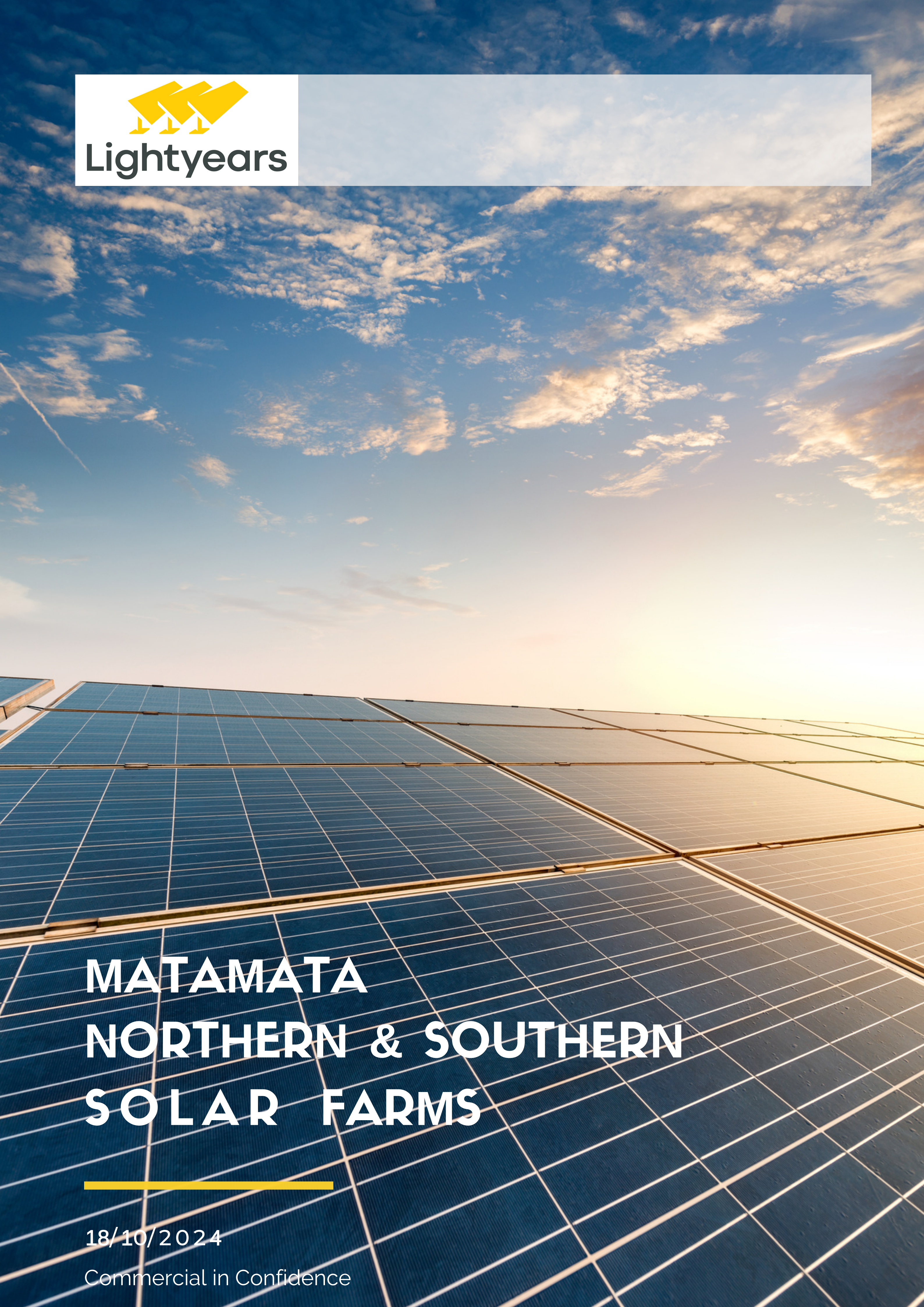


Lightyears

MATAMATA NORTHERN & SOUTHERN SOLAR FARMS

18/10/2024

Commercial in Confidence

Contents

Quality Information

Document Matamata Northern and Southern Solar Farms

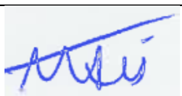
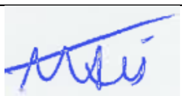
Ref MASF01

Date 18/10/2024

Prepared by Glen Jacobsen

Reviewed by Matt Shanks

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	18/10/2024	For Information	Matt Shanks / Development Manager	
1	10/12/2024	Revised For Information	Matt Shanks / Development Manager	

1.0 Lightyears Solar

1.1 Introduction

Lightyears Solar are an industry leading utility scale solar farm developer, EPC contractor, and operator in New Zealand. Since our inception in 2019 we have built up a valuable project pipeline and portfolio of MW scale solar farm projects. Our team are experienced in large scale solar (NZ and offshore), project development and construction (in NZ) with a strong focus on constructability and de-risking of projects.

Lightyears Solar has differentiated itself by developing multiple small to medium sized solar farms in the 2-30 MW range that are designed specifically to integrate into the existing distribution networks. Through Lightyears Solar's extensive experience in power systems and local infrastructure, we have developed projects through to shovel ready stage and into construction. We have well established project delivery partnerships across NZ and a proven process for taking solar projects through the development lifecycle.

1.2 Track Record

Lightyears is a leading solar farm developer in New Zealand. We have consented more utility-scale solar farms in New Zealand than any other solar farm developer. Lightyears has developed projects across New Zealand within many different district councils and distribution network boundaries. As such, we have a unique understanding of the requirements for solar farm development.

In 2023, Lightyears completed the construction of what was New Zealand's largest utility-scale ground-mounted solar project in Waiuku, Auckland, with a capacity of 2.5 MWp. The project marked a significant milestone in the country's renewable energy sector. We are currently in final construction stages of a 7 MW solar farm on the south side of Ashburton and a 4.5 MW solar farm in Masterton.

Lightyears has earned a reputation as a developer of high-quality solar farms that minimise construction and operational risks. That is why Lightyears has been contracted by other New Zealand and international developers for project development.

Lightyears Solar staff have worked with Powerco on our own Masterton project and have a good understanding of their connection and commissioning requirements. We expect this understanding, and experience will be beneficial to the Matamata Solar Farm Projects.

Figure 1 - Cows at Waiuku Solar Farm

1.3 Construction Risks Minimised

Our team are technical specialists with a deep knowledge of engineering, detailed design and construction across disciplines. We expect to hold risk identification workshops to ensure construction and project risks are minimised. We have a strong focus on optimisation of the plant, from power generation, delivery and supply chain through to land use.

1.4 Health and Safety

Lightyears Solar has a strong commitment to health and safety with stringent systems in place and a comprehensive policy, ensuring that health and safety is a priority across all our sites.

Our duty of care to our staff and other workers at our sites is paramount to us. This includes addressing our responsibilities under all relevant legislation, including the Health and Safety at Work Act 2015, the Health and Safety at Work Regulations 2015, and given Lightyears Solar works in the power industry, the safety-related provisions of the Electricity Act 1992 and associated safety regulations.

Our staff and subcontractors hold the necessary qualifications and experience to ensure health and safety is managed across our sites, including first aid certifications, and all contractors must have the necessary qualifications to work on our sites, and must adhere to our health and safety policy. The overarching intent of our health and safety policy, and our daily practices when at work, is to provide and maintain a work environment or work premises that are without risks to health and safety. We also have a strong focus on the timely reporting of risks, incidents and near misses, to respond to these, mitigate the risks and learn from them.

Figure 2 - Health and safety briefing at Waiuku Solar Farm

Figure 3 - Ashburton Solar Farm

1.5 Ethical Development and Positive Procurement

From our business partners to our suppliers, we have made a commitment to work with only those businesses that have proven ethical and social credentials. As such we do not work with companies that choose to breach international conventions or that breach conventional social safeguards, be it through breaches of standards around environmental or labour principles.

We have a strong commitment to positive procurement with respect to human rights and modern slavery and hold those we do business with to the same high standards of labour and human rights that our employees and others are entitled to.

Lightyears Solar does not tolerate any form of modern slavery, which is a violation of fundamental human rights, involves the deprivation of a person's liberty in order to exploit him or her for personal or commercial gain and is illegal. This includes forced labour, indentured labour, slave labour and human trafficking. We are committed to complying with anti-slavery laws and regulations in every jurisdiction in which we conduct business, including compliance with disclosure obligations under applicable legislation, and to acting ethically and with integrity in all its business dealings and relationships.

Additionally, we do not tolerate the hiring of child labour by any companies we do business with, including suppliers, and adhere strictly to New Zealand’s labour laws in this regard, and all other workplace requirements.

1.6 Diversity in the Workplace

Lightyears Solar values diversity in the workplace, and recognises the unique contributions that employees can bring, based on their background, gender, race or age and many other factors.

The workforce of Lightyears Solar is diverse in some areas, whereas in others, we are still developing. As we grow our business, we are committed to building a diverse company, both via our hiring processes, including the development and implementation of a strategy that corrects for bias while attracting, and retaining, qualified candidates, and creating an inclusive workplace culture that values and celebrates diversity, where all employees feel safe and welcome. As a New Zealand owned and operated business, we also recognise the unique opportunity we have to support the aspirations of Māori and Pasifika staff and businesses in this sector.

We also seek to work with other companies who value diversity in the workplace, and prioritise it in their hiring practices, their inhouse support, training and internal career paths and in their workplace culture.

1.7 Environmental and Sustainability

We are committed to ensuring our solar farm construction projects are as low impact as possible, both during and after construction. This includes contributing to the productivity of New Zealand’s agricultural sector via dual use solar farms and agrivoltaics, and working with landowners to ensure that our designs not only enable agricultural productivity, but support it.

Our developments are also designed in a way that considers the effects on the land during construction, and the reinstatement of the land once the project is at the end of its life. We also work to ensure native species on site are protected, for instance, working with ecologists at our Waiuku Solar Farm to ensure our construction did not damage native bat habitat.

Our sustainability practices also extend to our transport choices to and from sites and other business commitments. This includes endeavouring to hire electric or hybrid vehicles when travelling outside of Auckland.

