ERM

APPENDIX L GLINT AND GLARE ASSESSMENT

Garoo Solar Farm and BESS

Glint & Glare Assessment

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Glint & Glare Assessment

Prepared for
ERM

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Executive Summary

Moir Studio have been engaged by ERM to prepare a Glint and Glare Assessment for the proposed Garoo Solar Farm and BESS (the Project). The report will accompany the Environmental Impact Statement (EIS) prepared for the Project.

The Glint and Glare Assessment has been prepared in accordance with the Department of Planning, Housing and Infrastructure (DPHI) Large-Scale Solar Energy Guideline (November 2024).

In accordance with the Guideline, the following receptors have been assessed:

- Residential dwellings within 3 km of the proposed solar array that have a line of sight to the Project.
- All roads and rail lines within 1 km of the proposed solar array.
- Aviation receptors identified within 5 km of the proposed solar array. No aviation receptors were identified for this assessment.

Moir Studio has undertaken this Glint and Glare Assessment utilising the Solar Glare Hazard Analysis Tool (SGHAT). The SGHAT is used to evaluate glare resulting from solar farms at different receptors, based on proximity, orientation and specifications of the Photovoltaic (PV) modules.

Three (3) scenarios have been modelled as part of this assessment, and are referenced in this report as Scenario 1 (no operational mitigation modelled) and Scenario 2 (with operational mitigation), and Scenario 3 (with operational mitigation).

It is important to note, this assessment is based on a worst-case scenario and does not take into account weather conditions, or intervening elements such as vegetation and built structures.

A total of eight 8 Observation Points (OP), ie, non-associated dwellings, were identified within 3 km of the Project. Based on the glare assessment, all eight (8) residential receptors have been assessed as either having low or nil glare impacts and therefore do not require mitigation.

Two (2) road receptors (Garoo Road and Bulls Road) were identified as part of the assessment. Based on the glare assessment, potential glare was identified for one (1) road receptor (Bulls Road).

No Aviation receptors were identified within 5 km of the Project.

Mitigation in the form of an operational management strategy using Scenario 3 tracking parameters is recommended to eliminate potential for glare at the affected Bulls Road (i.e. no backtracking occurs during daylight hours and panels only move to resting angle during the night). In the glare assessment using Scenario 3 parameters, all potential for glare is eliminated for all receptors (including all eight (8) residential and two (2) road receptors).

Principles for mitigation have been discussed in detail in this report, in accordance with the DPHI Large-Scale Solar Energy Guideline.

1.0 Introduction

1.1 Introduction

Moir Studio have been engaged by ERM to prepare a Glint and Glare Assessment for the proposed Garoo Solar Farm and BESS (referred to hereafter as the Project). The report will accompany the EIS prepared for the Project.

The Glint and Glare Assessment has been prepared in accordance with the New South Wales (NSW) Department of Housing, Planning and Infrastructure (DPHI) Large-Scale Solar Energy Guideline, referred to hereafter as 'the Guideline' (DPHI, 2024).

1.1.1 Overview of Glint and Glare

The Guideline defines glint as a momentary flash of bright light and glare as a continuous source of continuous, excessive brightness (DPHI, 2024). While it is acknowledged that '*significant glint and glare impacts are uncommon with large-scale solar energy developments* ' (DPHI, 2024), the purpose of this report is ' *to model and assess these impacts to ensure any potential significant impact is avoided or mitigated appropriately*' (DPHI 2024).

The Guideline provides Performance Objectives for the impacts of glare only, therefore this report has focused on the impact of glare on surrounding receptors. The Performance Objectives of the Guideline for residential receptors, road and rail receptors and aviation receptors are outlined in **Section 4.2, Section 5.2** and **Section 6.2** respectively.

A Glint and Glare Assessment needs be undertaken to ensure that sensitive visual receptors such as road users, surrounding rail network, air traffic controllers and pilots are not significantly impacted by the potential glare from the Project, and that nearby residential locations have a reduced level of 'nuisance' from potential glare (DPHI 2024).

1.1.2 Likelihood of Glint & Glare Impacts

The Guidelines note that '*significant glint and glare impacts are uncommon with large-scale solar energy developments because*:

- *Solar panels are designed to absorb light and typically reflect less than 2% of incoming sunlight*
- *Glint and glare typically occur for short periods of time and require very specific geometric and atmospheric conditions*
- *Many solar energy projects are now fitted with tracking panels that can be adjusted to avoid or minimise the geometric conditions needed to cause glint and glare (DPHI 2024).*

The purpose of this report is to identify any potential large scale glare impacts and take appropriate measures to mitigate these potential impacts.

1.2 Glint and Glare Key Principles

The key glare principles for ensuring the Project can be undertaken whilst maintaining an acceptable level of amenity are outlined in the Guideline as follows:

1. **Solar panels should be sited to reduce the likely impacts of glint and glare.**

2. **Solar panels and other infrastructure should be constructed of materials and / or treated to minimise glint and glare.**

3. **If a large scale-solar energy development is likely to exceed the relevant criteria for glare and standards for glint, mitigation strategies must be adopted to reduce the impacts.**

1.3 Assessment Requirements

This Glint and Glare Assessment Report (report) has been structured in accordance with the Guidelines, as required by the Secretary's Environmental Assessment Requirements (SEARs) issued on the 04 March 2025. **Table 01** outlines where the relevant matters have been addressed in this report. The objective of the assessment as stated in the Guideline is to "*demonstrate that glint and glare would not pose a significant risk to motorists or pilots and that nuisance from glare is minimised for residential locations in accordance with the objectives outlines in [the Guideline]*".

Table 01 Overview of Assessment Requirements

Report Structure	
Requirements for Glint and Glare Assessment:	**Addressed in report:**
A description of the proposed PV panels indicating: - The axis of rotation and maximum tilt angle - The light absorption efficiency and / or refractive index values at different angles. - Whether any backtracking is proposed and the time and duration of these operations.	**Refer to:** **Section 3.0: Project Overview**
A justification for excluding any modelled glare results because they would be insignificant due to the size, position and luminance of the glare source or high ambient luminance.	**Refer to:** **Section 2.0: Study Method**
Results of the glint and glare analysis for each assessable receiver	**Refer to:** **Section 4.0: Residential Receptors** (Assess all residential dwellings within 3 km of the proposed solar array that have a line of sight.) **Section 5.0: Road and Rail Receptors** (Assess all roads and rail lines within 1 km of the proposed solar array.) **Section 6.0: Aviation Receptors** (Assess all air traffic control towers and take off / landing approaches to any runway or landing strip within 5 km of the proposed solar array.)
Identification of existing vegetation or built structures and a quantitative assessment of whether these features would eliminate or reduce the modelled impacts.	**Refer to Summary Tables**
Details of strategies to either avoid or mitigate impacts including re-siting or sizing the Project, altering the tracking patterns, implementing vegetation screening, or entering neighbour agreements with landowners if all other measures have been exhausted.	**Refer to:** **Section 8.0: Mitigation Recommendations**

1.4 Agency Advice

Agency advice from Tamworth Regional Council was issued with the SEARs on March 04 2025. **Table 02** provides an overview of the Council requirements and where these have been addressed in the Glint and Glare Assessment:

Table 02 Overview of Council Requirements

SEARs Requirement Reference	
	Relevant Section of Glint and Glare Assessment
'As mentioned in the scoping report, further assessment should be undertaken to assess the impacts of glint and glare using industry standard methodology ...' *A detailed assessment will need to be provided to address all points to highlight immediate impact on residences within the 5km radius of the project. Glare from the solar panels for oncoming traffic along Garoo Road in either direction throughout the day will need to be considered. Noting that the panels have a single axis track.*	**Refer to:** **Section 1.3: Assessment Requirements**

2.0 Study Method

2.1 Assessment Methodology

Moir Studio have undertaken this Glint and Glare Assessment utilising Solar Glare Hazard Analysis Tool (SGHAT) developed by Sandia National Laboratories. The SGHAT is used to evaluate glare resulting from solar farms at different receptors, based on proximity, orientation and specifications of the PV modules. This tool is recognised by the Australian Government Civil Aviation Safety Authority (CASA).

