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Attention: Mr David Pradd
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11A Newton Street
Richmond VIC 3121

SLR Project No.: 640.30523.00101

RE: Hazelwood North Solar Farm
Helipad Aviation Glare Assessment

Introduction

SLR has previously completed a glint and glare assessment for this project covering the surrounding roads, railway and residences (Report 640.30523-R02-v1.0-20230627).

Following on from this, a request for information has been made to investigate the impact of the solar farm on the helicopter operations at nearby Latrobe Regional Hospital.

Figure 1 Aerial View of Site

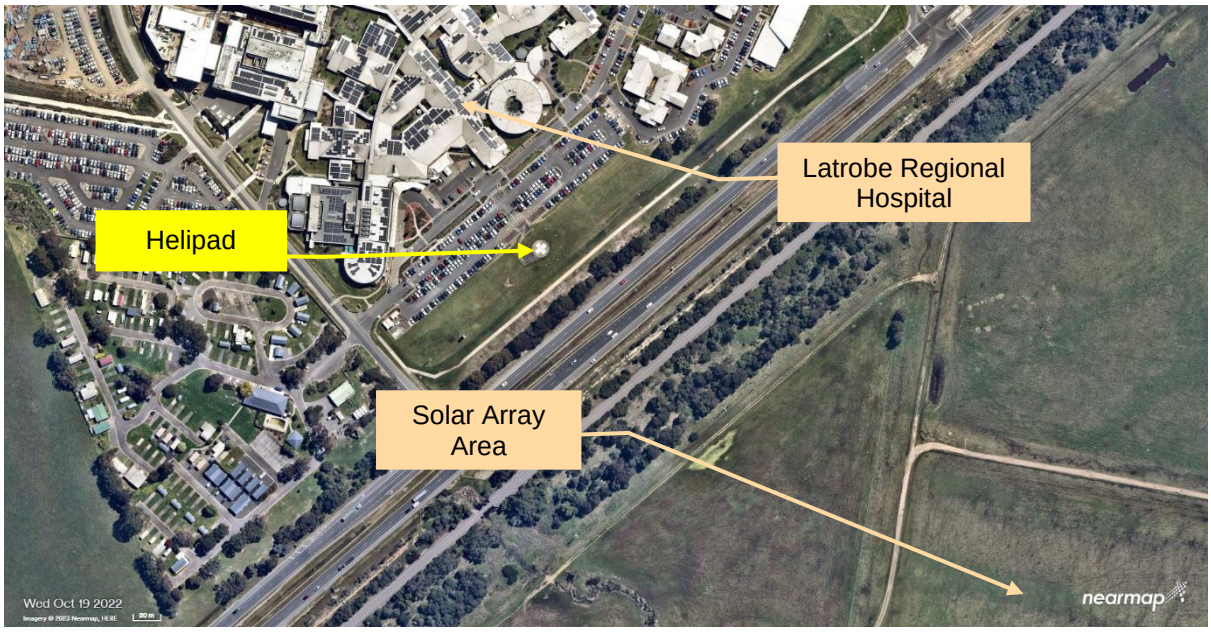


Image: Nearmap (October 2023)