2.0 Reference Projects

The summary below lists recent solar farm development projects that showcase our development services skills and experience.

Table 1 - Reference Projects

Project	Details
Morley Road Solar Farm	Lightyears have developed the Morley Road 2.4 MW solar farm from greenfield through to shovel ready and is now constructing the solar farm. The solar farm features fixed and tracking technologies and is connected to Counties Energy's network at 11kV.
Auckland Transport	Auckland Transport engaged Lightyears Solar to complete a technical and financial feasibility study including concept design for a rooftop solar system on the Wiri Rail Depot rooftop. The system is 650kW in size and connects to the existing electrical network. Lightyears are preparing an installation specification for Auckland Transport for tendering.
Infratec / WEL	Lightyears completed project development from site identification and acquisition through to consenting and shovel-ready for the 4.4MWp Naumai solar farm in 2020-2021. Lightyears engaged contractors for pull-out tests and to undertake geotechnical investigations.
Kapiti Coast District Council	Lightyears has been engaged by KCDC to conduct feasibility studies and early stage development for a 5-10MW ground mounted solar farm on council land, and for rooftop solar on council buildings.
Confidential Developer	Project development of a portfolio of ground mounted solar farms throughout NZ for a developer.
Centralines Limited	Centralines engaged Lightyears to prepare site layout drawings, overall system electrical schematics, yield modelling using PVSyst and consenting outline information for a proposed solar farm in the Hawkes Bay.
New Plymouth Airport	New Plymouth Airport engaged Lightyears to prepare an initial application for an 11kV connected solar farm on their land. Lightyears prepared a single line diagram and associated documentation for the initial application. Lightyears continues to be engaged as a technical advisor to the airport.

3.0 Project overview

3.1 Introduction

Lightyears Solar and Maven Associates are proposing the development of two renewable energy generation plants (Northern Solar Farm & Southern Solar Farm) on approximately 36.7 hectares of existing farmland located on the northern and southern sides of Station Road west of Matamata.

The proposed developments are expected to generate 10 megawatts (MW) of renewable electricity at the northern site and 20 megawatts (MW) at the southern site. These plants will connect to Powerco's newly dedicated 33 kV distribution lines on Station Road, which link to the Browne Street substation located approximately 2.55 kilometers northeast of the site. This proximity allows for efficient energy delivery to the electricity grid.

3.2 Project Outline

Unity Developments engaged Barker & Associates ('B&A') to provide planning services for the master planning, consenting and design of Ashbourne. Ashbourne is located approximately 1.8 kilometres south-west of the centre of Matamata in the Waikato and comprises a total area of 125 hectares. Ashbourne is a multi-use development that includes four key precincts:

1) A new residential community, comprising circa 520 new residential units with a variety of densities, a green space and a commercial node;
2) A multi-functional greenway that weaves from the neighbourhood centre and commercial node to the Waitoa River on the site's western boundary with an active-mode pathway along the length;
3) A retirement living core, comprising circa 218 units, an aged care service and supporting facilities that will be provided across a staged development; and
4) Two solar farms which will provide a sustainable energy resource onsite, with the potential to integrate into the wider electricity network to generate energy outside of the immediate development.

This three-stage development, with each of the four key precincts having their own sub-stages, will ensure demand is met over the short, medium and long term.

The 42-hectare residential community is underpinned by a series of design principles, which focus on creating a well-connected, legible and diverse community on the edge of Matamata. The eight-stage development is framed around a central spine road which runs from Station Road, to the north of the site, down to the eastern boundary. Intersecting this is a secondary spine road connection to link the wider residential precinct to the commercial node, green space and greenway. This transport network, supported by local roads, pedestrian and cycle connections, enables a legible grid structure in the residential area. A range of housing typologies and densities are proposed to meet the growing and changing needs of the housing market to ensure there are options for future residents.

The commercial node located in the heart of the development, includes a number of amenities and services to support the Ashbourne development, wider community and local economy, such as local shops, a childcare facility and a café. The commercial node comprises an area of 0.75 hectares in the centre of the Ashbourne development, that includes a number of commercial properties, café, childcare facility and superette. This element of the proposal has been scaled to support the density proposed in the residential and retirement village components to ensure it does not threaten the primary purpose of the town centre of Matamata.

The multi-functional greenway links the commercial node and open spaces of the Ashbourne development area. This corridor interconnects infrastructure, cultural narrative, ecological wellbeing, connectivity and amenity to support a place-based identity. A number of uses are proposed along this corridor to encourage future residents to interact with the greenway, such as sheltered rest areas for relaxation and socialisation, active mode pathways, and play areas.

To support the growing demand for retirement living in Matamata, Ashbourne is anticipated to deliver circa 218 retirement living units, as well as the supporting healthcare and community facilities across an area of 19 hectares. A staged approach is proposed, from north to south, to establish a high-quality development overlooking the greenway.

Two solar farms are proposed to produce energy for over 7,000 homes per year, with the ability of powering not only Ashbourne but the wider community. The northern solar farm has an area of 12.7 hectares, while the southern solar farm is twice the size with an area of 24 hectares. An underpinning design principle of the solar farms is the dual-use, with agrivoltaic farming proposed to be undertaken underneath the solar panels to promote sustainability and preserve the identified highly productive land. Typical landscaping, planting and security will complement the solar farms to ensure their integration with the wider Ashbourne development.

Lightyears Solar Limited are investing in renewable agrivoltaic solar power generation to contribute to New Zealand’s future energy demand increases and provide an affordable and reliable energy supply to New Zealanders, as we transition to a low emission economy.

The Matamata Solar Farm Projects propose the installation of ground mount direct current (DC) solar panels, connected to string inverters for conversion to high voltage alternating current (AC), connected via power transformers to a newly dedicated 33 kV distribution line to the Browne Street Zone Substation into Powerco’s power grid.

The northern 10 MW and southern 20 MW solar farm developments are planned to be constructed in a two stage process, with the northern site constructed first.

3.3 Project Objectives

The objective of the Matamata Solar Farm Projects is to develop a safe, reliable, compliant, and efficient ground mount renewable solar generation plant, utilising the available solar resource in the Waikato, within proximity to Powerco’s Browne Street Zone substation, to support New Zealand’s future electricity demand requirements and assist New Zealand’s transition to a low emission economy, whilst continuing the existing agricultural use of the farm.

3.4 Rationale

The proposal aligned with the Paris Agreement (a global agreement on climate change), where New Zealand committed to a target to reduce greenhouse gas emissions by 30 per cent by 2030, a target which has now been increased to 50 per cent.

The Matamata Project will produce clean electrical energy and offset electricity produced elsewhere in New Zealand using fossil fuels, producing enough energy to power approximately 3000 homes per year. The project will contribute to NZ’s goal to become carbon neutral.

A solar farm sends the energy it creates directly into the power grid, adding much needed diversity into the grid at a time where demand for electricity is high, and will only continue to grow. The output profile from a solar farm is weighted towards daytime summer and aligns particularly well with electricity consumption in the Matamata area. The project will have a net carbon benefit of 292,800 tCO2 (offsetting this amount of carbon producing power generation in the NZ grid).

This project directly aligns with Aotearoa's emissions reduction strategy by providing investment in renewable electricity generation to assist Aotearoa's transition to a low emissions future and meet its climate change targets.

This project is being designed to meet the definition of an "agrivoltaic" project or "dual-use" solar farm, a facility that is designed to continue the agricultural use of the property at the same time as harvesting power via the solar panels. In this case sheep will be grazed amongst the solar panels.