SGHAT is used to indicate the nature of glare that can be expected at each potential receptor. Glare can be broadly classified into three categories and presented by the following three colours:

- **Green Glare**: Low potential for temporary after-image
- **Yellow Glare**: Potential for temporary after-image
- **Red Glare**: Retinal burn, not expected for PV.

Note: The main focus of this assessment is the yellow glare. Red glare is not expected for PV and green glare has low potential to cause after image and deemed low impact (HO,2011).

The glare analysis tool used to assess the glint and glare hazard was run at a simulation interval of one minute, based on the reflectivity of solar rays off PV modules which typically lasts for at least one minute.

Modelling for the solar farms in the SGHAT tool is based on the following factors:

- Position of the sun over time with respect to the location of the proposed solar farm.
- Assessment is based on a worst case scenario assuming clear weather all year round, (ie. no consideration of cloud coverage).
- Tracking axis tilt, tracking axis orientation and properties of the PV modules.

2.2 Modelling Limitations

It should be emphasized that the results of the SGHAT represent a worst-case scenario model. Any results of potential for glare and corresponding proposed mitigation measures are based off this conservative estimate. The analysis gives an indication of potential glint and glare effects and does not consider:

- Intervening elements such as existing vegetation, built structures or topography.
- Varying weather conditions that reduce glare such as cloud cover. The analysis is only based on worst-case scenario weather conditions for glare (ei. Clear weather conditions).
- Technical improvements to Solar Panel materials to reduce glare reflectivity in the last 10 years (the modelling is based off 2015 Solar Panel materials and glare effects) (Reference Forge Solar and 2015 study).

2.3 Modelling Assumptions

The glare and glint impact for a project is calculated utilising the geographic location, elevation, position of the sun and other vector calculations including module orientation, reflective environment and visual factors. Sun position is determined at every one (1) minute interval through out the year.

Although the SGHAT is an extensive software to understand the impacts of potential glare, it does not consider weather conditions, separation between PV modules and existing surrounding vegetation (if present) between the Project and a sensitive receptor.

Single axis tracking PV panels capable of rotating to a maximum of 60° have been considered to indicate a full rotational range of 120° for this analysis. The trackers are oriented north-south with a maximum pitch distance of 5.8 m. Glare modelling has been conducted to correspond to maximum tracker height to provide a wider range of observed solar glare based on the extremities.

The glint and glare effects of PV panels depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed screening measures to reduce visibility of the site.

Glare modelling has been conducted using the Shade-slope backtracking function within the SGHAT tool. Ground Coverage Ratio (GCR) calculations are used within the SGHAT tool for 'Shade-Slope' backtracking analysis. GCR is defined as the ratio of the array length (L) to proposed pitch distance (R) (Doubleday et al. 2016).

For this assessment GCR is calculated considering L = 2.4 m and R = 5.8 m.

The resulting GCR = 0.414.

Section 3.0 provides an overview of the PV panel parameters used for the assessment.

$$\mathrm{GCR} = \frac{L}{R} .$$

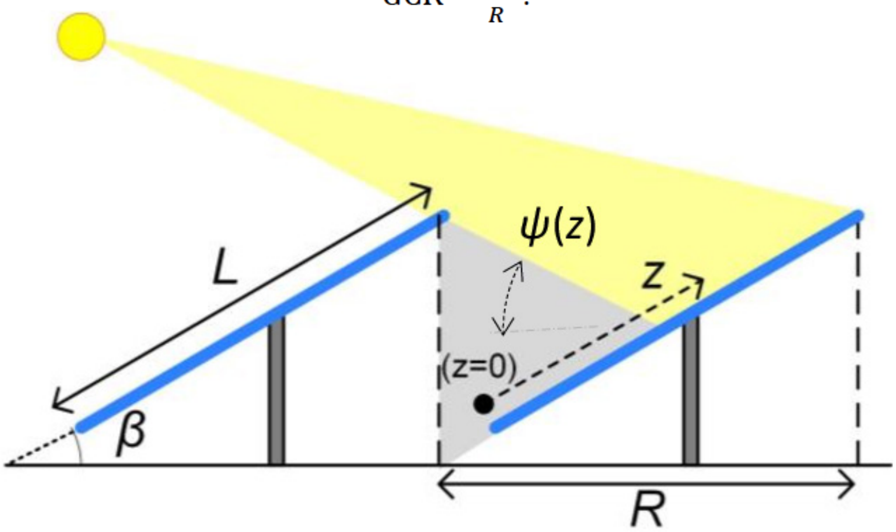


Figure 01 GCR Calculation

Imagery Source: Doubleday et al. 2016

2.4 Backtracking Operations

A single axis horizontal tracking system can be configured to do a 'backtracking' technique, which implies that when the sun is low in the sky in the morning or evening, the tracking system can adjust the panels to maximise solar capture while minimising overshadowing.

The SGHAT software utilised for this assessment uses a simplified model of backtracking. Single-axis trackers follow the movement of the sun as it moves east to west throughout the day. Yields are maximised, and light reflection is minimised when panels are directly facing the sun. In times when the sun is not in the tracking range, we assume that the panels instantaneously revert to their resting angle of 0°. Due to this assumption, glare from the backtracking mechanism will be more conservatively simulated for the purposes of this assessment and at times of sunset and sunrise, when the sun is at a lower angle relative to the array, glare impacts will be more noticeable.

Variable angles of incidence of the sun relative to the panels may occur when the tracking system is performing a backtracking operation, and this variation is somewhat represented by SGHAT software.

Shade-slope backtracking function within the SGHAT software considers the lowest possible panel rotation angle during backtracking. Therefore, backtracking operations are determined using the 0° resting angle option. This function simulates the impression of the panels returning to a pre-defined angle after the maximum tilt angle has been attained.

It is important to note that this backtracking modelling is not a realistic representation of how a backtracking technique would work in reality, however, it provides the worst-case scenario of the potential glare consequences of shifting the PV panels away from the sun after the maximum tilt is reached.

The following parameters have been considered for this assessment in Scenario 1 to simulate a typical backtracking process for the Project:

- A maximum tracking angle of 60° is considered to indicate a full rotational range of 120°.
- To simulate 'backtracking', the 'resting angle' is determined as 0°, assuming the PV modules move directly to 0° once maximum tilt of 60° is reached. This represents a worst case scenario.

2.5 Operational Management Strategy

Utilising operational management techniques (forming an operational mitigation strategy) is an alternative mitigation measure to alter the functioning of the PV array during the backtracking mode.

This approach serves to mitigate glare effectively by addressing the potential causes of glint and glare impact through operational intervention. To address this strategy and reduce the potential glare impacts linked to the Project, the operation of the Project has been rigorously assessed and adjustments to the tracking patterns have been modelled using the SGHAT software. The following aspects of each scenario have been undertaken to ascertain an appropriate mitigation strategy:

- Scenario 1 (worst case): This scenario was modelled with a normal tracking angle of ±60°with backtracking operation and a resting angle of 0° This scenario was modelled as a worst-case scenario for the Project. In this case, the panels move between the full operational range (maximum tilt) discussed in **Section 2.4** (refer to **Figure 02**).
- Scenario 2 (resting angle of 5°): This scenario was modelled with a normal tracking angle of ±60° with backtracking operation and a resting angle of 5°. In this scenario, the panels move between the operational range (maximum tilt) and backtrack to 5° when the sun is out of range and remain at this angle, only switching back to 0° during the night for night-time stowing (refer to **Figure 03**).
- Scenario 3 (resting angle of 60°): This scenario was modelled where the movement of the PV modules backtracking to 0° is only expected to occur during the night. Therefore, the scenario simulates normal tracking during daylight hours, assuming that the PV modules will be following the sun during all daylight hours where the maximum tilt of 60° will be reached for sunrise and sunset. The movement of the PV modules backtracking to 0° is only expected to occur during the night, and therefore has not been considered in this assessment (Refer to **Figure 03**).

