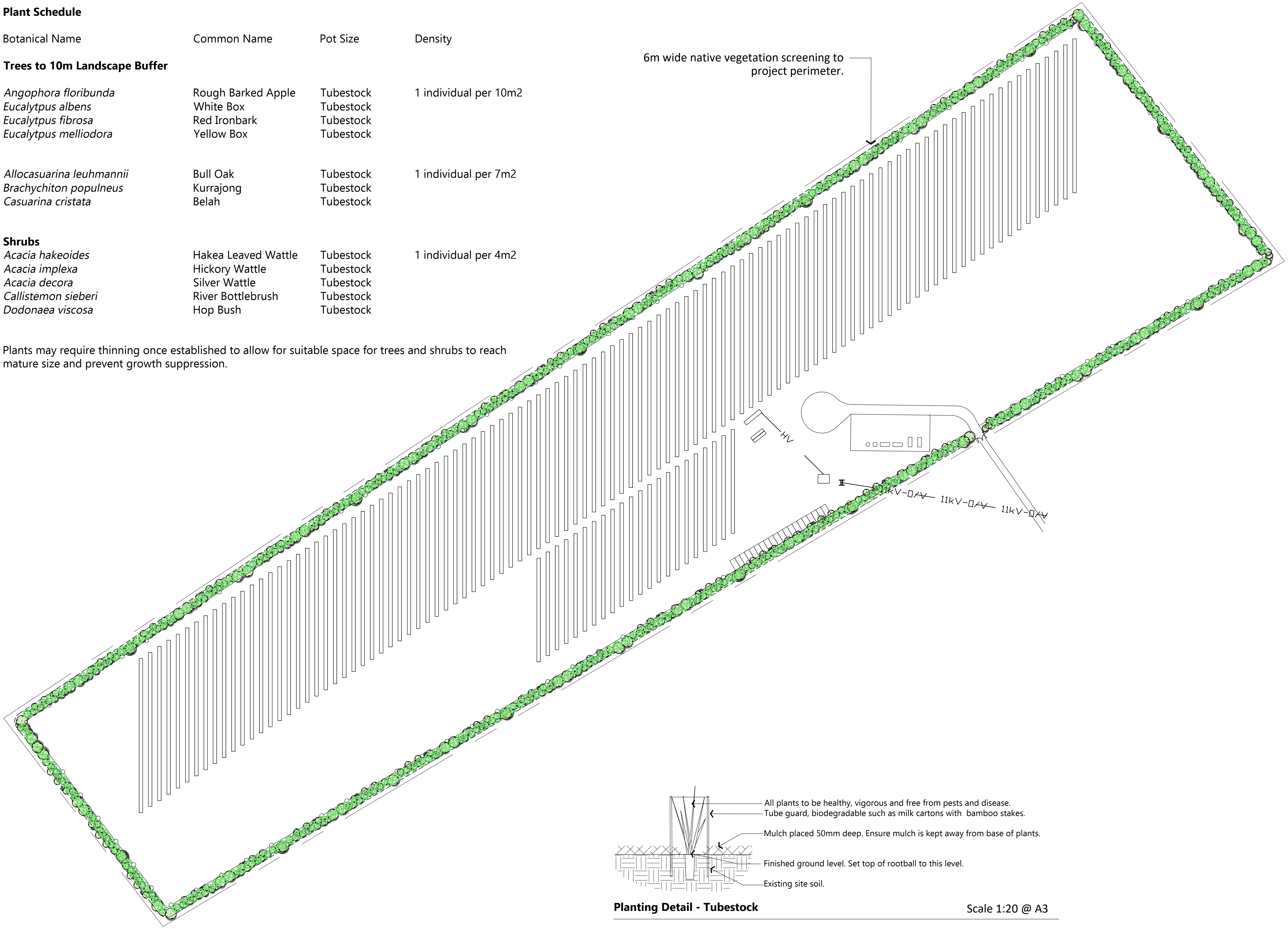
Plant Schedule

Botanical Name	Common Name	Pot Size	Density
Trees to 10m Landscape Buffer			
Angophora floribunda	Rough Barked Apple	Tubestock	1 individual per 10m2
Eucalyptus albens	White Box	Tubestock	
Eucalyptus fibrosa	Red Ironbark	Tubestock	
Eucalyptus melliodora	Yellow Box	Tubestock	
Allocasuarina leuhmannii	Bull Oak	Tubestock	1 individual per 7m2
Brachychiton populneus	Kurrajong	Tubestock	
Casuarina cristata	Belah	Tubestock	
Shrubs			
Acacia hakeoides	Hakea Leaved Wattle	Tubestock	1 individual per 4m2
Acacia implexa	Hickory Wattle	Tubestock	
Acacia decora	Silver Wattle	Tubestock	
Callistemon sieberi	River Bottlebrush	Tubestock	
Dodonaea viscosa	Hop Bush	Tubestock	

Plants may require thinning once established to allow for suitable space for trees and shrubs to reach mature size and prevent growth suppression.