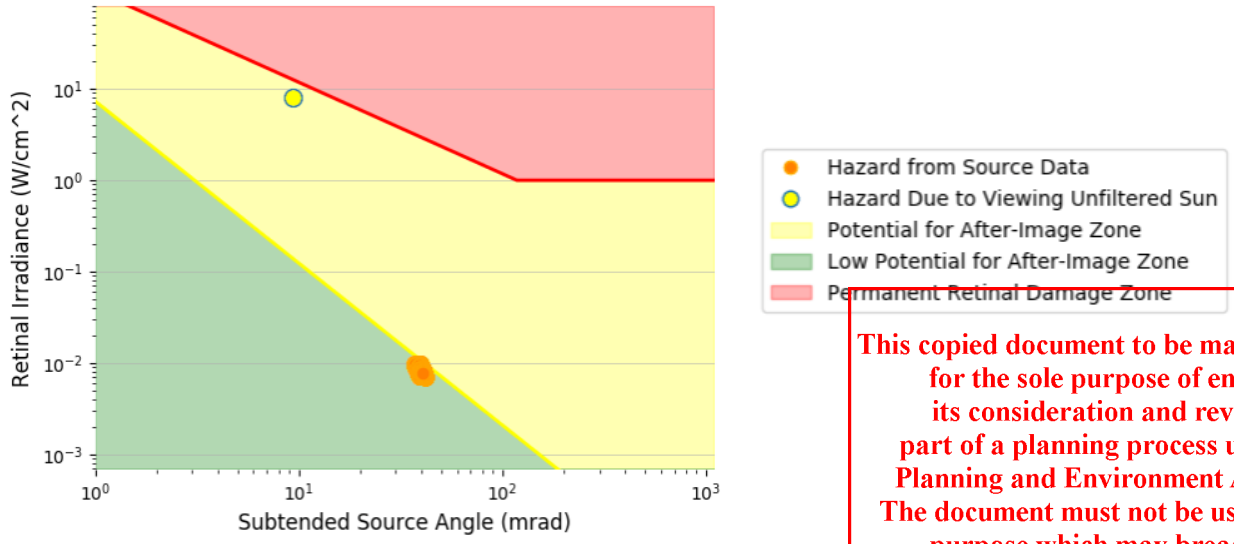
The heliport is located on the north side of the Princes Highway approximately 300 metres from the edge of the solar arrays.

Background

The SGHAT modelling provides output in the form of an ocular hazard analysis plot, a sample of this is shown in **Figure 2**.

The analysis contained in this plot is derived from solar simulations that extend over the entire calendar year in 1-minute intervals, sunrise to sunset.

Figure 2 Example Solar Glare Ocular Hazard Plot (SGHAT Software Output)



The following is noted regarding the figure above:

- SGHAT ocular impact is a function of both the "retinal irradiance" (ie the light seen by the eye) and "subtended source angle" (ie how wide an arc of view the light appears to be arriving from).
- SGHAT ocular impact falls into three categories:
  - . GREEN: low potential to cause "after-image"
  - . YELLOW: potential to cause temporary "after-image"
  - . RED: potential to cause retinal burn (permanent eye damage)
- "After Image" is the term applied to a common retinal phenomenon that most people have experienced at some point or other, such as the effect that occurs when a photo with flash is taken in front of a person who then sees spots in front of their eyes for a few seconds. A more extreme example of "after-image" occurs when staring at the sun. "After-image" (also known as "photo bleaching") occurs because of the de-activation of the cells at the back of the eye's retina when subjected to a very bright light.
- The SGHAT plot provides an indication of the relative intensity of both the incoming reflection and the sources of light itself (ie the sun).

  . The occurrence of glare is shown in the plot as a series of **orange circles**, one circle for each minute that a reflection is visible.

  . A reference point is also shown in each SGHAT plot, the **yellow circle** with the **green outline**, representing the hazard level of viewing the sun without filtering, ie staring at the sun.
- In **Figure 2**, it can be seen that the reflection visible by the receiver is roughly 1,000 times less intense than the light from the sun.

- Finally, in relation to PV Solar facilities, it is important to note that the third SGHAT Ocular Plot "RED" category is not possible, since standard PV modules do not focus reflected sunlight.

Methodology

While there are specific requirements for aeroplane pilots built into the SGHAT software, this is not available for helicopter pilots, so the following details the modelling process.

To begin with, the same flightpath modelling elements will be used. These extend 3.2 km from the helipad with viewing angles of 50^0 side to side and 30^0 downward, typical of aviation policies. These elements cover the landing phase and this assumption will be kept for this exercise.

Theoretically, the helipad at Latrobe Regional Hospital can be approached from any bearing. In practice, this is not the case. Through consultation with Air Ambulance Victoria, it is understood that helicopters are not flown over the hospital buildings and the most frequently used approaches are from the northeast or southwest parallel to Princes Highway. The other possible approach is in the case of strong northerly winds when approaches are made from the south. These three approach bearings have been included in the present modelling.