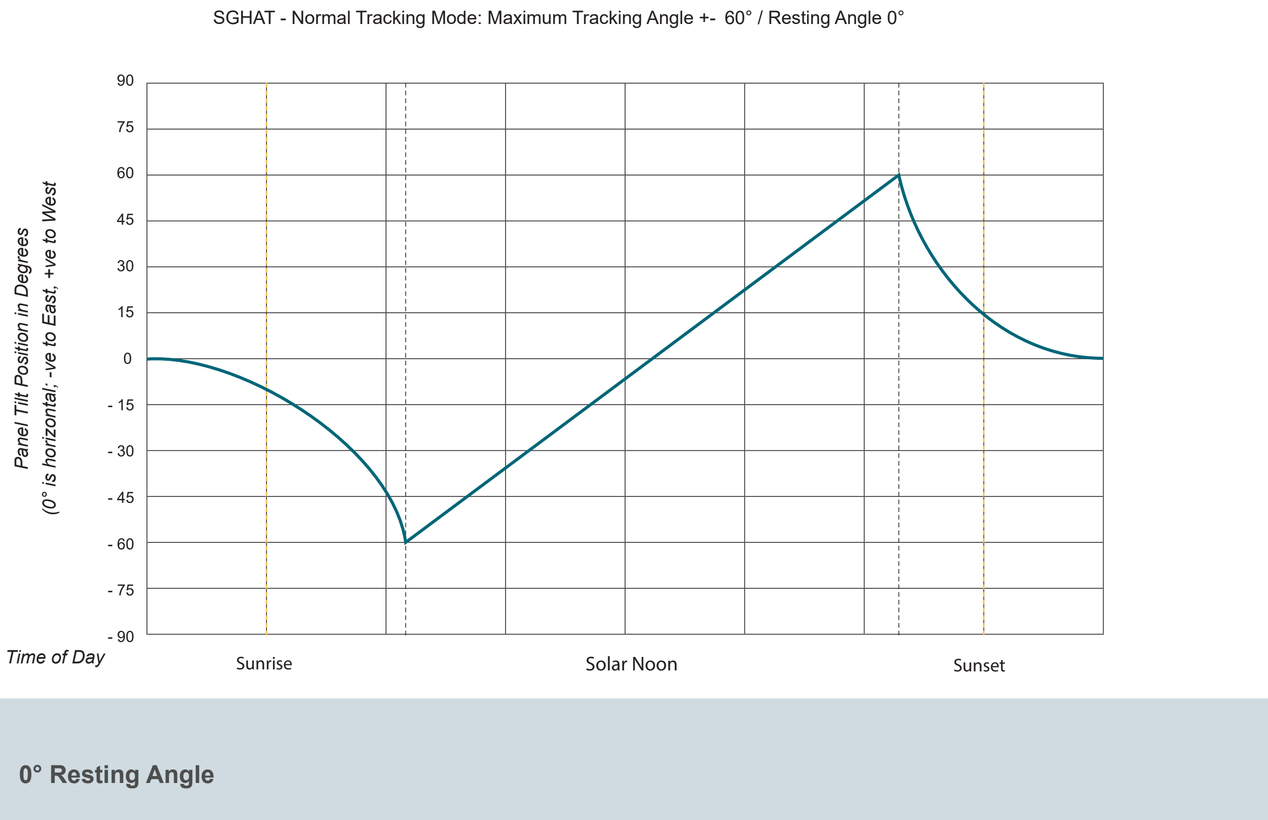


Figure 02 Normal Tracking with Backtracking and Resting Angle of 0° (2024)

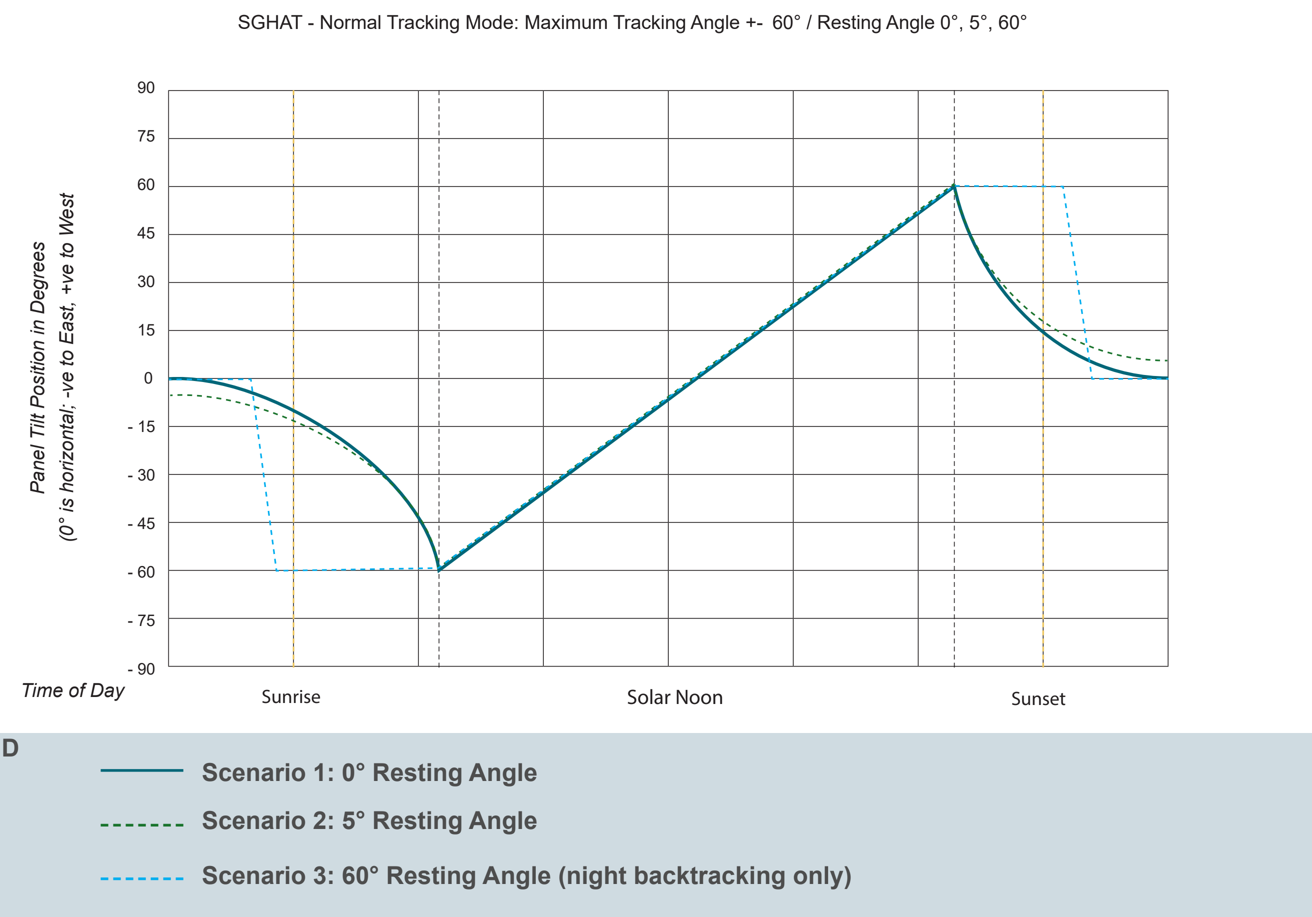


Figure 03 Backtracking Operations for Mitigation (2024)

3.0 Project Overview

3.1 Site Context

The Project is located to the northeast of Wallabadah, approximately 35 km south of Tamworth within the Tamworth Regional LGA (refer to **Figure 04**).

The Project involves the construction and operation of a solar farm consisting of a Solar Photovoltaic (PV) Array, referred to hereafter as the PV Array.