Planting Detail - Tubestock Scale 1:20 @ A3

Note

This drawing is to be read as an appendix to the Wallamore Micro Solar Farm Visual Impact Assessment report.

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NORTH

Scale 1 : 2500 @ A3

Revisions

Issue	Details	Date
A	For Review	10.01.24
B	Final	24.07.24

Project: Wallamore Solar Farm

Client: Green Gold Energy Pty Ltd

Title: **Planting Plan**

Site: Wallamore NSW

Date: 10 January 2024

Job No: E231117

Revision: B

Sheet: L01

Appendix B

Glint and glare analysis results

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FORGESOLAR GLARE ANALYSIS

Project: **Wallamore SF**
Site configuration: **Wallamore 01**

Created 10 Jan, 2024
Updated 12 Jan, 2024
Time-step 1 minute
Timezone offset UTC10
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 5 MW to 10 MW
Site ID 109511.18948

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Byamee Lane	0	0.0	0	0.0
Oxley Highway	0	0.0	0	0.0
Wallamore Road	0	0.0	0	0.0
FP 06	0	0.0	0	0.0
FP 12 L	0	0.0	0	0.0
FP 12 R	0	0.0	0	0.0
FP 18	0	0.0	0	0.0
FP 24	0	0.0	0	0.0
FP 30 L	0	0.0	0	0.0
FP 30 R	0	0.0	0	0.0
FP 36	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	**hr**	**min**	**hr**
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: None
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Rated power: -
Panel material: Light textured glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-31.043159	150.828519	378.38	2.60	380.98
2	-31.043922	150.829237	375.01	2.60	377.61
3	-31.043215	150.830600	372.12	2.60	374.72
4	-31.044014	150.831480	370.77	2.60	373.37
5	-31.041872	150.834216	371.00	2.60	373.60
6	-31.041358	150.833754	371.85	2.60	374.45
7	-31.039813	150.836190	368.88	2.60	371.48
8	-31.039096	150.835535	370.68	2.60	373.28

Route Receptors

Name: Byamee Lane
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-31.040217	150.819965	397.19	1.50	398.69
2	-31.032642	150.833225	387.26	1.50	388.76

Name: Oxley Highway
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-31.012617	150.800460	414.03	1.50	415.53
2	-31.013500	150.801146	414.38	1.50	415.88
3	-31.014971	150.802047	415.10	1.50	416.60
4	-31.018061	150.802992	419.56	1.50	421.06
5	-31.021849	150.805867	423.00	1.50	424.50
6	-31.046303	150.824621	382.55	1.50	384.05
7	-31.049281	150.825951	375.54	1.50	377.04
8	-31.051965	150.826123	377.18	1.50	378.68
9	-31.054796	150.826423	383.34	1.50	384.84
10	-31.057332	150.827458	392.82	1.50	394.32
11	-31.059722	150.828960	396.19	1.50	397.69
12	-31.065236	150.834411	383.44	1.50	384.94

Name: Wallamore Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-31.017362	150.845587	374.31	1.50	375.81
2	-31.023283	150.844171	370.16	1.50	371.66
3	-31.028983	150.844257	365.85	1.50	367.35
4	-31.033874	150.844729	365.71	1.50	367.21
5	-31.043030	150.849878	377.26	1.50	378.76
6	-31.047737	150.849878	374.75	1.50	376.25
7	-31.051046	150.850393	370.08	1.50	371.58
8	-31.058656	150.853998	376.04	1.50	377.54

Flight Path Receptors

Name: FP 06
Description:
Threshold height: 15 m
Direction: 74.3°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.083128	150.843056	401.08	15.24	416.32
Two-mile	-31.090971	150.810524	409.39	175.61	585.00

Name: FP 12 L
Description:
Threshold height: 15 m
Direction: 132.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.071109	150.836984	392.03	15.24	407.27
Two-mile	-31.051763	150.811869	379.52	196.43	575.95

Name: FP 12 R
Description:
Threshold height: 15 m
Direction: 128.4°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.081463	150.833008	400.99	15.24	416.23
Two-mile	-31.063488	150.806535	383.49	201.43	584.92