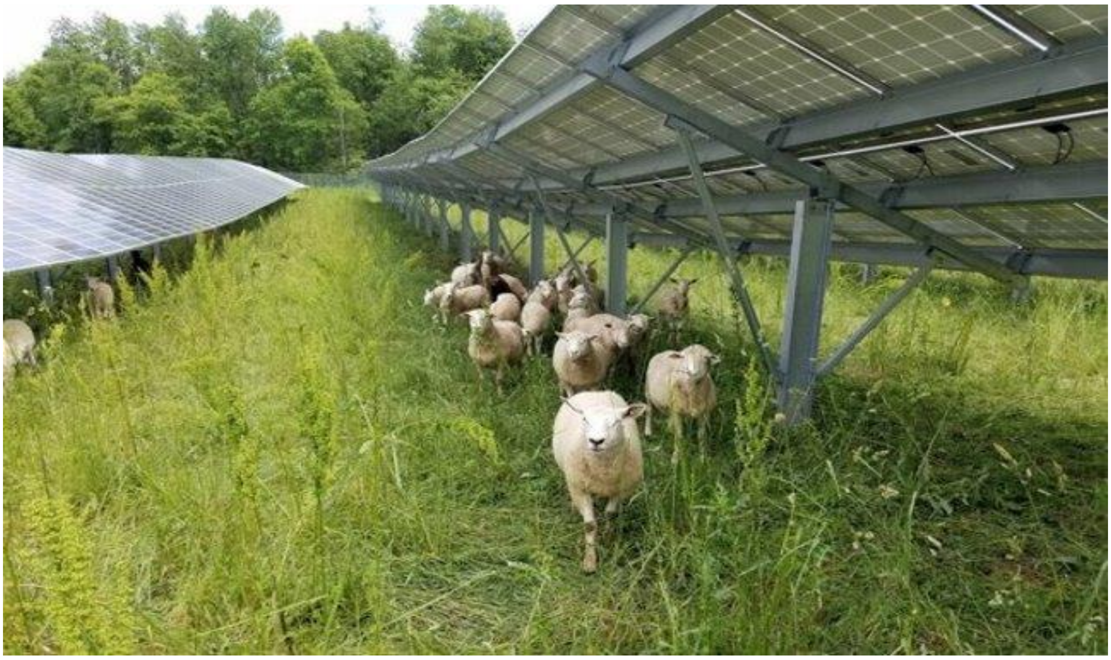
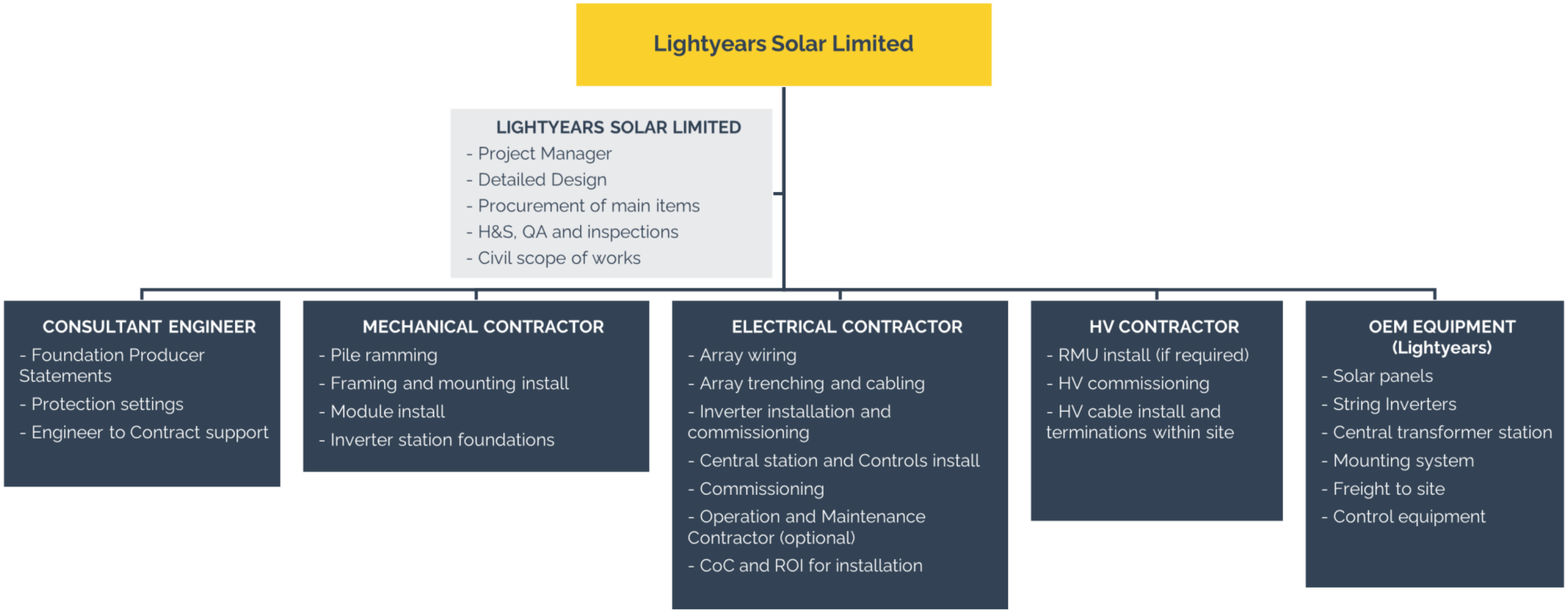


Figure 4 - Agrivoltaic Farm in Action

3.5 Delivery Model



4.0 Technical Description

4.1 Technology

The combined solar farms will consist of approximately 50,000 solar panels (modules) attached to a solar tracking system (trackers). The panels will be installed in rows of up to 110m in length. The rows will have a proposed height of 2.5 m above ground when fully tilted (morning and evening). Each row is approximately 2.4m in width with a gap between rows of approximately 3m. The figure below shows a basic representation of the modules and trackers.

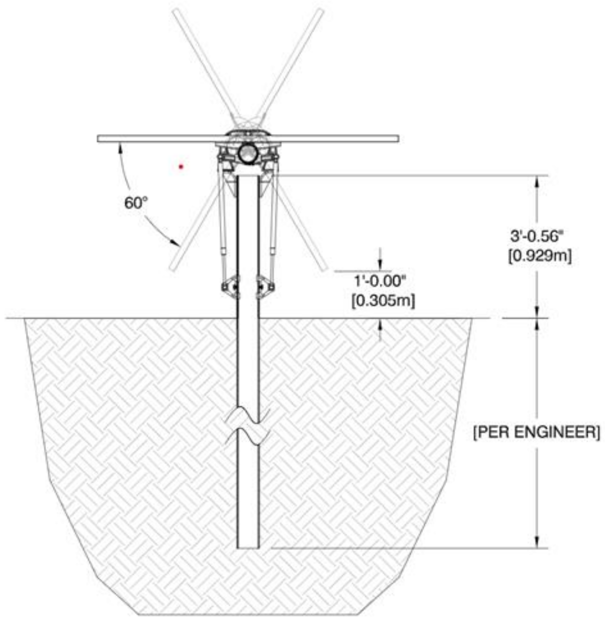


Figure 5- Example cross section drawing of a tracker table and solar panel

4.2 Working Principle

The solar panels convert incoming sunlight into electrical power using the photo-voltaic (PV) principle. The power is collected with wires between each panel and sent to a power conversion unit (inverter station). The power is then converted to the voltage of the local Powerco network through a transformer.

4.3 The Benefits of a solar PV Power Plant

Solar power is quiet and has few moving parts. A solar farm sends the energy it creates directly into the power grid, adding much needed diversity into the grid at a time where demand for electricity is high, and will only continue to grow. The project will provide a net carbon benefit (offsetting carbon producing power generation in the NZ grid). The solar system will operate for a period of 30 years, after which the equipment will be removed and the land returned to its former state.

4.4 Framing / Mounting

The framing system is proposed to be a steel pile mounted system with aluminium framing that tracks the sun across the day. The steel piles are located at approximately 10m spacings and are driven into the ground.

Figure 6 - Example illustration of a solar tracker system

4.5 Solar Panels

The proposed solar panels are 610-Watt modules, each measuring approximately 1.3m in width by 2.4m in length. The panels are mounted onto the tracker system. The solar panels have a very low reflectance or glare (less than a typical residential roof), as they are designed to absorb sunlight rather than reflect it. The proposed panels are bi-facial type which means they generate electricity from both sides of the panel – from sunlight on the front and reflected sunlight off the rear of the panel.

Figure 7- Example illustration of bi-facial solar panel (module)

4.6 Inverters and MV Switchgear

The solar panels are connected with wiring to string inverters distributed throughout the site. These string inverters convert the DC (direct current) electricity generated by the solar panels into AC (alternating current) electricity, which is the form used in homes and businesses. Each string inverter operates independently, providing flexibility and efficiency. The system also includes transformers and electrical switchgear to protect the equipment in case of a fault or to disconnect the system from the grid during maintenance activities.

Figure 8- MV Transformer Station

4.7 Grid Connection

The connection to the Powerco grid will be made to a newly dedicated 33kV line on Station Road. The Powerco Browne Street substation is located at 11 Farmers Road, approximately 2.55km's away from the site. The existing powerlines at the site are low capacity so will require upgrade to accommodate the power export from the solar farms. The initial grid application has already been completed and supports the connection of the solar farms (refer Appendix A).

4.8 General Safety Features

The installation is required to comply with NZ electrical safety standards (AS/NZS3000 and others relevant to solar installations). The system will be inspected and signed off by a registered electrical inspector in NZ to ensure it is installed in accordance with the applicable standards.

An electrical protection system will be installed that will shut down the solar farm in the case of any abnormality, in a similar way to electrical circuit breakers in a house. The electrical protection requirements are determined by NZ standards and also by Powerco's connection standards.

The tracking system features safety modes that will tilt the panels into a stowed position in the event of high winds, and for panel cleaning, to enable access with a tractor or other panel cleaning system during maintenance.

4.9 Solar Resource

The Solar resource at the site, and in Waikato region, is some of the highest solar potential in New Zealand.

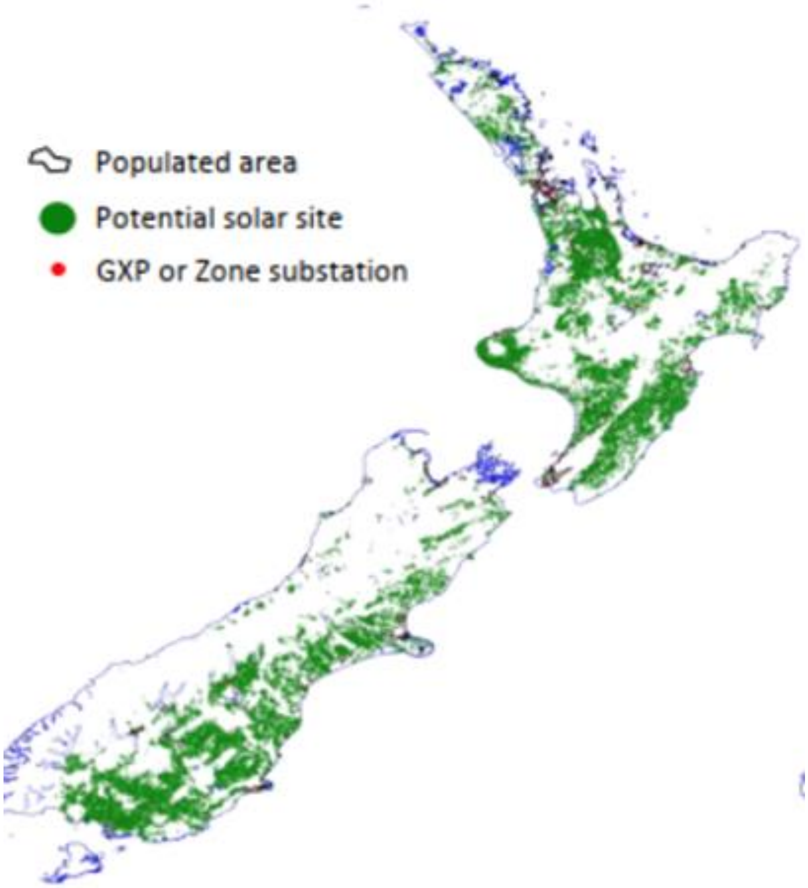


Figure 9- Map Showing Solar Resource over New Zealand

5.0 Construction

5.1 Civil Works

Civil works for the development will be undertaken in a single stage at each site, with each site expected to be completed over a 10 week period. The most intensive works will be completed in the first month of the construction, after which, there will be very little disruption from the site. The operational life is expected to be up to 30 years with the site being restored back to its former state after this period.