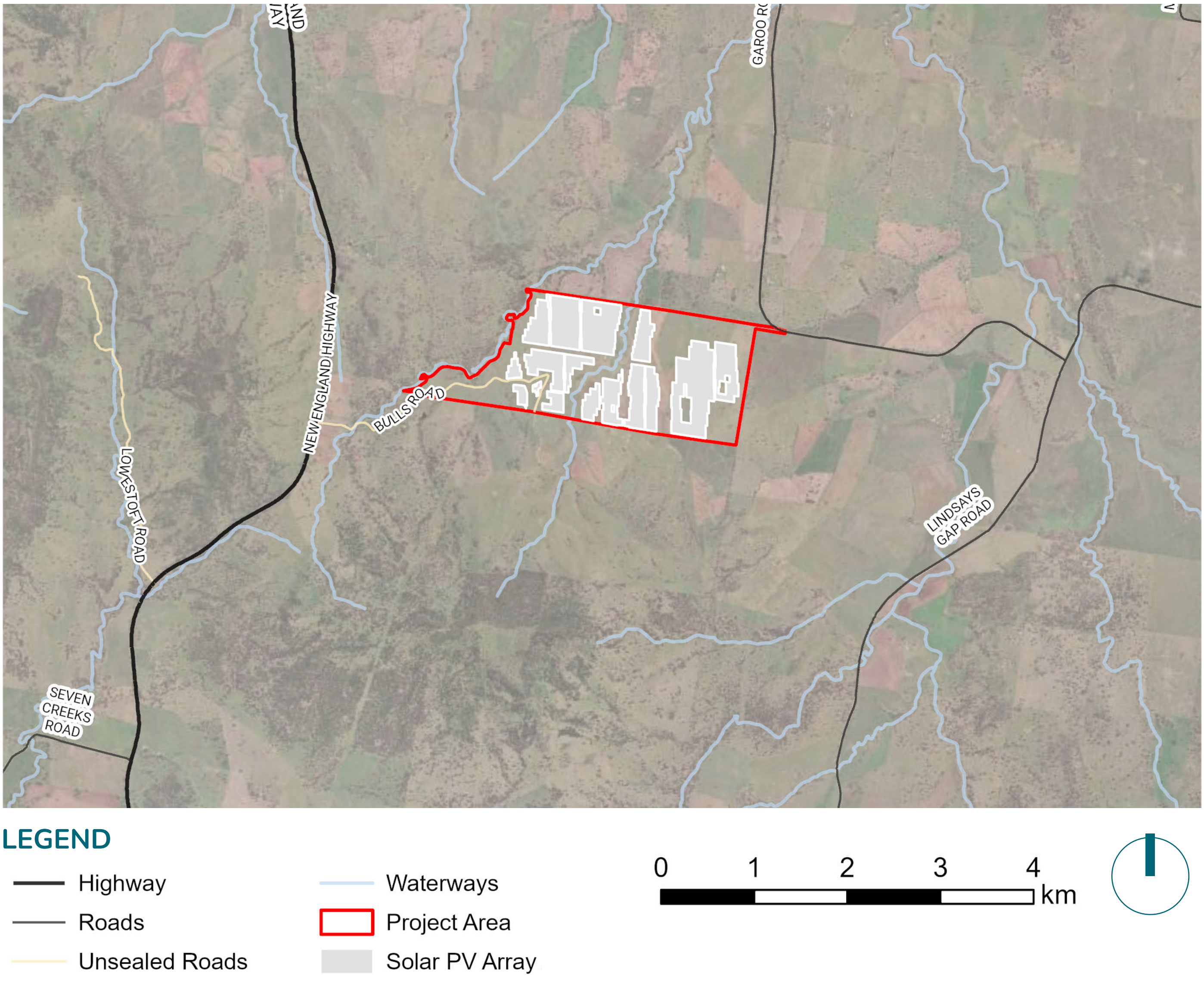


Figure 04 Project Site Context

Imagery Source: ESRI, 2024

3.2 Solar Panel Specifications

To attain optimum solar energy collection, the Project modelling has utilised a maximum rotational range of 120°. The panels are fixed on a tubular frame with a single axis tracking procedure. For accuracy, glare analysis has been performed using maximum tracker height not exceeding 2.75 m when facing at the highest angle.

Refer to **Figure 05** for typical panel dimensions utilised for this assessment.

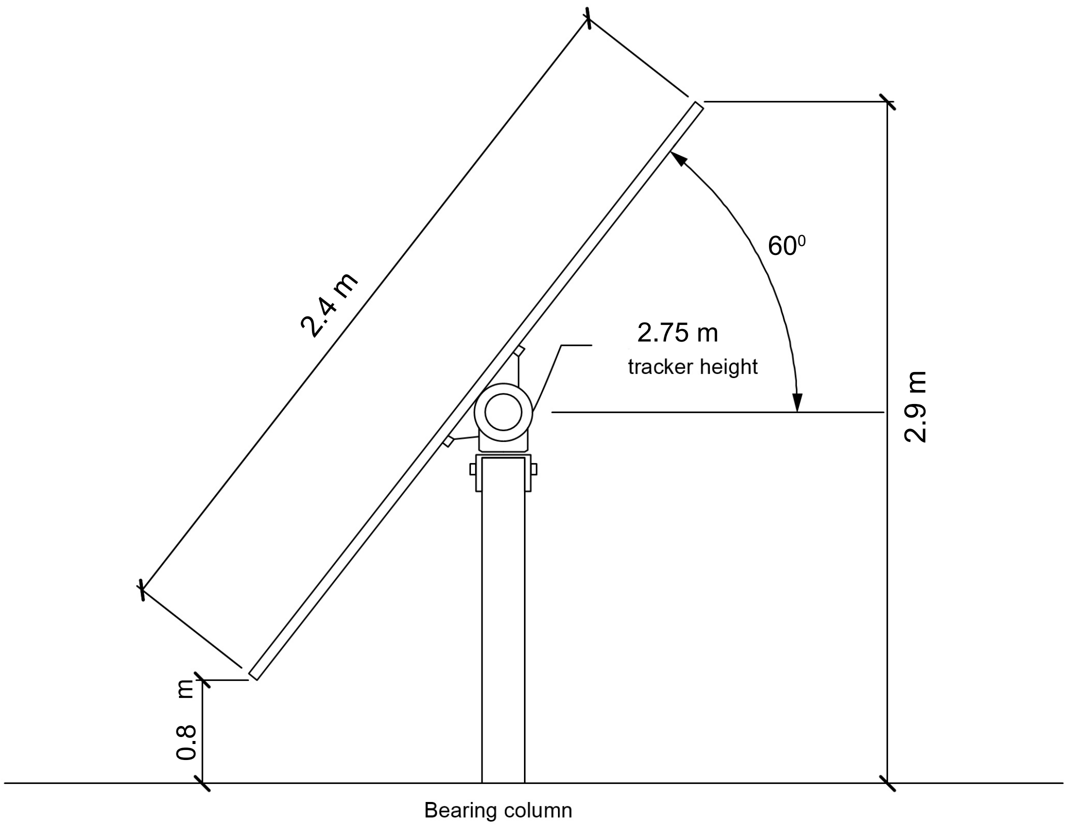


Figure 05 PV Parameters utilised for this assessment
Imagery Source: Provided by the Client