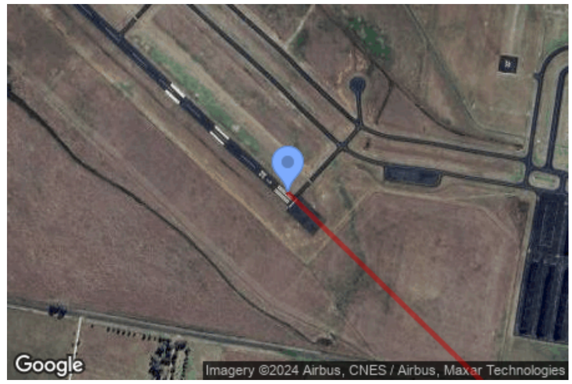
Name: FP 18
Description:
Threshold height: 15 m
Direction: 186.3°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.077578	150.846511	396.39	15.24	411.63
Two-mile	-31.048839	150.850208	372.46	207.86	580.32

Name: FP 24
Description:
Threshold height: 15 m
Direction: 255.5°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.081015	150.851189	399.07	15.24	414.31
Two-mile	-31.073795	150.883917	371.37	211.62	582.99

Name: FP 30 L
Description:
Threshold height: 15 m
Direction: 314.1°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

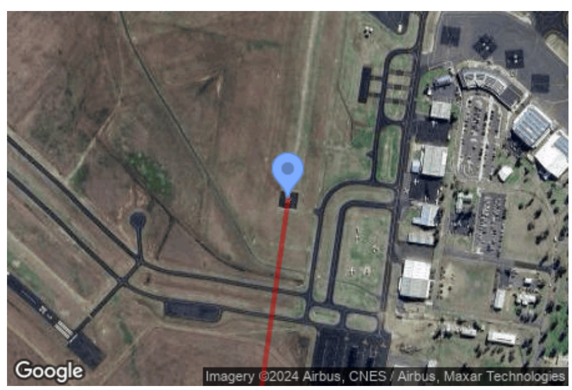


Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.087950	150.841291	409.09	15.24	424.33
Two-mile	-31.108071	150.865564	419.78	173.23	593.01

Name: FP 30 R
Description:
Threshold height: 15 m
Direction: 312.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.084194	150.853549	404.53	15.24	419.77
Two-mile	-31.103540	150.878667	391.64	196.81	588.45

Name: FP 36
Description:
Threshold height: 15 m
Direction: 8.1°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-31.086048	150.845073	404.43	15.24	419.67
Two-mile	-31.114674	150.840328	425.48	162.88	588.36

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	-31.081302	150.843109	399.10	22.50
OP 2	2	-31.034452	150.830958	391.49	1.60
OP 3	3	-31.038705	150.823374	398.21	1.60
OP 4	4	-31.040470	150.821813	397.07	1.60
OP 5	5	-31.039571	150.822189	398.80	1.60
OP 6	6	-31.040987	150.822291	396.37	1.60
OP 7	7	-31.041437	150.822068	396.07	1.60
OP 8	8	-31.042674	150.824292	385.21	1.60
OP 9	9	-31.036939	150.832568	385.18	1.60
OP 10	10	-31.033963	150.834465	380.31	1.60
OP 11	11	-31.049177	150.828381	377.88	1.60

Map image of 1-ATCT

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Byamee Lane	0	0.0	0	0.0
Oxley Highway	0	0.0	0	0.0
Wallamore Road	0	0.0	0	0.0
FP 06	0	0.0	0	0.0
FP 12 L	0	0.0	0	0.0
FP 12 R	0	0.0	0	0.0
FP 18	0	0.0	0	0.0
FP 24	0	0.0	0	0.0
FP 30 L	0	0.0	0	0.0
FP 30 R	0	0.0	0	0.0
FP 36	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Byamee Lane	0	0.0	0	0.0
Oxley Highway	0	0.0	0	0.0
Wallamore Road	0	0.0	0	0.0
FP 06	0	0.0	0	0.0
FP 12 L	0	0.0	0	0.0
FP 12 R	0	0.0	0	0.0
FP 18	0	0.0	0	0.0
FP 24	0	0.0	0	0.0
FP 30 L	0	0.0	0	0.0
FP 30 R	0	0.0	0	0.0
FP 36	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 1 and Route: Byamee Lane

No glare found

PV array 1 and Route: Oxley Highway

No glare found

PV array 1 and Route: Wallamore Road

No glare found

PV array 1 and FP: FP 06

No glare found

PV array 1 and FP: FP 12 L

No glare found

PV array 1 and FP: FP 12 R

No glare found

PV array 1 and FP: FP 18

No glare found

PV array 1 and FP: FP 24

No glare found

PV array 1 and FP: FP 30 L

No glare found

PV array 1 and FP: FP 30 R

No glare found

PV array 1 and FP: FP 36

No glare found

PV array 1 and 1-ATCT

No glare found

PV array 1 and OP 2

No glare found

PV array 1 and OP 3

No glare found

PV array 1 and OP 4

No glare found

PV array 1 and OP 5

No glare found

PV array 1 and OP 6

No glare found

PV array 1 and OP 7

No glare found

PV array 1 and OP 8

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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