5.2 Assessment

It is expected that Lightyears Solar Ltd will commission the preparation of the relevant geotechnical assessment to inform the civil engineering design. It is expected that the geotechnical assessment will include relevant recommendations for foundations, piling and earthworks, among other relevant information.

5.3 Security

The project sites are currently fenced with typical rural post and wire fencing. It is expected that this fencing will remain in place until construction works commence. At this point, it is expected that 2.2m high security fencing will be installed around solar farm boundaries, as well as entranceway gateways to match the security fencing. Lightyears Solar Ltd may choose to install a security system, but this is yet to be determined.

Any fencing will need to be incorporated within the landscape and visual impact assessment.

5.4 Entrance to Site

The Northern Solar Farm adjoins Station Road and has existing access from there. This is currently formed to a rural standard. Visibility from the access appears adequate.

It is proposed that this existing access be maintained as the main access to site as it is the most compliant and logical.

The Southern Solar Farm is offset approximately 350m south of station road. While formed rural roads provide access to the site, it is proposed that a new access road is developed on the eastern boundary as part of the Residential Development Area 1.

5.5 Internal Access Tracks

Given the relatively small scale of the projects, limited internal access tracks are proposed. The formation will be as a rural access track with aggregate surface. Earthworks to form any internal tracks are expected to be minimal noting the flat nature of the site.

5.6 Earthworks – general

The only expected earthworks on site may include trenching for power cabling. It is not expected that an erosion and sediment control plan will be required as the scale of the development is relatively small and on flat land with no waterbodies or drains on site.

5.7 Stormwater, Water and Drainage

Services for water supply and wastewater are not required for either of the solar farms. It is expected that stormwater will be via soakage to ground as the development will not cause any concentration of water different to the existing situation.

Consideration of Matamata - Piako District Council (MPDC) requirements will need to be met as part of the process. It is not expected to trigger consenting requirements.

5.8 Plant Construction

Construction will follow an agreed programme of deliverables to meet the overarching project objectives. Where possible, construction works will utilise existing infrastructure during establishing and implementation. This will include existing entranceways and road networks.

Lightyears Solar has construction management plans that will be personalised to the site prior to engaging civil contractors. Once the plan has been prepared, it is expected that the following process of works will follow:

- Piling for the panels – the choice of the ground piles (foundations) will be determined by the geotechnical assessment.
- Installation of the main beam which is screwed on the top. Purlins will be installed for the support of the panels. The installation process may differ depending on the tracking system.
- The panels are then fixed to the structure by clamps.
- All cable installation is completed to New Zealand standards and meet the requirements of electrical inspectors to ensure electrical safety.
- The installation of the prefabricated inverter and transformer units are moved to site and connected to the electrical equipment is undertaken.
- Distribution connection to be connected to Powerco’s newly dedicated distribution line on Station Road.
- Landscaping, as detailed below will be completed.

5.9 Landscaping

As part of the resource consent process, it is expected that a landscape and visual impact assessment (LVIA) will be required. This will determine and provide recommendations for mitigation.

6.0 Operation

Once construction is complete, it is expected that operational requirements will be restricted to quarterly cleaning of the panels and maintenance checks. Due to the panel tracking system, the panels will follow the sun automatically, therefore decreasing operational requirements.

Sheep will graze underneath the panels avoiding any need for mowing.

Staffing requirements are expected to be minimal once construction is complete with traffic movements to and from the site minimal.

7.0 Summary of Project Impacts

7.1 Earthworks

Any earthworks are expected to be minimal, of short duration, and adequately controlled by a construction management plan prepared as part of a resource consent condition. This will address matters like traffic, noise, dust and erosion and sediment control.

7.2 Hazardous Substances

It is not expected that the site will require the use or storage of any hazardous substances. The solar panels are sealed units that even if damaged will not release materials into the soil.

7.3 Noise and Light Emissions

No lighting is proposed to illuminate the site. The site will be unmanned except for programmed maintenance visits. Noise and vibration levels from operational equipment and site activities will not exceed standards for the Rural Zone.

Noise emissions are likely to be restricted to the construction phase only. This can be suitably mitigated through a construction management plan. An assessment of acoustic effects for the construction and operation phases will be undertaken as part of the consent application process.

The construction management plan will identify days and hours of operation in accordance with relevant District Plan standards and New Zealand standards.

7.4 Electromagnetic Fields

There are no radiofrequency, electrical field or magnetic effects associated with solar farms that would be in excess of NZ guidelines for public or workers.

The National Policy Statement and National Environmental Standard on Electricity Transmission are instruments under the Resource Management Act to manage the environmental effects associated with electricity transmission. These apply the 1998 EMF health protection guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) to manage EMF. The ICNIRP re-issued their guidelines in 2010, revising the public exposure limit for magnetic field from 100 to 200 µT (micro tesla) and NZ Ministry of Health recommend the revised limit.

Based on experience from similar installations it is expected that the solar farm equipment will have a minimal/negligible effect on EMF readings at the boundary and that the actual EMF readings will be significantly below the 200 µT public limit. Additionally, equipment with potential to generate EMF's will be positioned away from the property boundaries.

7.5 Fire Risk

As there are no combustible materials on site the risk of fire is minimal. The equipment will be installed by a qualified solar installer in accordance with applicable AS/NZS standards for safe electrical installations and solar installations:

- AS/NZS 5033:2021 Installation and safety requirements for photovoltaic (PV) arrays
- AS/NZS 3000:2018 Electrical installations - Known as the Australian/New Zealand Wiring Rules

Programmed maintenance will include vegetation control to reduce risk of vegetation fire.

7.6 Glare

Albedo (reflectance) information related to the solar panels is provided by solar panel manufacturers. Solar panels do not result in glare effects which could be a safety and visual issue. Reflectivity is measured as "albedo," defined as the reflecting power of a surface. Albedo is measured from 0 to 1, 0 representing no light reflected, and 1 representing 100% of incident sunlight reflected. Since glare strength is directly related to the amount of light reflected, an object with a low albedo would typically produce a lower level of glare compared with an object with a higher albedo. Typical solar panels with an anti-reflective coating have an albedo around 0.10 (approximately 10 percent of light reflected). A condition of consent is offered to ensure the albedo value of the panels is below 10%.

7.7 Traffic

It is expected that traffic movements will primarily be restricted to the construction phase and any effects can be suitably controlled and mitigated by the construction management plan. Civil construction works will be completed within two months for each site, whereby any effects are temporary in nature only.

Construction traffic will be concentrated to the civil construction period. Vehicles used in construction will be similar in size as those used for existing farm operations (such as stock trucks). A laydown area is available within where the panels are erected (and progressively moved as areas are installed, or nearby to the existing accessway. No stripping or earthworks are proposed for the laydown area.

Installation of the panels and fencing will involve posts straight into the ground and will not require earthworks beyond ramming of piles. The surrounding ground will be retained as pasture.

Following the construction stage the plant is autonomous and the only vehicle movements expected will be for periodic panel cleaning, grounds maintenance and electrical inspections. The frequency for movements for panel cleaning and grass trimming is expected to be monthly and would be with light vehicles such as a ute or van.

7.8 Dust

Dust is likely to be generated from construction site traffic and earthworks activities. Any effects can be controlled and mitigated by the construction management plan and erosion and sediment control plan, which is likely to include wetting of any exposed earth and immediate cleaning of any debris that is tracked into the road reserve.

7.9 Stormwater Discharge

Stormwater discharge is expected to be minimal and no different to existing.

7.10 Management Plans

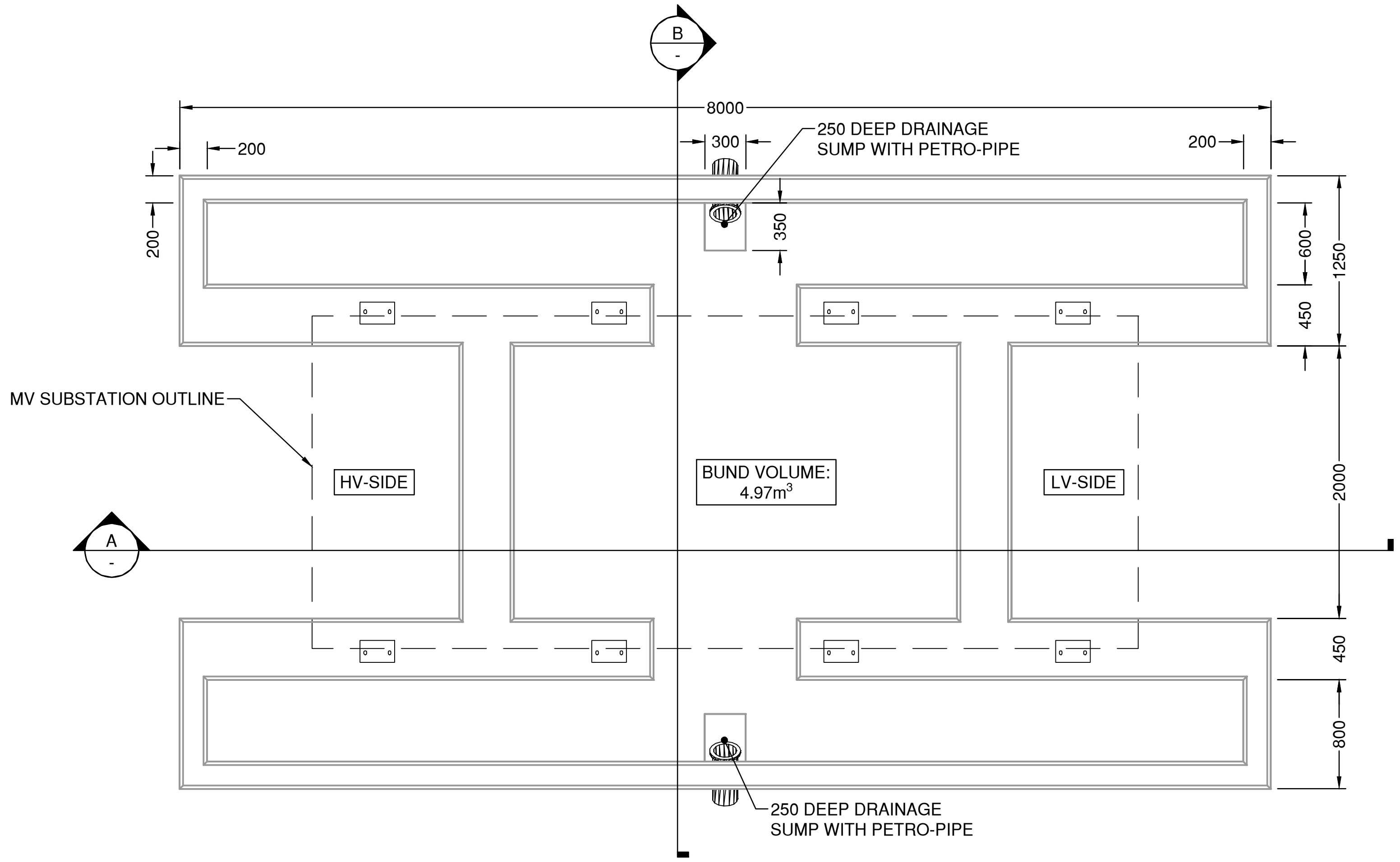
The following management plans are likely to be required with the certification of these by Council anticipated to be conditions of resource consent:

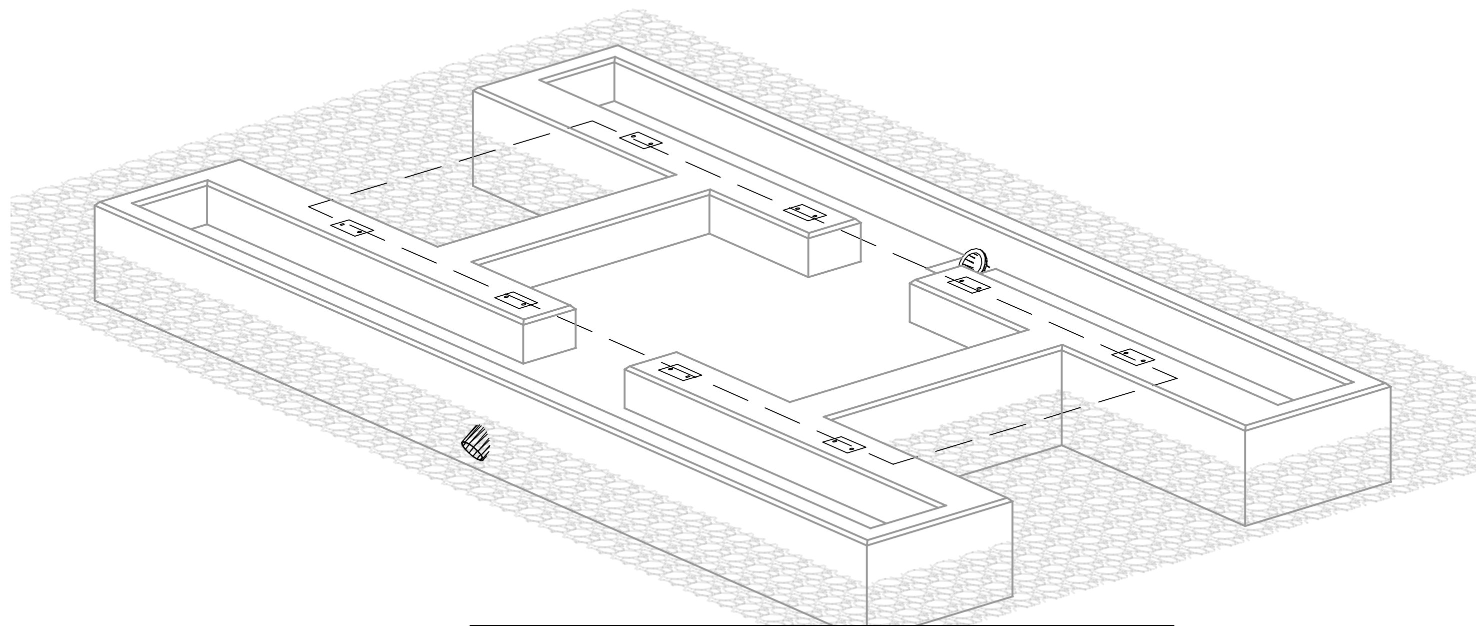
- Construction Management Plan.
- Erosion and Sediment Control Plan.
- Landscaping Plan

7.11 Decommissioning of Solar Panels

At the end of life for a solar farm installation, there are several options for disposing of the panels. While solar panels are designed to last for decades, eventually they may stop functioning properly or become outdated. One option is to recycle the panels, which involves separating the different materials and components so they can be reused, to reduce the amount of waste that ends up in landfills. Another option is to repurpose the panels, which involves finding new uses for them beyond generating electricity. For example, old panels can be used to heat water in a swimming pool or to power outdoor lighting.

Appendix A – Powerco High Level Connection Assessment

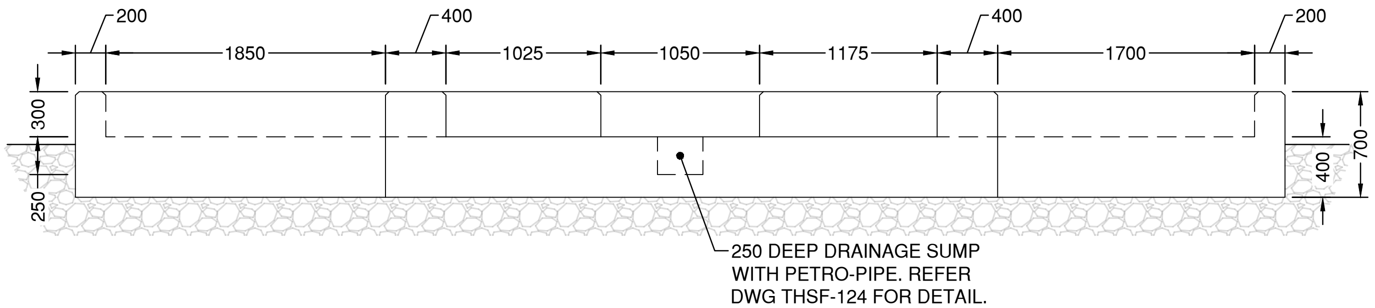


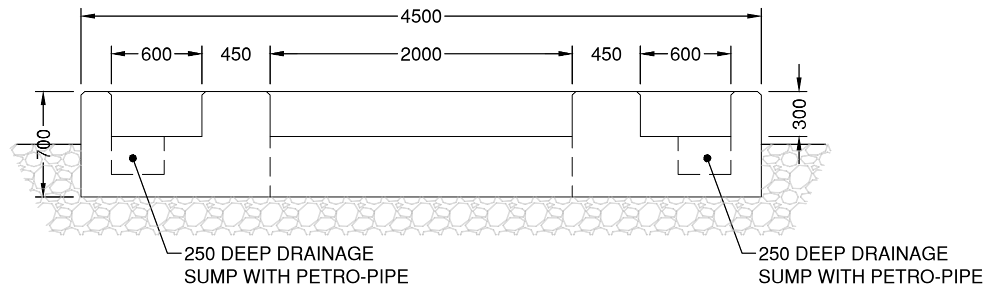


TRANSFORMER OIL WEIGHT <2.9t (3600L).
BUND TO BE FREE-DRAINING VIA SPI PETROPIPE - NO SITTING WATER.
BUND VOLUME 4.97m^3 / >138% OF TRANSFORMER OIL VOLUME.

- | MV SUBSTATION FOUNDATION - PLAN VIEW
Scale 1:50

- | MV SUBSTATION FOUNDATION - PERSPECTIVE
Scale NTS





A | FRONT ELEVATION - SECTION A
Scale 1:50

B | SIDE ELEVATION - SECTION B
Scale 1:50

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REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
A	FOR CONSENT	DM	GJ	MS	07.10.2024

CLIENT:

UNITS: | SHEET SIZE: A3 | SCALE: 1:50 (U.N.O.) | PROJECTION:

ADDITIONAL INFORMATION:

FOR CONSENT

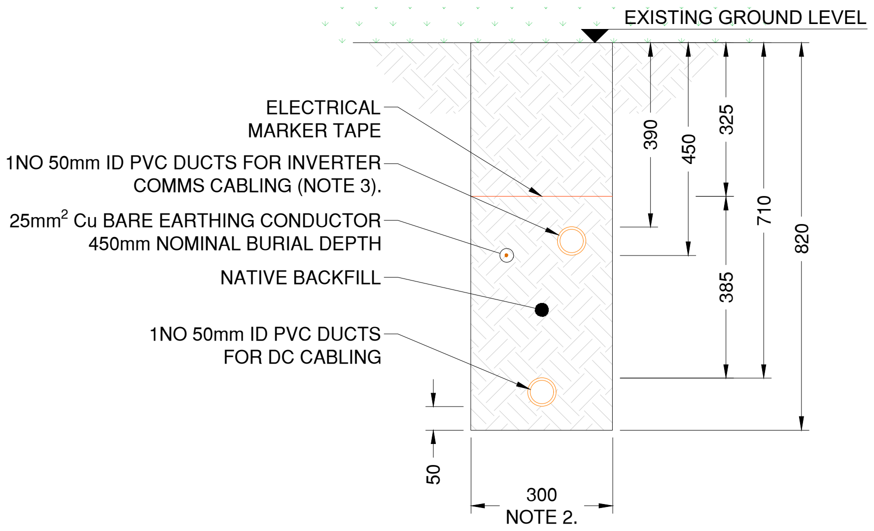
LIGHTYEARS SOLAR
AUCKLAND, NEW ZEALAND
www.lightyearssolar.co.nz