Next the downward approach angle needs to be determined. Three scenarios have been modelled:

- A typical flightpath element angle of 3^0.
- Section 3.3 of the Victorian Government's Protection of EMS helicopter flightpaths for the Latrobe Regional Hospital helipad document discusses an approach with an elevation 40 m above the helipad at a distance of 250 m. This gives an approach angle of approximately 9^0. To provide some conservatism in the results SLR has used an angle of 10^0.
- The final approach modelled was an essentially flat approach at a height of 50 m above ground level to the helipad before descending vertically to land.

The same PV array layout was used as for the previous glint and glare report and the tree lines between the helipad and the PV arrays were also included.

Other assumptions made for the modelling are as follows.

- 50 degree single axis tracking panels have been used.
- Backtracking with a rest angle 0 degrees and ground coverage ratio of .35 has been used.
- Direct Normal Irradiance has been set to vary during the day.
- The array area has been broken into 13 smaller sub-arrays to better follow the terrain features.

Requirements

The SGHAT model is typically applied to fixed wing aircraft but given the general acceptance of the Forge Solar SGHAT software tool by the FAA and other regulatory bodies around the world, the accompanying SGHAT acceptance criteria will be used, namely:

- Aircraft Landing: NO YELLOW Glare (GREEN is permissible)

Glare Impacts

Modelling Inputs

The figure below shows the helicopter approach paths in red, the tree lines in orange and the nearby solar panel arrays in blue.

Figure 3 Modelling Setup

Modelling Results

The results for each scenario are summarised in the tables below.

Table 1 Scenario 1 – 3^0 Slope

Approach Bearing	SGHAT Modelling Result
Northeast Approach	No glare impacts
Southwest Approach	"Yellow" impact glare was found to occur in the early morning emanating from a number of PV sub-arrays. This occurs in most locations along the flightpath.
South Approach	"Yellow" impact glare was found to occur in the morning and afternoon during the winter months and occasionally around midday. These reflections tend to originate from PV sub-arrays which the flightpath is passing over.

Table 2 Scenario 2 – 10^0 Slope

Approach Bearing	SGHAT Modelling Result
Northeast Approach	No glare impacts
Southwest Approach	Yellow" impact glare was found to occur in the early morning emanating from the same PV sub-arrays as Scenario 1. This occurs in most locations along the flightpath. Modest increases in impact duration were found to occur at this angle.
South Approach	"Yellow" impact glare was found to occur in the morning and afternoon during the winter months and occasionally around midday also during the winter months. These reflections tend to originate from PV sub-arrays close to the flightpath. Modest decreases in impact duration were found to occur at this angle.

Table 3 Scenario 3 – Flat and Descend

Approach Bearing	SGHAT Modelling Result
Northeast Approach	No glare impacts
Southwest Approach	While "Yellow" impact glare still occurred in the early morning, there was a moderate reduction found in impact duration when compared to the other scenarios.
South Approach	Similar overall "Yellow' impact glare was found for this case when compared to Scenario 1.