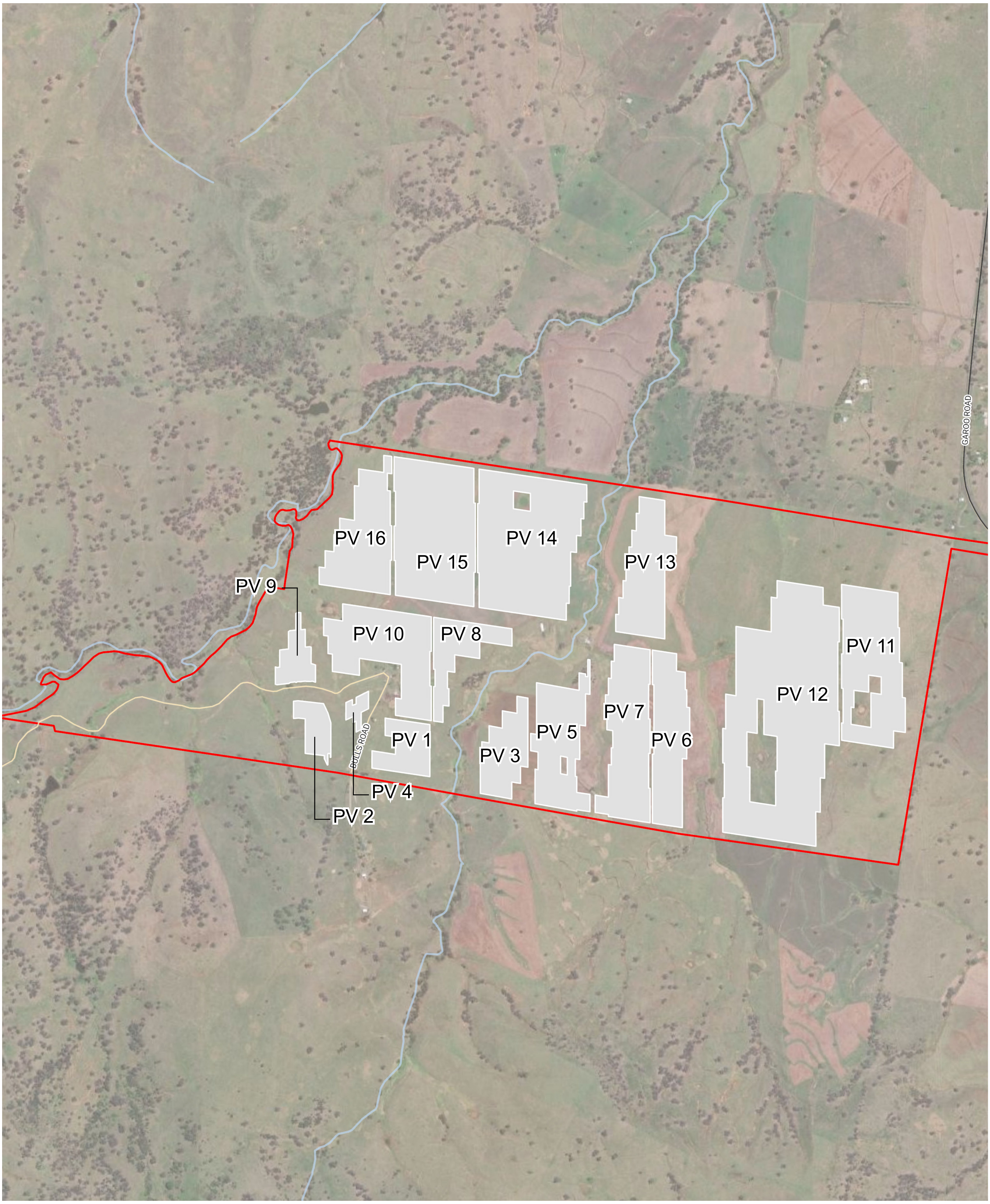
Table 03 Summary of modelling parameters (Scenario 1)

General Solar PV system inputs:			
Input Data	**Units**	**Value**	**Comments**
Time Zone	UTC	+10	Australian Eastern Standard Time (AEST)
Orientation of Array	Degrees	0	Rows aligned in north-south directions
PV Surface materials	-	Smooth Glass with Anti-Reflective Coating	Provided by ERM
Mounting Type	-	Single Axis Tracking	Provided by ERM
Panel Maximum Height	Metres	2.9 m	Provided by ERM
Panel Dimensions	Metres	2.4 (L) x 1.1 (W)	Provided by ERM
Pitch Distance	Metres	5.8 m	Provided by ERM
Single Axis Tracking Parameters			
Module Offset angle	Degrees	0	Facing upwards Panels rotate during operation
Max tracking angle	Degrees	±60° (Range of 120°)	Panels following the Sun
Resting angle	Degrees	0 (Scenario 1) 5 (Scenario 2) 60 (Scenario 3)	Angle of rotation of panels when sun is outside tracking range and backtracking rotation has settled
Maximum Tracker Height	Metres	2.75 m	Provided by ERM
Backtracking	-	Shade-Slope	Provided by ERM
Ground Coverage Ratio	-	39.7% or 0.414	Calculated (refer to **Section 2.3**)

3.3 Array Layout

A single axis tracking system follows the sun's trajectory and rotates the panels across east to west. There will be an estimated 234,000 Solar photovoltaic (PV) modules (solar panels) mounted on a north/south axis to slowly track the movement of the sun. The rows of modules will be spaced approximately 5.8 m apart to ensure no shading occurs and allow for ease of access for maintenance purposes (refer to **Table 03**).

Refer **Figure 06** for PV array areas and sections.



LEGEND

- Roads
- Unsealed Roads
- Waterways
- Solar PV Array Area
- Project Area

0 1 km

Figure 06 PV Areas

Imagery Source: ESRI Aerial Imagery 2024

4.0 Residential Receptors

4.1 Overview of Methodology

Table 04 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on residential receptors. In accordance with the Guideline, residential receptors within 3 km were considered in the Glint and Glare Assessment.

Table 04 Residential Receptors Assessment Requirements (Source: DPHI, 2024)

Glint and Glare Requirements - Residential Receivers		
Scope	**Methodology**	**Performance Objective**
All residential viewpoints within 3 km of the proposed solar array that have a line of sight to the Project. Representative viewpoints may be used for residential receivers that are clustered together.	**Analysis of the daily and yearly glare impacts in minutes.** **All residential receivers must be assessed at a height of 1.5 m above ground level.**	**Refer to Table 05.**
Note: Modelling for residential receptors is calculated on a receptor height of 1.5 m AGL.		

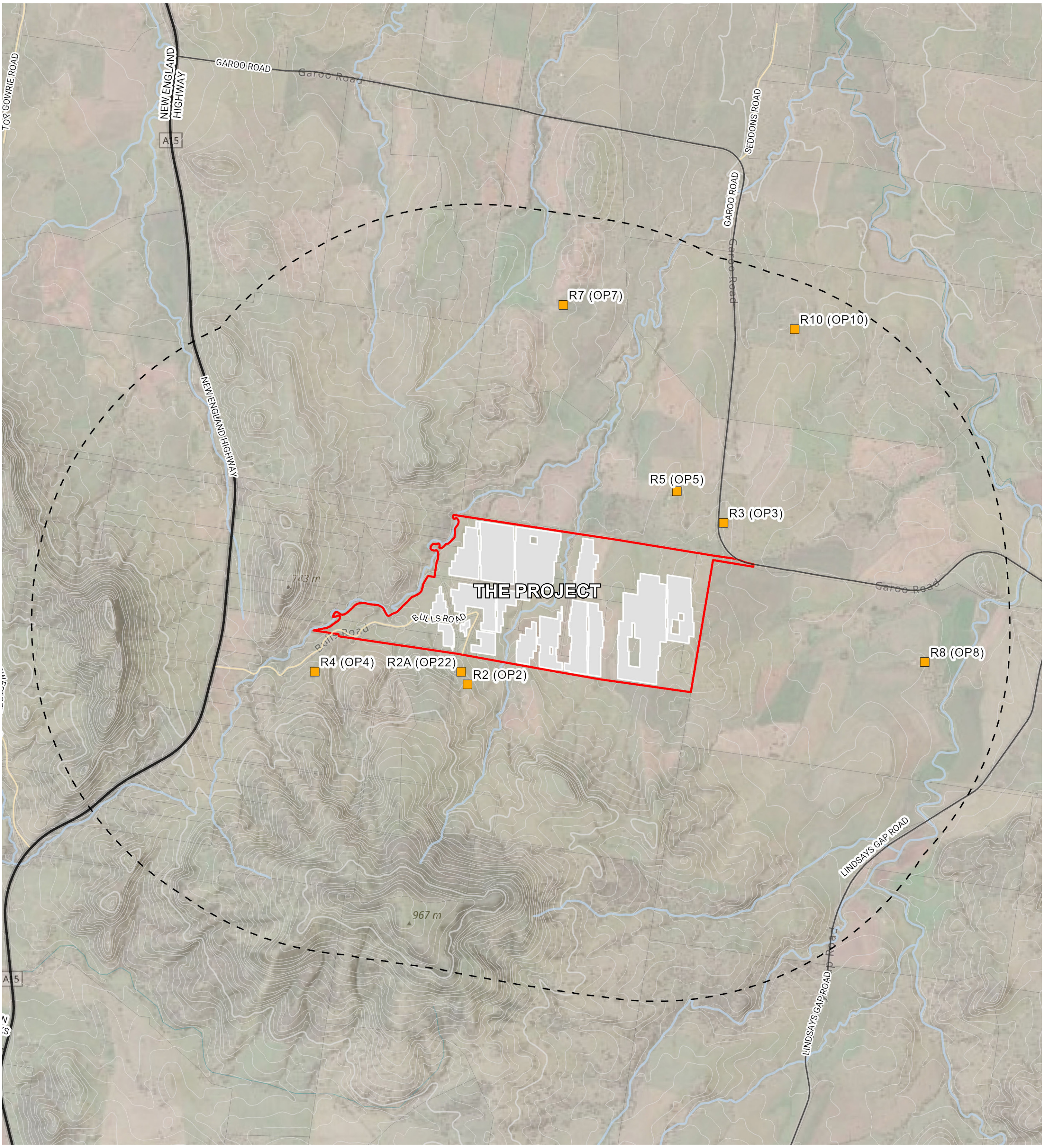
Table 05 Residential Receptor Performance Objectives (Source: DPHI, 2024)