DESIGNED:	DM
DRAWN:	DM
DATE:	07/10/2024
CHECKED:	GJ
APPROVED:	MS

TITLE: MATAMATA SOLAR FARM
MV SUBSTATION FOUNDATION
GENERAL ARRANGEMENT

DRG. NO.: MASF-121

REVISION: A



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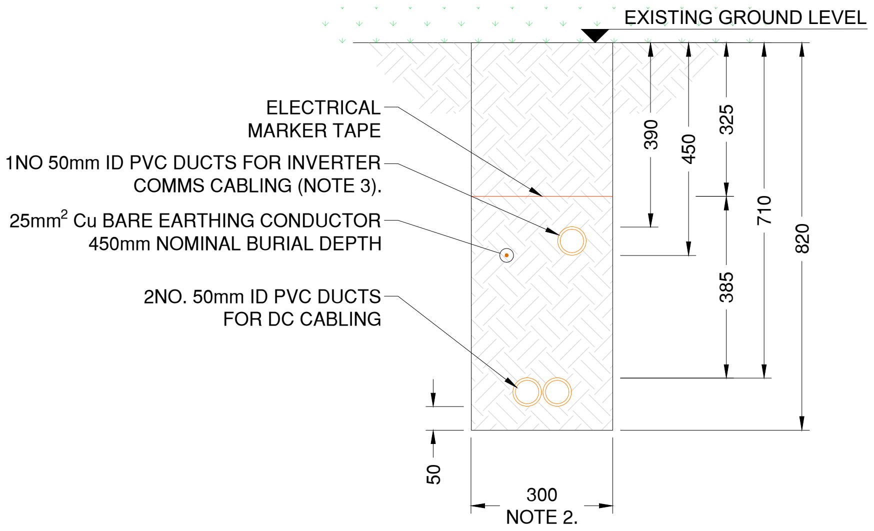

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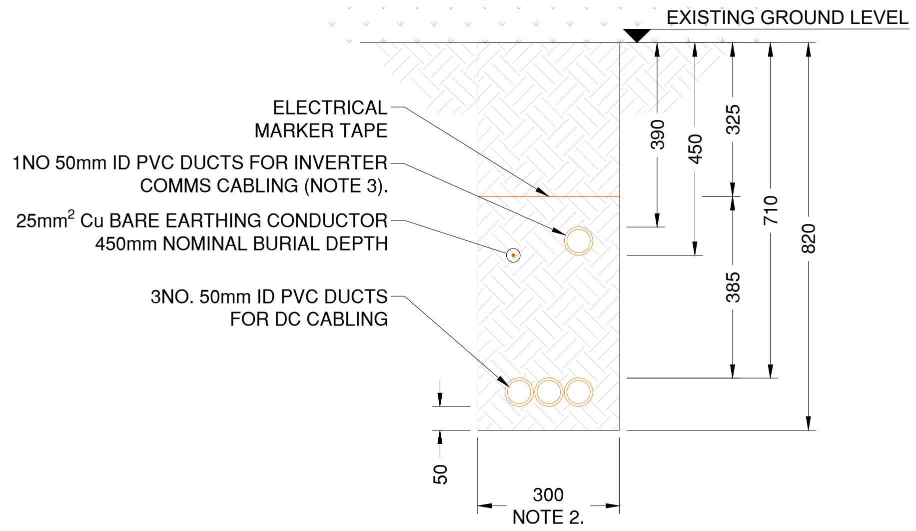

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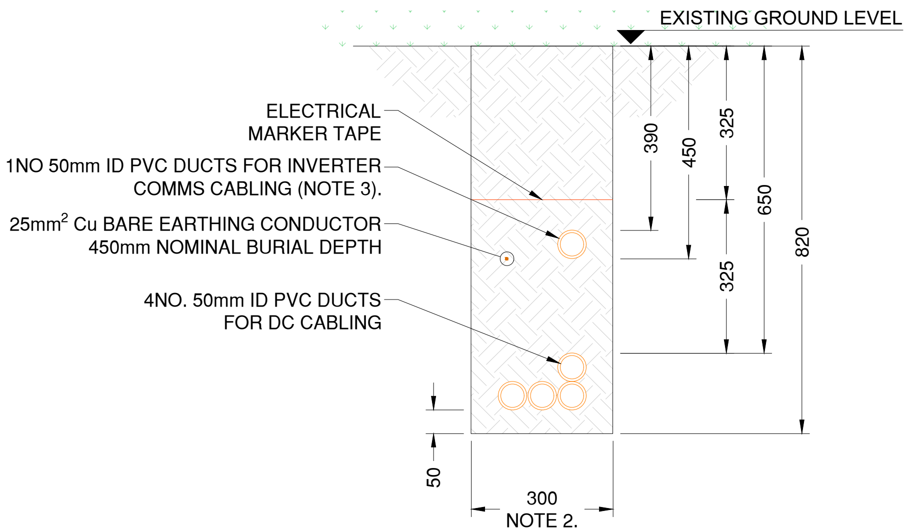

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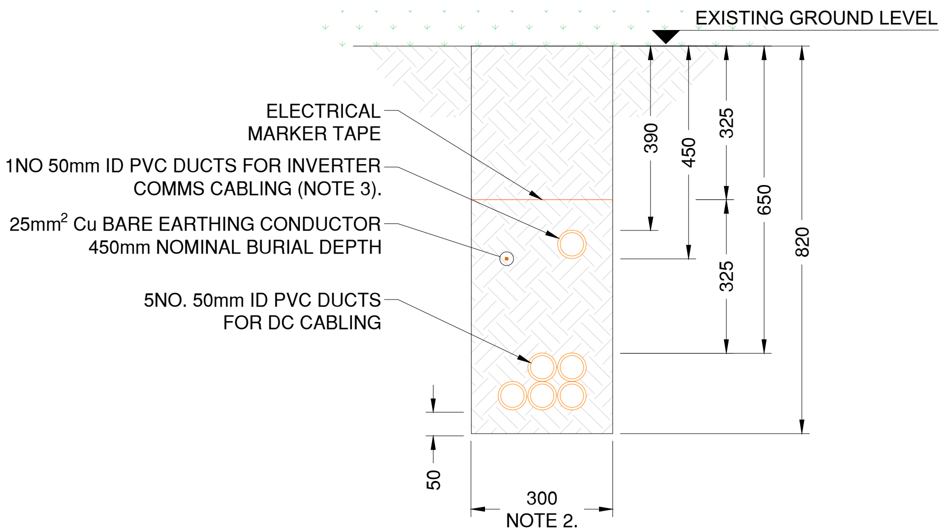

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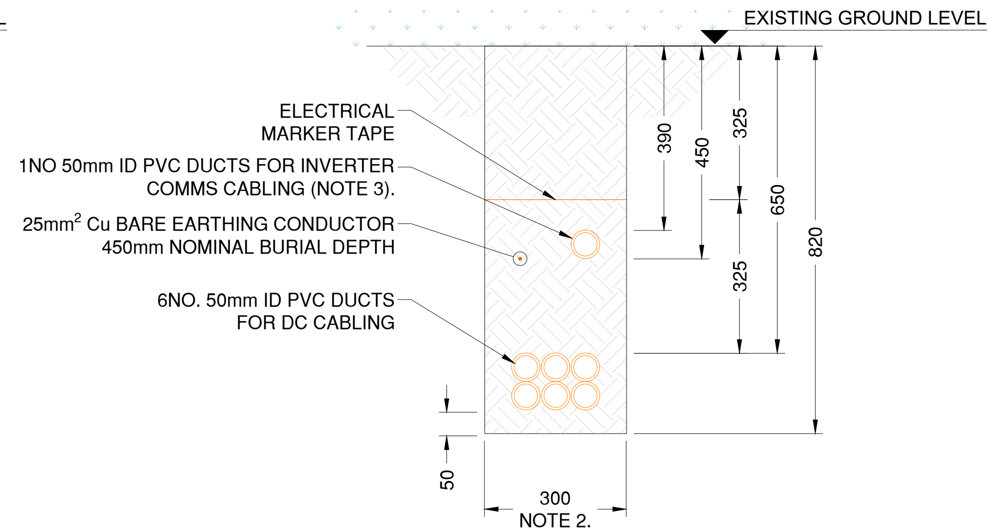

F | 6 DUCT DC TRENCH
- | Scale 1:16

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES UNO.
2. NO MINIMUM TRENCH WIDTH REQUIREMENT. THE CONTRACTOR MAY EXCAVATE TO NEAREST BUCKET WIDTH AVAILABLE, THAT ACCOMODATES THE WIDTH OF DUCTS.
3. DUCTS FOR INVERTER COMMS TO GO VIA ADJACENT INVERTERS (LOOP-IN / LOOP-OUT) TO THE RESPECTIVE FIELD CABINET.
4. WHERE LARGE BOULDERS ARE PRESENT IN THE NATIVE SOIL, COVER DUCTS & CABLES WITH MIN.100mm SAND OR FINES TO PREVENT DAMAGE TO DUCTS DURING BACKFILLING AND COMPACTION.

