AMENITY REPORT

BOOKAAR SOLAR FARM

Bookaar Renewables Pty Ltd

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Introduction

1.1 REPORT PURPOSE

This report assesses potential amenity impacts associated with the proposed Bookaar Solar Farm (the 'Proposal') on the surrounding area. In doing so, the report addresses the application requirements relating to amenity considerations listed under Clause 53.13 of the Corangamite Planning Scheme and the Solar Energy Facilities Design and Development Guideline July 2019 (the 'Guideline'). Specifically the report considers:

- Noise and vibration;
- Glint;
- Light Spill;
- Emissions to air, land and water;
- Smell; and
- Electromagnetic interference.

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1.2 THE SITE

The Site is approximately 588 ha and is defined as 520 Meningoort Road, Lots 51 and 52 and Res 1 on LP4677 and adjacent parts of Meningoort Road, Bookaar. The Site is located within two broader landholdings which are currently used for agriculture.

The landholdings are dominated by Mount Meningoort which is a volcanic cone that sits in its centre. The main homestead, known as 'Meningoort', is situated at the base of Mount Meningoort overlooking the southern extent of the landholding. The homestead includes an adjoining garden and a number of outbuildings all of which are listed on the Victorian Heritage Register (Ref no. H300). The homestead is a grand, single-storey, bluestone Italianate building which dates back to 1851, and is considered to be of architectural, historical and scientific (horticultural) significance to the State of Victoria. A number of other modern dwellings are located within the grounds of the homestead.

The rest of the land within the landholdings is generally flat and dominated by improved open pastures and characteristic wind breaks (tree lines) along some fence lines. The topography slopes gently in a southerly direction with a more undulating section of land located in the north west corner.

A high voltage transmission line suitable for distributing electricity generated by the Proposal transects the area connecting the Terang and the Ballarat substations of the National Electricity Market. A local 11kv distribution line also crosses the area in general location of Meningoort Road (north).

The Site lies within the Blind Creek catchment which is itself a tributary of the Mt Emu Creek catchment. Blind Creek catchment generally flows from north to south. During small rainfall events the runoff is collected in a series of mostly constructed drains through the catchment. One of the more significant drains within this series of drains crosses the Site in an East West direction (the 'East-West Drain').

The Site is surrounded by agricultural land and there are generous distances to dwellings from the Site Boundary. There are only four (4) dwellings within 1 km to the Site, the nearest of which is approximately 450m. These dwellings are shown in Figure 1.

The Site for the Proposal has been carefully selected to avoid sensitive areas identified through technical studies conducted to support this application and to ensure access to the high voltage transmission lines. The final location of the Site is shown on the plan titled 'Design Response' and illustrates how the Proposal has been situated outside constraints identified within the two host landholdings and the wider area.

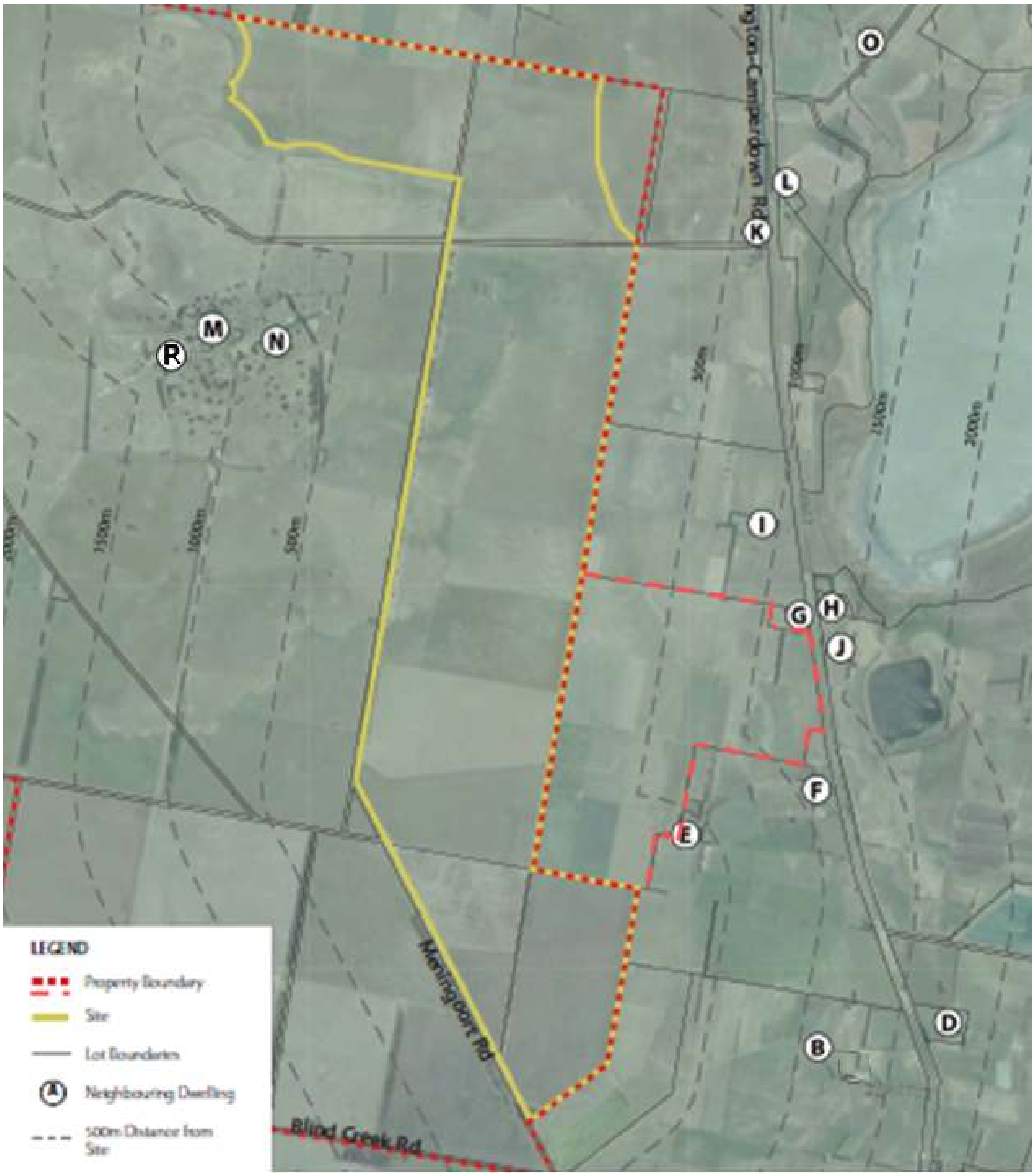

Figure 1: Site boundary and nearby dwellings with approximate 500 m distance rings

Note dwellings 'M', 'N' and 'R' **are landowner properties.**

1.1 The Proposal

The Proposal involves the installation of a solar energy facility with a capacity of 200 MWac (282 MWdc). The Proposal includes the following elements (see Figure 2, the 'Site Plan'):

- 'Array Areas', containing Photovoltaic (PV) panels mounted on a single axis tracking system with a maximum height of 4 m above natural ground at maximum tilt. The tracking system would be supported by piles driven into the ground. Row spacing is either 12.75 m south of the 220kV transmission lines, or 13 m north of the 220 kV transmission lines (pile to pile);
- 82 inverters located centrally throughout the Site in pairs at 41 locations across the Site (inverter stations). Inverter stations are located at least 170 m from the Site boundary;
- Below ground cabling connecting the PV panels between trackers and inverters;
- Below ground cabling connecting the inverters to the substation;
- An internal track network of all-weather gravel tracks (4 m), including a perimeter track which forms part of a 10 m wide defendable Asset Protection Zone (APZ) that surrounds the Site;
- Four (4) gated main site access points via Meningoort Road (north);
- Four (4) gated emergency access points along the western boundary of the Site;
- Eight dedicated water tanks for firefighting (maximum of 3.6m high), located adjacent to each access point;
- A perimeter security fence 2.5 m high (chain mesh);
- Perimeter vegetation screens (20 m wide with 4 rows of trees and maintained to a height of at least 4 m), planted on the outside of the security fencing;
- Agricultural style fencing 1.2m high, around the perimeter of the vegetation screens and the perimeter of existing vegetation on the western boundary;
- A SCADA system that will gather, monitor and analyse data generated through operating the Proposal;
- On-demand, downward facing lighting (restricted to 4m in height); and
- Sensor triggered CCTV security cameras located around the perimeter of the Site and adjacent to key infrastructure.

Substation Area (1.76 ha, see 'Site Plan, Appendix A'):

- Substation connecting the Proposal to the onsite 220KV transmission line, via two (2) new high voltage (HV) 220 kV transmission lines;
- A Control building (3 m high);
- Substation Operations and Maintenance building (up to 5 m high);
- A security fence (chain mesh) up to 2.5 m high, enclosing the Substation;
- A 10 m wide defendable APZ around the perimeter of the Substation; and
- Parking for 5 vehicles.

Battery Area (0.91 ha, see the 'Site Plan', Appendices 'A' and 'C'):

- A series of separate containerised battery units, connected by underground cables to the Substation (approximately 2.5 m high);
- A separate transformer adjacent to each battery; and
- A 10m defendable APZ around the perimeter of the Battery Area.

Operations Buildings Area (area 0.96 ha, see 'Site Plan, Appendix D'):

- A Site office building including amenities with a height of 3.6 m;
- A maintenance building and workshop with a height of 5 m;
- 3 Storage sheds with a height of 4.1 m;
- Car parking for twelve (12) vehicles;
- A septic tank and potable water tank; and
- A defendable APZ of 20 m, which allows the area to function as the nominated 'Shelter in Place' location (see Bushfire Risk Assessment and Mitigation Plan).

In addition to the key components outlined above, there will be a temporary construction compound (1.44 ha, see the Site Plan) to facilitate the construction of the Proposal. The construction compound would include:

- Temporary construction offices (up to 5 m high);
- Car and bus parking areas for construction vehicles (51 workers cars, 5 mini vans; and additional parking space provided for delivery vehicles and construction machinery);
- Staff amenity block including portable toilets, showers and a kitchen, designed for peak staff numbers during the construction period; and
- Laydown areas.

Once the Proposal is operational, the construction compound will be decommissioned and revegetated. The Proposal is shown in Figure 2 below.

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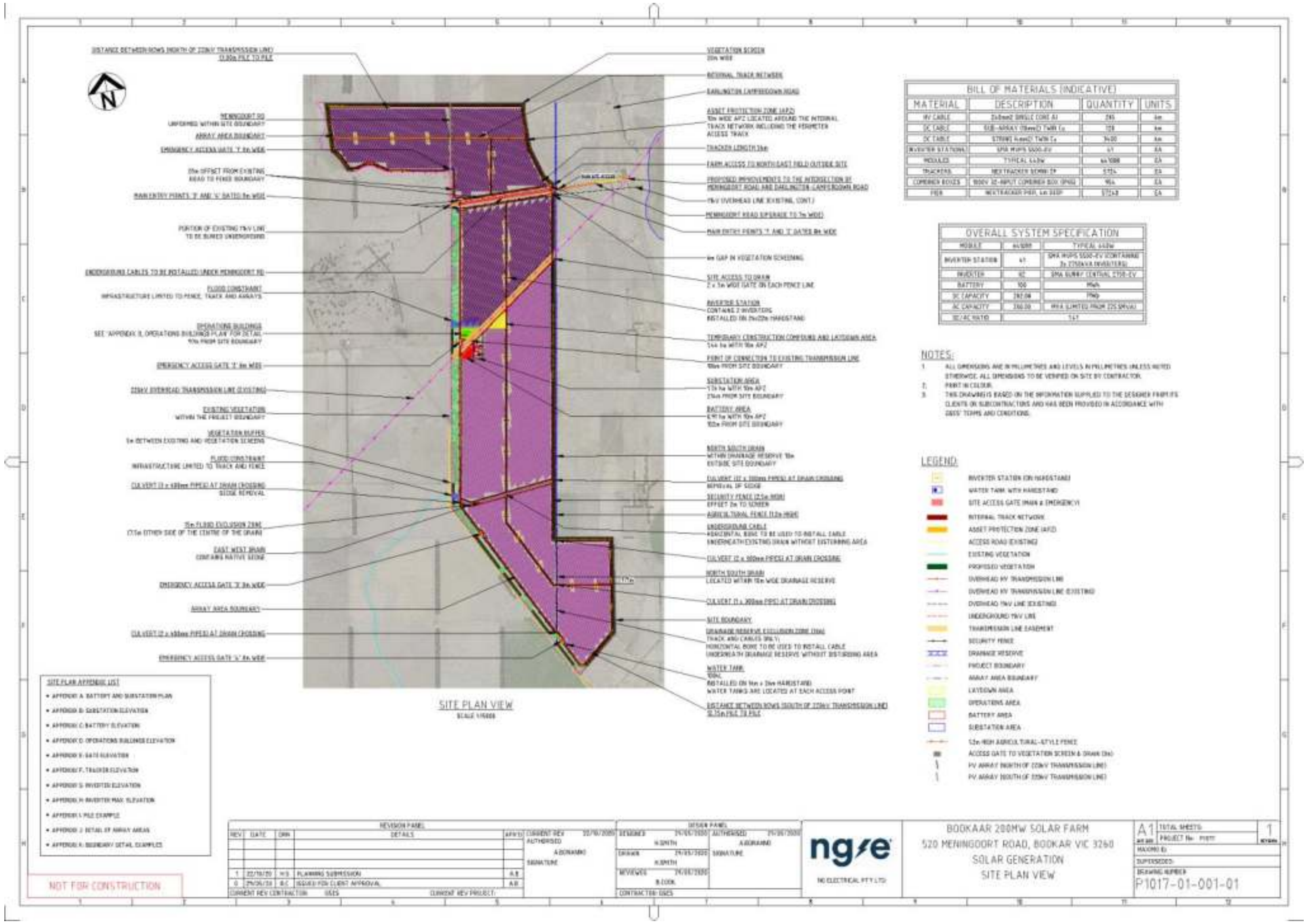

Figure 2: Site Plan (See the 'Site Plan' accompanying the Planning Report for a scaled version of this plan).

1.2 Construction Activities

The following section outlines construction activities.

Primary Construction Activities

The primary construction activities would be, in no particular order, as follows:

- Mobilisation; establishment of temporary construction compound and laydown areas;
- Road improvements to Meningoort Road and the intersection of Meningoort Road and Darlington Camperdown Road;
- Planting of the vegetation screens;
- Construction of the internal track network and culverts;
- Construction of the perimeter security fence and the establishment of the APZs;
- Establishment of the substation;
- Installation of piles and the tracking system;
- Securing panels to the tracking system;
- Rehabilitation of any disturbed areas;
- Trench digging and cable laying;
- Installation and connection of inverters;
- Construction of the operations area;
- Removal of temporary construction compound and facilities;
- Rehabilitation of remaining disturbed areas; and
- Solar farm commissioning.

Earthworks

The Proposal has been located on flat land, in order to minimise ground disturbance. As such, areas that will require significant earthworks are limited to the following:

- The construction of the internal track network, including the installation of 5 culverts over drains within the Site. Note, the internal track network will follow current ground contours and will be constructed at ground level;
- The construction of cable trenches to bury the electricity cables and associated communication lines to connect onsite infrastructure (i.e. connecting the tracker infrastructure to the inverter stations, the inverter stations to the substation, and between the substation and the battery area). Where underground cables are proposed to cross onsite drains, a horizontal bore will be used to install the cables underground to ensure that drain infrastructure is not disturbed;
- The construction of a cable trench to reroute an existing 11kV distribution line underground where it crosses the Site;
- Land will be graded to form a flat and stable surface under the Operations Buildings Area, Substation Area, Battery Area and the Temporary Construction Compound;
- An existing farm dam located adjacent to Meningoort Rd (north), will be filled to allow panel infrastructure to be constructed in this location; and

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- Improvements to Meningoort Rd (north) and the intersection of Meningoort Road and Darlington Camperdown Road.

In addition, there may also be a requirement for minor localised earthworks associated with the installation of the tracker infrastructure, although a desktop analysis indicates that this is unlikely due to the flat topography of the Site.

Rehabilitation of disturbed land

Rehabilitation of disturbed areas will be a priority during the construction phase of the Proposal and will occur as soon as possible following the completion of construction activities in a location.

As described above, due to the flat topography of the Site, significant earthworks associated with the construction of the Proposal are limited mainly to track and hardstand construction. Within the array areas, soil disturbance would be predominantly restricted to the direct area where the piles are driven into the ground to support the tracking systems, and areas of trenching for the installation of underground cables.

As such, most of the existing groundcover will be retained across the Site during the construction of the Proposal. Consequently, soil disturbance from localised excavation activities will be relatively small, isolated and temporary.

Rehabilitation of disturbed land will involve:

- Backfilling cable trenches;
- Revegetating any disturbed areas as soon as possible; and
- Monitoring revegetation sites to ensure success.

1.3 Operational Period

The following section outlines the main operational activities.

Operational Activities

The operational period is expected to begin in early 2022. Operational activities include:

- Monitoring of solar production – analysis of data;
- Export of solar energy to the national electricity network;
- Maintenance of all plant and equipment – visual inspections and/or engineering work as required, analysis of data; replacement of equipment as required;
- Security – remotely and through routine site inspections;
- Annual maintenance and preparation activities required to comply with the Bushfire Mitigation Operational Schedule;
- Vegetation monitoring and management – routine vegetation management and monitoring in panel areas (small live stock may be permitted to graze within panel areas, for example sheep) and within the landscape screens;

- Erosion monitoring – routine monitoring for scouring beneath the panels and along access tracks and waterways. Boundary fences will be checked and unblocked as required; and
- Any other activities that may be required as a condition of consent.

During the operational period there would be approximately 6 Full Time Equivalent (FTE) positions created. Staff would routinely visit the solar farm to carry out activities as listed above. Travel would be in standard 4x4 vehicles. Should there be a requirement for major maintenance works larger trucks and equipment may need to be deployed.

Ground Cover revegetation and maintenance

During the operation of the Solar Facility, groundcover will be maintained across the Site both between and under the panel rows. The groundcover will stabilise soils preventing soil erosion and will assist in localised water penetration.

Operational activities (as described above), are unlikely to result in the disturbance of groundcover at the site. When land disturbance does occur, groundcover will be reinstated as soon as possible.

The fuel load across the Site will be monitored at all times of the year and will be actively managed through mechanical slashing and/or mowing or grazing as required to reduce the risk of grass fires starting within the Site, and ensuring that fires originating from outside the Site do not intensify as a consequence of entering the Site. During the annual Fire Danger Period, groundcover (including under the panels) will be maintained at less than 100mm to ensure fuel load is minimal in line with CFA guidance. If grazing is utilised, overgrazing will be avoided to maintain groundcover and reduce the potential for erosion.

Protocols for the management and reinstatement of groundcover will be provided in an EMP to ensure groundcover is preserved and managed during the operational life of the solar farm.

Erosion monitoring

Routine monitoring for scouring beneath the panels and along access tracks and waterways will be carried out. Sediment removal in internally draining areas and scour repairs at culvert inlets and outlets, may be required after significant flood events, although as noted in the 'Flood Impact Assessment', the flow rates associated with the 1 in 100 AEP Flood event would be unlikely to cause erosion. Drains will be kept clear.

Amenity Assessment

The following section provides an assessment of potential amenity impacts as required by Clause 53.13 of the Planning Scheme. Mitigation commitments are identified and, where specialist assessments have been conducted full reports are provided as an Appendix to this report.

2.1 NOISE AND VIBRATION

The 'Acoustic Report' assesses construction noise, construction vibration, and operational noise that may be generated as a consequence of the Proposal in line with requirements of the Guideline. The Acoustic Report is provided in Appendix A. The report concludes that there will be no unreasonable noise impacts at sensitive receivers (residential dwellings) in the surrounding area during the construction or operation of the Proposal.

2.2 GLINT

The 'Solar Photovoltaic Glint and Glare Study' provides an assessment of potential glint and glare impacts from the solar arrays. The assessment has been carried out in line with the requirements of the Guideline and is provided in Appendix B. The Report concludes that there will be no unreasonable glint or glare impacts resulting as a consequence of the Proposal at sensitive receivers in the surrounding area.

2.3 LIGHT SPILL

Lighting requirements for the Proposal will be minimal. Lighting for the Proposal will consist of on-demand lighting only. All lighting will be limited to a maximum height of 4.0 m in line with the maximum height of the proposed solar panels. All lighting that is not motion activated will be downward facing.

It is considered that light spill from the Proposal will not result in impacts to amenity in the surrounding area.

2.4 EMISSIONS TO AIR

During the construction, operational and decommissioning phases, the Proposal has the potential to create air quality impacts, particularly dust from soil disturbance and construction traffic, and emissions from vehicles and machinery. These impacts may cause nuisance to nearby residential receptors and the adjoining environment. At worst, they can impact on ecosystem function, pose a human health risk and/or contribute to anthropogenic climate change. Without appropriate mitigation, these impacts could reduce amenity at surrounding properties.

<u>Existing environment</u>

The baseline air quality in the Bookaar area is considered to be typical of a rural area with moderate to good air quality. Potential air pollution sources include, agricultural practices, a nearby composting facility, and road transport.

The Site is likely to receive afternoon wind speeds averaging around 19km/h, and around 100 rain days in an average year. Wind is consistent throughout the year, whilst more rainfall occurs during autumn, winter and spring[1].

Construction and Decommissioning

Dust generation can be caused by excavation, earthworks, and the movement of trucks and other work vehicles along unsealed access roads and tracks during the construction and decommissioning of the Proposal. Air emissions would also be produced from equipment and vehicle exhaust fumes.

As described in Section 1.2, due to the flat topography of the Site, significant earthworks associated with the construction of the Proposal are limited mainly to track and hardstand construction. The primary construction activity of pile driving is unlikely to result in high levels of dust generation.

As noted, the Proposal is sited away from neighbouring dwellings and there are only four non-involved dwellings within 1 km of the Site (Figure 1). The closest dwelling (Dwelling 'E') is approximately 450 m to the east of any construction activities and is screened from the Proposal by existing vegetation. The next closest dwelling is approximately 630 m to the east of the Proposal (Dwelling 'K'), with a further two residences (Dwellings 'L' and 'I') within 1 km of the Proposal (approximately 840 m and 890 m respectively). Dwelling 'K' is adjacent (approximately 50 m) to the proposed improvements of the intersection of Meningoort Road and the Darlington Camperdown highway, and to some of the length of Meningoort Road (north) to be upgraded.

While some level of dust generation is inevitable during construction, particularly during dry months, the considerable distance of the Site from neighbouring dwellings means that the potential for dust to carry towards nearby residences is low for construction activities at the Site. There is potential for additional dust impacts at Dwelling 'K' during construction due to its proximity to the proposed road improvements, and due to its location adjacent to the access route that construction traffic will use during the construction and decommissioning of the Proposal. However, the road upgrades are relatively minor and will occur over a short period of time (approximately 18 days) prior to construction activities occurring onsite and construction traffic will be limited to the approximate 12-month construction period.

These factors, in combination with the low potential for dust generation through the main construction activity of pile driving, means that potential impacts to air arising from construction works are considered to be minor, would be short-term in nature, and are unlikely to significantly affect nearby residential dwellings or neighbouring properties. While there is potential for dust to impact Dwelling 'K' during road improvement works and as a consequence of construction traffic, the nature of the impacts would be short term and are unlikely to be significant without mitigation. However, dust that is generated through road improvements, construction traffic or the construction activities, listed above can be effectively mitigated through the measures identified in the mitigation section below.

During the construction phase, engine emissions would be generated from road transport, earth-moving equipment, diesel generators, cranes and pile driving equipment. Again, the generous separation distances between the Site and neighbouring dwellings mean that the impact of temporary engine emissions generated on Site during the construction phase are not likely to be significant. However,

[1] The nearby Bureau of Meteorology weather at Mortlake, and historical records for Camperdown were considered, see BoM, 2020).

mitigation measures that will be adopted during the construction phase to reduce emissions are set out below.

Construction traffic associated with the Proposal is considered to be moderate (with a daily maximum of 50 Heavy Vehicles, 4 Medium Vehicles and 56 Light Vehicles arriving at and leaving the Site during the busiest period of construction), and would be temporary in nature ('Traffic Impact Assessment'). Mitigation measures to reduce traffic emissions are described in the section below.

No air quality impacts in addition to those detailed for construction are anticipated during the decommissioning phase. Traffic generation would be similar in type but potentially of shorter duration than that required to support the construction phase.

Operations

The generation of solar energy during the operation of the Proposal would result in negligible air quality impacts and emissions. Indeed, during its operational life, the Proposal would have a positive impact on emissions to air by displacing traditional carbon intensive electricity, and as such result in a reduction of associated greenhouse gas emissions.

Maintenance activities during operation would result in some minor, localised vehicle and machinery emissions, and potentially some dust generation from vehicles travelling on internal access tracks. However, impacts are likely to be on a par with those associated with current agricultural activities at the Site and, overall, would be very minor.

Mitigation

It is considered that, with the implementation of effective mitigation measures relating to dust control and vehicle/plant emissions, emission impacts relating air amenity would be acceptable. The following mitigation measures to prevent, minimise and treat dust emissions will be implemented in line with EPA Publication 480 *'Environmental Guidelines for Major Construction Sites'* (EPA, 1996)**:**

- Implement a dust prevention strategy for construction activities (the strategy should aim to prevent dust generation rather than its treatment);
- Limit the extent of clearing and excavation;
- Stage excavation activities to minimise the total areas of exposed soil;
- Minimise the volume of stockpiled soil;
- Revegetate progressively as each section of works is completed;
- Promptly water exposed areas when visible dust is observed;
- Modify activities if dust is observed leaving the Site or the access route towards nearby sensitive receptors; and
- Develop a complaints' procedure to promptly identify and respond to issues generating complaints.

The following mitigation measures to prevent or minimise vehicle and plant emissions will be implemented in line with EPA Publication 480 *'Environmental Guidelines for Major Construction Sites'* (EPA, 1996)**:**

- Ensure all vehicles and machinery that enter the Site meet relevant standards for emissions;

- Maintain vehicles and plant in accordance with manufacturer's requirements to minimise emissions;
- Ensure vehicles and machinery are not left idling when not in use; and
- Develop a complaints' procedure to promptly identify and respond to issues generating complaints.

Mitigation measures as outlined above would be included in an EMP for the construction, operation and decommissioning stages of the Proposal. A preliminary EMP has been developed to support the Permit Application for the Proposal.

The Traffic Management Plan (TMP) for the Proposal would also include specific measures to reduce potential traffic related air emissions as follows:

- Define designated access and travel routes;
- Set construction traffic speed limits onsite and on the access route along Meningoort Road (north);
- Adopt trip management protocols to avoid unnecessary trips e.g.:
  - The use of minibuses for most construction staff;
  - Carpooling where feasible for remaining construction staff;
  - coordinating delivery and removal of materials; and
  - Develop a complaints' procedure to promptly identify and respond to issues generating complaints.

<u>Summary</u>

The construction, operational and decommissioning phases of the Proposal have the potential to generate emissions to air that could potentially impact local amenity. However, the Proposal is sited away from residential dwellings, and any emissions are likely to be localised, temporary, and where emissions to air cannot be avoided, mitigation strategies have been identified.

With mitigation, the Proposal is not expected to result in significant amenity impacts in the local area through the generation of emissions to air. Importantly, during the operation of the solar facility, the Proposal will offset emissions generated by fossil fuel based electricity, and is therefore expected to make a positive contribution with respect to air emissions associated with greenhouse gas emissions.

2.5 EMISSIONS TO LAND

The Proposal has the potential to result in emissions to land as a consequence of waste generated during all phases of the development. The Potential impacts of waste may cause nuisance at the Site, to nearby residential receptors and the adjoining environment. At worst, they can impact on ecosystem function or pose a human health risk. Without appropriate mitigation, these impacts could reduce amenity in the surrounding area.

Waste generation and its storage for each stage of the Proposal's life cycle is considered below.

Existing environment

The existing site is characterised by agricultural production and grazing activities. Responsibility for the management of waste generated by these activities lies with the landholder.