Recommendations

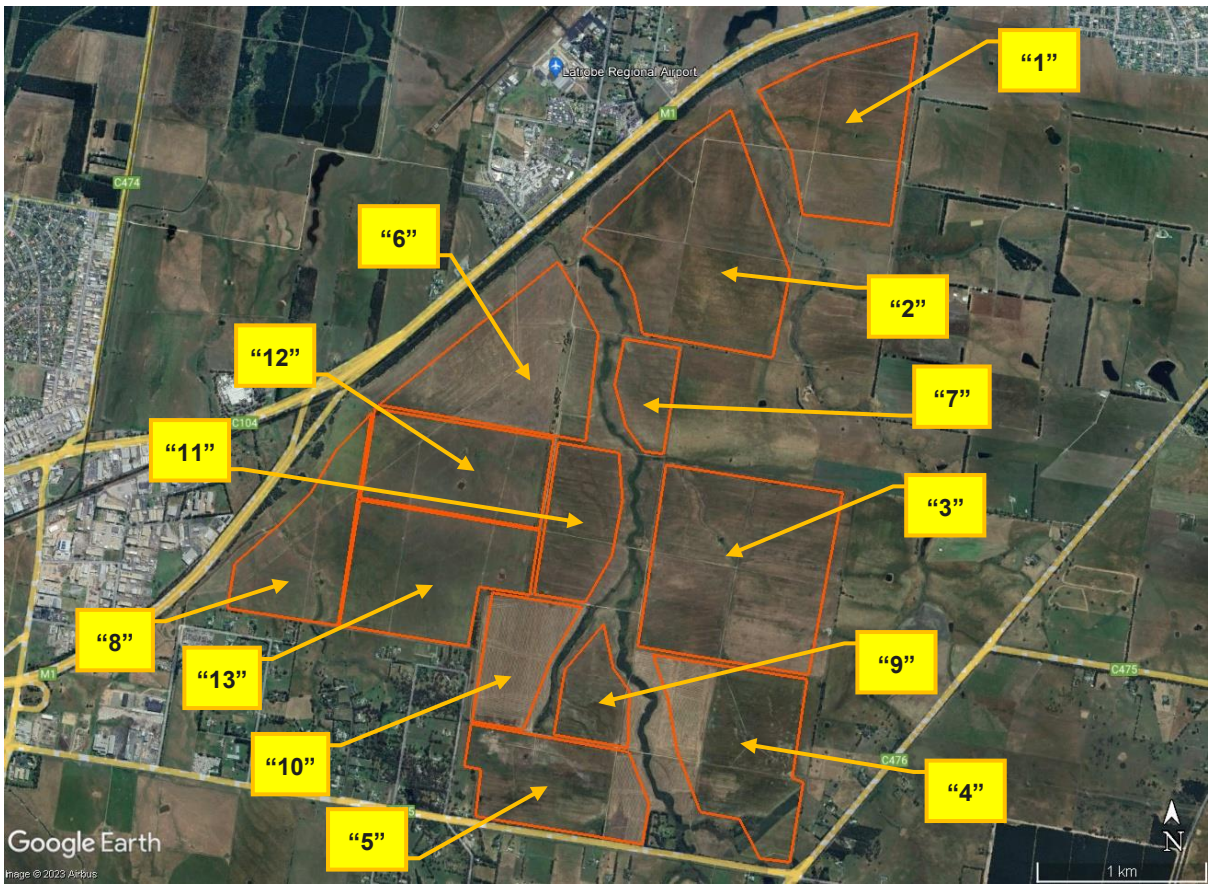
These results indicate that some of the typical flight paths can be impacted by glare which would be deemed unacceptable for pilots on the final approach to landing. As increased facility perimeter shielding would not be effective, an operational mitigation approach may be appropriate in this situation. The following factors would need to be taken into account:

- The northeast approach can be used at any time.
- The southwest approach should be avoided in the early morning (generally before 8:30 am).
- If a southerly approach is required, the time of day should be considered to avoid the incidence of solar reflections. For example, in the morning the approach should have an easterly component and in the afternoon the approach should have a westerly component.

Results Discussion

The following shows examples of the glare conditions found in the modelling. The sub-array modelling layout is shown below.

Figure 4 HNSF Modelling Layout



Southwest Approach

Reflections impacting on this approach tend to come from the areas just to the south of the road. As an example the results for Sub-array 8 are shown. Figure 5 shows the that the glare impacts occur in the early morning for a maximum of approximately 18 minutes. Figure 6 shows that this occurs across most of the sub-array footprint and generally in the first half of the approach.