PLOTTED: 8/10/2024 8:38 am
MASF-212.dwg

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A	FOR CONSENT	DM	GJ	MS	07.10.2024

CLIENT:

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ADDITIONAL INFORMATION:

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LIGHTYEARS SOLAR
AUCKLAND, NEW ZEALAND
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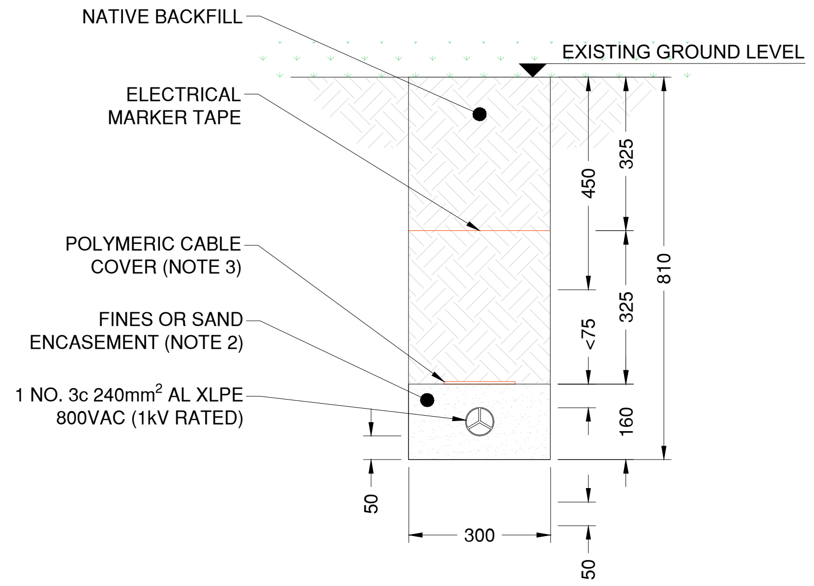
DESIGNED:	DM
DRAWN:	DM
DATE:	07.10.2024
CHECKED:	GJ
APPROVED:	MS

TITLE: MATAMATA SOLAR FARM
1500V DC
TRENCH PROFILES

DRG. NO.: MASF-212

REVISION: A



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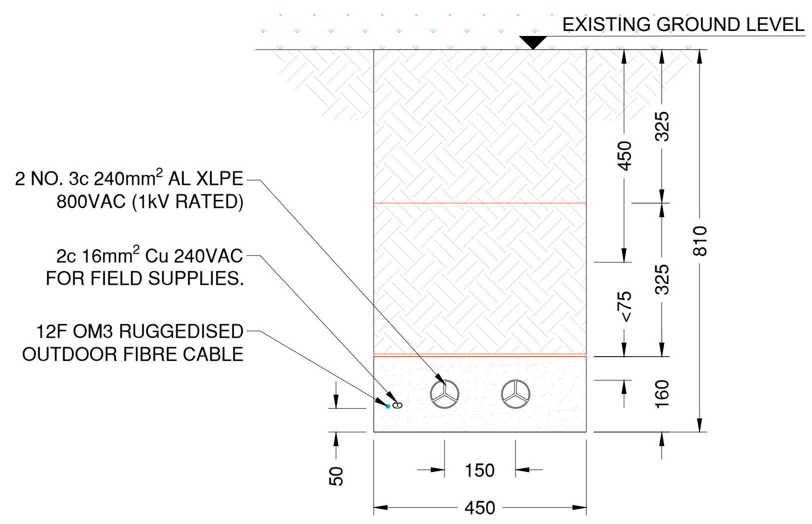

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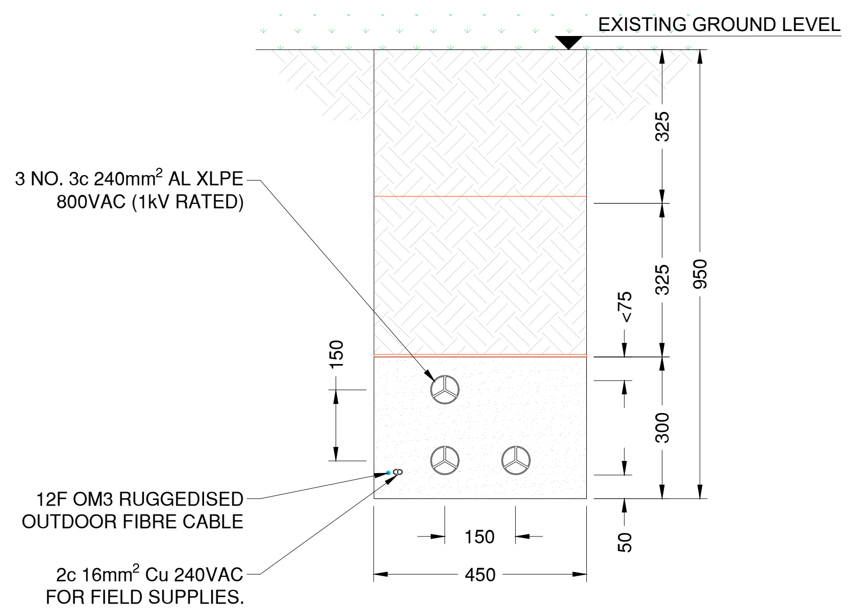

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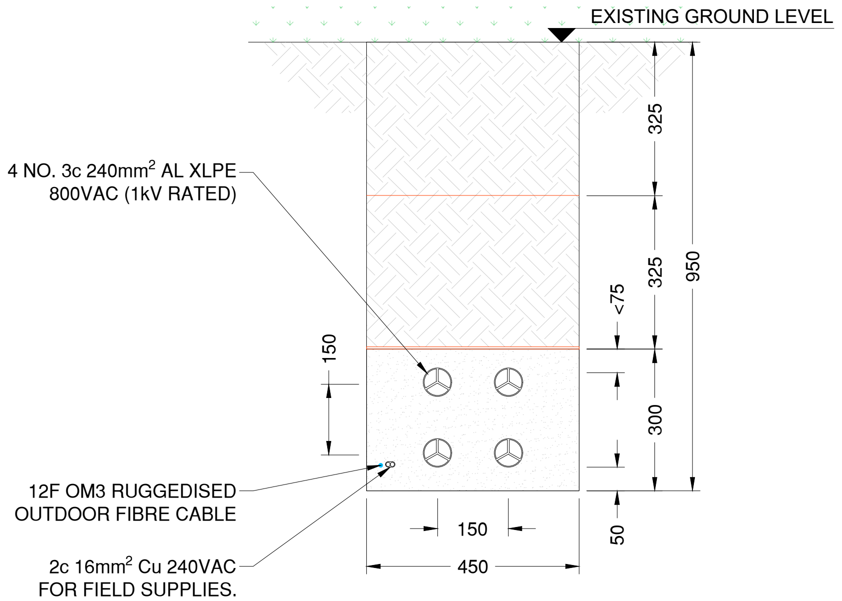

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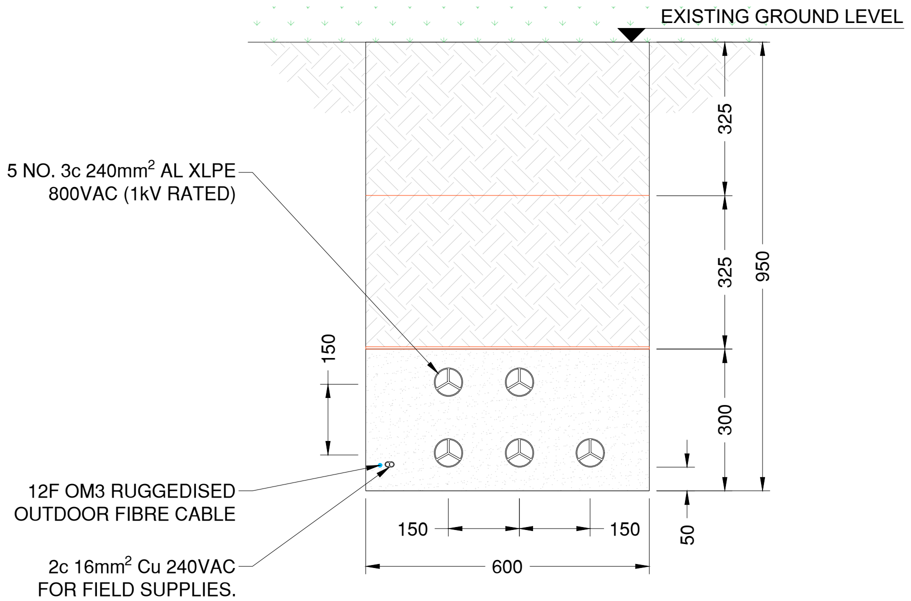

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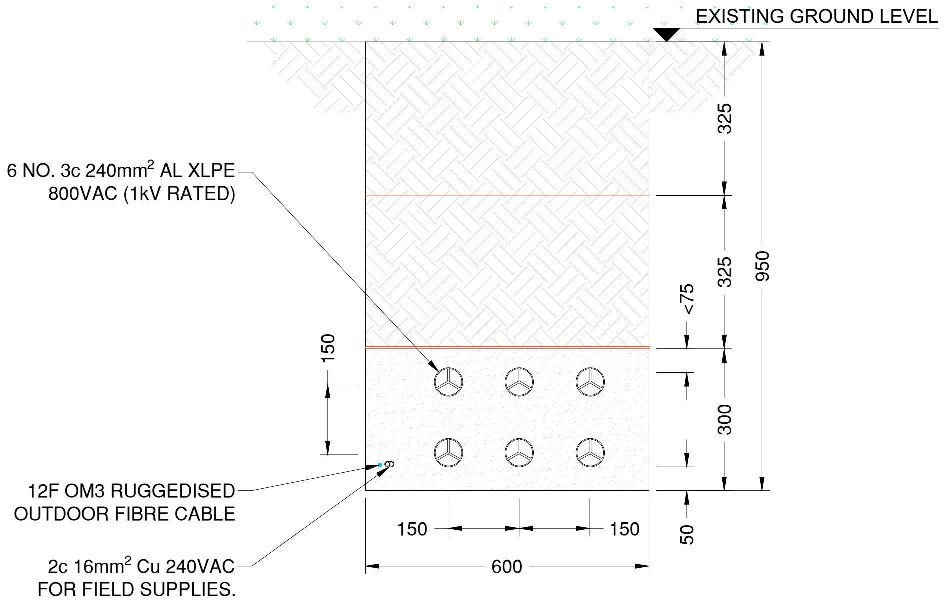

F | 6 CABLE AC TRENCH
- | Scale 1:16

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES UNO.
2. 800V AC CABLING TO BE ENCASED IN SAND OR FINES, MIN. 50mm TOP AND BOTTOM PRIOR TO BACKFILL WITH NATIVE SOIL.
3. AS/NZS 4702 POLYMERIC CABLE COVER OR MAGSLAB. TO EXTEND MINIMUM 40mm HORIZONTALLY BEYOND THE CABLE OR DUCT INSTALLED BELOW.
4. WHERE LARGE BOULDERS ARE PRESENT IN THE NATIVE SOIL, COVER DUCTS & CABLES WITH MIN.100mm SAND OR FINES TO PREVENT DAMAGE TO DUCTS DURING BACKFILLING AND COMPACTION.