Waste Generation and storage - Construction

During the construction phase, solid wastes will be the main waste generated by construction activities. Solid wastes will include packaging, excavated material, metal and cable off-cuts, excess building materials, general refuse and other non-putrescible wastes. Ancillary facilities in the Site compound would also produce sanitary wastes classified as general solid waste (putrescibles). Waste would either be stored at the temporary construction compound in suitable containers (by waste type), or contained at the worker's temporary sanitation facilities, for disposal offsite in line with the waste reduction hierarchy outlined in the mitigation section below. The construction compound would also include a bunded area for the storage of any waste oils and other hazardous liquids.

Waste Generation and storage - Operation

Waste streams during the operation of the Proposal would be very low. There would be solid waste streams associated with maintenance activities (non-putrescibles) and the solid waste generated as a consequence of having employees and/or contractors on site (putrescibles). Some materials such as, fuels and lubricants, and metals may require replacement over the operational life of the Proposal. The Operations Buildings area would also include a bunded area for the storage of any waste oils and other hazardous liquids. Waste would be stored at the Operations Buildings by waste type, for correct disposal offsite in line with the waste reduction hierarchy outlined in the mitigation section below.

No waste streams would be associated with the generation of electricity using PV panels. While it is very unlikely, it is possible that a limited number of PV panels could become damaged during operation and would fall into the waste stream. For this to occur they would need to be functionally faulty or physically damaged. PV panels are robust and are manufactured to withstand a wide range of environmental conditions including extremes in temperature, rainfall, hail and humidity[2]. This robust design, combined with a standard 25 year warranty[3] ensures that the likely numbers of panels that would fall into the waste stream would be low. As any faulty or damaged PV panels would not be suitable for reuse, they would be stored in the Operations Buildings area in a suitable location for collection and, where possible, recycled offsite as described under 'decommissioning' below.

[2] Clean Energy Review (2019). *Solar Panel Construction*. Retrieved from: https://www.cleanenergyreviews.info/blog/solar-panel-components-construction. Accessed 15 Oct. 2019.

3 DNV-GL. (2017). PV Module Reliability Scorecard. Report. Retrieved from www.dnvgl.com.

<u>Waste Generation and storage – Decommissioning</u>

The Proposal has an operational life of approximately 28 years after which it will be decommissioned and the Site rehabilitated and returned to its current state.

Decommissioning activities will involve the removal of all above ground infrastructure, including the PV modules, the racking system, the piles, and grid connection infrastructure. Note, underground cables (inert and stable) at a depth greater than 0.5 m would be left in the ground to avoid unnecessary ground disturbance, and some of the access tracks may be retained depending on the requirements of the landowner.

Decommissioning of the Proposal would involve the recycling or reuse of materials including:

- Solar panels and the tracking system; and
- Metals from piles, cabling, and fencing.

Infrastructure and equipment that may be suitable for reuse include grid connection equipment, substation equipment and invertors. Support buildings will be removed from the Site for reuse if possible.

Where reuse of a material is not possible, recycling is considered to be the next desirable option. Solar panels are made of valuable materials that can be recycled at recovery rates greater than 90%, with this figure expected to improve as recycling techniques develop over time[4]. The recovery, reuse and/or recycling of panels at the end of their life is necessary to avoid and reduce waste ending up in landfill.

The Australian solar market is already developing its capacity to take advantage of the future opportunity that recycling will offer as panels reach the end of their useful life[5]. The first Australian panel recycling company ('Reclaim PV Recycling', based in Adelaide) is expanding its recycling drop-off locations to include Brisbane, Sydney, Melbourne and Perth[6]. More recently a second company has joined the market offering panel recycling services across Australia[7].

The steel tracking system and other metals used to support the solar panels are considered to be readily recyclable.

Solid wastes will be generated by decommissioning activities (non-putrescibles, putrescibles), although to a lesser degree than during the construction phase. Solid wastes will include packaging, excess building materials, general refuse and other non-putrescible wastes. Waste not removed from the Site directly would be stored at the Construction Compound area in suitable bins (by waste type), or

[4] IEA. (2017). Life Cycle Inventory of Current Photovoltaic Module Recycling Processes in Europe. International Energy Association Photovoltaic Power Systems Program (PVPS T12-12: 2017).

[5] Reneweconomy. (2016). Solar panel recycler leads Australia in emerging industry. Retrieved from https://reneweconomy.com.au/solar-panel-recycler-leads-australia-in-emerging-industry-99038/. Accessed 15 August 2020.

[6] Reclaim PV (2020). News. Reclaim PV Website. Retrieved from: https://reclaimpv.com/. Accessed 15 August 2020.

[7] Ecoactiv (2020). Solar Panel Recycling. Ecoactiv Website. Retrieved from: https://www.ecoactiv.com.au/solar-panel-recycling/. Accessed 15 August 2020.

contained at the worker's temporary sanitation facilities, for disposal offsite in line with the waste reduction hierarchy outlined below.

Mitigation

In order to encourage the efficient use of resources and reduce environmental impacts waste will be managed according to the following hierarchy:

1. Avoid waste production;
2. Reduce waste production;
3. Reuse;
4. Recycle;
5. Reprocess; and
6. Dispose of waste appropriately.

In order to avoid and minimise the potential for waste, purchasing protocols to reduce the likelihood for equipment failure will be adhered to in the selection of all components of the Proposal.

Opportunities for reuse and recycling will be investigated during all phases of the Proposal. Waste that cannot be recovered will be disposed of lawfully at a licensed waste facility.

A Waste Management Plan will be prepared in order to meet the hierarchy set out above, and will form part of each stage specific Environment Management Plan (EMP). The objectives, protocols and responsibilities will be communicated to all staff and contractors through a site induction process and ongoing training. Specific measures to be incorporated into the Waste Management Plan would include, but not be limited to the following:

- Protocols to identify opportunities to follow the waste hierarchy - to ensure that waste is minimised, recovered, and disposed of appropriately, and also to ensure a culture of responsible waste management is upheld by staff;
- Quantification, classification, and tracking of all waste streams - to encourage waste reduction and minimise inter-contamination of waste streams;
- Controls on the disposal methods of all waste streams;
- Provision of recycling facilities onsite to reduce waste streams;
- Provision of a dedicated waste management area onsite;
- Protocols for the transportation of waste, for example covered loads; and
- Robust protocols governing procedures for checking equipment integrity throughout the lifetime of the Proposal.

The adoption of the mitigation principles outlined above will ensure that the Proposal will control waste streams at all stages of the Proposal. This will avoid environmental harm and ensure that emissions to land are avoided and will not result in amenity impacts in the surrounding area.

2.6 EMISSIONS TO WATER

This section considers potential impacts associated with the Proposal on water resources in the local area.

Existing Environment

The Site lies within the Blind Creek catchment which is itself a tributary of the Mt Emu Creek catchment. Blind Creek catchment generally flows from north to south. During small rainfall events the runoff is collected in a series of mostly constructed drains through the catchment. Two significant drains within this series of drains cross the Site as explained below.

The northern portion of the Site generally slopes to the east, except for the northern extremity which slopes to the north. Along the northern boundary of the Site is a drain which captures runoff from the Site and conveys it to the east. To the east of the Site it joins with a drain from the north and one form the east and turns to the south (the 'North South' drain). The North South drain travels under Meningoort Road and along the eastern boundary of the Site. The North South drain intercepts runoff from the northern and central portion of the Site taking the runoff to the south.

Towards the southern part of the Site on the western boundary, the North South drain bifurcates with the larger drain cutting across the Site to the southwest (the 'East West' drain' see Photograph 3) and exiting the Site along the western boundary. At the bifurcation, the North South' drain becomes smaller and continues south where it passes through the Site before exiting at the southern extremity of the Site (see Figure 2).

During large rainfall events the capacity of these drains can be exceeded resulting in runoff collecting in lowland areas which typically have poor drainage.

Lake Bookaar, which is listed as a permanent saline wetland as part of the Western District Lakes Ramsar Site, lies approximately 2.5 km to the east of the Proposal. There is no hydrological connection between the Site and Lake Bookaar (Flood Impact Assessment).

Potential Impacts

Hydrology Impacts

Within the Australian context, the development of solar energy facilities has generally been shown to have a very small and easily managed impact on rainfall runoff and downstream hydrology. This is because the vast majority of infrastructure associated with solar energy facilities is located above the ground on posts which are driven into the ground with minimal disturbance to the surface or existing groundcover vegetation (Cook & McCuen, 2013[8]).

Hydrological modelling for the Proposal shows that while parts of the Site are prone to inundation during significant rainfall events, the construction of the Proposal, which has been designed in response to the flood assessment, does not alter predicted flood levels or flow velocities at the Site or in the surrounding area ('Flood Impact Assessment'). Furthermore, as the flow velocities of flood events are very low, the potential for erosion and sedimentation is also low.

[8] Cook L.M. & McCune R.H. (2013). Hydrological Response of Solar Farms. *Journal of Hydrologic Engineering, 18*(5), 536 – 541.

Construction and Future Decommissioning

The proposed construction and decommissioning works involve a range of activities that disturb soils and could potentially lead to sediment laden runoff, affecting local waterways during rainfall or flood events. These activities include:

- Excavations for the construction of internal access tracks, inverter hardstands, Substation, Operations buildings Area, Battery Area and the Temporary Construction Compound;
- Trenching for below ground cable installation; and
- Soil compaction and reduced permeability in areas of hardstand and access tracks.

The use of fuels, lubricants, herbicides and other chemicals during construction and operation pose a risk of contamination to surface and groundwater in the event of a spill. Chemicals commonly used onsite would include fuels, lubricants and herbicides.

Operations

Operational impacts to surface water resources are considered negligible. The operational land use as a solar energy facility would likely reduce the potential for impacts to water quality when compared to current agricultural land use practices. The elimination of grazing, or a substantial reduction in stocking rates, would decrease soil disturbance and therefore reduce erosion, sedimentation and riparian disturbance at the Site and hence reduce impacts on surface water quality. In addition, a decrease in fertiliser use and stocking rates would reduce the potential for nutrients to enter surface waters.

During the life time of the Proposal, groundcover will be maintained across the Site both between and under the panel rows. The groundcover will stabilise soils preventing soil erosion and will assist in localised water penetration. Should mowing be utilised as a method to control grass growth under the solar panels, the grass would be directly mulched back onto the soil surface therefore building soil organic matter and enhancing carbon capture while improving water infiltration.

Although the installation of PV panels presents a large impervious surface standing above the ground at approximately 2 m, the flat nature of the panels, and the separation distance between rows (either 12.75 m or 13 m) will quickly return rainfall as runoff to the natural ground to allow surface penetration and/or run-off to occur in a typical manner (‘Flood Impact Assessment’). Disturbed areas would be revegetated in order to stabilise the ground surface. This should prevent soil erosion and, thus, sedimentation impacts to surface water.

Soil scouring under the panels resulting from intense rainfall events is not expected given the low velocity environment (‘Flood Impact Assessment’) and the vegetative cover. Regardless, routine monitoring for scouring beneath the panels will be undertaken and remediation works undertaken if required. Increased localised runoff from more impervious areas (access tracks, inverters, operations compound (buildings and hardstand) and the Substation may generate some additional sediment that would require management.

Mitigation

Procedures shall be adopted to minimise the risk of water quality impacts associated with erosion, sedimentation and potential contamination of surface water resources.

Erosion and sedimentation impacts associated with soil disturbance from construction and decommissioning activities will be minimised by undertaking works in accordance with provisions of the *Environmental Guidelines for Major Construction Sites 1996,* as follows:

- Keep land clearance to a minimum;
- Avoid wherever possible clearing areas of highly erodible soils and steep slopes which are prone to water and wind erosion;
- Revegetate and mulch progressively as each section of works is completed. The interval between clearing and revegetation should be kept to an absolute minimum;
- Coordinate work schedules, if more than one contractor is working on a site, so that there are no delays in construction activities resulting in disturbed land remaining unstabilised;
- Program construction activities so that the area of exposed soil is minimised during times of the year when the potential for erosion is high, for example during summer when intense rainstorms are common;
- Stabilise the site and install and maintain erosion controls so that they remain effective during any pause in construction. This is particularly important if a project stops during the wetter months;
- Keep vehicles to well-defined haul roads;
- Keep haul roads off sloping terrain wherever practical;
- Design the slope of a cut to minimise the angle of incline; and
- Cultivate the cut surface to increase infiltration of rainfall and decrease the velocity of water across the slope during rain (therefore reducing erosion).

Many of the measures identified to minimise soil erosion above have been considered in the design of the Proposal. For example, the Site selected for the Proposal only requires the removal of 0.019 ha of native vegetation and as the Site is flat all access tracks avoid sloping terrain.

Water quality protocols include maintaining groundcover across the Site to minimise potential for erosion and consequently, to therefore minimise potential sedimentation impacts to water quality. Groundcover species selection and management will be undertaken in consultation with local agronomists and seek to maintain groundcover at the Site.

Access tracks shall be maintained in good condition, so that potential erosion associated with the tracks, which could lead to impacts on water quality, is minimised.

All hazardous materials will be classified and appropriately stored to prevent contamination of drainage lines. All hazardous materials (fuels, lubricants, construction chemicals, herbicides, etc.) will be transported and disposed offsite in line with relevant guidelines to avoid release to the environment, and contamination of water systems.

Onsite refuelling shall occur within designated areas located more than 100 m from the nearest drainage line and within an impervious bund. Machinery will be inspected daily to ensure no oil, fuel or lubricants are leaking from engines or hydraulic systems. All contractors and staff will participate in induction talks to prevent, minimise and manage accidental spills.

A Spill Response Plan (SRP) will be developed and included as part of the Environmental Management Plans. All contractors and staff will be trained regarding appropriate spill response strategies. Should a spill occur, incident management procedures provided in the SRP will be implemented and the EPA will be notified of any incidents that cause harm to the environment.

Although the design and siting of the Proposal means that changes to the water environment and flows within the Site and beyond are minimised, the Proposal does share a drainage system with neighbouring farms. As such, it is important that drains at the Site are maintained and monitored throughout the life of the Proposal. This would include monitoring those elements of the Proposal that could led to a change in flow conditions across the Site, for example all fences will need to be regularly checked for, and cleared of debris, and all drains within and abutting the Site will need to be checked for, and cleared of blockages.

Protocols for erosion and sediment mitigation and drain and infrastructure monitoring and management to protect water quality at the Site and beyond will be included in stage specific EMPs. With the implementation of mitigation, it is considered that impacts to amenity though emissions to water can be avoided.

2.7 SMELL

There is limited potential to impact on amenity through smell because of activities associated with the construction, operation and decommissioning of the Proposal.

2.8 ELECTROMAGNETIC RADIATION AND INTERFERENCE

This Section considers the potential for electromagnetic interference impacts to amenity through the operation of the Proposal.

Electromagnetic radiation

Electromagnetic radiation is produced by electrical equipment of all size and voltage, and also occurs naturally. Electromagnetic radiation is comprised of Electric fields and Magnetic fields. Electric fields are produced by voltage while magnetic fields are produced by current. Electromagnetic radiation is emitted from live electrical devices, appliances and wires, and the strength of electromagnetic radiation decreases with distance (EMFs Info, 2020[9]; ARPNSA, 2020[10]).

The Guideline

The Guideline, with reference the Australian Radiation Protection and Nuclear Safety Agency, advices that the following information should be accounted for in the design and layout of a solar farm proposal:

- *Electromagnetic radiation will become indistinguishable from background radiation within 50m of a high voltage powerline; and*

[9] EMFs info. (2020). *EMFs.info Electric and Magnetic Fields and Health*. Retrieved from http://www.emfs.info/. Accessed 23 September 2020.

[10] ARPNSA (2020). Electricity and Health Fact Sheet. Retrieved from https://www.arpansa.gov.au/understanding-radiation/radiation-sources/more-radiation-sources/electricity. Accessed 23 September 2020.

- *Electromagnetic radiation will become indistinguishable from background radiation within 10m of a substation.*

The Proposal's Response to the Guideline

The Proposal has been designed with the following distances to boundaries from key electrical infrastructure.

Electrical Infrastructure	Approximate distance to nearest Site Boundary	Approximate distance to nearest neighbouring property boundary
Substation	186m	722m
High Voltage Cable	186m	722m

The design of the Proposal includes setback distances to the Site boundary for key electrical infrastructure that exceeds the distances noted by ARPNSA[11] that are required for radiation levels to be indistinguishable from background. Furthermore, all electrical equipment supplied to the Proposal, such as transformers and inverters, will meet performance standards required by Australian legislation.

It is therefore considered that the Proposal will not result in levels of electromagnetic radiation that would affect local amenity.

[11] *Ibid.*

APPENDIX A:

ACOUSTIC REPORT

Acoustics
Vibration
Structural Dynamics

BOOKAAR SOLAR FARM

Acoustic Report

17 December 2020

Bookaar Renewables Pty Ltd

MD196-01F01 Acoustic Report (r6).docx

Melbourne Sydney Brisbane Gold Coast Kuwait Singapore
Renzo Tonin & Associates ABN 30 117 463 297
Level 2, 7 Meaden Street, Southbank VIC 3006
P (03) 9690 6005 melbourne@renzotonin.com.au www.renzotonin.com.au

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Executive summary

Renzo Tonin & Associates was engaged by Bookaar Renewables Pty Ltd to undertake an acoustic assessment of the proposed 200MWac (282 MWdc) Solar Farm in Bookaar, Victoria (Corangamite Shire) (the Proposal). The assessment responds to the DELWP *'Solar Energy Facilities - Design and Development Guideline - August 2019'* (the Guideline). The Guideline states:

> *The design response should also include one or more written reports and assessments including: … an assessment of:*
>
> - *an assessment of potential noise impacts … EPA Victoria's Noise from industry in regional Victoria …* (EPA Pub 1411 'NIRV')
> - *construction management plan… EPA Victoria's Environmental Guidelines for Major Construction Sites has best-practice guidelines for general construction*. … (EPA Pub 480)

The assessment comprised:

- Review of the surroundings, the Subject Site and Proposal
- Determination of relevant noise criteria:
  - NIRV maximum recommended noise levels
  - Construction noise and vibration criteria
- Assessment of the operational noise from the Proposal
- Recommendations with respect to noise and vibration during the construction phase

On the basis of the assessed configuration, it considered that the Proposal is very low risk with respect to operational and construction noise and vibration, and can operate without adverse acoustic impact on residential amenity.

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1 Introduction

Renzo Tonin & Associates was engaged by Bookaar Renewables Pty Ltd (the Proponent) to undertake an acoustic assessment of the proposed 200MWac (282 MWdc) Solar Farm (the Proposal) encompassing part of 520 Meningoort Road, Lots 51 and 52 and Res 1 on LP4677 and adjacent parts of Meningoort Road, Bookaar (the 'Site') (Corangamite Shire). The assessment responds to the DELWP *'Solar Energy Facilities - Design and Development Guideline - August 2019'* (the Guideline).

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Context

2.1 Application history

It is understood that the Proposal follows from an earlier design for a 200MWac solar farm (the Previous Application) on the same site. The Previous Application was the subject of a 2019 Victorian Civil and Administrative Tribunal (VCAT) hearing (Bookaar Renewables Pty Ltd vs Corangamite SC[2019] VCAT 1244). The VCAT decision was not in favour of the Previous Application (noting the decision was not based on acoustic matters) and, therefore, revised plans have been prepared for a new application.

With regard to noise, the VCAT decision noted the following of the Previous Application:

- *"Clause 13.05 of the scheme addresses noise abatement. Clause 53.13-3 requires us to consider the effect of the proposal on the surrounding area in terms of, amongst other things, noise.*
- *We have not been persuaded that there are specific impacts in terms of noise that will affect amenity or neighbours. The proposal is well separated from dwellings in terms of the potential for any noise intrusions."*

As noted, this assessment considers the new plans (the Proposal), however its conclusions are in line with those reached by the Tribunal above. This is due to the Proposal being within the same footprint as the Previous Application, and remaining a proposal for a 200MW solar farm, as described in Section 2.2 below.

2.2 The Proposal

Bookaar Renewables Pty Ltd is proposing to develop a 200MW solar energy facility (the 'Proposal'), located within the 'Farming Zone'.

Renzo Tonin & Associates has been provided with the following briefing with respect to the Proposal (refer to the 'Site Plan' accompanying the planning report for detail):

- 'Array Areas', containing Photovoltaic (PV) panels mounted on a single axis tracking system with a maximum height of 4 m above natural ground at maximum tilt. The tracking system would be supported by piles driven into the ground. Row spacing is either 12.75 m or 13 m (pile to pile);
- 82 inverters located centrally throughout the Site in pairs at 41 locations across the Site (inverter stations). Inverter stations are located at least 170 m from the Site boundary;
- Below ground cabling connecting the PV panels between trackers and inverters;
- Below ground cabling connecting the inverters to the substation;
- An internal track network of all-weather gravel tracks (4 m), including a perimeter track which forms part of a 10 m wide defendable Asset Protection Zone (APZ) that surrounds the Site;
- Four (4) gated main site access points via Meningoort Road;
- Four (4) gated emergency access points along the western boundary of the Site;
- Eight dedicated water tanks for firefighting (maximum of 3.6m high), located adjacent to each access point;
- A perimeter security fence 2.5 m high (chain mesh);
- Perimeter vegetation screens (20 m wide with 4 rows of trees and maintained to a height of at least 4 m), planted on the outside of the security fencing;
- Agricultural style fencing 1.2 m high, around the perimeter of the vegetation screens and the perimeter of the existing vegetation on the Site's western boundary;
- A SCADA system that will gather, monitor and analyse data generated through operating the Proposal;
- On-demand, downward facing lighting (restricted to 4m in height); and
- Sensor triggered CCTV security cameras located around the perimeter of the Site and adjacent to key infrastructure.

Substation Area (1.76 ha):

- Substation connecting the Proposal to the onsite 220KV transmission line, via two (2) new high voltage (HV) 220 kV transmission lines;
- A Control building (3 m high);
- Substation Operations and Maintenance building (up to 5 m high);
- A security fence (chain mesh) up to 2.5 m high, enclosing the Substation;
- A 10 m wide defendable APZ around the perimeter of the Substation; and
- Parking for 5 vehicles.

Battery Area (0.91 ha):

- A series of separate containerised battery units, connected by underground cables to the Substation (approximately 2.5 m high);
- A separate transformer adjacent to each battery; and
- A 10m defendable APZ around the perimeter of the Battery Area.

Operations Buildings Area (0.96 ha):

- A Site office building including amenities with a height of 3.6 m;
- A maintenance building and workshop with a height of 5 m;
- 3 Storage sheds with a height of 4.1 m;
- Car parking for twelve (12) vehicles;
- A septic tank and potable water tank;
- A defendable APZ of 20 m, which allows the area to function as the nominated 'Shelter in Place' location (see Bushfire Risk Assessment and Mitigation Plan).

In addition to the key components outlined above, there will be a temporary construction compound (1.44 ha) to facilitate the construction phase of the Proposal. The construction compound would include:

- Temporary construction offices (up to 5 m high);
- Car and bus parking areas for construction vehicles (51 workers cars, 5 mini vans; and additional parking space provided for delivery vehicles and construction machinery);
- Staff amenity block including portable toilets, showers and a kitchen, designed for peak staff numbers during the construction period; and
- Laydown areas.

Once the Proposal is operational, the construction compound will be decommissioned and revegetated.

The Proposal would take approximately 12 months to construct and would be operational for approximately 28 years. Following the operational period, all above ground infrastructure would be removed from Site, which would take approximately 12 months.

3 Overview of site and surrounds

Renzo Tonin & Associates has based its assessment of the Proposal on the drawing set P1017-01 dated October 2020 by NG Electrical Pty. Ltd and the Proposal description provided in Section 2. The Proposal includes the following items relevant to acoustics:

- Approximately 640,000 panels supported by approximately 5724 x NEXTracker Gemini 2P tracker motors
- 82 x SMA Sunny Central 2750-EV inverters
- A substation area including 2 x 100 MVA transformers
- A battery area including:
  - 88 x 1.2 MW inverters
  - 88 x 2.5 MWH batteries
  - 44 x transformers

The Proposal will have the capacity to generate electricity during day light hours. This will predominantly be during day and evening periods (7am-6pm and 6pm-10pm, respectively) throughout the year and potentially part of the night-time period (prior to 7am) during the summer months. Batteries could potentially operate at all times.

Nearby dwellings relevant for the assessment were identified using aerial maps and are presented in Table 1. As noise reduces with distance, assessment of noise levels at these dwellings also addresses noise impacts at more distant dwellings.

Table 1: Dwellings near the Proposal

ID	Address	Approximate distance to Site	Zone
N[1]	520 Meningoort Road, Bookaar 3260 – landowner property	800 m	Farm Zone 1 (FZ1)
B	391 Darlington Road, Bookaar 3260	1280 m	Farm Zone 1 (FZ1)
E[1]	599 Darlington Road, Bookaar 3260	450 m	Farm Zone 1 (FZ1)
G	699 Darlington Road, Bookaar 3260	1210 m	Farm Zone 1 (FZ1)
I[1]	745 Darlington Road, Bookaar 3260	890 m	Farm Zone 1 (FZ1)
K[1,2]	905 Darlington Road, Bookaar 3260	630 m	Farm Zone 1 (FZ1)
L[1]	924 Darlington Road, Bookaar 3260	840 m	Farm Zone 1 (FZ1)

Notes: As noise reduces with distance, assessment of noise levels at these dwellings also addresses noise impacts at more distant dwellings.

1. Dwelling is within 1km of the Subject Site boundary. Dwelling IDs match those used in the 'Amenity Report'
2. Dwelling is located approximately 50 m from proposed upgrade works to Meningoort Road (north)

Figure 1, overleaf, presents an overview of the Subject Site and surrounding land uses.

Figure 1: Overview of the Site and dwellings assessed (not to scale)

Note: Dwelling 'E' is the closest dwelling (approximately 450m from the Proposal). For scale details of the Proposal see the 'Site Plan' accompanying the Planning Application.

4 Noise criteria

4.1 Planning scheme

As noted in Section 2, the VCAT decision for the Previous Application noted the following with respect to acoustics (para. 342 -343):

- *"Clause 13.05 of the scheme addresses noise abatement. Clause 53.13-3 requires us to consider the effect of the proposal on the surrounding area in terms of, amongst other things, noise.*
- *We have not been persuaded that there are specific impacts in terms of noise that will affect amenity or neighbours. The proposal is well separated from dwellings in terms of the potential for any noise intrusions."*

With respect to Corangamite Planning Scheme Clauses mentioned above:

- Clause 13.05-1S references the following acoustic criteria documents:
  - *State Environment Protection Policy (Control of Music Noise from Public Premises) No. N-2*
    - Music noise policy – not applicable to the Proposal
  - *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 in metropolitan Melbourne*
    - Applicable within the Melbourne Metropolitan boundaries, not Corangamite.
  - *Interim Guidelines for Control of Noise from Industry in Country Victoria (Environment Protection Authority, 1989)*
    - Superseded by Noise from Industry in Regional Victoria (NIRV), which is addressed in this acoustic report
  - *A Guide to the Reduction of Traffic Noise (VicRoads 2003)*
    - Not applicable to the Proposal
- Clause 53.13-3 sets out the following decision guidelines with respect to acoustics:
  - *"The effect of the proposal on the surrounding area in terms of noise, …"*
    - Addressed in this acoustic report.
  - *"Solar Energy Facilities Design and Development Guideline (Department of Environment, Land, Water and Planning, August 2019)"*
    - Addressed in this acoustic report.

4.2 DELWP Solar Energy Facilities – Design and Development Guideline

The Department of Environment Land Water and Planning (DELWP) *Solar Energy Facilities – Design and Development Guideline, 2019* (the 'Guideline') provides an overview of the policy, legislative and statutory planning arrangements for solar energy facilities in Victoria. The Solar Facilities Guideline states the following in relation to acoustics:

- *"Noise*

  A facility should keep its noise impacts at or below the levels in EPA Victoria's Noise from industry in regional Victoria guideline [see Section 4.3]*. Noise attenuation measures could include:*
  • ensuring any components operate to relevant standards
  • acoustic housing or baffles at the noise source
  • conducting maintenance and other operational activity during the daytime
  • using landscaping or locating noisier components centrally within a site"

- *"Construction noise and dust management*

  To address impacts on nearby sensitive land uses, a proponent should reduce the potential noise from vehicles servicing the site, from fixed machinery onsite and from construction activities, for example by limiting times when noisy operations are allowed. It should also engage with stakeholders to address any potential impacts...
  The EMP should outline measures to address noise and the disturbance of dust and sediment during construction and operation of the facility.
  EPA Victoria's Environmental Guidelines for Major Construction Sites has best-practice guidelines for general construction" [see Section 4.4 and Section 4.4.2]

4.3 Noise from Industry in Regional Victoria (NIRV)

State Environment Protection Policy (Control of Noise from Industry, Commerce and Trade) No. N-1 (SEPP N-1) governs noise from commercial premises affecting residential properties within the Melbourne metropolitan region; legislated by way of the Environment Protection Act 1970, to protect beneficial domestic uses, in particular sleep during the night period. SEPP N-1 is not legislatively applicable to patron or music noise.