Impact rating and performance objectives for glare impacts on residential receptors		
High Glare Impact	**Moderate Glare Impact**	**Low Glare Impact**
> 30 minutes per day **> 30 hours per year**	**< 30 minutes per day** **< 30 hours per year**	**< 10 minutes per day** **< 10 hours per year**
Significant amount of glare that should be avoided.	*Implement mitigation measures to reduce impacts as far as practicable.*	*No mitigation required.*

4.2 Residential Receptors

A desktop assessment identified eight (8) residential receptors with a line of sight to the Project within 3 km (refer to Figure 07). These have been labelled as free standing Observation Point (OP) receptors within the detailed findings (Refer to Appendix A - Glint and Glare Results).

Table 06 provides an overview of the potential annual glare experienced by the eight (8) residential receptors based on Scenario 1 (refer to **Section 2.5**).



LEGEND

- 3 km from PV Array
- Non-Associated Dwellings
- Highway
- Roads
- Unsealed Roads
- Waterways
- Lots
- Project Area
- Solar PV Array Area

0 1 2 km

Figure 07 Residential Receptors

Imagery Source: ESRI Aerial Imagery 2023

Table 06 Residential Receptor Assessment Results (Scenario 1)

Dwelling	Location	Distance to the PV Array Area (m)	Green Glare (Hours Per Year)	Yellow Glare (Hours Per Year)	Requirements
R2a (OP2)	BULLS ROAD, GAROO, NSW	293	5.8	0	Low Glare Impact, no mitigation required.
R3 (OP3)	903 GAROO ROAD, GAROO, NSW	618	0.3	0	Low Glare Impact, no mitigation required.
R4 (OP4)	108 BULLS ROAD, GAROO, NSW	544	8.2	0	Low Glare Impact, no mitigation required.
R5 (OP5)	848 GAROO ROAD, GAROO, NSW	756	0.3	0	Low Glare Impact, no mitigation required.
R7 (OP7)	418 GAROO ROAD GAROO	2143	0	0	Nil, no glare impacts
R8 (OP8)	GAROO ROAD GAROO	2206	0	0	Nil, no glare impacts
R10 (OP10)	597 GAROO ROAD GAROO	2562	0	0	Nil, no glare impacts
R2b (OP22)	BULLS ROAD, GAROO, NSW	193	1.9	0	Low Glare Impact, no mitigation required.

4.3 Residential Receptor Results

Based on the desktop assessment for Scenario 1, zero potential “yellow” glare has been identified for all dwellings in the Study Area. 'Green' Glare was identified at five (5) residential receptors.

Based on Scenario 1, all five (5) residential receptors have a low overall glare impact (less than 10 hours per year). A detailed assessment of the results indicate that:

- All five (5) residential receptors experience low levels of 'green' glare (R2a, R3, R4, R5 & R2b) and do not require mitigation.

The detailed findings for the receptors are included in the **Appendix A - Glint and Glare Results.**

**It is crucial to emphasise that this assessment is based on a worst-case scenario and does not account for factors such as weather conditions, intervening elements like vegetation, or built structures, which may influence the actual glare experienced.*

5.0 Road & Rail Receptors

5.1 Overview of Methodology

Table 07 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on road and railway line receptors. In accordance with the Guideline, road and rail receptors within 1 km were considered in the Glint and Glare Assessment.

Table 07 Road and Rail Receptor Assessment Requirements (Source: DPHI, 2024)

Glint and Glare Requirements - Road & Rail		
Scope	**Methodology**	**Performance Objective**
All roads and rail lines within 1 km of the proposed solar array.	**Solar glare analysis to identify whether glint and glare are geometrically possible within the forward looking eyeline of motorists and rail operators.**	**If glare is geometrically possible, then measures should be taken to eliminate the occurrence of glare.** **Alternatively, the applicant must demonstrate that glare would not significantly impede the safe operation of vehicles or the interpretation of signals and signage.**
Note: Modelling for road receptors is calculated on a maximum height of 2.4 m AGL - representative of the eye level for truck drivers (Source: Austroads Ltd. 2021). **Modelling for rail lines is based a representative eye height of 3 m AGL to represent the eye level of train drivers** (Source: Transport Asset Standards Authority 2020).		