Figure 5 Time of Glare Occurrence

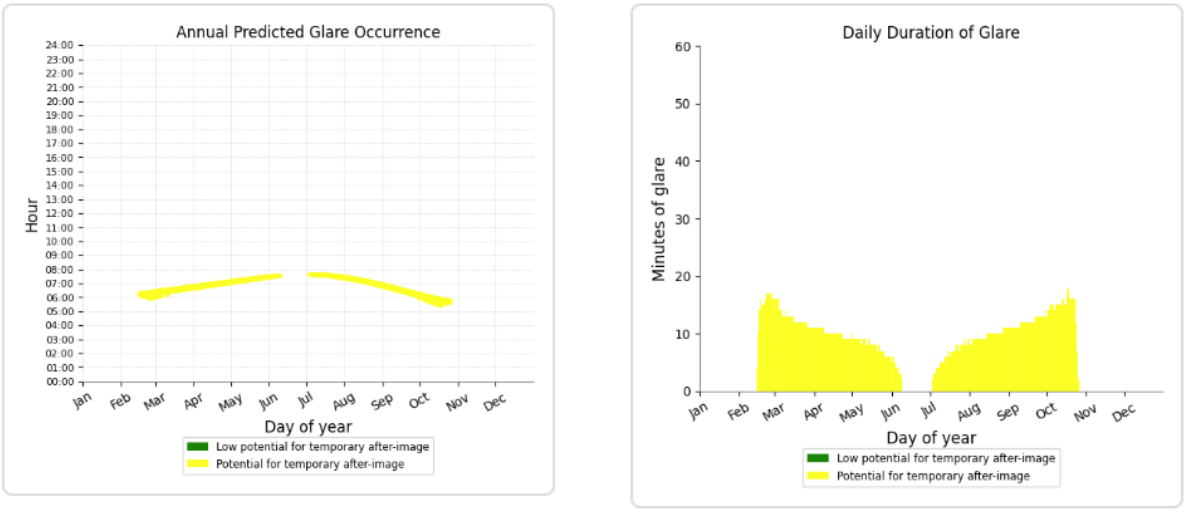
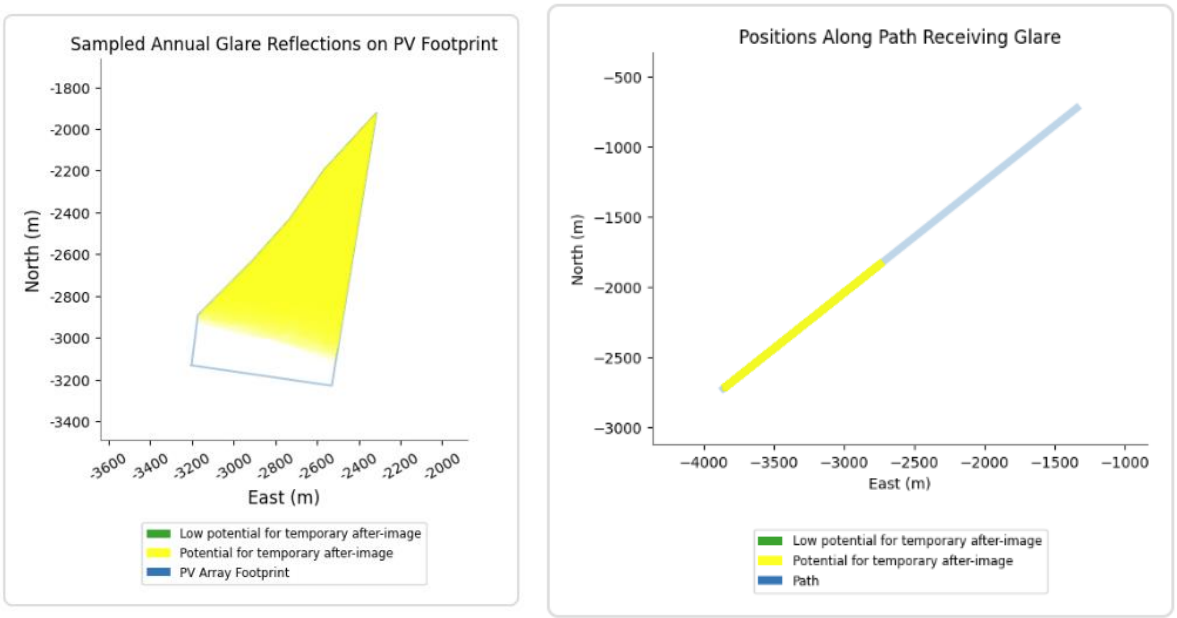


Figure 6 Location of Occurrence



South Approach

As discussed reflections impacting on this approach tend to come from the subarrays that the approach passes over. As an example the results for Sub-array 11 are shown. Figure 7 shows the that the glare impacts here more toward the afternoon with a band of “yellow impact glare in the morning between roughly 8am and 9am the total minutes per day is significant but is mostly in the “green” impact range which is acceptable. Figure 8 shows that this occurs from the part of the sub-array which is closet to the flightpath and again is generally in the first half of the approach.