In areas outside the Melbourne metropolitan area, Victorian EPA Publication 1411, *'Guidelines: Noise from Industry in Regional Victoria'* (NIRV) sets out maximum recommended noise levels. Per Victorian EPA Publication 1413, *'Guidelines: Applying NIRV to Proposed and Existing Industry,'* these maximum recommended noise levels may be used *"…to help decide whether the noise is excessive, unreasonable or a nuisance when using the Public Health and Wellbeing Act or Environment Protection Act."*

The applicable noise criteria are presented in Table 2.

Table 2: NIRV maximum recommended noise levels

Noise generating planning zone	Noise receiving planning zone	Period	Noise criteria, L_{eq} dB(A)
Farming Zone (FZ)	Farming Zone (FZ)	Day	46
		Evening	41
		Night	36

Period Definitions:				
	Day:	Weekdays 7am - 6pm;	Saturdays 7am - 1pm;	Sundays NA
	Eve:	Weekdays 6pm - 10pm;	Saturdays 1pm - 10pm;	Sundays 7am - 10pm
	Night:	All days 10pm - 7am		

NIRV assesses commercial premises in terms of the representative noise impact in a 30-minute period. Noise impacts are typically assessed outside, at noise sensitive premises including dwellings.

NIRV night-time noise criteria are typically more stringent than that of the day or evening periods. As such, compliance during the night-time period implies compliance during the day and evening periods, provided that emitted noise levels do not vary.

4.4 Construction noise and vibration

4.4.1 Legislation

There are currently no objective legislative requirements to limit noise and vibration from construction in Victoria however there are Guidelines that set out best practice and are considered below.

4.4.2 EPA Environmental Guidelines for Major Construction Sites, Publication 480

Per Section 0, the DELWP *Solar Energy Facilities – Design and Development Guideline* states that "…*EPA Victoria's Environmental Guidelines for Major Construction Sites has best-practice guidelines for general construction"*

The Environmental Guidelines for Major Construction Sites (EPA Pub. 480) states:

"While no specific statutory controls exist for noise from construction sites, all noise nuisance should be reduced wherever possible from vehicles, fixed machinery within the site, blasting, general construction activities, and from movements of vehicles servicing the site."

EPA Pub. 480 sets out the following suggested measures, with the objective to "…*ensure nuisance from noise and vibration does not occur*":

- *"Fit and maintain appropriate mufflers on earth-moving and other vehicles on the site*
- *Enclose noisy equipment*
- *Provide noise attenuation screens, where appropriate*
- *Where an activity is likely to cause a noise nuisance to nearby residents, restrict operation hours to between 7am and 6pm weekdays and 7am to 1pm Saturday, except where, for practical reasons, the activity is unavoidable*
- *Noise should not be above background levels inside any adjacent residents between 10pm and 7am*
- *Advise local residents when unavoidable out-of-hours work will occur*
- *Schedule deliveries to the site so that disruption to local amenity and traffic are minimised*
- *Conduct a study on the impact of ground vibration from construction activities, where these operations occur within 50 metres of a building and take appropriate action*
- *Minimise air vibrations"*

Per Section 5.5 of EPA Pub. 480:

- *"A British study has found that nuisance from ground vibration and building damage is unlikely to occur if the operation is conducted at distances greater than 50 metres.*
- *Complaints about air vibrations from blasting have been received from people 100 metres away from the activity."*

It is understood that blasting is not proposed for the construction of the Proposal, therefore vibration and noise distance thresholds for typical construction activities are considered to be less onerous (ie. closer), than the 50 metres and 100 metres thresholds respectively.

4.4.3 EPA Noise Control Guidelines, Publication 1254

EPA Publication 1254 Noise Control Guidelines applies to:

- *"industrial and commercial premises*
- *large-scale residential premises under construction in non-residential zones, as defined in regulation 9 of the Environment Protection (Residential Noise) Regulations 2008."*

As such EPA Pub. 1254 is understood not to be intended for application to major infrastructure projects such as the Proposal. However, EPA Pub. 1254 does present noise level targets, and non-prescriptive recommendations including, but not limited to:

- *"Inform potentially noise-affected neighbours about the nature of construction stages and noise reduction measures.*
- *Give notice as early as possible for periods of noisier works such as excavation. Describe the activities and how long they are expected to take. Keep affected neighbours informed of progress.*
- *Appoint a principal contact person for community queries.*
- *Provide 24-hour contact details through letters and site signage. Record complaints and follow a complaint response procedure suitable to the scale of works.*
- *Within normal working hours, where it is reasonable to do so:*
  - *Schedule noisy activities for less sensitive times, (for example, delay rock-breaking task to the later morning or afternoon)*
  - *Provide periods of respite from noisier works (for example, periodic breaks from jackhammer noise)*
- *The weekend/evening work hours in the schedule (including Saturday afternoon or Sunday) are more sensitive times and have noise requirements consistent with quieter work.*
- *The weekend/evening periods are important for community rest and recreation and provide respite when noisy work has been conducted throughout the week. Accordingly, work should not usually be scheduled during these times.*
- *Where work is conducted in a residential area or other noise-sensitive location, use the lowest noise work practices and equipment that meet the requirements of the job.*
- *Site building, access roads and plant should be positioned such that the minimum disturbance occurs to the locality. Barriers such as hoardings or temporary enclosures should be used. The site should be planned to minimise the need for reversing of vehicles.*
- *Site building, access roads and plant should be positioned such that the minimum disturbance occurs to the locality. Barriers such as hoardings or temporary enclosures should be used. The site should be planned to minimise the need for reversing of vehicles.*
- *All mechanical plant is to be silenced by the best practical means using current technology. Mechanical plant, including noise-suppression devices, should be maintained to the manufacturer's specifications. Internal combustion engines are to be fitted with a suitable muffler in good repair.*
- *Fit all pneumatic tools operated near a residential area with an effective silencer on their air exhaust port.*
- *Install less noisy movement/reversing warning systems for equipment and vehicles that will operate for extended periods, during sensitive times or in close proximity to sensitive sites. Occupational health and safety requirements for the use of warning systems must be followed.*
- *Turn off plant when not being used.*
- *All vehicular movements to and from the site to only occur during the scheduled normal working hours, unless approval has been granted by the relevant authority.*
- *Where possible, no truck associated with the work should be left standing with its engine operating in a street adjacent to a residential area.*
- *Special assessment of vibration risks may be needed, such as for pile-driving or works structurally connected to sensitive premises."*

EPA Publication 1254 noise level targets are:

Table 3: EPA 1254 - operation schedule & noise guidelines

Normal working hours		Weekend/evening work hours		Night period	
Mon-Fri	07:00-18:00 hours	Noise level at any residential premises is not to exceed background noise by 10dB(A) (for the first 18 months, 5dBA thereafter). During the hours of:		Noise inaudible within a habitable room of any residential premises during the hours of:	
Sat	07:00-13:00 hours	Mon-Fri	18:00-22:00 hours	Mon-Sun	22:00-07:00 hours
		Sat	13:00-22:00 hours		
		Sun and Public Holidays	07:00-22:00 hours		

4.4.4 Construction vibration

Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy, however, Australian Standard AS 2187.2 *'Explosives—Storage and use'*, refers to British Standard BS 7385.2 '*Evaluation and measurement of vibration in buildings'* for prevention of minor or cosmetic damage occurring in structures from ground vibration.

Regarding application to heritage buildings, British Standard 7385.2 notes that *"a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

German Standard DIN 4150.3 '*Structural vibration in buildings - Effects on Structure*' also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative. Per DIN450.3 "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible. Exceeding the values in table 1* [provided in Table 6 below] *does not necessarily lead to damage; should they be significantly exceeded; however, further investigations are necessary."*

The tables overleaf present summaries of applicable BS 7385 and DIN 4150.3 criteria.

Table 4: BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	25[(1)]	25[(1)]	25[(1)]
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	7.5[(1)] to 10[(1)]	10[(1)] to 25[(1)]	25[(1)]

Note: 1. Presented noise levels are 50% lower than presented in BS 7385.2, as per BS 7385.2 Section 7.3.3 *"Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values ... may need to be reduced by up to 50%"*

Table 5: DIN 4150-3 structural damage criteria (recognised to be conservative)

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

Table 6: DIN 4150-3 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

Note: For gas and water supply pipes within 2 m of buildings, the levels given in Table 13 should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

For long-term vibration the guideline levels presented should be halved.

Referring back to EPA Pub. 480 (See section 4.4.2 above):

- *"A British study has found that nuisance from ground vibration and building damage is unlikely to occur if the operation is conducted at distances greater than 50 metres.*
- *Complaints about air vibrations from blasting have been received from people 100 metres away from the activity."*

As it is understood that blasting is not proposed for the construction of the Proposal, vibration and noise distance thresholds for typical construction activities are considered to be much less onerous (ie. closer) than the 50 metres and 100 metres thresholds respectively.

5 Noise impact assessment

5.1 Noise propagation model

A CadnaA three-dimensional noise model, implementing ISO 9613 noise propagation algorithms was built, to calculate noise propagation from the Proposal to surrounding residential premises during the operational period. The built form of the Proposal and surrounding dwellings were integrated into the model. The following propagation effects were included in the predictive model:

- Mitigation of noise with distance, including geometrical spreading and air absorption (per ISO 9613)
- Reflections from buildings and environment (max. order 3 reflections)
- Barrier effects due to obstructions between noise sources and dwellings (predominantly due to topography)
- Ground absorption effects (G=1.0)
- Local topography (Topographic data for the Subject Site and surrounding area was in the form of 10-20m resolution contour lines from VicMaps.)

Appendix B presents a graphical overview of the noise model and noise model contours for reference.

5.2 Operational noise

Table 7 provides details of typical equipment and corresponding sound power levels which have been incorporated into this assessment. Equipment has been assumed to be distributed uniformly across the site except where equipment locations been indicated specifically in provided drawings.

Table 7: Typical equipment and associated sound power levels

Plant Item	Plant Description[1]	$L_{W,eq}$ Sound Power Levels, dB(A) re. 1pW
1	NEXTracker Gemini 2P tracker motors (5723 in total)	52 (each)[3]
2	Inverter/power stations: SMA SC 2750-EV inverters (82 in total)	92 (each)[3]
3	Substation area: 100 MVA transformers (2 in total)	96 (each)[2,4]
4	Battery area: 2.5 MWH battery storage units (88 in total)	87 (each)[2]
5	Battery area: 1.2 MW inverters (88 in total)	88 (each)[2]
6	Battery area: Transformers (44 in total)	83 (each)[2,4]

Notes:
1. The above equipment is understood to comprise typical equipment and corresponding sound power levels. Once the project has progressed to design development, the equipment shall be selected and installed such that NIRV noise criteria are conformed with at all times.
2. Based on sound power level data from past projects and/or RT&A's acoustic database
3. Based on sound power level data provided by the client or manufacturer
4. +5dB correction applied to plant during assessment to account for tonality

Table 8 presents the predicted noise levels at the nearest dwellings. Since noise reduces with distance, assessment of noise levels at these dwellings also addresses noise impacts at more distant dwellings. As shown, noise levels conform with NIRV night time criteria and therefore also conform with day and evening NIRV criteria.

On the basis of the assessed configuration, without additional noise mitigation measures, it is considered that the Proposal can operate without adverse acoustic impact on residential amenity, and is considered very low risk with respect to noise. This is as a result of the significant intervening distances between the Proposal and the nearest dwellings (approximately 450 metres to the nearest dwelling), and location of noisier infrastructure away from boundaries with neighbouring properties.

Table 8: Predicted noise levels at dwellings from operation

Dwelling ID	Predicted noise levels, L_{eq} dB(A)	NIRV maximum recommended night time noise level (most stringent), L_{eq} dB(A)	Complies?
N	32	36	✓
B	17	36	✓
E	28	36	✓
G	21	36	✓
I	27	36	✓
K	24	36	✓
L	22	36	✓

5.3 Construction noise and vibration

It is understood that the construction of the Proposal is to occur over 12 months, between the following hours:

- Mondays – Fridays: 7am – 6pm
- Saturdays: 7am – 5pm

During the standard building activity hours (Weekdays 7am-6pm; Saturdays 7am-1pm), there are no quantitative noise criteria and therefore noise monitoring is not mandatory during these hours.

Between 1pm and 5pm on Saturdays, EPA Pub. 1254 recommends construction noise levels at dwellings be limited to:

- $L_{eq} \leq L_{90}$ + 10dB(A) **for** the first 18 months
- $L_{eq} \leq L_{90}$ + 5dB(A) **after** the first 18 months

It is therefore recommended that only low noise works occur during the Saturday 1pm-to-5pm period. Decommissioning is expected to occur over a similar 12 month period and the same recommendations would apply. In consideration of local stakeholders, it is understood that the movement of Heavy Goods Vehicles to and from the Site, and Meningoort Road/ Darlington Road upgrade works (to occur over only an 18 day period) will be managed to standard construction hours (Weekdays 7am-6pm; Saturdays 7am-1pm).

With consideration of the significant distance to dwellings, and with implementation of appropriate noise management strategies (see Section 4.4 for examples), construction of the Proposal and associated access upgrades is considered very low risk with respect to noise and adverse acoustic impact on residential amenity.

Referring to EPA Pub. 480 (See section 4.4.2 above):

- *"A British study has found that nuisance from ground vibration and building damage is unlikely to occur if the operation is conducted at distances greater than 50 metres.*
- *Complaints about air vibrations from blasting have been received from people 100 metres away from the activity."*

As it is understood that blasting is not proposed for the Proposal, vibration and noise distance thresholds for typical construction activities are much less onerous than the 50 metres and 100 metres thresholds respectively.

The Proposal is considered very low risk with respect to construction noise and vibration impact on the basis of:

- The Proposal commitment to construction noise and vibration management strategies consistent with EPA Pub 1254 and EPA Pub 480.
- The significant intervening distance between the Proposal and nearest dwellings (approximately 450 metres to the nearest).
- The significant intervening distance between road upgrade works on Meningoort Road (north) and to the intersection of Meningoort Road and Darlington Camperdown Road and the nearest dwelling (approximately 50 metres at the minimum distance to 'Dwelling 'K').
- A Proposal commitment to limit HGV construction movements and road upgrades to standard construction hours.

6 Conclusion

Renzo Tonin & Associates was engaged by Bookaar Renewables Pty Ltd to undertake an acoustic assessment of the proposed 200MWac (282 MWdc) Solar Farm in Bookaar, Victoria (Corangamite Shire) (the Proposal). The assessment responds to the DELWP *'Solar Energy Facilities - Design and Development Guideline - August 2019'* (the Guideline). The Guideline states:

> *The design response should also include one or more written reports and assessments including: … an assessment of:*
>
> - *an assessment of potential noise impacts … EPA Victoria's Noise from industry in regional Victoria …* (EPA Pub 1411 'NIRV')
> - *construction management plan… EPA Victoria's Environmental Guidelines for Major Construction Sites has best-practice guidelines for general construction*. … (EPA Pub 480)

The assessment comprised:

- Review of the surroundings, the Subject Site and Proposal
- Determination of relevant noise criteria:
  - NIRV maximum recommended noise levels
  - Construction noise and vibration criteria
- Assessment of the operational noise from the Proposal
- Recommendations with respect to noise and vibration during the construction phase

On the basis of the assessed configuration, it considered that the Proposal is very low risk with respect to operational and construction noise and vibration, and can operate without adverse acoustic impact on residential amenity.

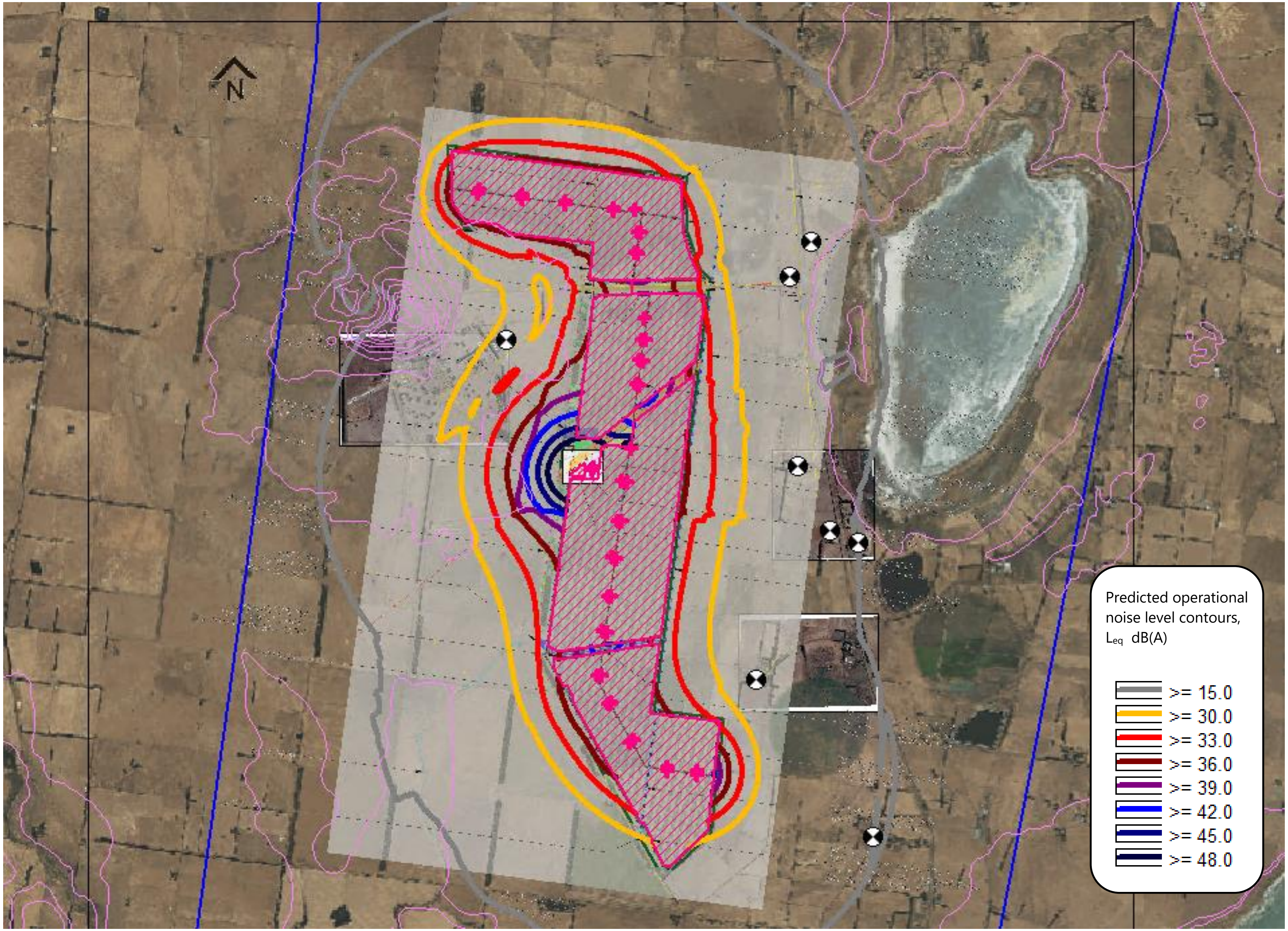
APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.		
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level if measured as an overall level or an L90 noise level when measured in octave or third-octave bands.		
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our environment:		
	threshold of hearing	0 dB	The faintest sound we can hear, defined as 20 micro Pascal
		10 dB	Human breathing
	almost silent	20 dB	
		30 dB	Quiet bedroom or in a quiet national park location
	generally quiet	40 dB	Library
		50 dB	Typical office space or ambience in the city at night
	moderately loud	60 dB	CBD mall at lunch time
		70 dB	The sound of a car passing on the street
	loud	80 dB	Loud music played at home
		90 dB	The sound of a truck passing on the street
	very loud	100 dB	Indoor rock band concert
		110 dB	Operating a chainsaw or jackhammer
	extremely loud	120 dB	Jet plane take-off at 100m away
	threshold of pain	130 dB	
		140 dB	Military jet take-off at 25m away
dB(A)	A-weighted decibel. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter is denoted as dB(A). Practically all noise is measured using the A filter.		
Reflection	Sound wave reflected from a solid object obscuring its path.		
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.		
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 pico watt.		
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 micro Pascals.		
Tonal Noise	Sound containing a prominent frequency and characterised by a definite pitch.		

APPENDIX B Operational noise level contours

Figure 2: Noise level contours predicted from operation



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APPENDIX B:
GLINT AND GLARE ASSESSMENT

PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Bookaar Renewables Solar Farm Pty Ltd.

Bookaar Solar Farm

November, 2020

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ADMINISTRATION PAGE

Pager Power job reference:	9201F
Date:	November, 2020
Author:	Danny Scrivener
Email:	danny@pagerpower.com
Phone:	+44 (0) 1787 319 001

Reviewer:	Kai Frolic
Date:	November, 2020
Email:	kai@pagerpower.com

Issue	Date	Detail of Changes
1	June, 2020	Initial issue (9201E)
1	6 August, 2020	Initial issue (9201F – an update to 9201E)
2	10 August, 2020	Second issue – minor amendments
3	9 October, 2020	Third issue – minor amendments including description and boundary change

Stour Valley Business Centre, Sudbury, Suffolk, CO10 7GB

T: +44 (0)1787 319001 E: info@pagerpower.com W: www.pagerpower.com

EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from the proposed Bookaar Solar Farm (the 'Proposal') located in Bookaar, Victoria. This assessment pertains to the possible effects upon surrounding roads, dwellings and key viewpoints in the surrounding area. A high-level assessment of aviation receptors has also been completed. The analysis includes modelling of a tracking system that optimises the panel angle throughout the day to maximise electricity generation.

Pager Power Glint and Glare Assessment and Guidance

Pager Power has undertaken over 450 glint and glare assessments in Australia and throughout the world. The company has also has produced glint and glare guidance[1] (the 'Page Power Guidance'), based on industry experience, independent studies, and extensive consultation with industry stakeholders including airports and aviation regulators.

Guidance

Guidance for Glint and Glare assessment of proposed solar photovoltaic (PV) developments has been produced by the Department of Environment Land Water and Planning (DELWP)[2], (the 'Guideline'). Within the Guideline, details regarding the requirements for a glint and glare assessment are stated. The Guideline is consistent with the Pager Power Guidance.

Glint and Glare

The definition of glint and glare used by Pager Power is as follows:

- Glint – a momentary flash of bright light;
- Glare – a continuous source of bright light.

[1] Solar Photovoltaic Development – Glint and Glare Guidance, October 2018. Pager Power's guidance is based on the existing available studies, guidance and Pager Power's assessment experience.
[2] Solar Energy Facilities Design and Development Guideline, August 2019. Department of Environment Land Water and Planning (last accessed 11/06/2020).

General Effects of Solar PV Glint and Glare

Independent studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[3].

Glint and glare effects can only ever occur when the weather is clear and sunny. In the scenario where a solar reflection is possible towards a road user or resident in a surrounding dwelling under baseline conditions, the individual will also be looking in the general direction of the Sun at or directly after/before sunrise and sunset respectively. This means the Sun and solar reflection will be visible simultaneously. The Sun is a significantly brighter source of light. Lastly, at any one location, only a particular area of solar panels will produce a solar reflection towards it. Not all receptors will experience a solar reflection at the same time.

Overall Results

Road Receptors

Overall, a low impact upon road users (at worst) on the assessed road is expected. Where the solar panels are not visible, no impact is expected. The overall results and reasoning are presented below.

- Considering baseline conditions, solar reflections are theoretically possible towards approximately 1.85km of Darlington-Camperdown Road. This road is classified as an arterial road;
- Road users would be expected to be travelling at (up to) 100 km/h with a low density of traffic expected;
- Any solar reflection would originate almost perpendicular to the direction of travel therefore a road user would be looking away from the direction of travel;
- In accordance with the methodology set out in Section 3 and Appendix E, the overall expected impact upon road users with respect to safety is classified as low where the reflecting solar panels are visible; and
- Where views of the reflecting solar panels are removed by mitigation or by existing screening, there will be no impact upon road users.

[3] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

Dwelling Receptors

Overall, a low impact upon residential amenity is expected (worst-case) considering the results of the geometric analysis, a dwelling site survey and proposed mitigation. Where the solar panels are not visible, no impact is expected. The overall results and reasoning are presented below.

- Solar reflections are possible towards three of the assessed dwelling receptors based on the modelling results. A site survey confirmed that visibility from these dwellings would be at least partially screened with mitigation proposed to significantly remove views;
- Under baseline conditions, the four dwellings could experience solar reflections for up to 20 minutes per day all year round. The results vary per dwelling therefore please see Table 2 and Appendix G for the detailed results breakdown for each dwelling;
- Under baseline conditions, a clear view of the reflecting solar panels at the particular time of day when a solar reflection was geometrically possible would be required. In addition, the weather would also have to be clear and sunny;
- When existing screening and mitigation is considered, the resulting impact significance is low to no impact in accordance with the methodology set out in Section 3 and Appendix E; and
- Where views of the reflecting solar panels are removed by mitigation or by existing screening, there will be no impact upon residential amenity.

Council Viewpoints

Three viewpoints (Mt Laura, Camperdown Botanic Gardens and Mt Elephant) that had been assessed as part of a previous Council request for a solar farm development proposed within the same footprint (the ‘Previous Application’) are beyond 7km from the site, and are situated north and south of the panel area. It is Pager Power’s methodology (and the methodology as put forward in the Guideline) to consider ground based receptors within 1km of a solar panel, however calculations were undertaken for completeness. The results of these calculations showed that no geometric solar reflections were possible. Considering this, no impact is expected at these viewpoints.

Aviation Receptors

No significant impact upon aviation activity at Kurweeton Airport and Cobden Airport is anticipated with respect to glint and glare from the Proposal. This is due to their relative locations (9.75km north east and 16.7km south of the Proposal respectively), and in line with Pager Power’s experience in assessing this issue.

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PAGERPOWER Urban & Renewables

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ABOUT PAGER POWER

Pager Power

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 48 countries within Europe, Africa, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from the proposed Bookaar Solar Farm (the 'Proposal') located in Bookaar, Victoria (Corangamite Shire Council).

Previously, Pager Power provided a Glint and Glare Assessment for a solar farm within the same footprint at the development site (the Previous Application). The Previous Application was the subject of a 2019 Victorian Civil and Administrative Tribunal (VCAT) hearing (Bookaar Renewables Pty Ltd vs Corangamite SC[2019] VCAT 1244), following refusal of the planning permit application by the Corangamite Shire Council.

Ultimately, the VCAT decision was unsuccessful for the proposed plans at the time (noting here the decision was not based on Glint and Glare matters), and therefore, revised plans have been prepared for submission for planning permissions from the Department of Environment, Water, Land and Planning (DEWLP).

With respect to Glint and Glare, the VCAT decision noted that '*even though proposed perimeter landscaping may mitigate impacts, with possible modifications to the layout based on the flexibility desired by the permit applicant, a revised glint and glare assessment would be appropriate*' (para 272).

This report therefore provides a new Glint and Glare assessment for the layout of the *new* Proposal.

This assessment pertains to the possible effects upon surrounding roads, dwellings and key viewpoints in the surrounding area. A high-level aviation assessment has also been completed. This report contains the following:

- Solar farm details;
- Explanation of glint and glare;
- Overview of relevant guidance;
- Overview of relevant studies;
- Overview of Sun movement;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- Results discussion;
- High-level aviation assessment; and
- High-level overview of mitigation options.

Following this a summary of findings and overall conclusions and recommendations is presented.