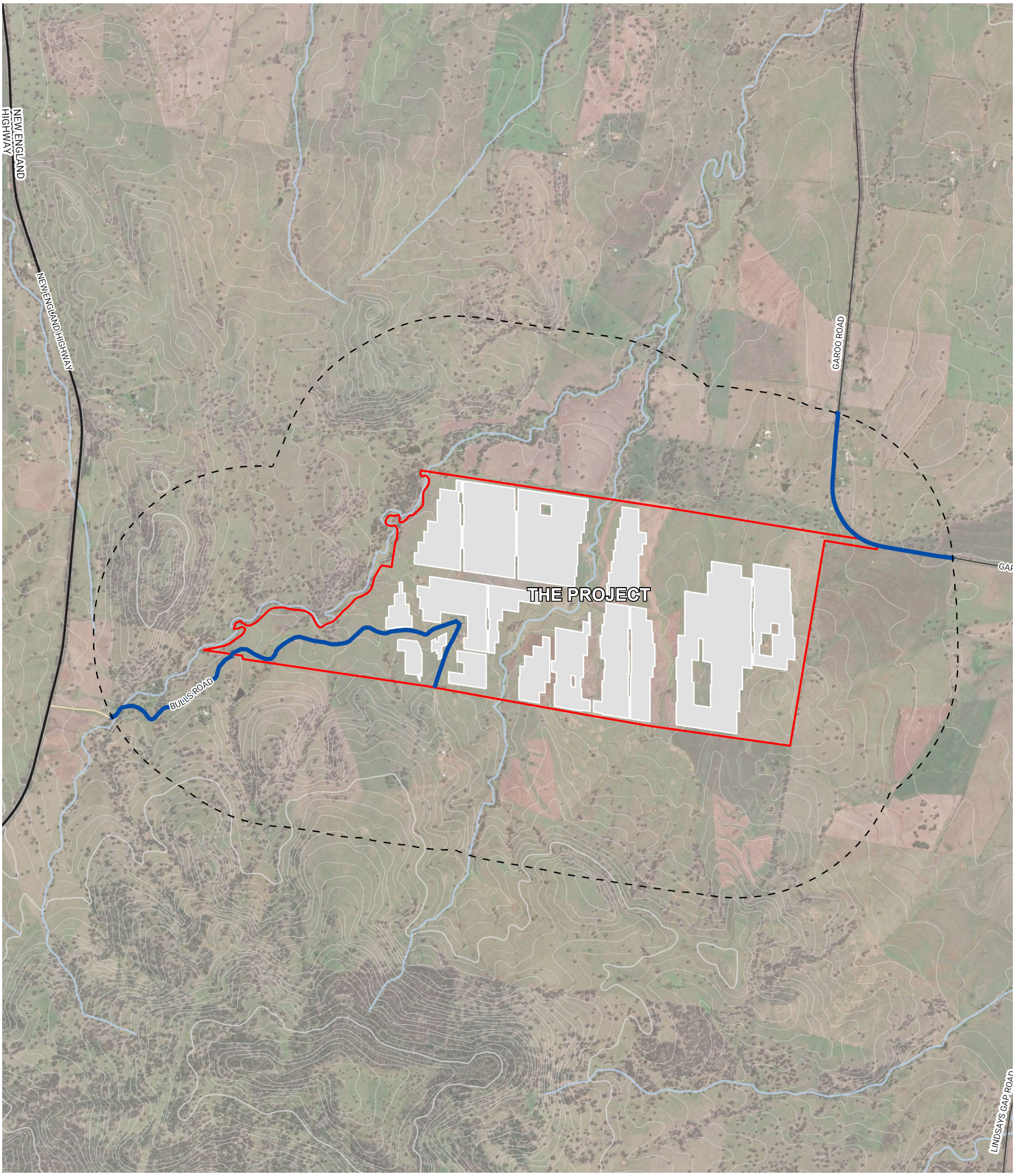
5.2 Road and Rail Receptors

A total of two (2) road receptors were identified within 1 km of the PV Array Area:

- Garoo Road
- Bulls Road (unsealed)

No rail receptors were identified within 1 km of the PV Array Area.

Figure 08 illustrates road receptors identified within 1 km of the PV Array Area.



LEGEND

- Project Area
- Solar PV Array Area
- 1 km from PV Array
- Highway
- Roads
- Unsealed Roads
- Waterways
- Roads within 1 km of PV Array

0 1 2 km

Figure 08 Rail and Road Receptors

Imagery Source: ESRI Aerial Imagery 2023

Table 08 Road & Rail receptor assessment results (Scenario 1)

Road/Rail Receptor	Distance to the PV Array Area (m)	Green Glare (Hours Per Year)	Yellow Glare (Hours Per Year)	Existing Screening Factors	Requirements
Garoo Road	440 m	27.4	0	Existing vegetation along the western side of the road, towards the Project, combined with intervening topography, provides some screening.	Low Glare Impact, no mitigation required.
Bulls Road (unsealed)	20 m	67.6	100.6	Scattered vegetation and intervening topography screens the majority of the project along the western section of the road. However limited screening exists along the road when running through the Project Area (eastern section of Bulls Road).	High Glare Impact, mitigation required. Refer to Section 8.0 for recommended mitigation.

5.3 Results of Glint and Glare Assessment - Road and Rail

Two (2) road receptors (Garoo Road and Bulls Road) were considered as part of the assessment.

Table 08 provides an overview of the annual glare experienced along the two (2) road receptors based on Scenario 1.

Impacts of Green and Yellow Glare on Road & Rail Receptors

Based on the Scenario 1, the glare assessment indicates that the Garoo Road and Bulls Road have the potential to experience 'green' glare. The potential for after-image from green glare is low; however, it may cause eye strain if observed for long periods. Due to the speed of travel along the road and rail routes, the time frame to experience the impacts of 'green' glare are short, therefore, the impacts of 'green' glare are low and do not require mitigation.

Based on Scenario 1, the glare assessment indicates that only one (1) road receptor (Bulls Road) has the potential to experience 'yellow' glare. 'Yellow' glare is expected to cause a temporary after-image, which can impact those operating vehicles on nearby roads and railways. Therefore, any potential for 'yellow' glare requires mitigation for road and rail receptors.

5.3.1 Garoo Road

Based on the Scenario 1 (worst-case) glare assessment, it has been determined that the Garoo Road is projected to experience zero ‘Yellow’ glare per year. Therefore, the potential glare impacts on Garoo Road have been deemed as a ‘low’ and do not require mitigation.

5.3.2 Bulls Road (unsealed)

Based on the Scenario 1 (worst-case) glare assessment, it has been determined that the Bulls Road is projected to experience a total of approximately 100.6 hours of 'yellow' glare per year which is deemed as a 'high' glare impact. The following outlines the PV Array areas and times that there is the potential for 'yellow' Glare:

- PV Array 10 is expected to contribute up to 20.1 hrs per year of 'yellow' glare during the period between October to March.
- PV Array 3 is expected to contribute up to 4.1 hrs per year of 'yellow' glare during the period between November to February.
- PV Array 4 is expected to contribute a significant amount of glare with up to 39.6 hrs per year during the period between October to March. The glare specifically occurs for up to 20 minute periods anytime between 5:30 pm - 7:30 pm, depending on the time of year.
- PV Array 8 is expected to contribute up to 7.9 hrs per year of 'yellow' glare during the period between May to August.
- PV Array 9 is expected to contribute up to 28.9 hrs per year of 'yellow' glare during the period between March to October.

**It is crucial to emphasise that this assessment is based on a worst-case scenario and does not account for factors such as weather conditions, intervening elements like vegetation, or built structures, which may influence the actual glare experienced.*

The detailed findings for the receptors are included in the **Appendix A - Glint and Glare Results.**

6.0 Aviation Receptors

6.1 Overview of Methodology

Table 09 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on aviation receptors. In accordance with the Guideline, aviation receptors within 5 km were considered in the Glint and Glare Assessment.

Table 09 Aviation Receptor Assessment Requirements (Source: DPHI, 2024)

Glint and Glare Requirements - Aviation Receptors		
Scope	**Methodology**	**Performance Objective**
All air traffic control towers and take off / landing approaches to any runway or landing strip within 5 km of the proposed solar array.	**Solar glare analysis that is worst case in all scenarios accounting for all aircraft using the airport (e.g. gliders, helicopters etc).**	**Any glint and glare should be avoided unless the aerodrome operator agrees that the impact would not be material (e.g. occurs at times when there are no flights or would not pose a safety risk to airport operations).**
Note: Modelling for Flight Path receptors is calculated on a threshold crossing height of 50 ft (15 m) in two mile (3.21 km) point ground elevation and the ±50 degree azimuthal and 30 degree vertical viewing angle representative of the pilot field view from cockpit (Source: Rogers, 2015).		

6.2 Aviation Receptors

The desktop assessment did not identify any landing strips within 5 km of the PV Array Area and therefore no further assessment was required.

7.0 Performance Objectives

7.1 Summary of Assessment Results

7.1.1 Residential Receptors

Table 05 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on residential receptors. The assessment undertaken by Moir Studio using Scenario 1 parameters has been summarised below:

All eight (8) residential receptors have been assessed as having a low overall glare impact.

Five (5) residential receptors (R2a, R2b, R3, R4, & R5) are projected to experience under 10 hours of glare per year, resulting in a 'low' glare impact. As a result, no further mitigation measures for these dwellings are required in accordance with the Guidelines.

The detailed glint and glare findings for the receptors are included in the **Appendix A - Glint and Glare Results.**

7.1.2 Road and Rail Receptors

Table 07 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on road and rail receptors. The assessment undertaken by Moir Studio using Scenario 1 parameters has been summarised below:

Two (2) road receptors have been assessed as having potential glare.

The assessment reveals that Bulls Road is projected to experience approximately 100.6 hours per year of "yellow" glare and Garoo Road will not be affected by "yellow" glare. It is to be noted that the results represent a worst-case scenario for potential glare, and does not account for existing mitigating factors such as weather or vegetation that will influence actual glare events.