Figure 7 Time of Glare Occurrence

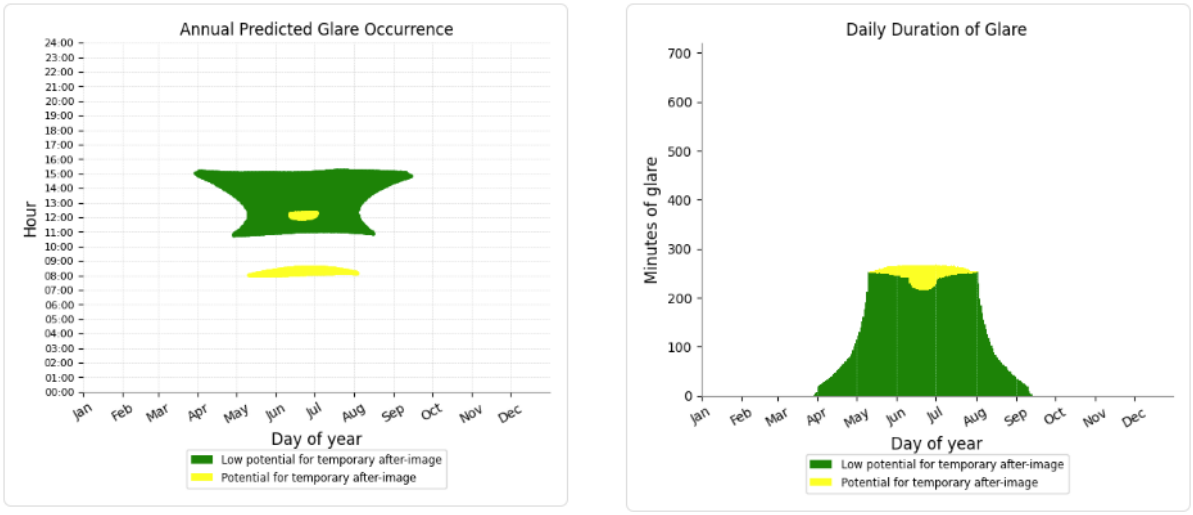
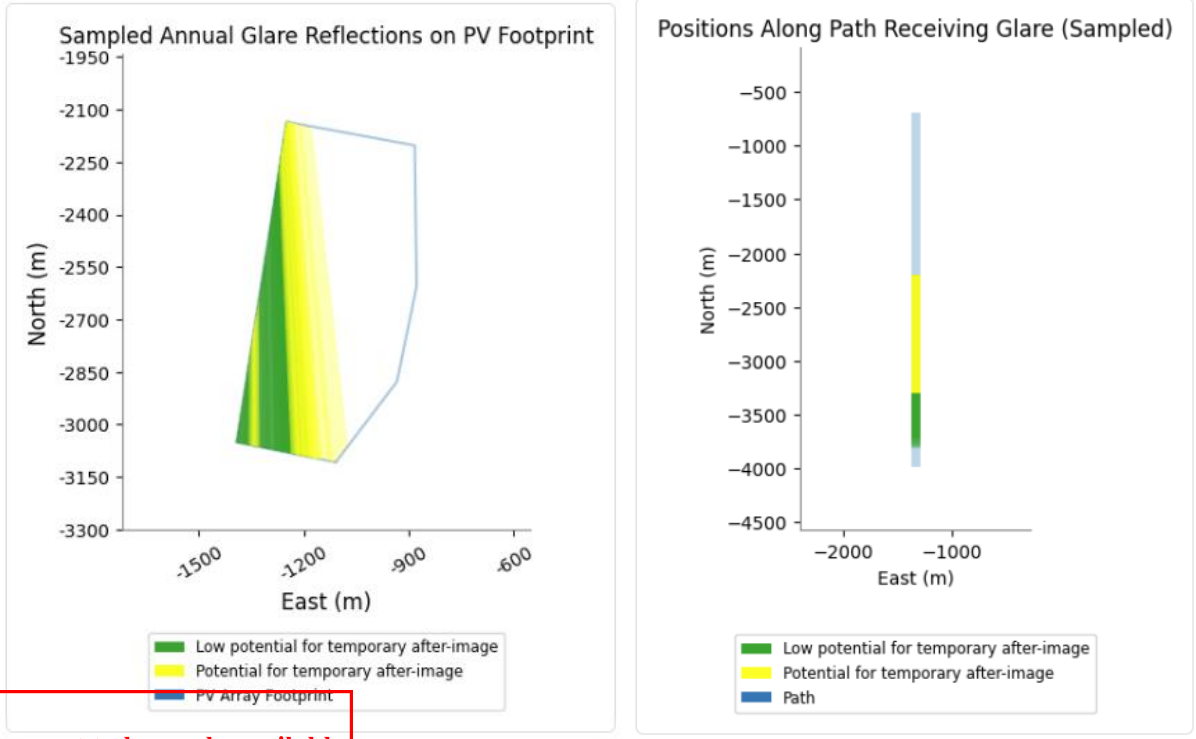