1.2 Pager Power's Experience

Pager Power has undertaken over 450 Glint and Glare assessments internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

1.3 Understanding Glint and Glare – General Overview and Definition

When sunlight illuminates an object, an amount of the incident light is reflected. This reflected light, when directed towards the eye of an observer, can become noticeable and cause a distraction or a nuisance. The definition of glint and glare can vary. The definition used by Pager Power is as follows:

- Glint – a momentary flash of bright light.
- Glare – a continuous source of bright light.

In context, glint will be witnessed by moderate to fast moving receptors whilst glare would be encountered by static or slow moving receptors with respect to a solar farm. The term 'solar reflection' is used in this report to refer to both reflection types i.e. glint and glare. Where reflected sunlight may be visible to a receptor, it can be concluded that glint and glare effects are possible.

2 PROPOSED SOLAR FARM DETAILS

2.1 The Proposal

Bookaar Renewables Pty Ltd (the Proponent) is proposing to develop a 200MW solar energy facility (the Proposal, see the 'Site Plan' which supports the 'Planning Report' for the Proposal). The proposal contains the following:

- 'Array Areas', containing Photovoltaic (PV) panels mounted on a single axis tracking system with a maximum height of 4 m above natural ground at maximum tilt. The tracking system would be supported by piles driven into the ground. Row spacing is either 12.75 m or 13 m (pile to pile);
- 82 inverters located centrally throughout the Site in pairs at 41 locations across the Site (inverter stations). Inverter stations are located at least 170 m from the Site boundary;
- Below ground cabling connecting the PV panels between trackers and inverters;
- Below ground cabling connecting the inverters to the substation;
- An internal track network of all-weather gravel tracks (4 m), including a perimeter track which forms part of a 10 m wide defendable Asset Protection Zone (APZ) that surrounds the Site;
- Four (4) gated main site access points via Meningoort Road;
- Four (4) gated emergency access points along the western boundary of the Site;
- Eight dedicated water tanks for firefighting (maximum of 3.6m high), located adjacent to each access point;
- A perimeter security fence 2.5 m high (chain mesh);
- Perimeter vegetation screens (20 m wide with 4 rows of trees and maintained to a height of at least 4 m), planted on the outside of the security fencing;
- Agricultural style fencing 1.2 m high, around the perimeter of the vegetation screens and the perimeter of the existing vegetation identified on the Site's western boundary;

- A SCADA system that will gather, monitor and analyse data generated through operating the Proposal;
- On-demand, downward facing lighting (restricted to 4m in height); and
- Sensor triggered CCTV security cameras located around the perimeter of the Site and adjacent to key infrastructure.

Substation Area (1.76 ha):

- Substation connecting the Proposal to the onsite 220KV transmission line, via two (2) new high voltage (HV) 220 kV transmission lines;
- A Control building (3 m high);
- Substation Operations and Maintenance building (up to 5 m high);
- A security fence (chain mesh) up to 2.5 m high, enclosing the Substation;
- A 10 m wide defendable APZ around the perimeter of the Substation; and
- Parking for 5 vehicles.

Battery Area (0.91 ha):

- A series of separate containerised battery units, connected by underground cables to the Substation (approximately 2.5 m high);
- A separate transformer adjacent to each battery; and
- A 10m defendable APZ around the perimeter of the Battery Area.

Operations Buildings Area (area 0.96 ha):

- A Site office building including amenities with a height of 3.6 m;
- A maintenance building and workshop with a height of 5 m;
- 3 Storage sheds with a height of 4.1 m;
- Car parking for twelve (12) vehicles;
- A septic tank and potable water tank;

- A defendable APZ of 20 m, which allows the area to function as the nominated 'Shelter in Place' location (see Bushfire Risk Assessment and Mitigation Plan).

In addition to the key components outlined above, there will be a temporary construction compound (1.44 ha, see the 'Site Plan') to facilitate the construction phase of the Proposal. The construction compound would include:

- Temporary construction offices (up to 5 m high);
- Car and bus parking areas for construction vehicles (51 workers cars, 5 mini vans; and additional parking space provided for delivery vehicles and construction machinery);
- Staff amenity block including portable toilets, showers and a kitchen, designed for peak staff numbers during the construction period; and
- Laydown areas.

Once the Proposal is operational, the construction compound will be decommissioned and revegetated.

2.2 Photovoltaic Panel Mounting Arrangements and Orientation

As noted, the solar panels will be mounted to the ground and fitted to a single-axis tracking system that tilts the panels from east to west throughout the day in rows orientated north to south. A single-axis tracking system has been modelled in this report. It is understood that:

- Rows of panels will be orientated north to south.
- The panels will face 90 degrees from north in the morning (east facing) and 270 degrees from north in the evening (west facing). During solar noon, when the Sun is directly overhead, the panels will be flat, directed immediately upwards.
- There will be no tilt on the solar panels along the north/south axis;
- The tilt of the panels throughout the day is programmed, based on the known path of the Sun and shading considerations i.e. the tilt angle is optimised to avoid having one row of panels cast a shadow on another row.
- The range of elevation angles will be ±60°.

The panel details are illustrated in Figures 1 and 2 below and on the following page.

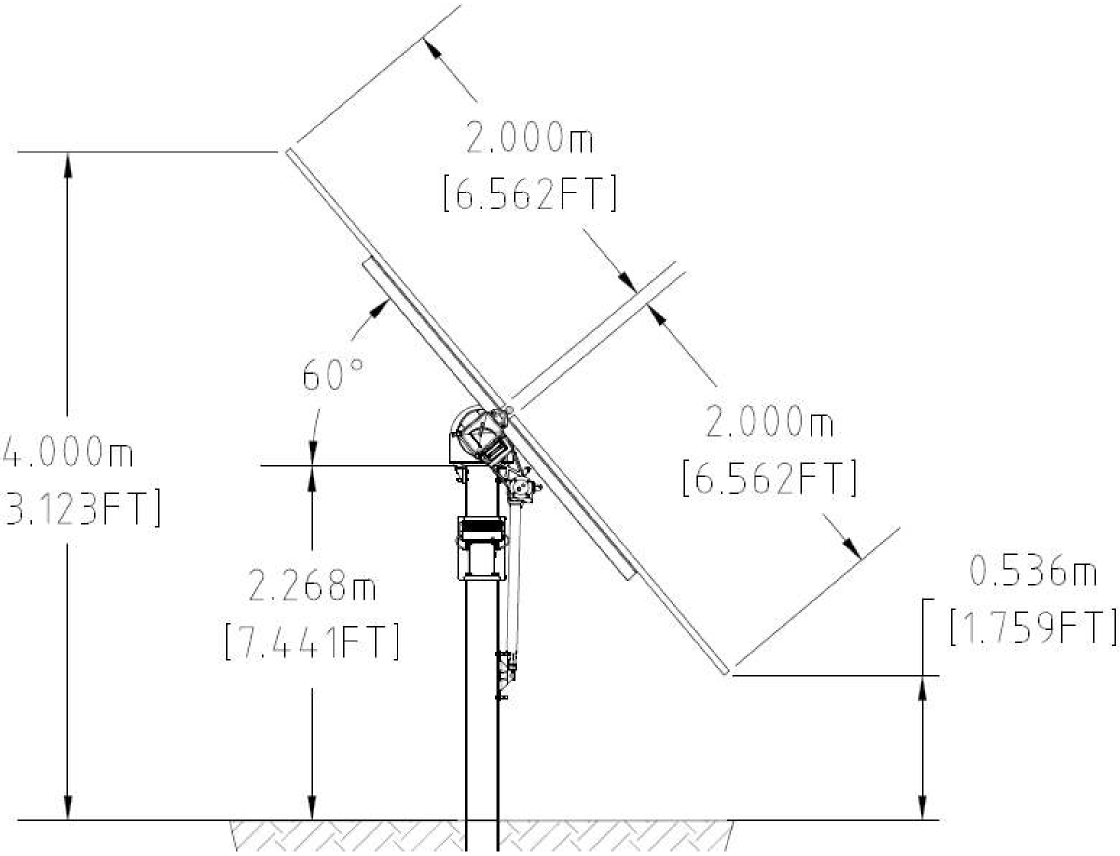

Figure 1 *Panel tracking details – 1*

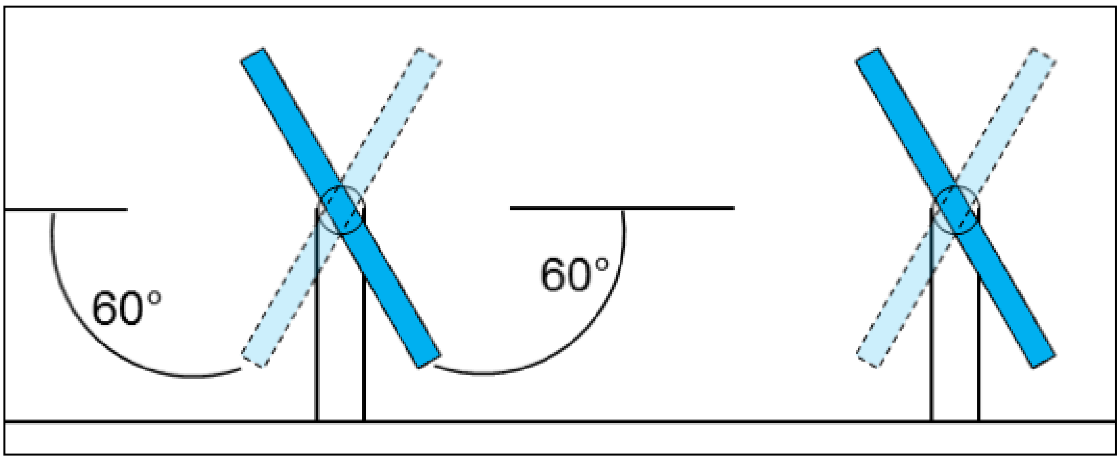

Figure 2 *Panel tracking details – 2*

Solar Panel Backtracking

Shading considerations dictate the panel tilt. This is affected by:

- The elevation angle of the Sun;
- The vertical tilt of the panels;

- The spacing between the panel rows.

This means that early in the morning and late in the evening, the panels will not be directed exactly towards the Sun, as the loss from shading of the panels (caused by facing the sun directly when the Sun is low in the horizon), would be greater than the loss from lowering the panels to a less direct in order to avoid the shading. Figure 3 below illustrates this.

Note the graphics in Figure 3 show two lines illustrating the paths of light from the Sun towards the solar panels. In reality the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The figure is for illustrative purposes only.

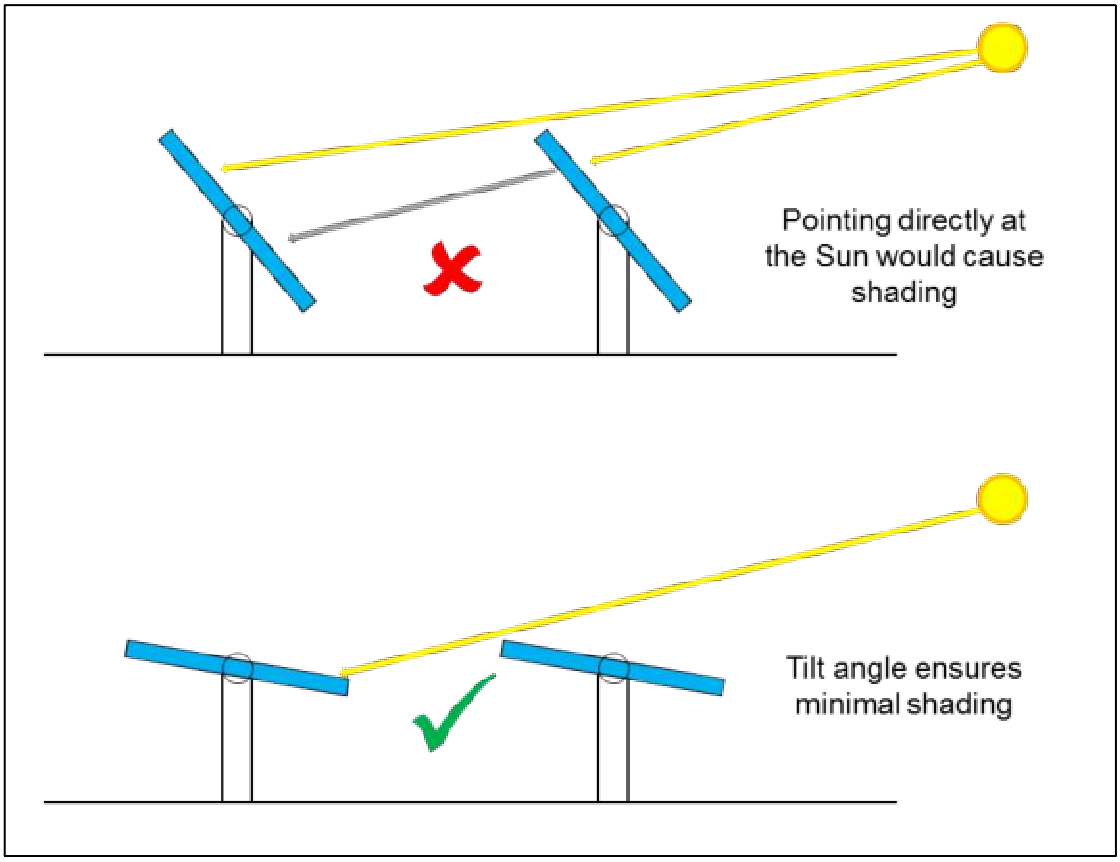

Figure 3 *Shading considerations*

Later in the day, the panels can be directed towards the Sun without any shading issues. This is illustrated in Figure 4 below[4].

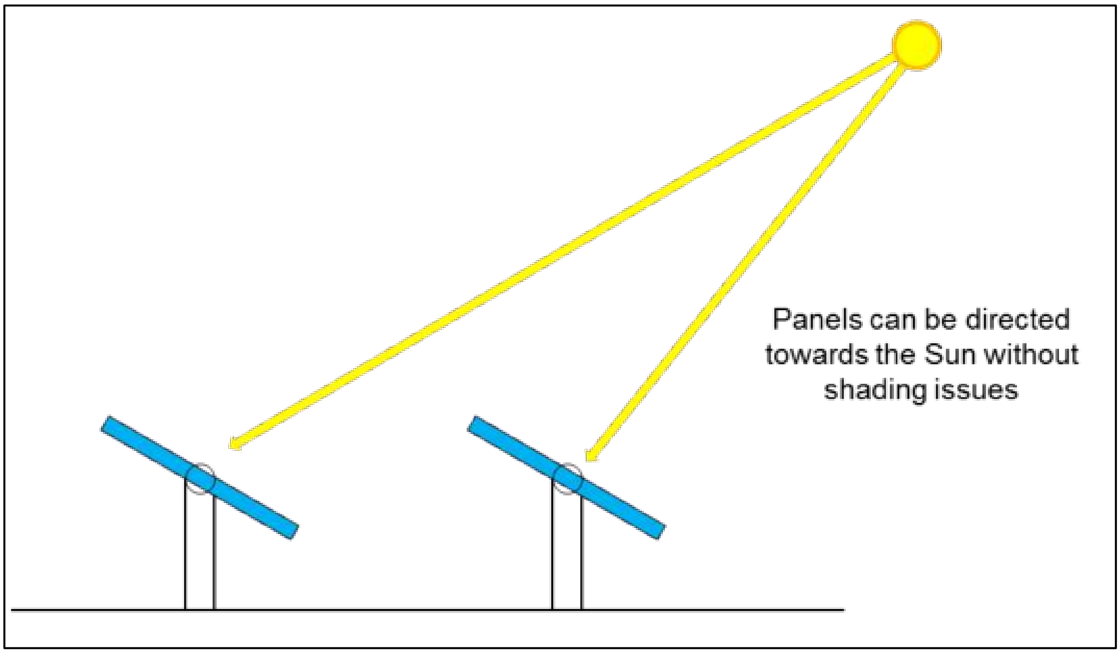

Figure 4 *Panel alignment at high solar angles*

The solar panels backtrack (where the panel angle gradually declines to prevent shading) by reverting to 0 degrees (flat) once the maximum elevation angle of the panels (60 degrees) becomes ineffective due to the low height of the Sun above the horizon and to avoid shading.

[4] Note that in reality the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The two previous figures are for illustrative purposes only.

2.3 Proposed Solar Farm Project Boundary

Figure 5[5] below (red line) shows the proposed Solar Farm Project Boundary overlaid on aerial imagery.

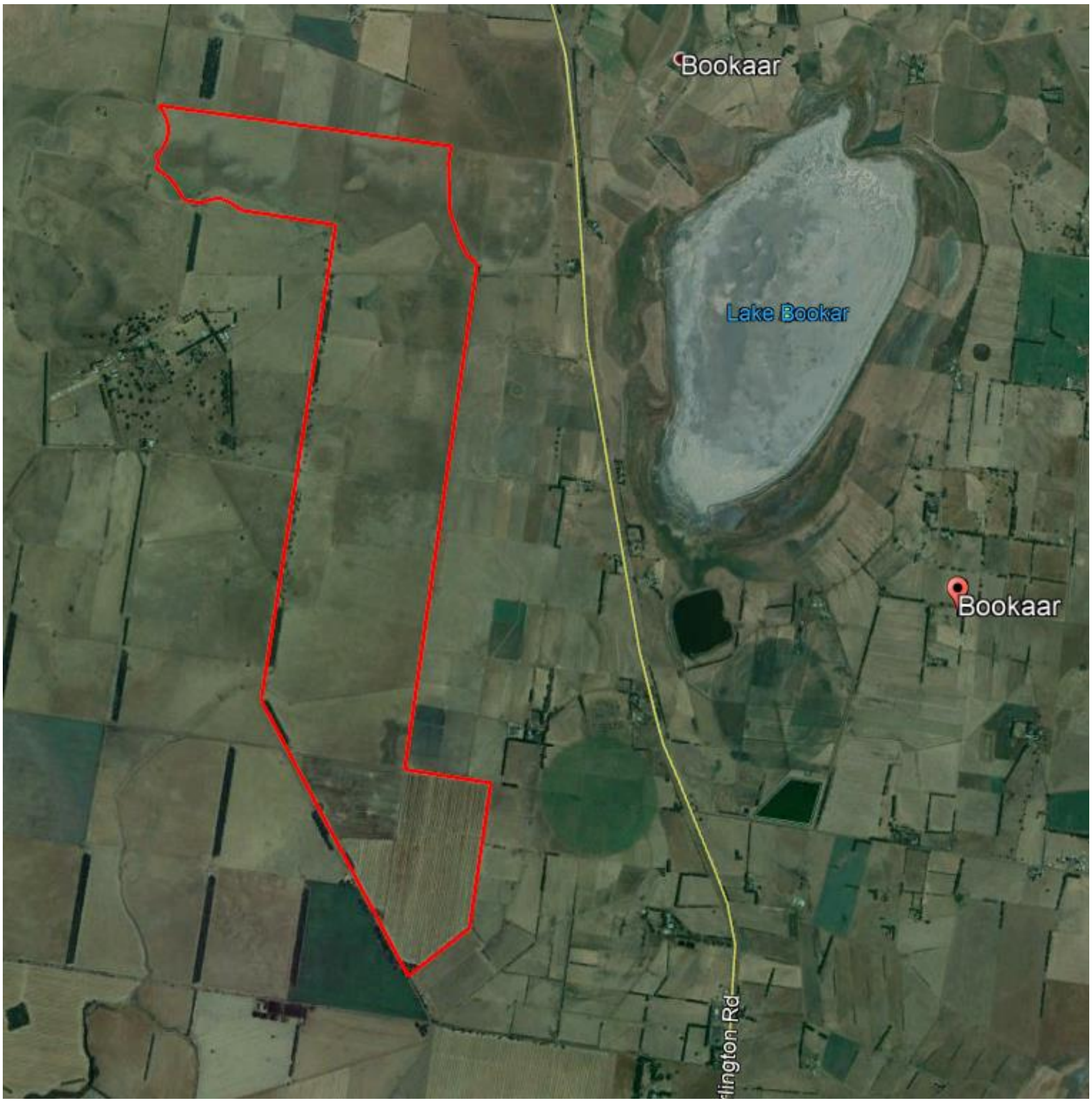

Figure 5 *Proposed project boundary*

[5] Source: Source: © 2020 Google/CNES/Airbus.

2.4 Assessed Solar Panel Area

Figure 6[6] below shows the assessed solar panel areas that have been used for modelling purposes. Coordinate data for the boundary points is shown in Appendix F. The maximum theoretical panel areas (constraint free areas within the Solar Farm Development Area) have been combined into one area for modelling purposes. The inclusion of small areas where panels will not be located will not change the overall results and provides a conservative assessment.

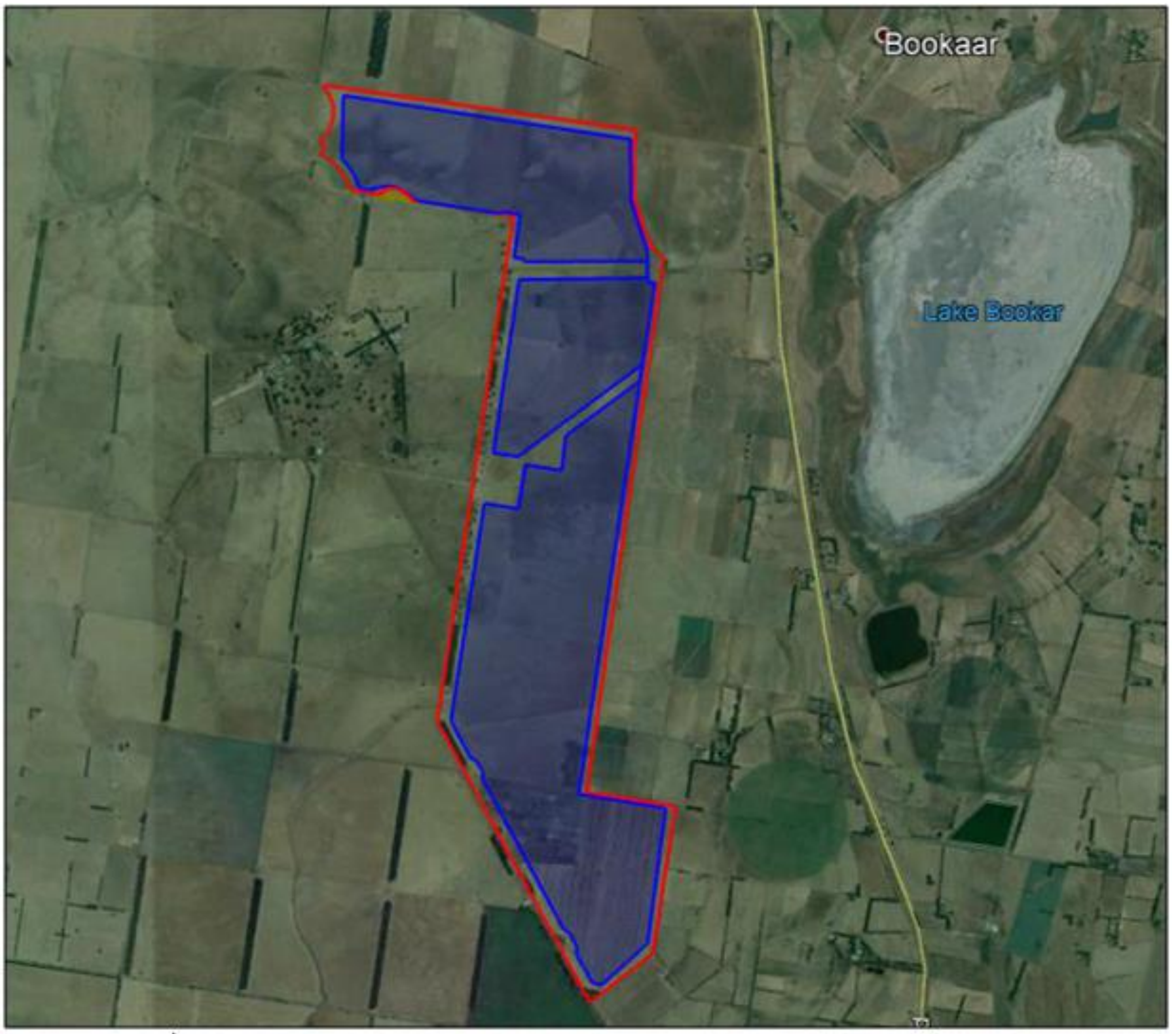

Figure 6 *Assessed solar farm panel area*

[6] Source: © 2020 Google/CNES/Airbus.

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guideline and Studies Overview

As noted, a guideline have been produced by the Department of Environment, Land, Water and Planning DELWP) pertaining to solar development (the Guideline)[7]. Within the Guideline, details regarding the requirements for a glint and glare assessment are stated. It is considered that the Guideline is consistent with Pager Power's Guidance which is now in its second edition[8]. The assessment approach is to identify receptors, undertake geometric reflection calculations and then to review the results against baseline conditions with comparisons against available solar panel reflection studies.

A number of studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The overall conclusions from available studies with regard to glint and glare issues from solar panels are as follows:

- Specular reflections of the Sun from solar panels are possible;
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence; and
- Published guidance shows that the intensity of reflections from solar panels are equal to or less than those from water. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces which are common in an outdoor environment such as those produced from glass and steel[9].

Appendix A and Appendix B present a review of relevant guidance and independent studies.

3.2 Background

Details of the Sun's movements and solar reflections are presented in Appendix C.

3.3 Methodology

The assessment methodology is based on guidance, studies, previous discussions with stakeholders and Pager Power's practical experience. Information regarding the methodology of the Pager Power glint and glare assessment is presented below:

- Identify receptors in the area surrounding the proposed solar farm;

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[7] Solar Energy Facilities Design and Development Guideline, August 2019. Department of Environment Land Water and Planning (last accessed 11/06/2020).
[8] Solar Photovoltaic Development – Glint and Glare Guidance, October 2018. Pager Power's guidance is based on the existing available studies, guidance and Pager Power's assessment experience.
[9] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

- Consider direct solar reflections from the proposed solar farm towards the identified receptors by undertaking geometric calculations – accounting for the tracker system and site layout;
- Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor then no reflection can occur;
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur;
- Consider both the solar reflection from the proposed solar farm and the location of the direct sunlight with respect to the receptor's position;
- Consider the solar reflection with respect to the published studies and guidance; and
- Determine whether a significant detrimental impact is expected.

For tracking solar panels, Pager Power uses a model developed by Forge Solar which is based on the Sandia National Laboratories methodology. The result is a chart that illustrates whether a reflection can occur and the approximate duration of any effects.

The full methodology is set out in Appendix E while further technical details relating to the methodology of the geometric calculations can be found in Appendix C.

3.4 Assessment Limitations

The list of assumptions and limitations are presented in Appendix D.

4 IDENTIFICATION OF RECEPTORS & MODELLING OVERVIEW

4.1 Ground Level Receptors – Overview

There is no technical limit to the distance at which reflections could occur. However, the significance of a reflection decreases with distance. This is because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. Terrain and shielding by vegetation are also more likely to obstruct an observer's view at longer distances.

A 1km buffer is therefore considered appropriate for glint and glare effects on ground-based receptors. This buffer zone has been determined and deemed appropriate considering existing studies, guidance, Pager Power's assessment experience and the DELWP Guideline.

All ground heights are based on interpolated SRTM data and calibrated, where required, by comparing against the digital elevation model (DEM) provided by the Proponent.

4.2 Road Receptors

Road receptors have been identified within the area surrounding the Proposal. The assessed road is Darlington-Camperdown Road. Meningoort Road and Blind Creek Road were reviewed however these are local roads where low-density traffic would be expected. Therefore an assessment of these roads is not recommended based on Pager Power's assessment methodology where the worst-case impact would be low and no mitigation required. Furthermore, there are areas of existing localised screening which would prevent any solar reflection along the majority of Blind Creek Road, and for sections of the southern part of Meningoort Road, which provides access to the landowner property.

The assessed length of road is shown in Figures 7-9[10] on the following pages. Approximately 200m separates each circular point; the total length of road assessed is approximately 9.4km and is represented by the turquoise line for clarity. The red line represents the solar farm boundary, the blue areas the assessed solar panel areas and the orange line the 1km buffer. The co-ordinates of the assessed roads are presented in the Appendix F.