'Yellow' glare is expected to cause a temporary after-image, which can impact those operating vehicles on nearby road and rail receptors. As noted in the performance objectives, *'If glare is geometrically possible then measures should be taken to eliminate the occurrence of glare. Alternatively, the applicant must demonstrate that glare would not significantly impede the safe operation of vehicles or the interpretation of signals and signage'.* Therefore, the 'yellow' glare impacts for Bulls Road require mitigation.

The assessment identified that Garoo Road may experience approximately 27.4 hours per year of 'green' glare, and Bulls Road approximately 67.6 hours per year of 'green' glare. It is to be noted that the results represent a worst-case scenario for potential glare, and does not account for existing mitigating factors such as weather or vegetation that will influence actual glare events.

'Green' glare is not expected to cause a temporary after-image, and only causes eye strain after a long period. Due to the speed of travel along the road and rail routes, the time frame to experience the impacts of 'green' glare are short, therefore the impacts of 'green' glare are negligible and do not require mitigation.

Mitigation strategies are detailed in Section 8.0.

7.1.3 Aviation Receptors

No aviation receptors were identified within 5 km of the Project, therefore no assessment was required.

8.0 Mitigation Measures

8.1 Summary of Assessment Results

In accordance with the Guideline: "*Details of strategies to either avoid or mitigate impacts of the Project must be provided.*" The following summarises the required mitigation for the Project: *Based on the assumptions and parameters for Scenario 1 (worst-case).

- All eight (8) residential receptors experience low potential glare impacts, and therefore do not require mitigation.
- Bulls Road may experience potential 'yellow' glare impacts and will therefore require mitigation.
- No aviation receptors were identified within the 5 km Aviation Study Area.

8.2 Proposed Mitigation Strategies

The Guideline states: "*While glint and glare impacts can be relatively uncommon, it is important to model and assess these impacts to ensure any potential significant impact is avoided or mitigated appropriately*" (DPHI, 2024).

To meet the Guideline's requirements, mitigation is necessary to reduce the impacts of 'yellow' glare on Garoo Road and Bulls Road, and both glare types on three (3) residential receptors.

Moir Studio has undertaken an additional assessment (Scenario 3) that involves modelling where no backtracking occurs during the day (only occurring at night when no glare can occur) as an operational management strategy to mitigate potential glare. As explained in Section 2.5, Scenario 3 involves modelling a different resting angle of 60° to imitate this scenario. .

The overview of results for Scenario 3 are shown in **Table 10** and **Table 11** and outlined in **Section 8.2.1** and **Section 8.2.2**. The detailed assessment results for Scenario 3 have been outlined comprehensively in **Appendix C**.

Additional mitigation measures also include revising the solar panel layout to eliminate previously identified glint and glare impacts as part of the iterative design process. Refer to **Appendix D** for details.

8.2.1 Residential Receptor Results with Mitigation

Based on the glare assessment for Scenario 3:

- **Potential glare has been eliminated at all residential receptors.**

The detailed findings for the receptors are included in the **Appendix C - Glint and Glare Results.**

Table 10 Residential Receptor Assessment Results (Scenario 3)

Dwelling	Location	Distance to the PV Array Area (m)	Green Glare (Hours Per Year)	Yellow Glare (Hours Per Year)	Requirements
R2a (OP2)	BULLS ROAD, GAROO, NSW	293	0	0	Nil, no glare impacts
R3 (OP3)	903 GAROO ROAD, GAROO, NSW	618	0	0	Nil, no glare impacts
R4 (OP4)	108 BULLS ROAD, GAROO, NSW	544	0	0	Nil, no glare impacts
R5 (OP5)	848 GAROO ROAD, GAROO, NSW	756	0	0	Nil, no glare impacts
R7 (OP7)	418 GAROO ROAD GAROO	2143	0	0	Nil, no glare impacts
R8 (OP8)	GAROO ROAD GAROO	2206	0	0	Nil, no glare impacts
R10 (OP10)	597 GAROO ROAD GAROO	2562	0	0	Nil, no glare impacts
R2b (OP22)	BULLS ROAD, GAROO, NSW	193	0	0	Nil, no glare impacts

Table 11 Road & Rail receptor assessment results (Scenario 3)

Road/Rail Receptor	Distance to the PV Array Area (m)	Green Glare (Hours Per Year)	Yellow Glare (Hours Per Year)	Existing Screening Factors	Requirements
Garoo Road	440 m	0	0	Existing vegetation along the western side of the road, towards the Project, combined with intervening topography, provides some screening.	Nil, no glare impacts
Bulls Road (unsealed)	20 m	0	0	Scattered vegetation and intervening topography screens the majority of the project along the western section of the road. However limited screening exists along the road when running through the Project Area (eastern section of Bulls Road).	Nil, no glare impacts

**It is crucial to emphasise that this assessment is based on a worst-case scenario and does not account for factors such as weather conditions, intervening elements like vegetation, or built structures, which may influence the actual glare experienced.*

8.2.2 Road and Rail Receptor Results with Mitigation

Based on the glare assessment for Scenario 3:

- **Potential glare has been eliminated at all road receptors (Garoo Road and Bulls Road).**

The detailed findings for the road and rail receptors are included in the **Appendix C - Glint and Glare Results.**

**It is crucial to emphasise that this assessment is based on a worst-case scenario and does not account for factors such as weather conditions, intervening elements like vegetation, or built structures, which may influence the actual glare experienced.*

8.3 Mitigation Results Summary

The Glint and Glare Assessment conducted for Scenario 3 has identified that utilising a 60° resting angle/no backtracking occuring during daylight hours, results in:

- Removal of all potential glare from all residential receptor. Therefore, utilising the solar panel tracking angles from Scenario 3 results in acceptable glare impacts for all residential receivers.
- Removal of all potential glare from Garoo Road. Therefore, utilising the solar panel tracking angles from Scenario 3 results in an acceptable glare impact from Garoo Road.
- Removal of all potential glare from Bulls Road. Therefore, utilising the solar panel tracking angles from Scenario 3 results in an acceptable glare impact from Garoo Road.

9.0 Conclusion

9.1 Conclusion

The purpose of this Glint and Glare Assessment Report is to identify potential glare impacts from the Project on the surrounding area, including residential receptors (within 3 km of the PV Array Area), road and rail receptors (within 1 km of the PV Array Area), and aviation receptors (within 5 km of the PV Array Area). Moir Studio has undertaken the assessment in accordance with the assessment process outlined within the NSW DPHI's 'Large Scale Solar Energy Guideline (2024)'.

Based on the assumptions and parameters for **Scenario 1** (refer to **Section 2.5**), the findings of the assessment are as follows:

Eight (8) residential receptors were identified within 3 km of the PV Array Area and within a line of sight to the Project. Upon assessment, it was determined that all eight (8) residential receptors have a low overall glare impact and therefore do not require mitigation.

Two (2) road receptors, Garoo Road and Bulls Road, were identified within 1 km of the PV Array Area. Garoo Road will not experience any 'yellow' glare and therefore does not require mitigation. Bulls Road may experience approximately 100.6 hours of 'yellow' glare per year. Mitigation measures are required to address the potential impacts of 'yellow' glare from Bulls Road.

Both road receptors may experience 'green' glare, however the glare impacts from 'green' glare only occur when exposed for long periods of time. Therefore, any impacts of 'green' glare from road or rail receptors, where exposure time is short, are low and do not require mitigation.

To mitigate against 'yellow' glare for the affected road receptor (Bulls Road), an alternate tracking pattern, as modelled in **Scenario 3** (refer to **Section 2.5**) is recommended (i.e. no backtracking occurs during daylight hours and panels only move to overnight resting angle during the night). **Scenario 3** will effectively eliminate all potential for glare from all receptors, including the eight (8) residential receptors and two (2) road receptors.

No aviation receptors were identified within 5 km of the PV Array Area. Therefore, no further assessment was required.

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Glint & Glare Appendix A

Scenario 1

Glint & Glare Appendix B

Scenario 2

Glint & Glare Appendix C

Scenario 3