Figure 8 Location of Occurrence



Closure

In conclusion, SGHAT "yellow" impact level glare was found for the southwest and south approaches. SLR has provided operational recommendations which minimise or avoid this impact.

It should be noted that the results are conservative as the modelling assumes sunny days all year round which will not be the case. By looking at modelling for Traralgon's climate a better picture of the actual conditions can be seen. Impacts on the south approach occur generally across the cooler months from mid-April till the end of August. Across this period the sky conditions are expected to be mostly cloudy of overcast at least 38% of the time. Impacts on the southwest approach occur over most of the year where the sky conditions are expected to be mostly cloudy of overcast at least 29% of the time. While this will not affect maximum daily durations, the total minutes of "yellow" glare experienced across the year can be expected to be approximately 60-70% of what is shown in the SGHAT models depending on the time of year.

Since the inception of the US Federal Aviation Administration's (FAA) interim policy covering glare from solar installations, the FAA has released updated guidance. This concluded the glare from solar installations is similar to the routine glare experienced by pilots from bodies of water and glass-facade buildings. The scope of the policy has been refined to focus on the glare received by air traffic control towers. It is also noted that the FAA strictly applies only to "Solar Energy System Projects on Federally-Obligated Airports".

At SLR we have taken a precautionary approach and have continued to include assessment of approach flightpaths when they are within five kilometres of a proposed facility, given that this is a still a new source of glare. In doing so we take into account the severity of the SGHAT predictions in terms of both the duration and the magnitude of predicted "yellow" zone glare, when recommending consideration of mitigation.

In the example shown in Figures 5 and 6, the predicted yellow glare occurred for a significant daily duration for a little over half of the year and was clearly in excess of the "green"/"yellow" glare impact boundary. Accordingly we felt it appropriate to consider a mitigation strategy.

SLR has also been advised by Latrobe Regional Hospital of plans to move the helipad to a new location on completion of the Stage 3 building works. There are several proposed locations, but this is yet to be finalised. This report covers only the existing helipad location and could be updated once the ultimate location has been determined.

Kind Regards,

SLR Consulting Australia

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References

https://weatherspark.com/y/144333/Average-Weather-in-Traralgon-Australia-Year-Round

The stations contributing to this reconstruction are:

- RAAF Base East Sale (YMES, 78%, 54 km, east, -39 m elevation change)
- Moorabbin Airport Aws (YMMB, 22%, 128 km, west, -31 m elevation change)

All other weather data, including cloud cover, precipitation, wind speed and direction, and solar flux, come from NASA's MERRA-2 Modern-Era Retrospective Analysis. This reanalysis combines a variety of wide-area measurements in a state-of-the-art global meteorological model to reconstruct the hourly history of weather throughout the world on a 50-kilometer grid.

Weather Spark gives the following caveats:

"We draw particular cautious attention to our reliance on the MERRA-2 model-based reconstructions for a number of important data series. While having the tremendous advantages of temporal and spatial completeness, these reconstructions: (1) are based on computer models that may have model-based errors, (2) are coarsely sampled on a 50 km grid and are therefore unable to reconstruct the local variations of many microclimates, and (3) have particular difficulty with the weather in some coastal areas, especially small islands."