[10] Source: © 2020 Google/CNES/Airbus.

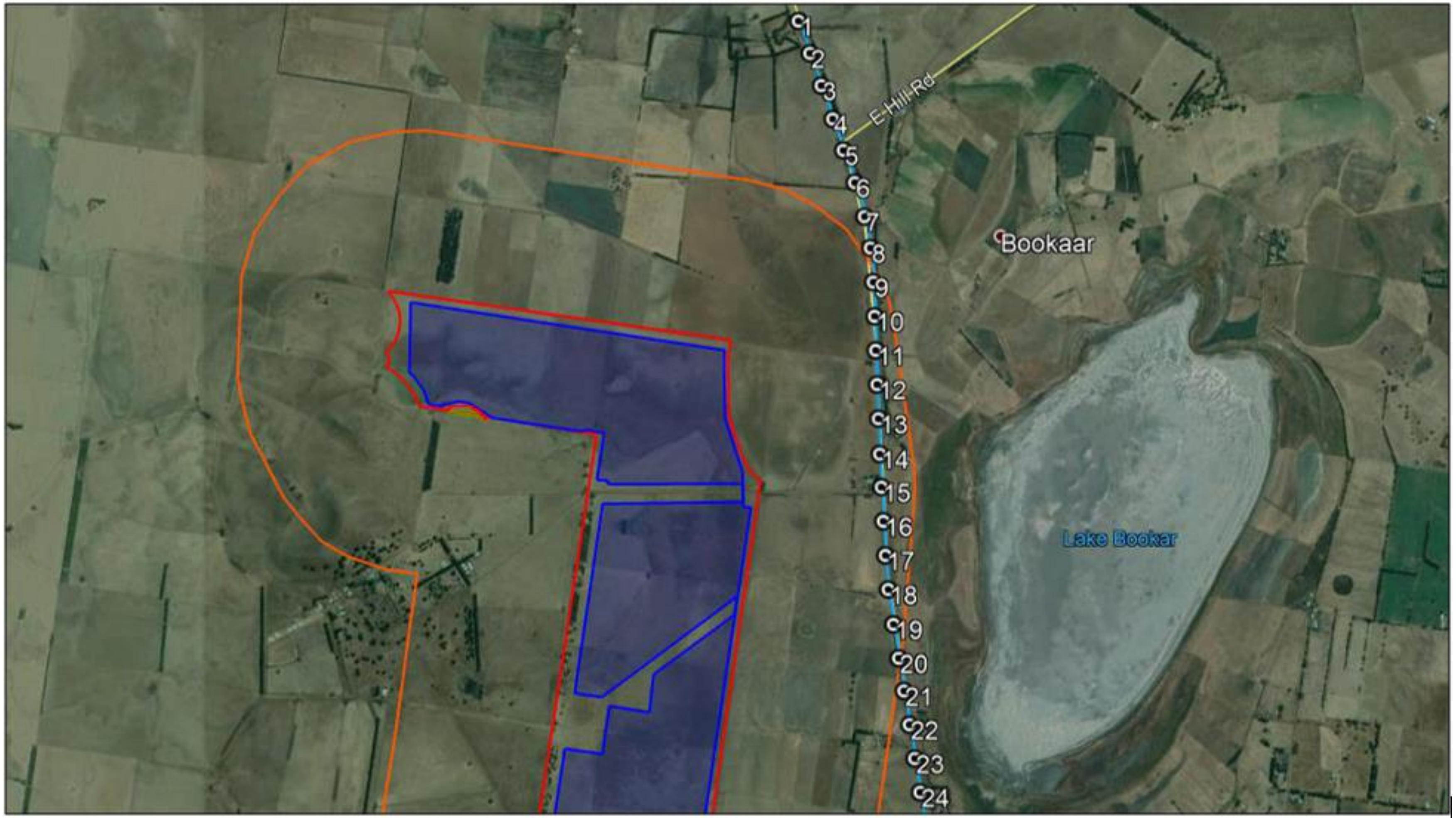

Figure 7 *Road receptors 1-24*

Figure 8 *Road receptors 24-48*

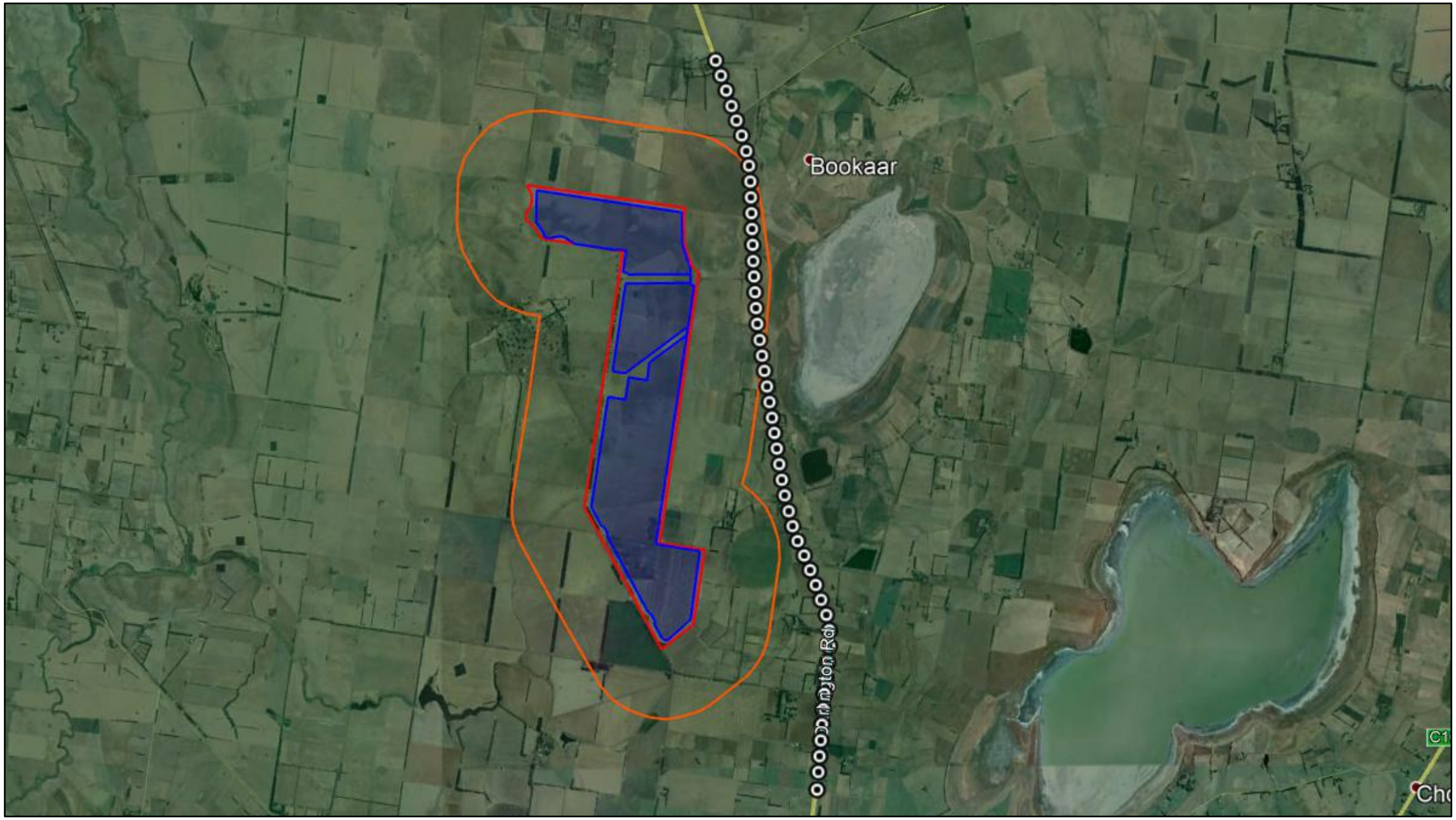

Figure 9 *All road receptors*

4.3 Dwelling Receptors

Potential dwelling receptors (excluding landowner dwellings) have been identified within the area surrounding proposed solar farm. These dwellings are shown in Figure 10[11] below.

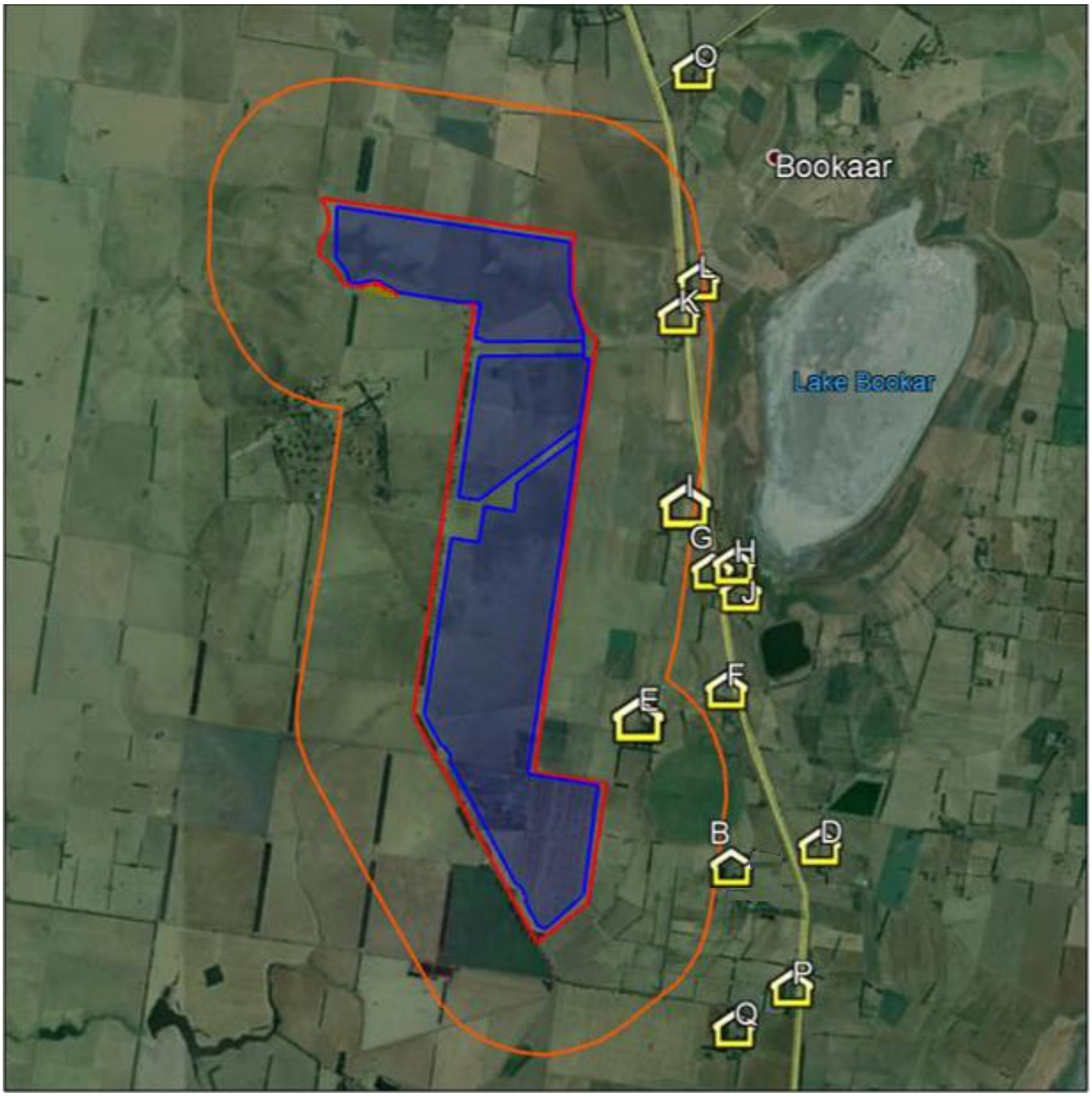

Figure 10 *Dwelling receptors*

The co-ordinates of the assessed dwellings are presented in the Appendix F.

[11] Source: ©2020 Google/CNES/Airbus.

4.4 Elevated Receptors in Wider Region – Viewpoints

An assessment of three viewpoints in the surrounding landscape has been requested. Their locations are shown in Figure 11[12] below.

Figure 11 *Viewpoint receptors*

All three viewpoints (Mt Laura, Camperdown Botanic Gardens and Mt Elephant) are beyond 7km from the proposed solar farm and are situated north and south of the panel area. It is Pager Power's methodology to consider receptors within 1km of a solar panel however geometric analysis has been undertaken for completeness.

The co-ordinates and land heights of the assessed viewpoints are presented in the Appendix F.

[12] Source: ©2020 Google/CNES/Airbus.

5 GLINT AND GLARE ASSESSMENT

5.1 Results

Tables 1 and 2 in the following subsection summarises the months and times during which a solar reflection could be experienced by a receptor.

This does not mean that reflections would occur continuously between the times shown.

The range of times at which reflections are geometrically possible is generally greater than the length of time for any particular day. This is because the times of day at which reflections could start and stop vary throughout the days/months.

Times are in GMT+11 which is the local time in south western Victoria, Australia. Geometric calculations do not account for any existing screening that may exist between the solar panels and the receptor.

Appendix G presents the detailed modelling output in cases where effects are possible.

5.2 Modelling Results Overview – Roads

The results of the geometric calculations for the assessed surrounding roads are presented in in Table 1 below.

Receptor	Results		Conclusion
	Solar reflection possible within 1km?		
	am	pm	
1-8	No	No	Road locations beyond 1km from the reflecting solar panels or no solar reflection geometrically possible. No significant impact expected.
9-10	No	No	No solar reflection geometrically possible. No impact expected.
11-20	No	Yes – approximately between 17:50 and 20:55 for 7-12 months a year. At or immediately before sunset.	Solar reflection possible if the reflecting solar panels are visible. Discussed further in Section 6.1.
21-48	No	No	Road locations beyond 1km from the reflecting solar panels or no solar reflection geometrically possible. No significant impact expected.

Table 1 *Geometric glint and glare reflection calculation results – roads*

5.3 Modelling Results Overview – Dwellings

The results of the geometric calculations for the assessed surrounding dwellings are presented in in Table 2 below.

Receptor	Results		Conclusion
	Solar reflection possible within 1km?		
	am	pm	
B,D	No	No	Dwelling locations beyond 1km from the reflecting solar panels. No significant impact expected.
E	No	Yes – approximately between 17:50 and 20:55 all year round. At or immediately before sunset.	Solar reflection possible if the reflecting solar panels are visible. Discussed further in Section 6.2.
F	No	No	No solar reflection geometrically possible. No impact expected.
G-H	No	No	Dwelling locations beyond 1km from the reflecting solar panels. No significant impact expected.

Receptor	Results		Conclusion
	Solar reflection possible within 1km?		
	am	pm	
I	No	Yes – approximately between 17:50 and 20:55 all year round. At or immediately before sunset.	Solar reflection possible if the reflecting solar panels are visible however this dwelling is on or just outside of 1km boundary relative to the reflecting solar panels. Discussed further in Section 6.2.
J	No	No	Dwelling location beyond 1km from the reflecting solar panels. No significant impact expected.
K	No	Yes – approximately between 17:50 and 20:55 all year round. At or immediately before sunset.	Solar reflection possible if the reflection solar panels are visible. Discussed further in Section 6.2.
L-O	No	No	No solar reflection geometrically possible. No impact expected.
P-Q	No	No	Dwelling locations beyond 1km from the reflecting solar panels. No significant impact expected.

Table 2 *Geometric glint and glare reflection calculation results – dwellings*

5.4 Modelling Results Overview – Viewpoints

The results of the geometric calculations for the assessed surrounding viewpoints are presented in in Table 3 below.

Receptor	Results		Conclusion
	Solar reflection possible?		
	am	pm	
Mount Elephant	No	No	No solar reflection geometrically possible. No impact expected.
Camperdown Botanic Gardens	No	No	
Mount Laura	No	No	

Table 3 *Geometric glint and glare reflection calculation results – viewpoints*

6 RESULTS DISCUSSION

6.1 Road Results

Based on a review of the geometric analysis with consideration of a 1km boundary, road users located at 10 of the 48 assessed road locations could experience a solar reflection from the Proposal (road receptor locations 11-20) under baseline conditions.

In general, a solar reflection originates from those solar panels immediately west of the road receptor location.

At the remaining assessed road receptor locations, no solar reflection is geometrically possible (receptors 1, 2, 5-7, 9, 10, 30, 31. 47 and 48) or the reflecting solar panels are beyond 1km from the assessed road (3, 4, 8, 21-29 and 32-45).

Figure 12[13] on the following page shows the lengths of road that could experience a solar reflection within 1km of the solar panels under worst-case baseline conditions, which is approximately 1.85km in length.

Road Assessment Conclusions

Overall, a solar reflection may only be visible from Darlington-Camperdown Road under baseline conditions however there are areas of existing vegetation at portions of the 1.85km length of road which would reduce baseline predictions. This road is classified as an arterial[14] road. Road users on this road would be expected to be travelling at (up to) 100km/h with a low density of traffic expected. Any solar reflection would originate almost perpendicular to the direction of travel and could last for approximately 10 minutes, however in reality, its duration would depend on the speed of the car travelling through the solar reflection zone. Note that not all of the zone will receive a solar reflection at the same time.

In accordance with Pager Power's guidance, the impact upon road users with respect to safety is therefore classified as **low** where the reflecting solar panels are visible. Where the solar panels are not visible, **no impact** is expected. There is no requirement for mitigation based on Pager Power's Glint and Glare Guidance however screening, designed to grow to at least 4m high, will be installed at the site boundary between the array areas and the road users which will likely remove any remaining visibility. This is because the landscape is relatively flat, the distance between receptors and panels is relatively large and the solar panels are 4m tall at their maximum tilt will likely reduce or completely eliminate views.

In the event that a solar reflection is experienced by a road user, further comments regarding the intensity of any solar reflection are presented in Section 6.4.

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[13] Source: © 2020 Google/CNES/Airbus.
[14] Local road, as per Pager Power's methodology.

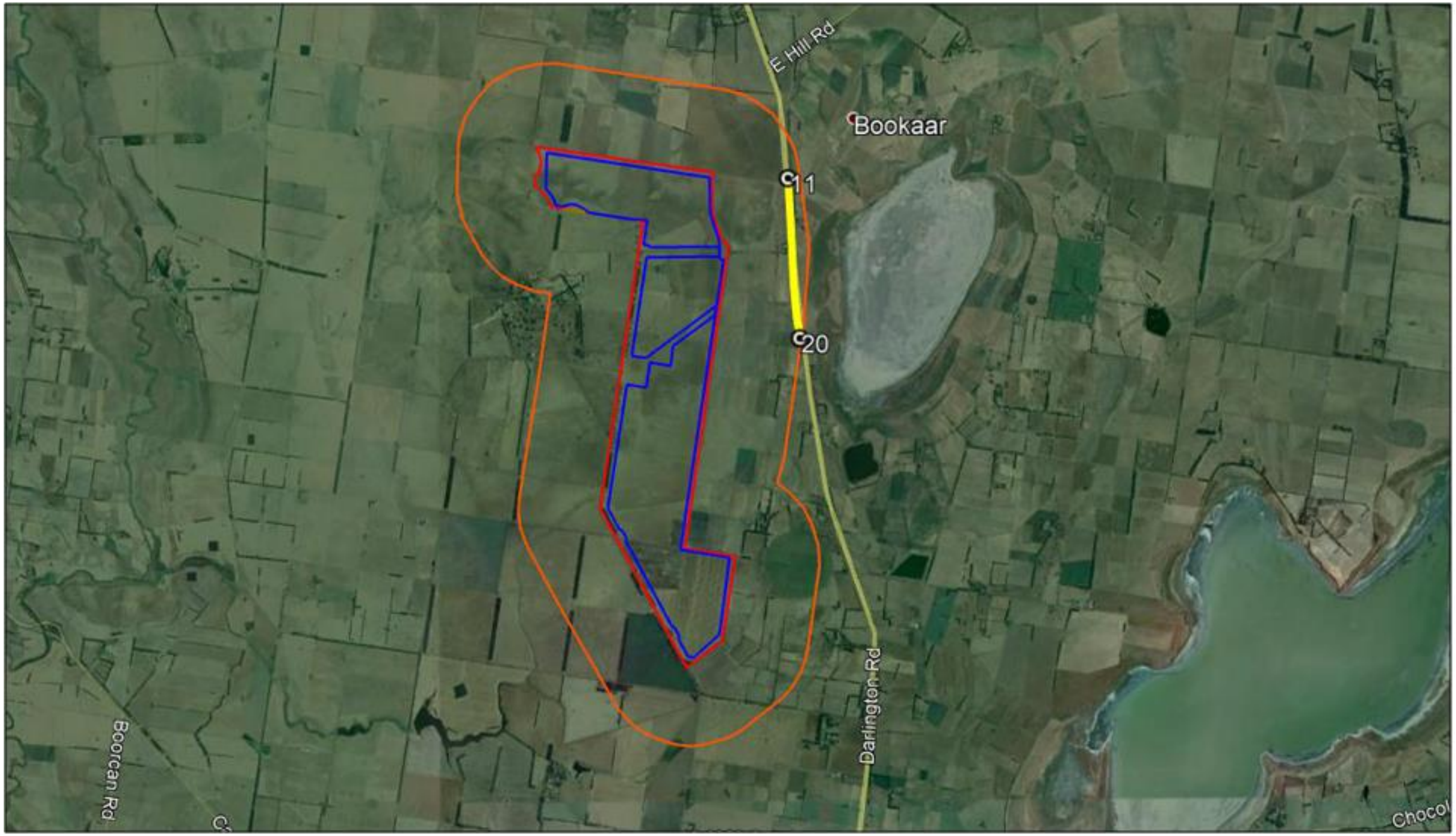


Figure 12 *Section of road that could experience a solar reflection*

6.2 Dwelling Results

Based on a review of the geometric analysis with consideration of a 1km boundary, residents located within three of the 14 assessed dwelling receptors could experience a solar reflection from the proposed solar farm (receptor locations E, I, and K) under baseline conditions.

At the remaining assessed dwelling receptor locations, no solar reflection is geometrically possible (receptors F, L and O) or the reflecting solar panels are beyond 1km from the proposed panels (receptors B,D, G, H, J, P and Q).

Figure 13[15] on the following page shows the dwelling receptor locations that could experience a solar reflection considering a worst-case scenario i.e. the reflecting solar panels are fully visible from the receptor. In reality there will be some existing screening between the solar panels as per a review of the available imagery, however complete elimination of views cannot be determined. Therefore, conservatively it is deemed that dwellings E, I and K would have some view of the reflecting solar panels considering baseline conditions. The effect of proposed screening is discussed in the following section.

[15] Source: © 2020 Google/CNES/Airbus.

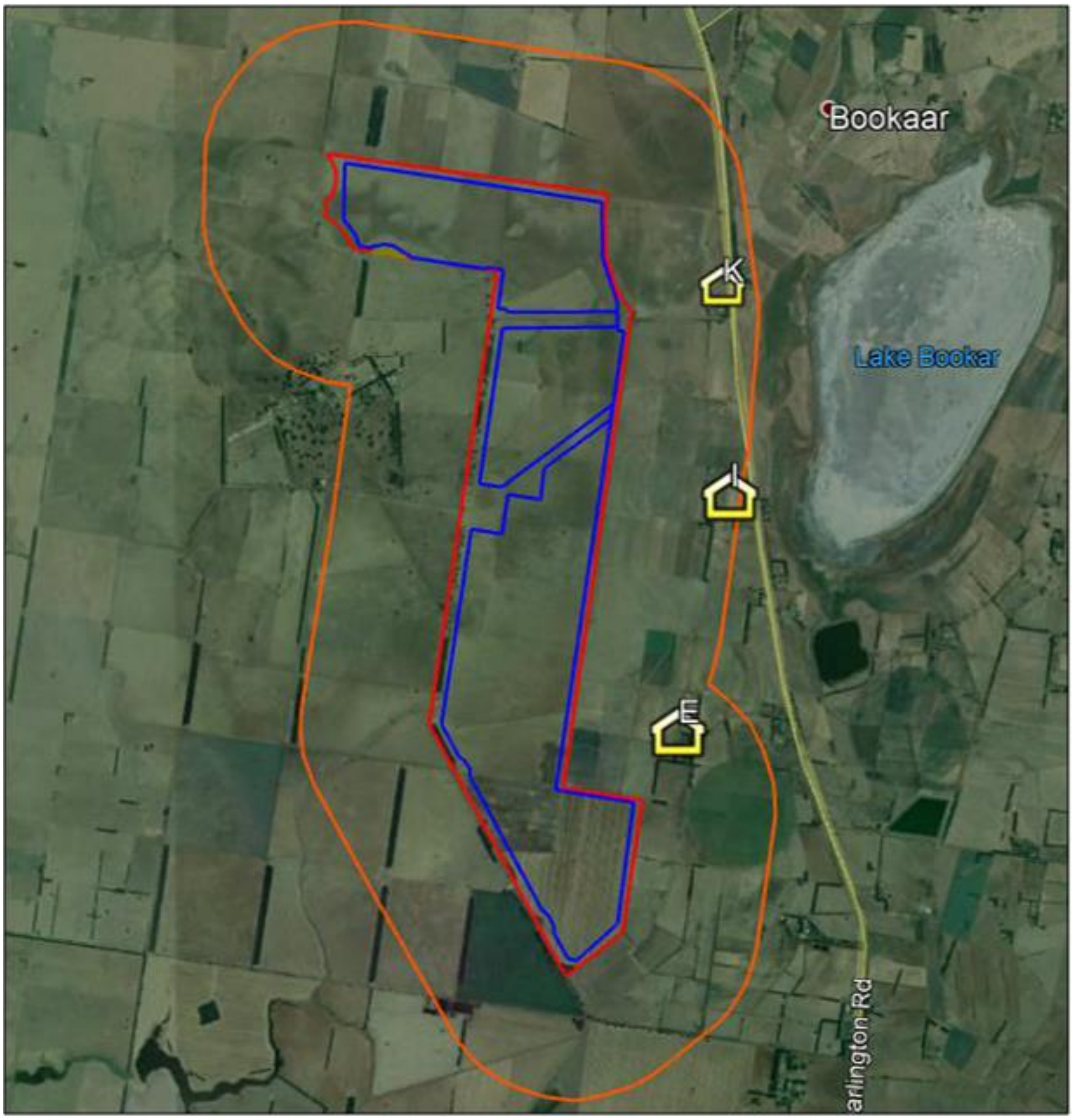


Figure 13 *Dwellings that could experience a solar reflection*

Dwellings Site Survey and Mitigation

A site survey was conducted[16] to consider the visibility of the Proposal from dwelling receptors E, I, and K, where a solar reflection is possible. The results, which have been considered against recent satellite imagery, are presented in Table 4 below.

Dwelling	Expected Visibility
E	Good screening from existing shelter belt and trees, unlikely to be views from the house but not conclusive.
I	Good screening from existing shelter belt, unlikely to be views from the house but not conclusive.
K	Views of northern half of site from property, potentially views from house but not conclusive.

Table 4 *Dwelling visibility site survey results*

The conclusions summarised in Table 4 are the same as those reached by the Tribunal with respect to views of the Proposal from nearby dwellings:

'Other dwellings, including the closest dwelling, have extensive plantings around the dwelling and private open spaces. They do not have expansive views because of their own plantings' (para. 185).

In addition to existing screening by trees and shelter belts, the Proposal's landscape screen, designed to grow to at least 4m high, will be installed at the Site boundary between the array areas and the dwellings, which will likely screen any remaining visibility (refer to the 'Landscape and Visual Impact Statement'). This is because the landscape is relatively flat, the distance between receptors and panels is relatively large and the solar panels are 4m tall at their maximum tilt. Therefore any predicted impacts at these dwellings, would likely be removed.

Dwelling Assessment Conclusions

Overall, a solar reflection is deemed possible towards three surrounding dwellings considering baseline conditions however the proposed screening would reduce or eliminate any impact.

Unmitigated, solar reflections would last for up to 15 minutes on any one day at any one location and only from windows with a clear view of the reflecting solar panels. Solar reflections would only occur on days when the weather is clear and sunny. See Table 2 and Appendix G for the detailed results breakdown.

[16] Completed by the Proponent in 2018.

The potential reflections would last for more than three months a year but less than 60 minutes per day when no screening is considered however they are expected to be at least partially screened by existing vegetation with the proposed landscape screen expected to reduce this further. In accordance with the methodology set out in Section 3 and Appendix E (for dwellings), the resulting impact significance is **low**[17]. If screening removes the solar panels from view, then there will be **no impact**.

In the event that a solar reflection is experienced by resident within a surrounding dwelling, further comments are presented in Section 6.4.

6.3 Viewpoints Results

Based on a review of the geometric analysis, no solar reflection is geometrically possible towards any of the three assessed viewpoints.

Viewpoint Assessment Conclusions

Overall, no solar reflection has been deemed possible towards any of the assessed viewpoints. In accordance with the methodology set out in Section 3 and Appendix E, **no impact** upon the viewpoints is expected.

6.4 Results Discussion Regarding Reflections from Solar Panels

In all scenarios where a solar reflection is geometrically possible towards surrounding roads and dwellings, direct sunlight would coincide with the solar reflection at or directly before sunset. This means that the viewer would be able to see the glare from the reflecting solar panels as well as the Sun directly. It is important to note that the direct sunlight would be a significantly brighter source of light when compared to the solar reflection. Furthermore, at any one location, only a particular area of solar panels will produce a solar reflection towards it. Note that not all receptors will experience a solar reflection at the same time.

To experience a solar reflection from the road, a road user would need to be located within the reflection zones, and have a clear view of the reflecting solar panels at the particular time of day when a solar reflection was geometrically possible. In addition, the weather would also have to be clear and sunny. In all cases, the driver would then be looking almost perpendicular to the direction of travel and in the direction of the Sun.

A view of a solar reflection from within the assessed dwellings would only occur where there is a clear view of the reflecting solar panels at the particular time of day when a solar reflection was geometrically possible. In addition, the weather would also have to be clear and sunny.

[17] Impact significance considers the scenario in which a solar reflection can be experienced. See Section 6.4.

7 HIGH-LEVEL AVIATION ASSESSMENT

7.1 Overview

A high-level aviation assessment has been undertaken considering the nearest aerodromes to the Proposal.

7.2 High-Level Assessment

Figure 14[18] on the following page shows the relative location of the two nearest identified aerodromes. The two aerodromes, Kurweeton Airport and Cobden Airport are 9.75km north east and 16.7km south of the proposed solar farm respectively. The runways at Kurweeton Airport are oriented east/west and north/south and the runway at Cobden Airport is orientated north/south.

At both airports, a typical ATC Tower would not be expected to have view towards the Proposal at the distances identified. A 3.2km approach path extending from the runway thresholds would also not pass over or near to the proposed solar farm.

Based on previous assessment experience, a solar reflection would not be geometrically possible towards or visible from either an ATC Tower or an approach path. In the unlikely eventuality that a solar reflection was possible, it is even further unlikely that a solar reflection would be significant in terms of aviation safety. This is also true for aircraft which may overfly the solar farm at low levels. In this instance a pilot would not specifically be looking at the ground as opposed to pilots on approach, which is a more sensitive procedure.

7.3 High-Level Assessment Conclusions

No significant impact upon aviation activity at Kurweeton Airport and Cobden Airport is anticipated with respect to glint and glare from the proposed solar farm.

[18] Source: © 2020 Google/CNES/Airbus.

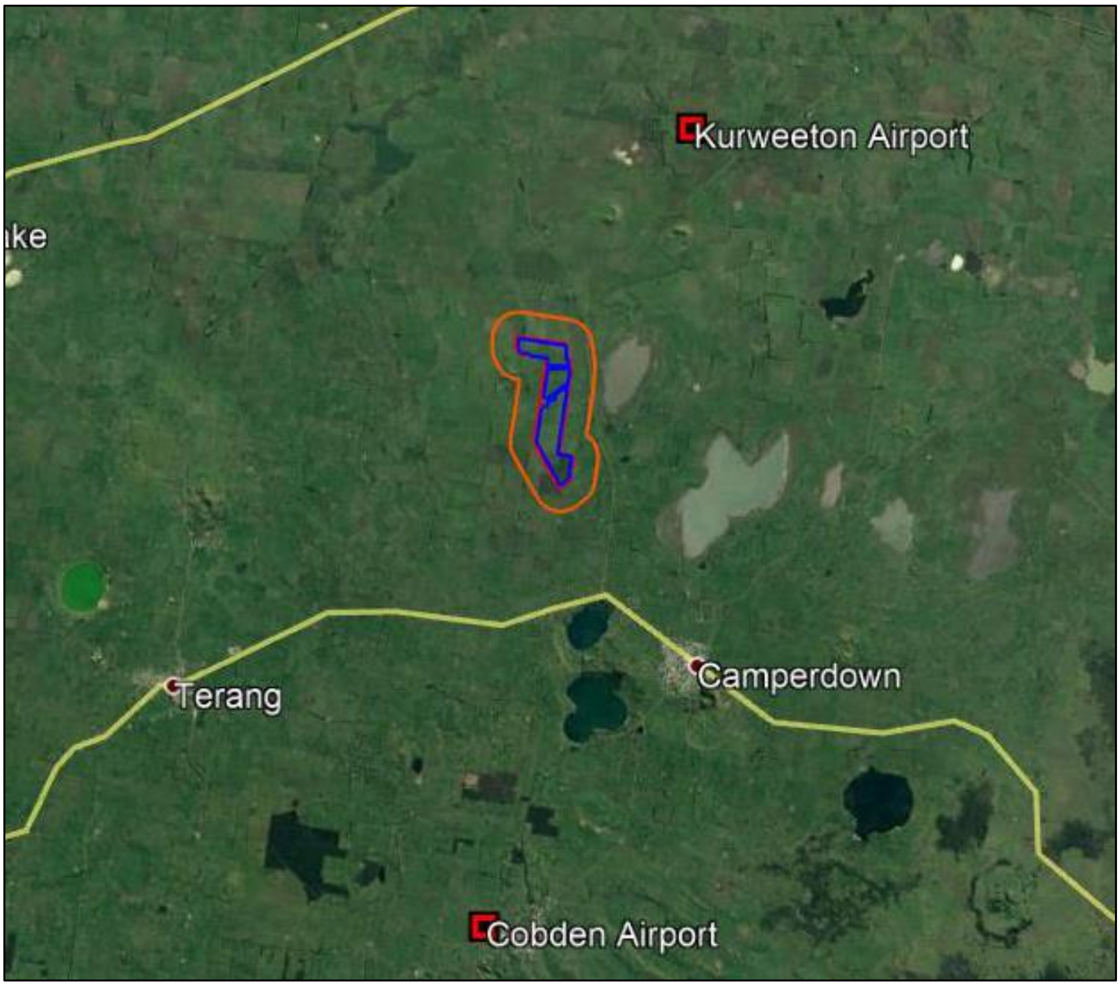


Figure 14 *Nearest aerodromes to the proposed solar farm*

8 OVERALL CONCLUSIONS

8.1 Road Results

Overall, a low impact upon road users (at worst) on the assessed road is expected. Where the solar panels are not visible, no impact is expected. The overall results and reasoning are presented below.

- Considering baseline conditions, solar reflections are theoretically possible towards approximately 1.85km of Darlington-Camperdown Road. This road is classified as an arterial road;
- Road users would be expected to be travelling at (up to) 100 km/h with a low density of traffic expected;
- Any solar reflection would originate almost perpendicular to the direction of travel therefore a road user would be looking away from the direction of travel;
- In accordance with the methodology set out in Section 3 and Appendix E, the overall expected impact upon road users with respect to safety is classified as low where the reflecting solar panels are visible;
- Where views of the reflecting solar panels are removed by mitigation or by existing screening, there will be no impact upon road users.

8.2 Dwelling Results

Overall, a low impact upon residential amenity is expected (worst-case) considering the results of the geometric analysis, a dwelling site survey and proposed mitigation. Where the solar panels are not visible, no impact is expected. The overall results and reasoning are presented below.

- Solar reflections are possible towards four of the assessed dwelling receptors based on the modelling results. A site survey confirmed that visibility from these dwellings would be at least partially screened with mitigation proposed to significantly remove views;
- Under baseline conditions, the three dwellings could experience solar reflections for up to 20 minutes per day all year round. The results vary per dwelling therefore please see Table 2 and Appendix G for the detailed results breakdown for each dwelling;
- Under baseline conditions, a clear view of the reflecting solar panels at the particular time of day when a solar reflection was geometrically possible would be required. In addition, the weather would also have to be clear and sunny;
- When existing screening and mitigation is considered, the resulting impact significance is low to no impact in accordance with the methodology set out in Section 3 and Appendix E; and

- Where views of the reflecting solar panels are removed by mitigation or by existing screening, there will be no impact upon residential amenity.

8.3 Council Viewpoints

All three viewpoints (Mt Laura, Camperdown Botanic Gardens and Mt Elephant) are beyond 7km from the proposed solar farm and are situated north and south of the panel area. It is Pager Power's methodology (and that of DELWP Guidance) to consider ground based receptors within 1km of a solar panel however calculations were undertaken for completeness. The results of these calculations showed that no geometric solar reflections were possible. Considering this, no impact is expected at these viewpoints.

8.4 Aviation

No significant impact upon aviation activity at Kurweeton Airport and Cobden Airport is anticipated with respect to glint and glare from the proposed solar farm. This is due to their relative locations (9.75km north east and 16.7km south of the proposed solar farm respectively) and the author's experience.

APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'. Relevant extracts from guidance published in the UK is presented below for reference.

This is not a comprehensive review of the data sources, rather it is intended to give an overview of the important parameters and considerations that have informed this assessment.

Victorian Planning Guidance

In August 2019, the Department of Environment Land Water and Planning released its own solar development guideline which included reference to glint and glare[19] (the 'Guideline'). It is understood that the methodology is based on Pager Power's own guidance. The Guideline states the following with respect to glint and glare:

Glint and glare management

Glint which is the momentary flashes of light, and glare which is continuous, excessive brightness, can affect nearby sensitive land uses under particular conditions. 'Receptors' of glint and glare from a solar energy facility can include residents in surrounding dwellings, road users and aviation service providers including pilots and air traffic controllers.

Glint can be caused by direct reflection of the sun from the surface of an object, whereas glare is a continuous source of brightness. Glare is much less intense than glint. A CST system is likely to have levels of glare greater than a ground mounted solar PV system, and requires a more tailored impact assessment approach. To avoid glint and glare, a proponent should:

- *site and design solar components and associated buildings and infrastructure to ameliorate glint and glare impacts to within acceptable levels*
- *use anti-reflective solar panel coatings and non-reflective frames and avoid using reflective materials and paints on buildings and infrastructure*
- *adjust the orientation of panels relative to glare risks such as oncoming traffic coming down a road from an elevated area*
- *locate landscape screening of a sufficient height, width and foliage density at maturity to reduce glint and glare impacts.*

[19] Source: Solar Energy Facilities Design and Development Guideline, August 2019. Victoria State Government (last accessed 11/06/2020).

Any assessment of glint and glare should use an accepted methodology based on best practice and consider impacts on:

- *dwellings and roads within 1 km of the proposed facility, taking into consideration their height within the landscape*
- *aviation infrastructure including any air traffic control tower or runway approach path close to the proposed facility*
- *any other receptor to which a responsible authority considers solar reflection may be a hazard.*

The impacts of solar reflection vary for each type of receptor. The following criteria for glint and glare effects, should be used to guide an assessment.

- *No impact: a solar reflection is not geometrically possible, or it will not be visible from the assessed receptor. No mitigation is required.*
- *Low impact: a solar reflection is geometrically possible, but the intensity and duration of an impact is considered to be small and can be mitigated with screening or other measure.*
- *Moderate impact: a solar reflection is geometrically possible and visible, but the intensity and duration of an impact varies according to conditions. Mitigation measures (such as through design, orientation, landscaping or other screening method) to reduce impacts to an acceptable level will be required.*
- *Major impact: a solar reflection is geometrically possible and visible under a range of conditions that will produce impacts with significant intensity and duration. Significant mitigation measures are required if the proposed development is to proceed.*

The responsible authority will require a glint and glare assessment, and a proponent should agree a methodology for the assessment with the responsibility authority. Where a solar energy facility is proposed close to an airfield, airport or road network, the proponent should consultant the owner/operator of the facility and the relevant roads corporation.'

UK Planning Policy

UK Planning Practice Guidance dictates that in some instances a glint and glare assessment is required however, there is no specific guidance with respect to the methodology for assessing the impact of glint and glare. The guidance for Renewable and Low Carbon Energy[20] (specifically regarding the consideration of solar farms) states:

[20] Source: 013 Reference ID: 5-013-20150327 (last accessed 11/06/2020).

'What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?

The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

Particular factors a local planning authority will need to consider include:

- *the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on **neighbouring uses and aircraft safety**;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun.*

Assessment Process

No process for determining and contextualising the effects of glint and glare are, however, provided for receptors such as roads or dwellings. Therefore, the Pager Power approach is to undertake geometric reflection calculations and then to review the results against baseline conditions with comparisons against available solar panel reflection studies.

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

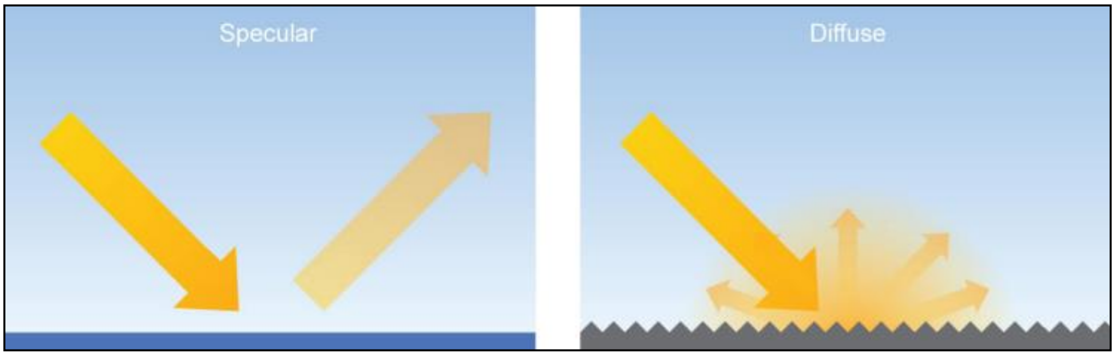
Overview

Studies have been undertaken assessing the type and intensity of solar reflections from various surfaces including solar panels. An overview of these studies is presented below.

There are no specific studies for determining the effect of reflections from solar panels with respect to dwellings. The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below[21], taken from the FAA guidance, illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

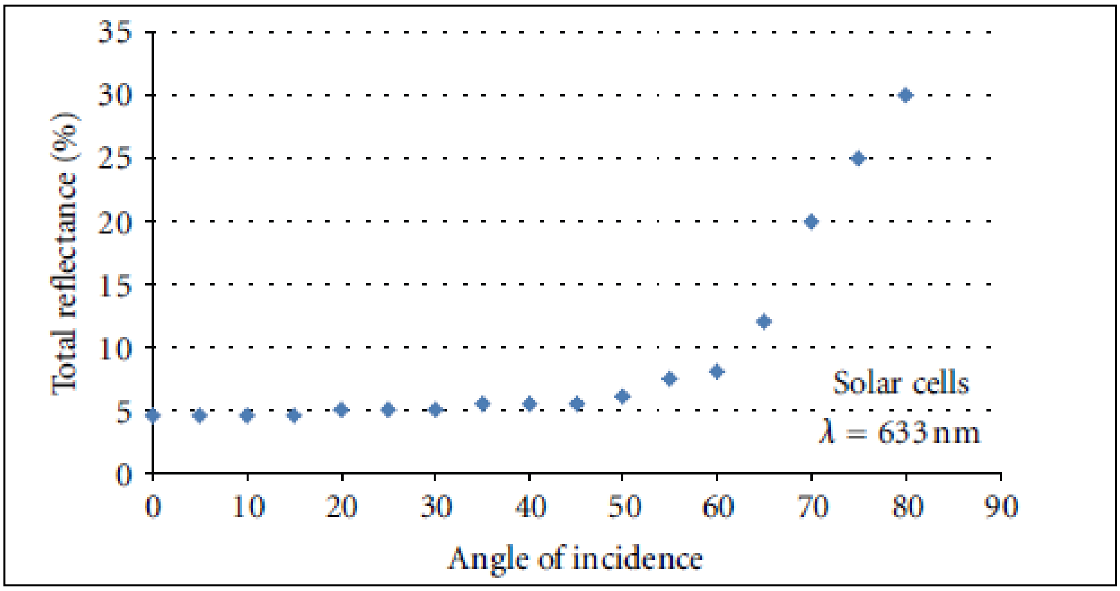
[21] Source: http://www.faa.gov/airports/environmental/policy_guidance/media/airport_solar_guide_print.pdf

Solar Reflection Studies

An overview of content from identified solar panel reflectivity studies is presented in the subsections below.

Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems"

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[22]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure on the following page.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;

[22] Source: Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems," ISRN Renewable Energy, vol. 2011, Article ID 651857, 6 pages, 2011. doi:10.5402/2011/651857

- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

FAA Guidance- "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[23]

The 2010 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure[24] within the FAA guidance, is presented on the following page.

Surface	Approximate Percentage of Light Reflected[25]
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

Relative reflectivity of various surfaces

Note that the data above does not appear to consider the reflection type (specular or diffuse).

[23] Source: FAA, November (2010): *Technical Guidance for Evaluating Selected Solar Technologies on Airports.*
[24] Source: http://www.faa.gov/airports/environmental/policy_guidance/media/airport_solar_guide_print.pdf
[25] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

SunPower Technical Notification (2009)

SunPower published a technical notification[26] to '*increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment'.* The study revealed that the reflectivity of a solar panel is considerably lower than that of '*standard glass and other common reflective surfaces'.* With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

Figures within the document show the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel. The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those produced from these surfaces.

[26] Source: Technical Support, 2009. SunPower Technical Notification- Solar Module Glare and Reflectance.

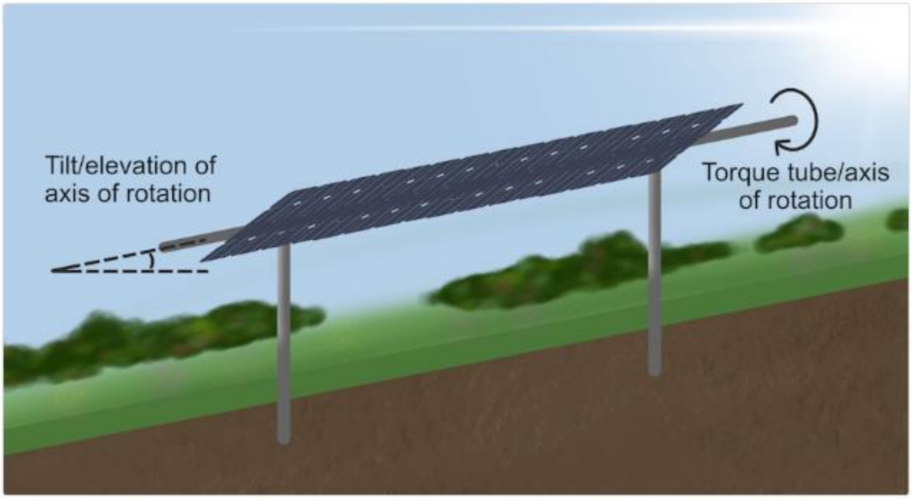
APPENDIX C –REFLECTION CALCULATIONS METHODOLOGY

Methodology

Extracts taken from the Forge Solar model.

Tracking System Parameters

Single-axis module tracking systems are described by a unique set of parameters. These angular inputs model the tracking axis, rotation range and backtracking behavior. Dual-axis module tracking systems are assumed to track the sun at all times.



Single-axis tracking system with torque tube tilted due to geography

Tilt of tracking axis (°)
Tilt above flat ground of axis over which panels rotate (e.g. torque tube). System on flat, level ground would have axis tilt of 0°.

Orientation of tracking axis (°)
Azimuthal angle of axis over which panels rotate. Angle represents the facing of the axis and system. For example, typical tracking system in northern hemisphere has tracking axis oriented north-south with an orientation of 180°, allowing panels to rotate east-west with potential south-facing tilt. Typical tracking system in southern hemisphere runs south-north with axis orientation of 0°, yielding east-west rotation with potential north-facing tilt.

Offset angle of module (°)
Additional tilt angle of PV module elevated above tracking axis/torque tube. Offset angle is measured from the torque tube.

Maximum tracking angle (°)
Maximum angle of rotation of tracking system in one direction. For example, a typical system with a 120° range of rotation has a *max tracking angle* of 60° (east/west).

Resting angle (°)
Angle of rotation of panels when sun is outside tracking range. Used to model backtracking. Panels will revert to the position described by this rotation angle at all times when the sun is outside the rotation range. Setting this equal to the *maximum tracking angle* implies the panels do not backtrack.

ForgeSolar utilizes a simplified model of backtracking which assumes panels instantaneously revert to the *resting angle* whenever the sun is outside the rotation range. For example, panels with *max tracking angle* of 60° and *resting angle* of 0° would lie flat from sunrise until the sun enters the rotation range, and immediately after the sun leaves the rotation range until sunset daily.

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APPENDIX D – ASSUMPTIONS AND LIMTIATIONS

Forge Solar

Key assumptions pertaining to the Forge Solar modelling is presented below.

Assumptions & Limitations

Summary of assumptions and abstractions required by the SGHAT/ForgeSolar analysis methodology

1. Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
2. Result data files and plots are now retained for two years after analysis completion. Files should be downloaded and saved if additional persistence is required.
3. 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.
4. Several 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 analyses of path receptors.
5. 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.
6. 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.)
7. The algorithm assumes that the PV array is aligned with a plane defined by the total heights of the coordinates outlined in the Google map. For more accuracy, the user should perform runs using minimum and maximum values for the vertex heights to bound the height of the plane containing the solar array. Doing so will expand the range of observed solar glare when compared to results using a single height value.
8. The algorithm does not 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.
9. 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.
10. 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.
11. 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.
12. Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
13. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

14. Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
15. PV array tracking assumes the modules move instantly when tracking the sun, and when reverting to the rest position.

APPENDIX E – ASSESSMENT METHODOLOGY

Overview

The significance of glint and glare will vary for different receptors. The following section presents a general overview of the significance criteria with respect to experiencing a solar reflection.

Impact significance definition

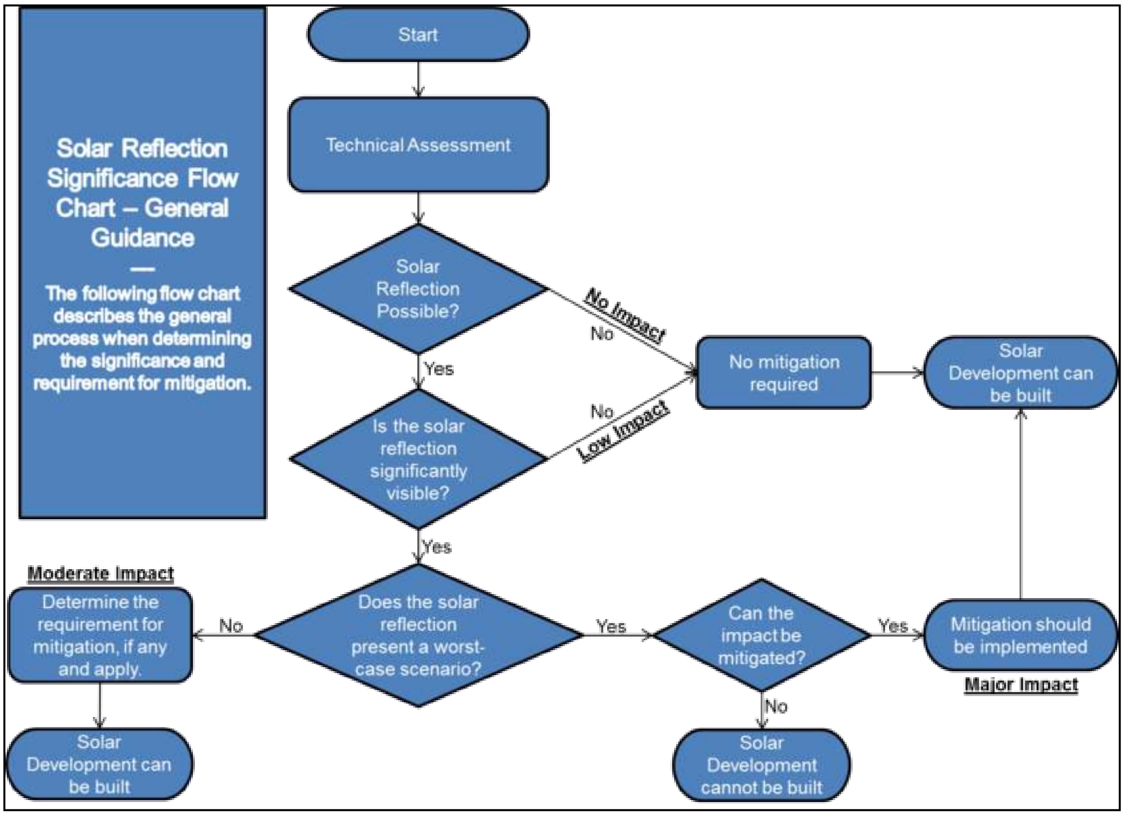
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels.	No mitigation required.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case.	Whilst the impact may be acceptable, consultation and/or further analysis should be undertaken to determine the requirement for mitigation.
Major	A solar reflection is geometrically possible and visible under conditions that will produce a significant impact. Mitigation and consultation is recommended.	Mitigation will be required if the proposed solar development is to proceed.

Impact significance definition

Assessment Process – General

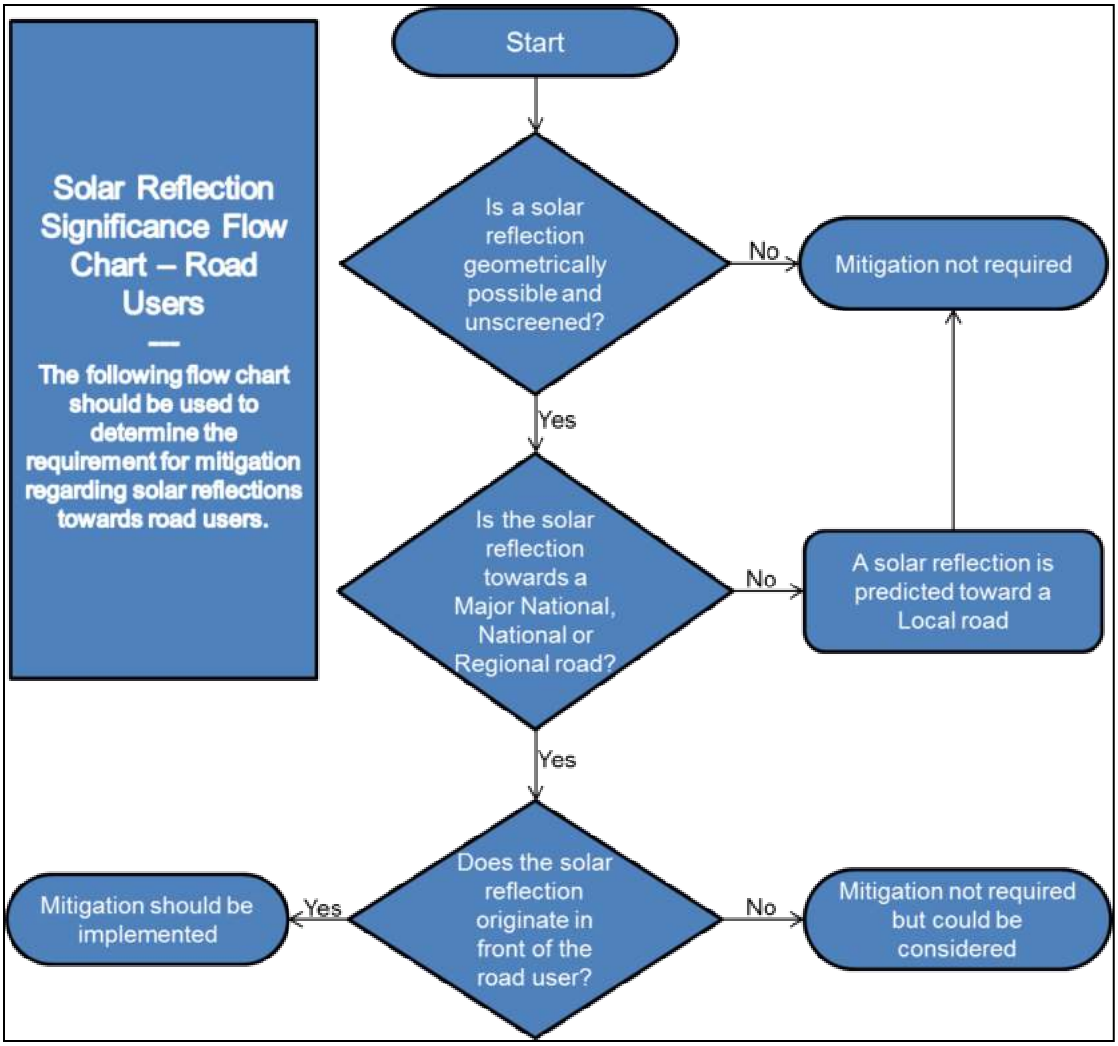
The flow chart presented below shows the general process for establishing a mitigation requirement for a glint and glare impact.



General mitigation requirement flow chart

Assessment Process for Road Receptors

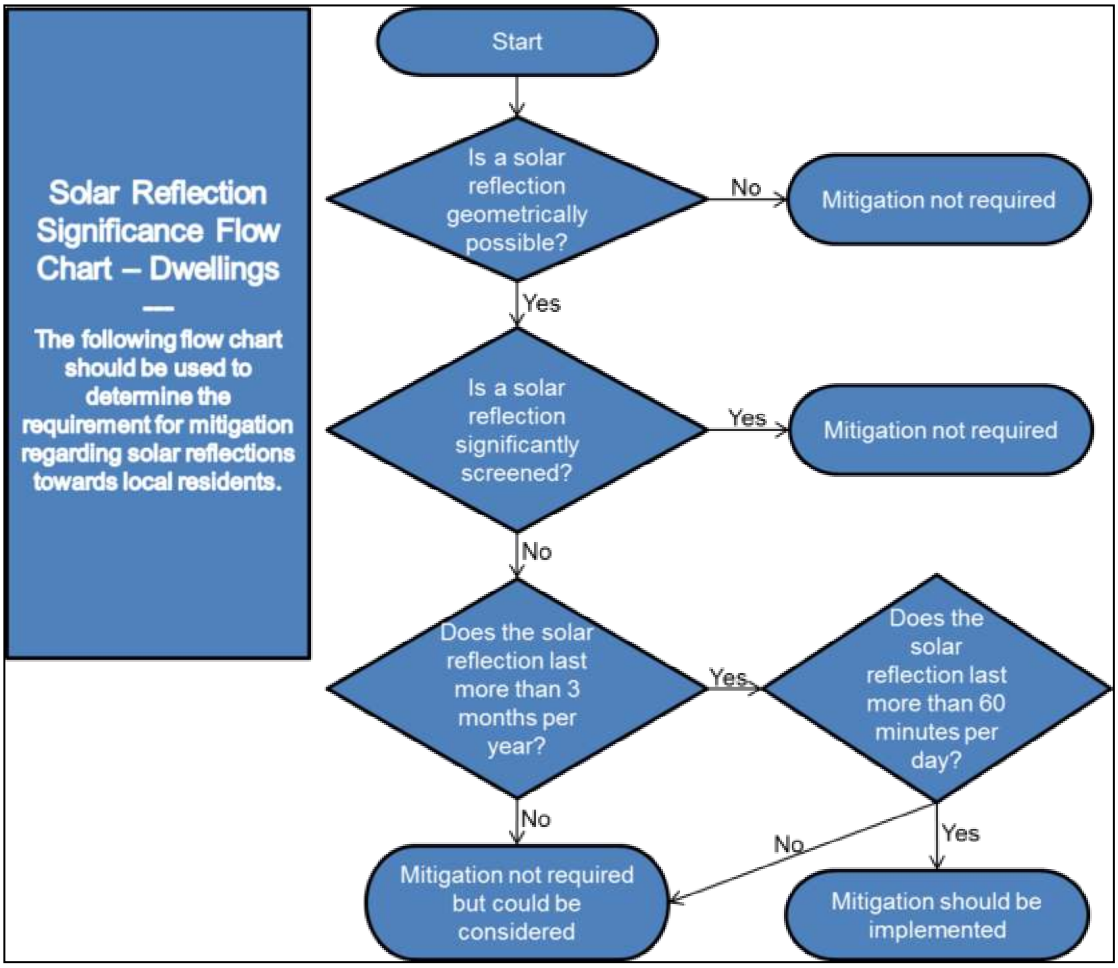
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road receptor mitigation requirement flow chart

Assessment Process for Dwelling Receptors

The flow chart presented below has been followed when determining the mitigation requirement for dwelling receptors.



Dwelling receptor mitigation requirement flow chart

APPENDIX F – COORDINATE DATA

Road Receptors

ID	Long. (°)	Lat. (°)	Z amsl + receptor height (m)[27]	ID	Long. (°)	Lat. (°)	Z amsl + receptor height (m)
01	143.09699	-38.10543	150.0	25	143.10548	-38.14775	147.0
02	143.09775	-38.10713	148.5	26	143.10583	-38.14953	145.9
03	143.09851	-38.10883	147.0	27	143.10618	-38.15131	145.3
04	143.09928	-38.11059	146.8	28	143.10655	-38.15308	145.6
05	143.09999	-38.11224	145.2	29	143.10698	-38.15485	146.1
06	143.10076	-38.11393	144.3	30	143.10755	-38.15665	143.8
07	143.10141	-38.11572	143.9	31	143.10811	-38.15834	143.4
08	143.10180	-38.11737	145.8	32	143.10883	-38.16005	147.1
09	143.10199	-38.11917	144.5	33	143.10980	-38.16168	149.0
10	143.10208	-38.12097	145.4	34	143.11066	-38.16334	146.5
11	143.10216	-38.12277	146.3	35	143.11146	-38.16503	146.6
12	143.10225	-38.12457	147.5	36	143.11225	-38.16672	147.7
13	143.10234	-38.12636	147.9	37	143.11299	-38.16842	145.5
14	143.10242	-38.12822	145.9	38	143.11343	-38.17019	147.1
15	143.10254	-38.12996	146.9	39	143.11343	-38.17198	148.3
16	143.10267	-38.13176	143.4 (adjusted to 146)	40	143.11318	-38.17377	152.6

[27] Based on Pager Power's SRTM terrain database plus receptor height.

ID	Long. (°)	Lat. (°)	Z amsl + receptor height (m)[27]	ID	Long. (°)	Lat. (°)	Z amsl + receptor height (m)
17	143.10281	-38.13356	143.4 (adjusted to 146)	41	143.11293	-38.17556	154.0
18	143.10300	-38.13535	145.5 (adjusted to 146)	42	143.11270	-38.17741	153.5
19	143.10335	-38.13719	145.7	43	143.11253	-38.17915	154.4
20	143.10369	-38.13897	145.9	44	143.11237	-38.18089	155.5
21	143.10404	-38.14069	146.5	45	143.11219	-38.18269	155.2
22	143.10441	-38.14247	146.7	46	143.11202	-38.18448	155.2
23	143.10477	-38.14425	148.0	47	143.11184	-38.18628	154.5
24	143.10513	-38.14603	145.9	48	143.11166	-38.18829	155.1

Dwelling Receptors

ID	Long. (°)	Lat. (°)	Z amsl + receptor height (m)[28]
B	143.10652	-38.16872	144.6
D	143.11450	-38.16729	147.3
E	143.09814	-38.15861	145.5
F	143.10608	-38.15620	143.4
G	143.10481	-38.14778	146.9
H	143.10675	-38.14740	148.3
I	143.10238	-38.14346	145.9
J	143.10736	-38.14932	148.7
K	143.10178	-38.12970	148.6

[28] Based on Pager Power's SRTM terrain database plus receptor height.

L	143.10357	-38.12726	145.0
O	143.10312	-38.11233	143.5
P	143.11199	-38.17729	152.8
Q	143.10678	-38.18019	158.6

Viewpoint Receptors

ID	Long. (°)	Lat. (°)	Z amsl[29] (m)
Mt Laura	143.158241	-38.243711	270
Camperdown Botanic Gardens	143.112309	-38.235422	256
Mt Elephant	143.195069	-37.960936	368

Panel Area Boundary Co-Ordinates

An additional height of 2m has been added to the ground height at each point to represent the mid-point of the panels. All ground heights are based on interpolated SRTM data and calibrated, where required, by comparing against the digital elevation model (DEM) provided by the developer.

ID	Long. (°)	Lat. (°)	ID	Long. (°)	Lat. (°)
1	143.07096	-38.12030	25	143.08693	-38.14189
2	143.09198	-38.12282	26	143.08721	-38.13989
3	143.09192	-38.12325	27	143.09262	-38.13675
4	143.09201	-38.12642	28	143.09280	-38.13579
5	143.09317	-38.12924	29	143.08376	-38.14108
6	143.09322	-38.13108	30	143.08193	-38.14088
7	143.09374	-38.13108	31	143.08381	-38.13091
8	143.08816	-38.16051	32	143.09318	-38.13081
9	143.09451	-38.16132	33	143.09316	-38.12984

[29] Provided by developer.

ID	Long. (°)	Lat. (°)	ID	Long. (°)	Lat. (°)
10	143.09320	-38.16908	34	143.08419	-38.12987
11	143.08986	-38.17145	35	143.08409	-38.12966
12	143.08917	-38.17134	36	143.08343	-38.12966
13	143.08798	-38.16967	37	143.08390	-38.12718
14	143.08804	-38.16927	38	143.08272	-38.12701
15	143.08743	-38.16842	39	143.08233	-38.12709
16	143.08708	-38.16828	40	143.07645	-38.12638
17	143.08112	-38.15962	41	143.07491	-38.12561
18	143.08118	-38.15923	42	143.07415	-38.12552
19	143.08064	-38.15855	43	143.07294	-38.12574
20	143.08028	-38.15844	44	143.07216	-38.12566
21	143.07882	-38.15630	45	143.07186	-38.12499
22	143.08128	-38.14379	46	143.07118	-38.12421
23	143.08377	-38.14409	47	143.07086	-38.12401
24	143.08425	-38.14155			

APPENDIX G – GEOMETRIC CALCULATION RESULTS

Overview

The charts for the receptors are shown on the following pages.

Road Receptors

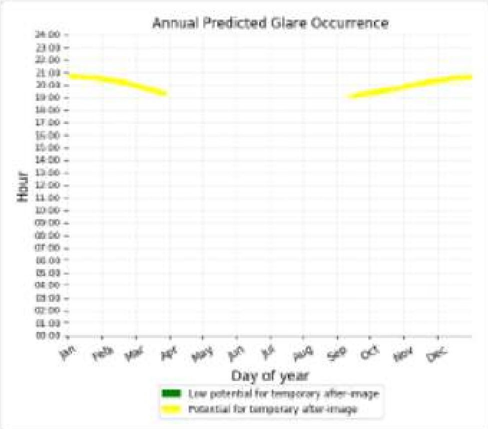
The glint and glare charts at the receptors where a solar reflection is deemed are presented below.

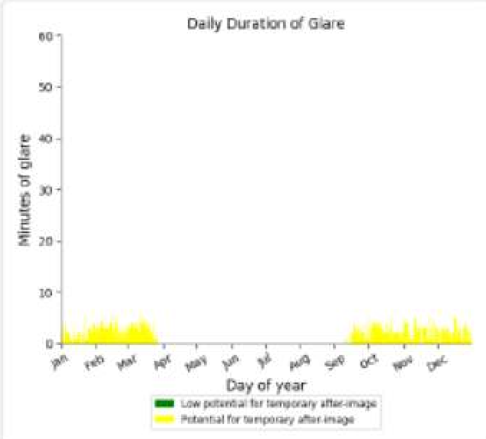
Road 11

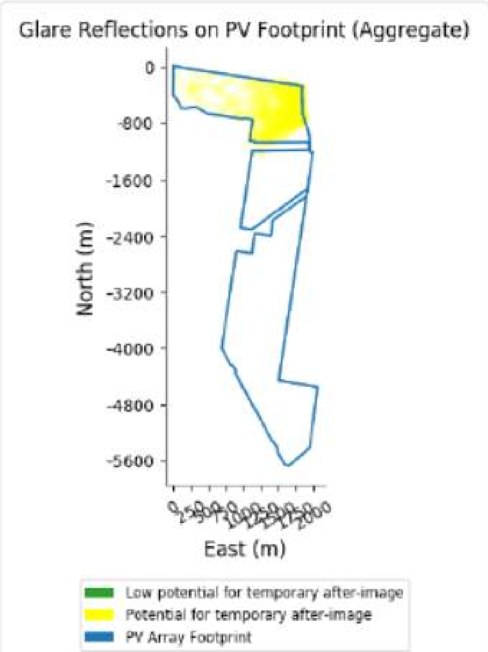
Solar Farm - OP Receptor (OP 11)

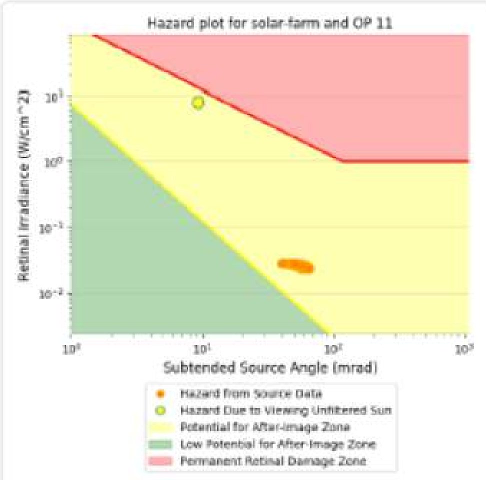
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 526 minutes of "yellow" glare with potential to cause temporary after-image.







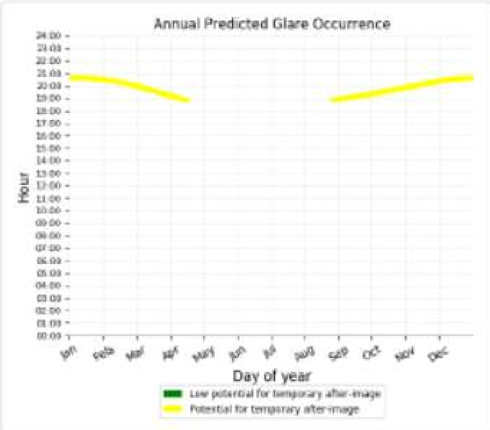


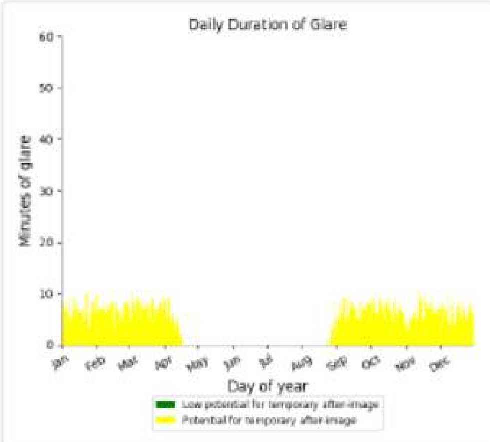
Road 12

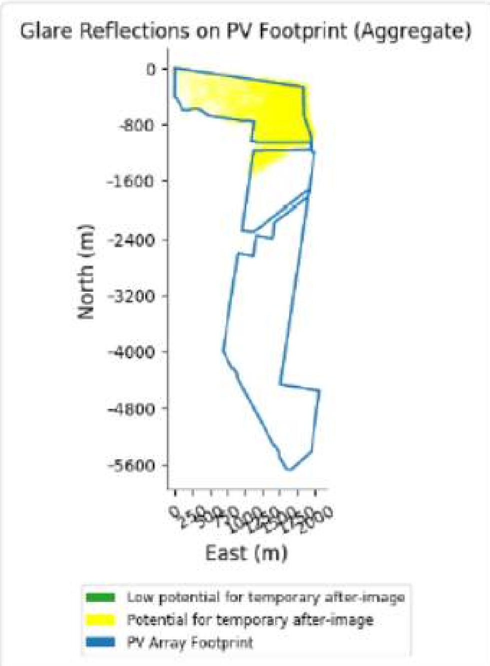
Solar Farm - OP Receptor (OP 12)

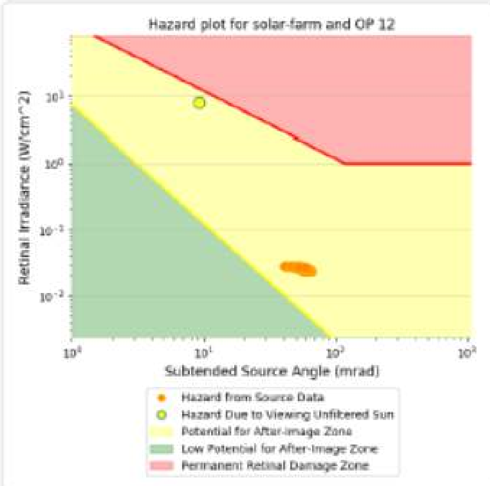
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,538 minutes of "yellow" glare with potential to cause temporary after-image.







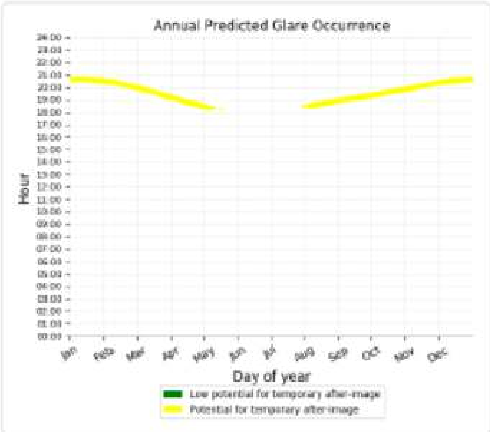


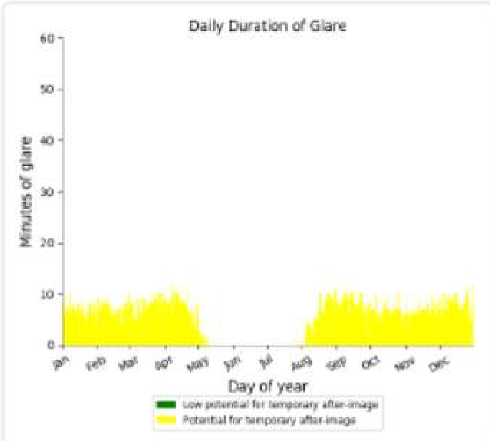
Road 13

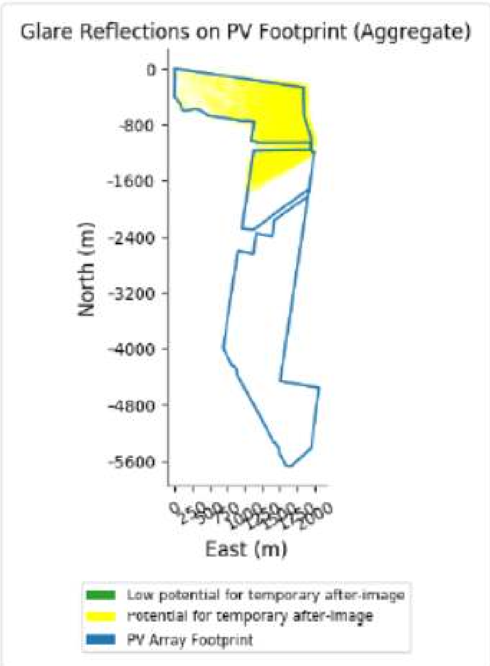
Solar Farm - OP Receptor (OP 13)

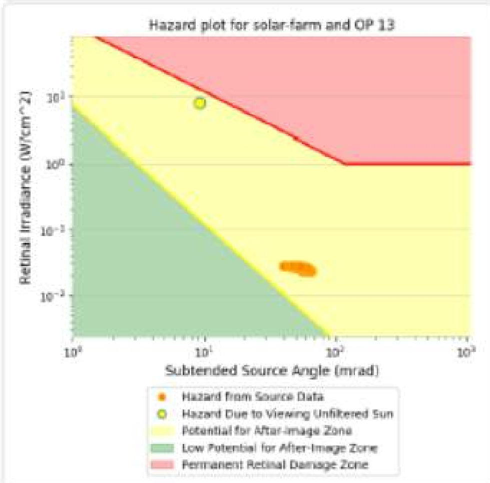
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,064 minutes of "yellow" glare with potential to cause temporary after-image.







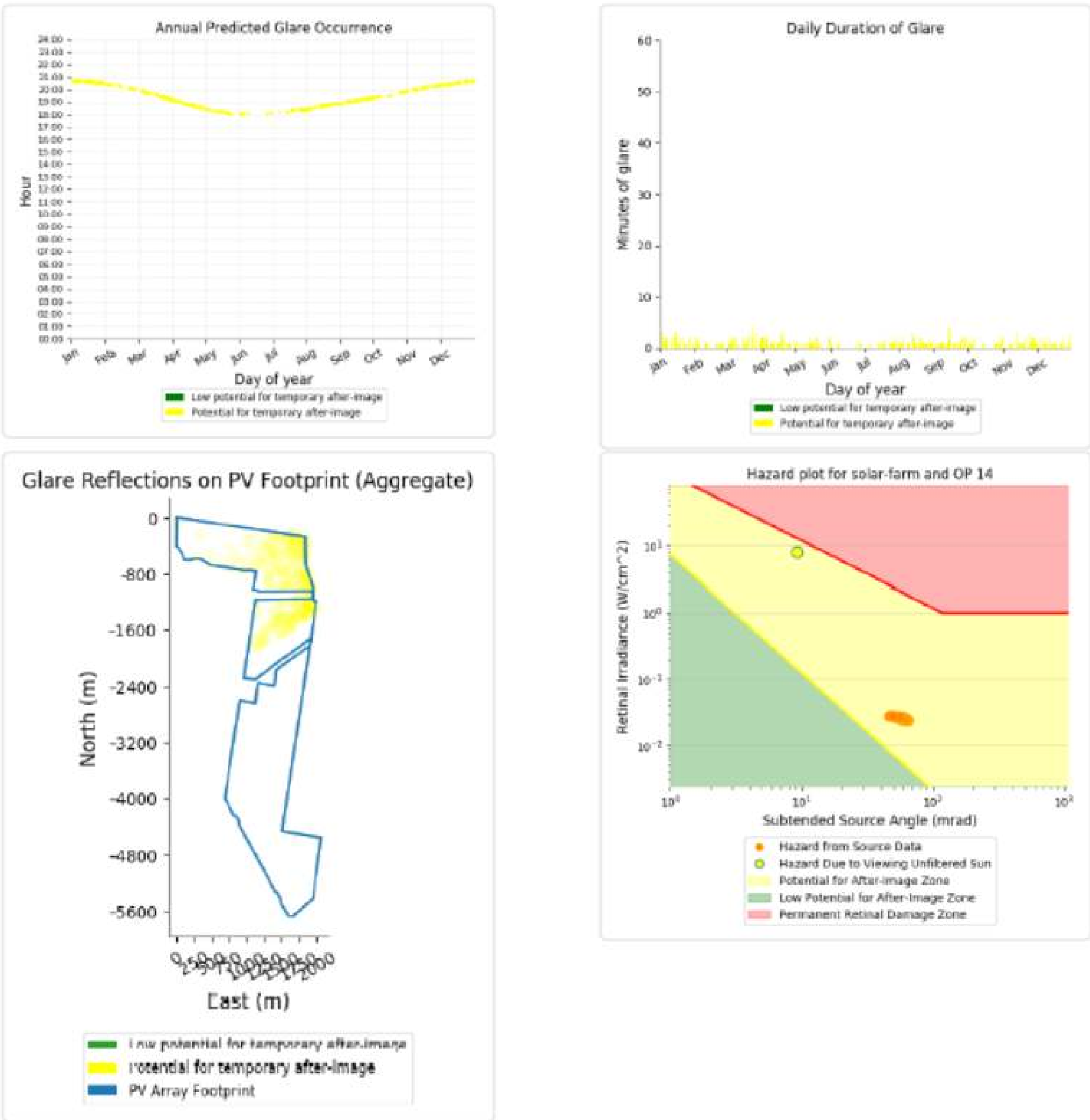


Road 14

Solar Farm - OP Receptor (OP 14)

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 268 minutes of "yellow" glare with potential to cause temporary after-image.

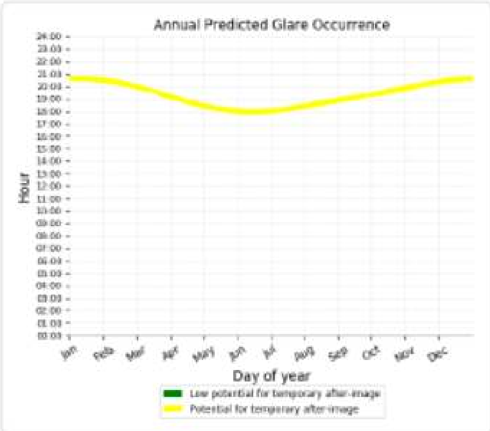


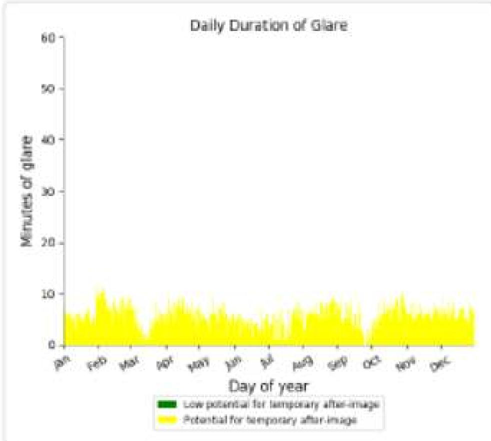
Road 15

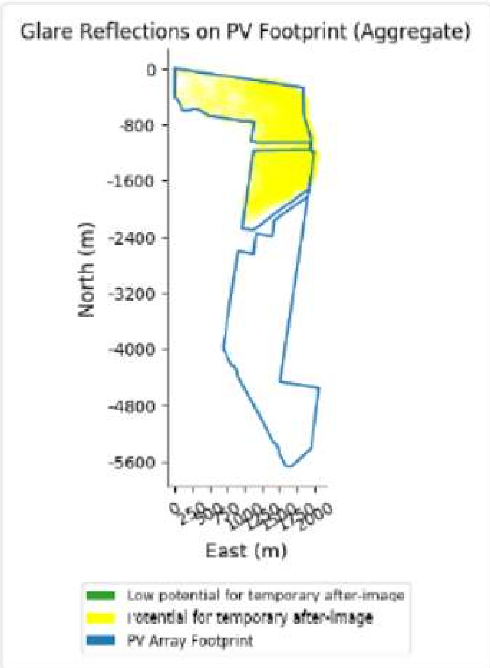
Solar Farm - OP Receptor (OP 15)

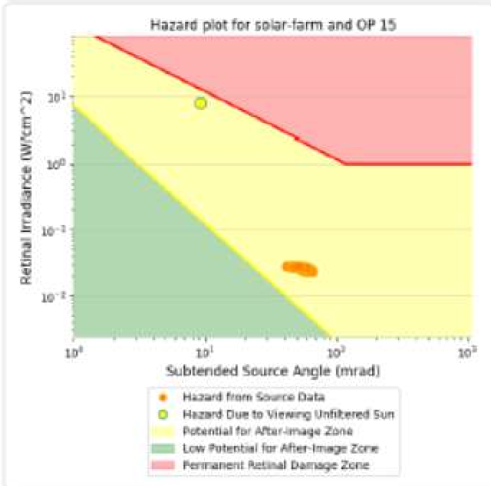
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,089 minutes of "yellow" glare with potential to cause temporary after-image.







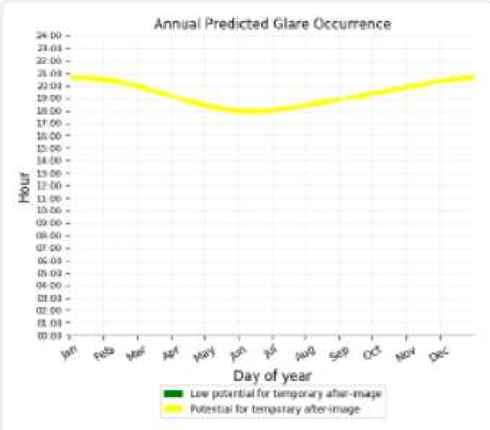


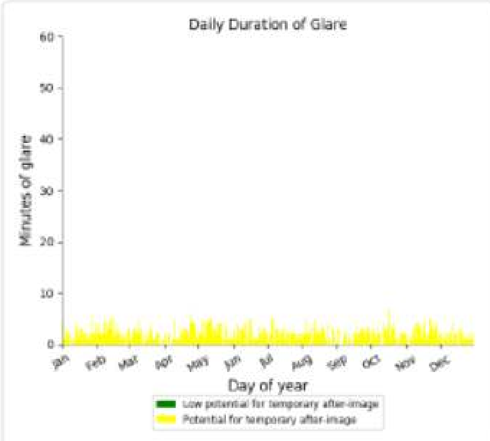
Road 16

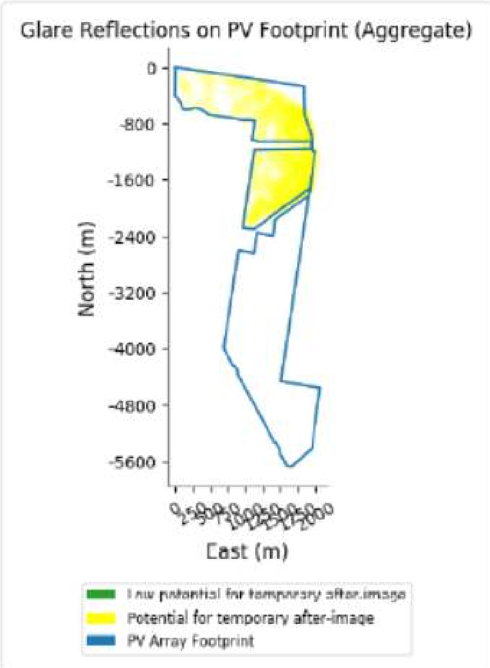
Solar Farm - OP Receptor (OP 16)

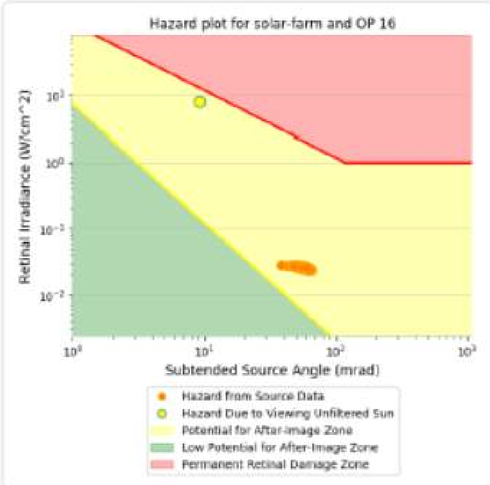
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 777 minutes of "yellow" glare with potential to cause temporary after-image.







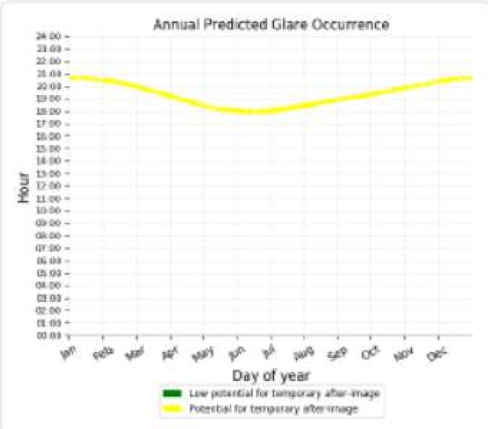


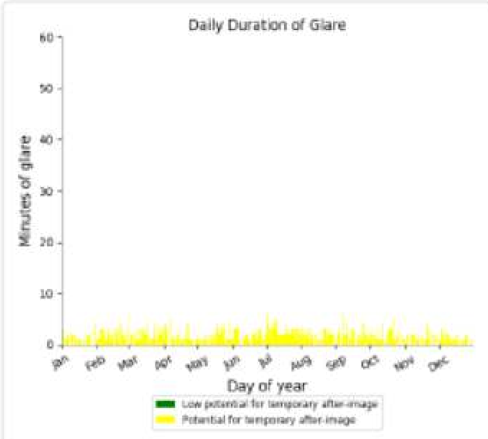
Road 17

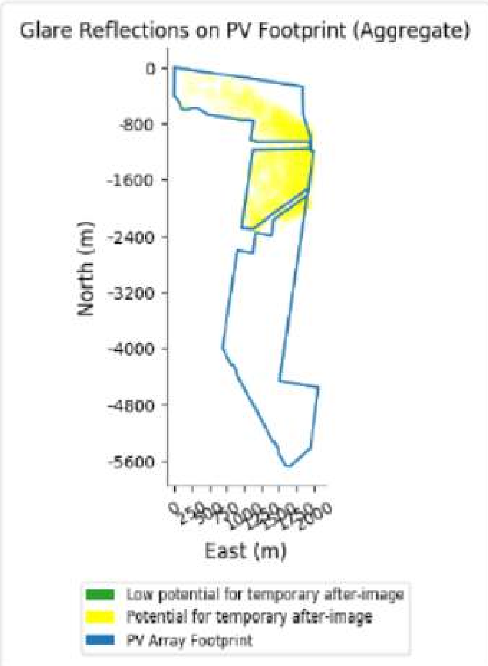
Solar Farm - OP Receptor (OP 17)

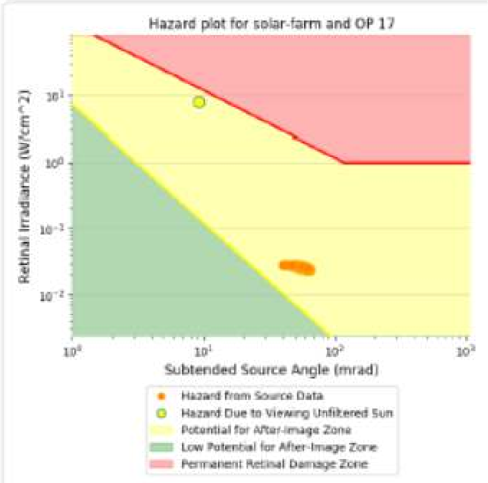
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 587 minutes of "yellow" glare with potential to cause temporary after-image.







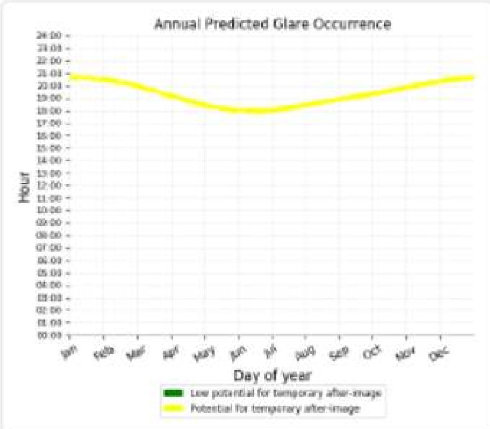


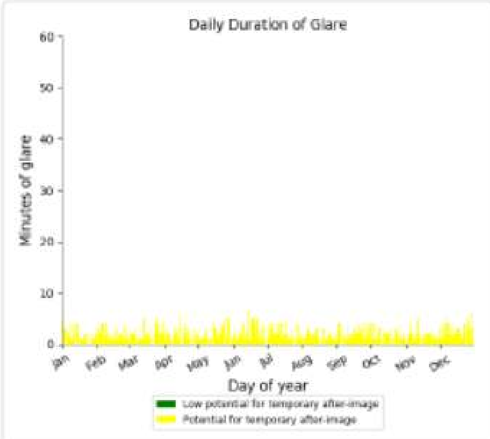
Road 18

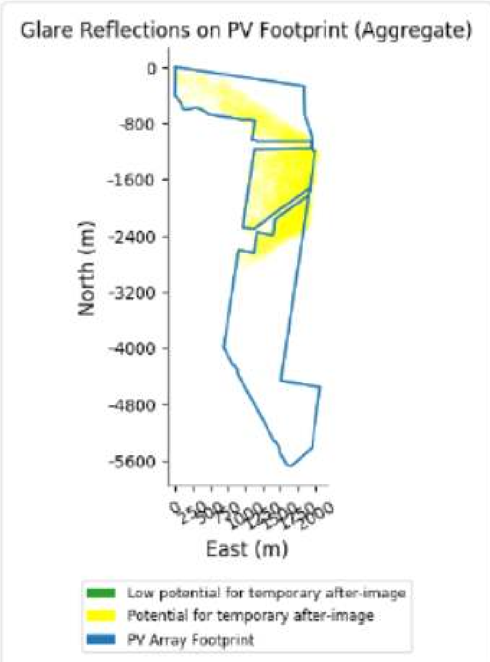
Solar Farm - OP Receptor (OP 18)

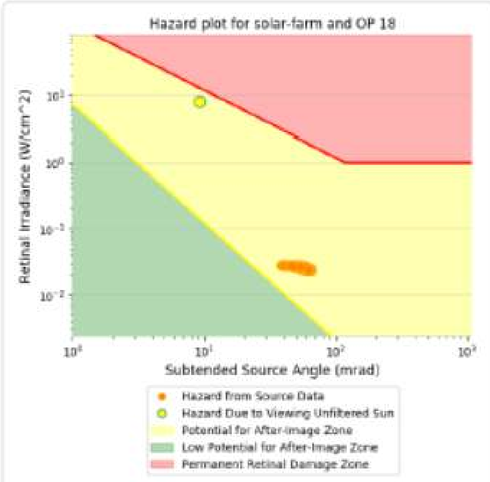
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 755 minutes of "yellow" glare with potential to cause temporary after-image.







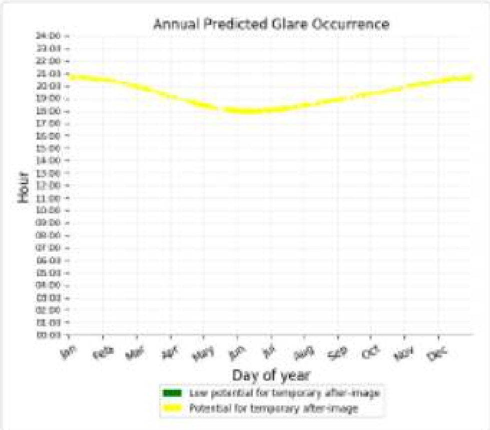


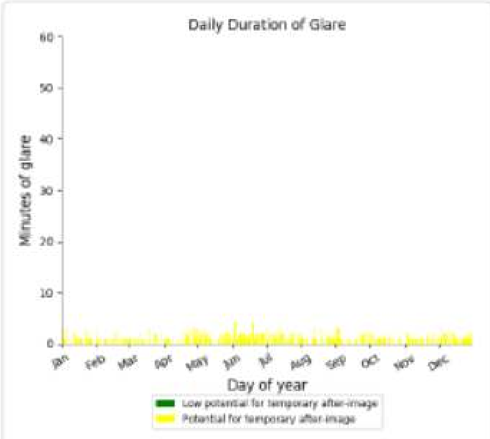
Road 19

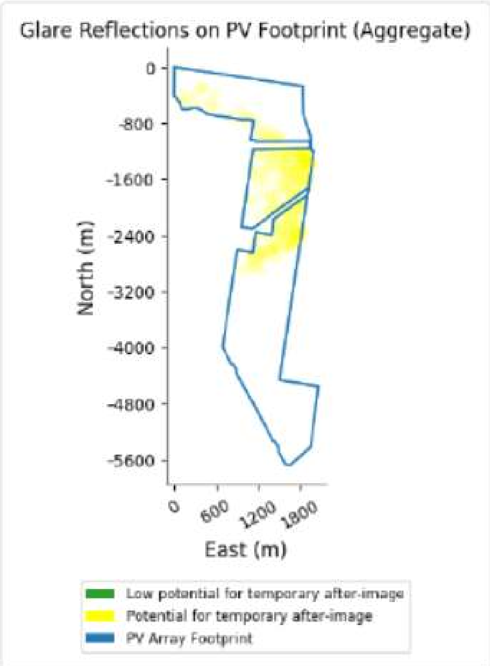
Solar Farm - OP Receptor (OP 19)

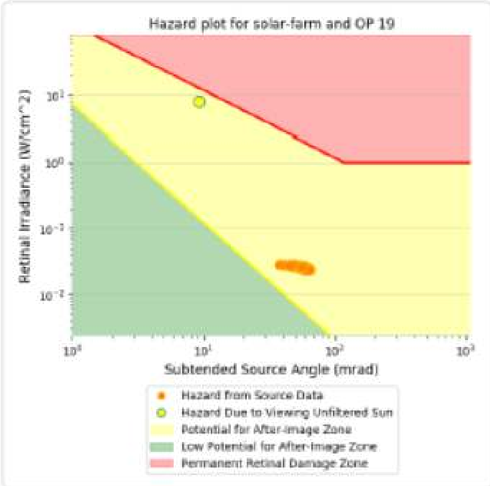
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 327 minutes of "yellow" glare with potential to cause temporary after-image.







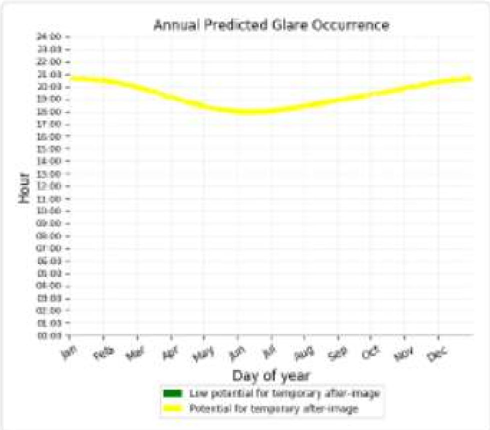


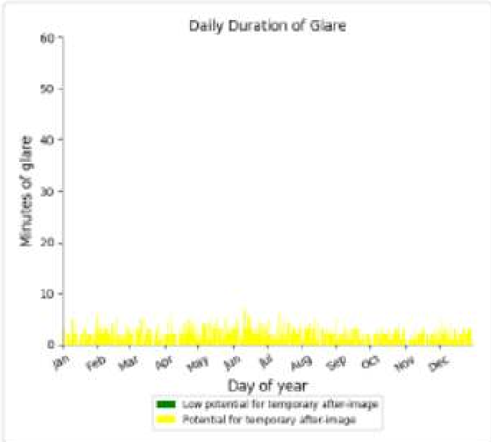
Road 20

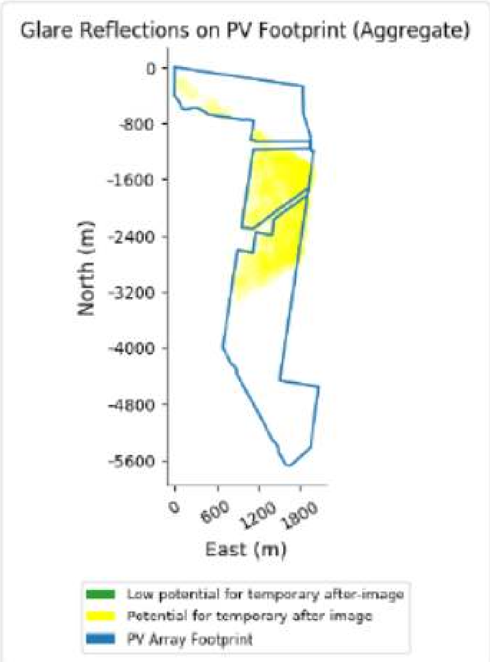
Solar Farm - OP Receptor (OP 20)

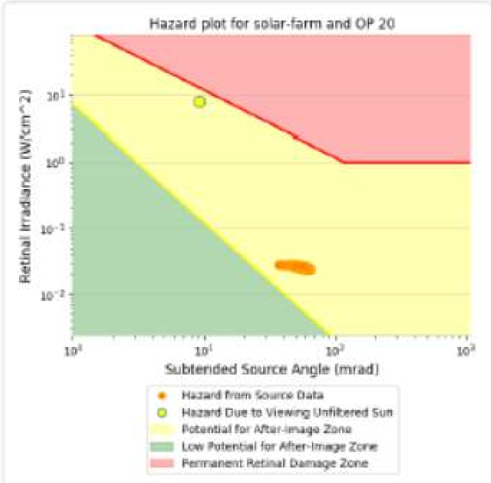
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 824 minutes of "yellow" glare with potential to cause temporary after-image.





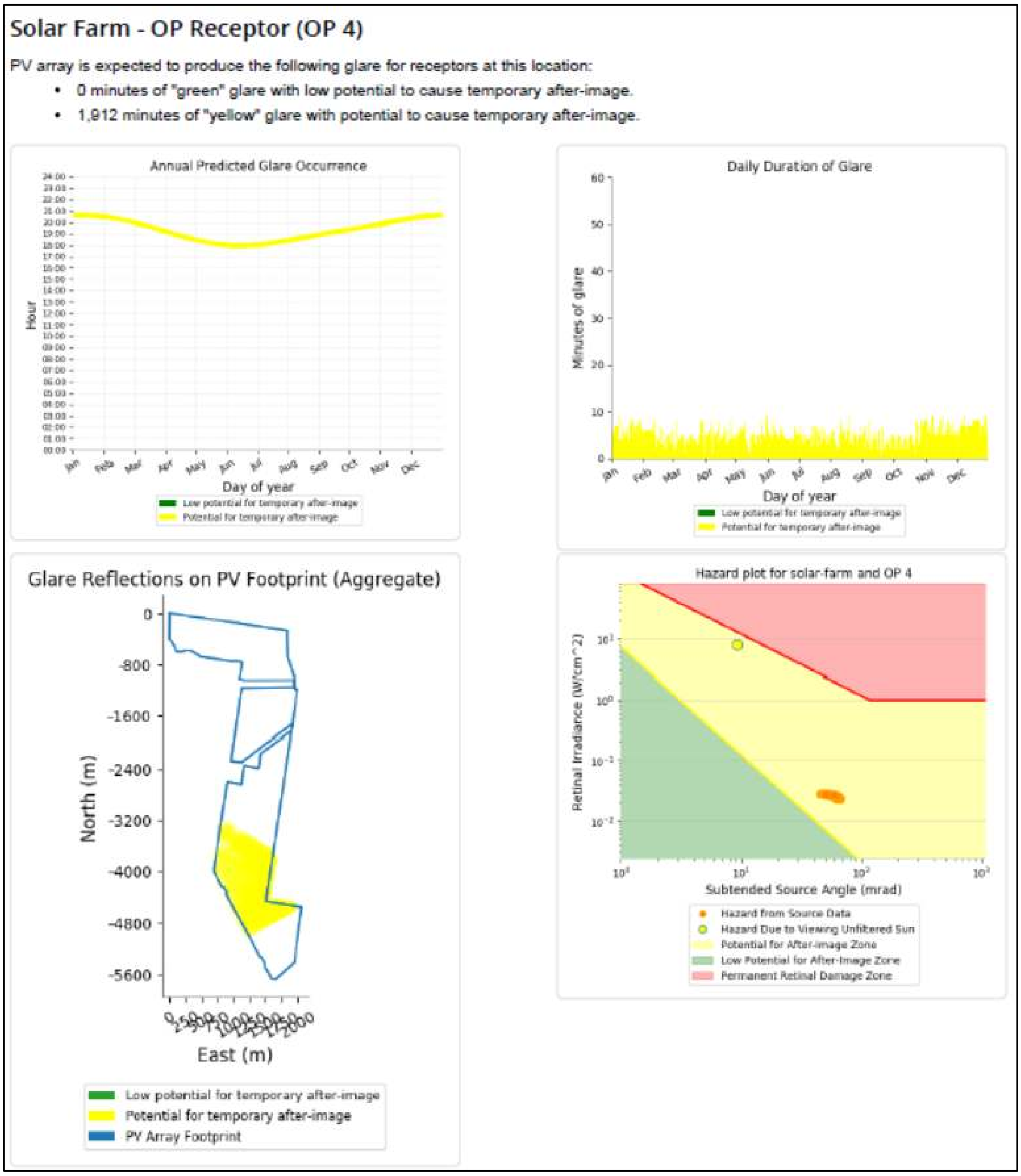




Dwelling Receptors

The glint and glare charts at the receptors where a solar reflection is deemed possible are presented below.

Dwelling E

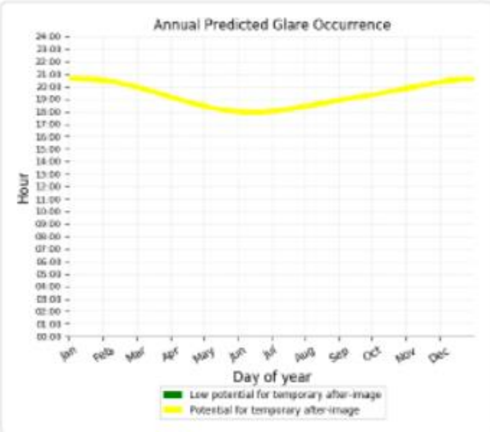


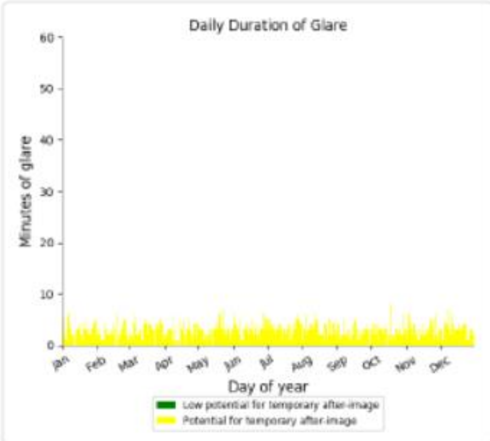
Dwelling I

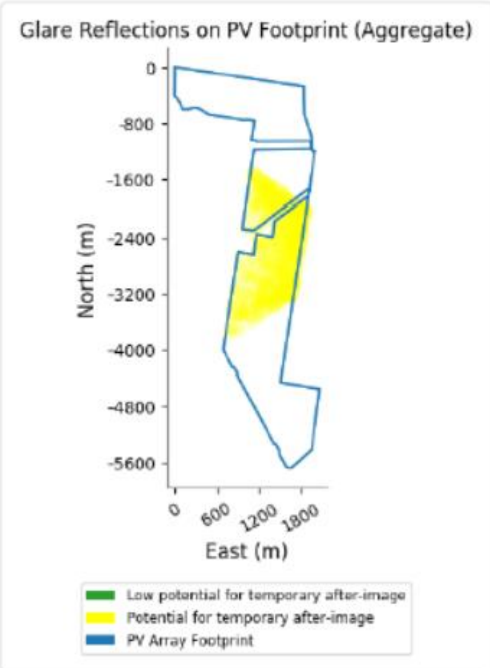
Solar Farm - OP Receptor (OP 8)

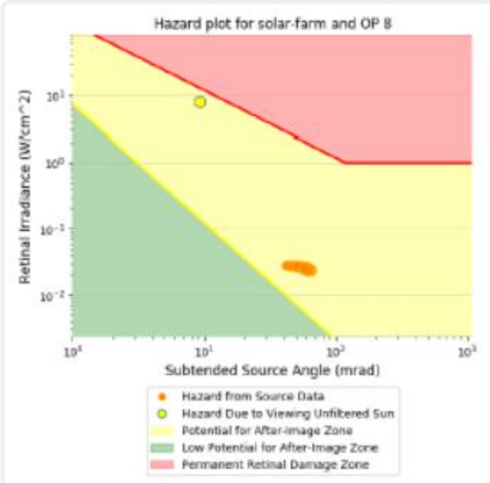
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,070 minutes of "yellow" glare with potential to cause temporary after-image.







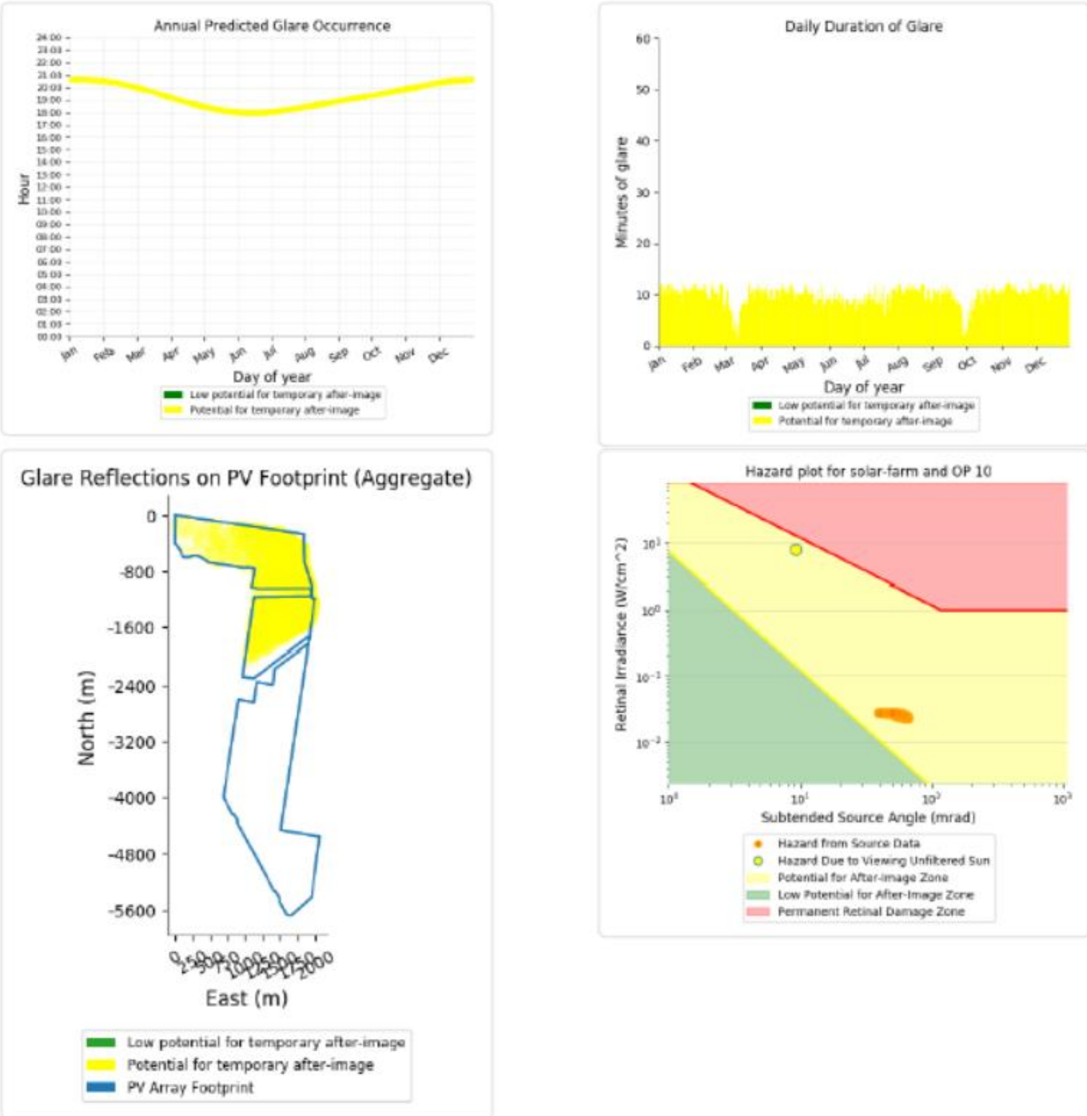


Dwelling K

Solar Farm - OP Receptor (OP 10)

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 3,667 minutes of "yellow" glare with potential to cause temporary after-image.



PAGERPOWER
Urban & Renewables

Pager Power Limited
Stour Valley Business Centre
Sudbury
Suffolk
CO10 7GB

Tel: +44 1787 319001 **Email:** info@pagerpower.com **Web:** www.pagerpower.com