PLOTTED: 8/10/2024 8:33 am

MASF-213.dwg

REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
A	FOR CONSENT	DM	GJ	MS	07.10.2024

CLIENT:

UNITS: mm | SHEET SIZE: A3 | SCALE: 1:16 (U.N.O.) | PROJECTION:

ADDITIONAL INFORMATION:

FOR CONSENT

LIGHTYEARS SOLAR
AUCKLAND, NEW ZEALAND
www.lightyearssolar.co.nz

DESIGNED:	DM
DRAWN:	DM
DATE:	07.10.2024
CHECKED:	GJ
APPROVED:	MS

TITLE: MATAMATA SOLAR FARM
800V AC
TRENCH PROFILES - SHEET 1 of 3

DRG. NO.: MASF-213

REVISION: A

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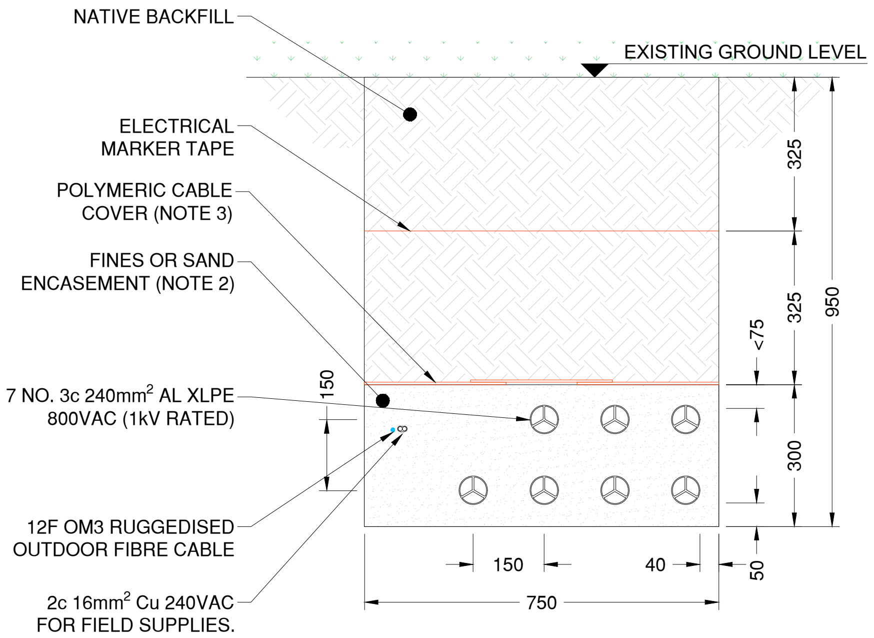

G | 7 CABLE AC TRENCH
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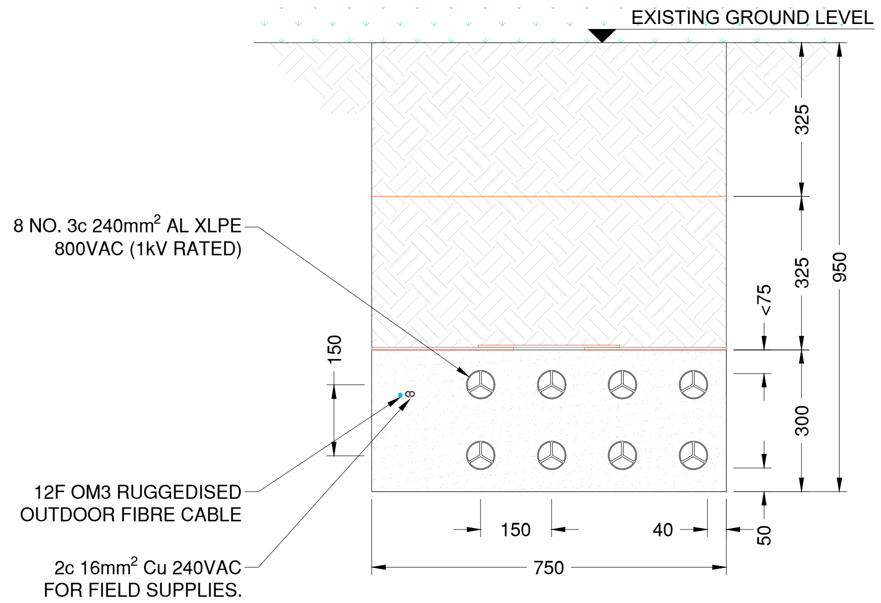

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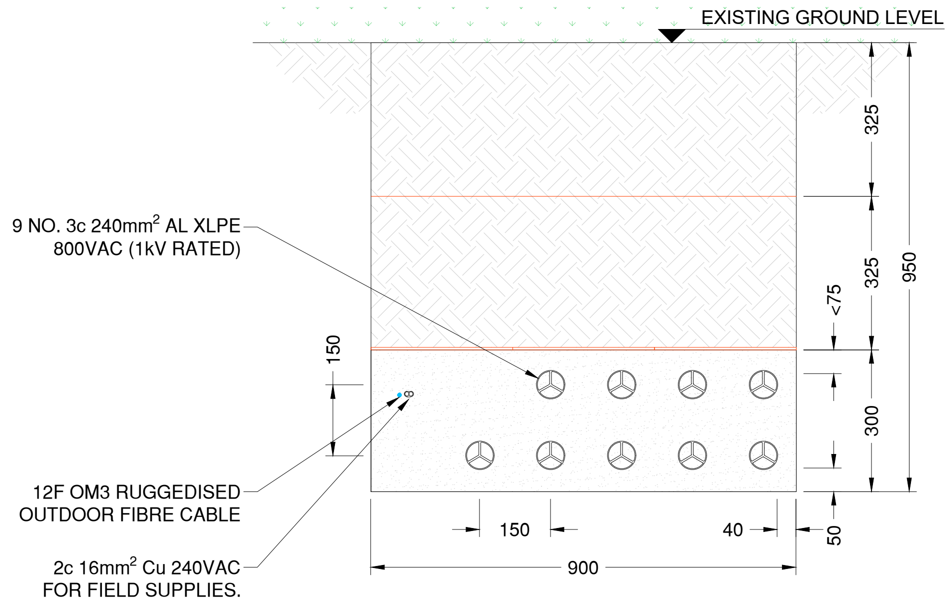

I | 9 CABLE AC TRENCH
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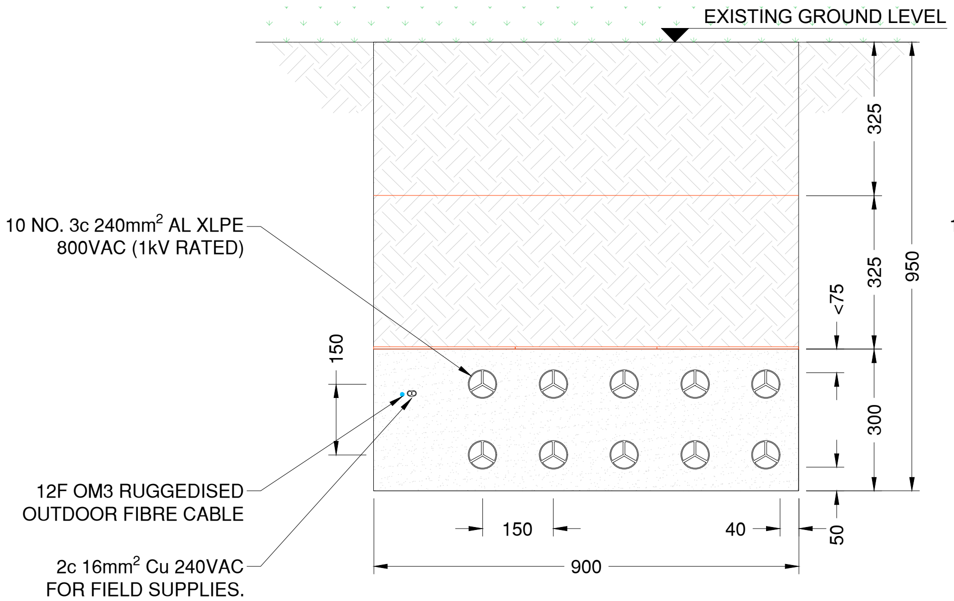

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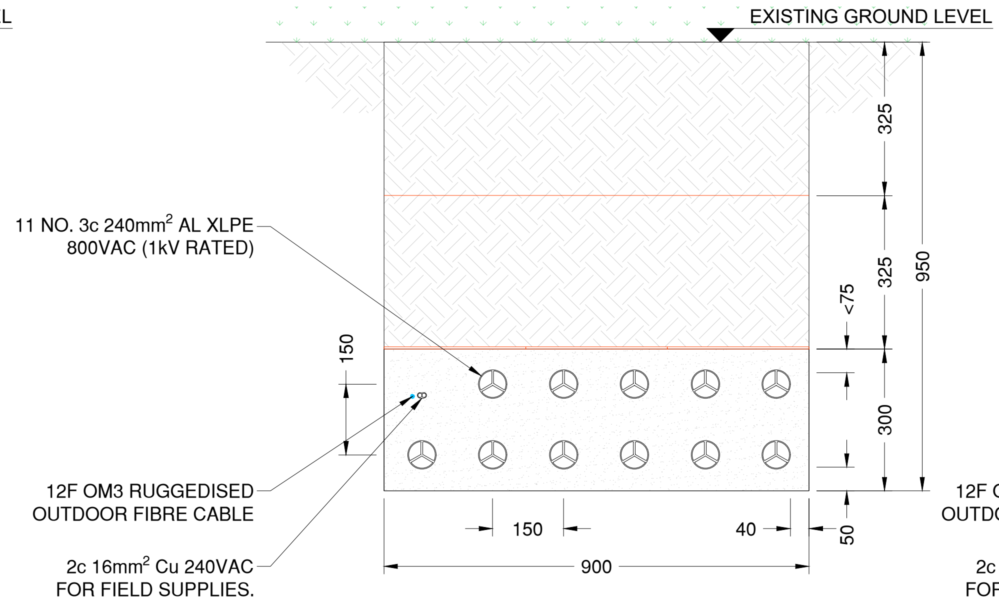

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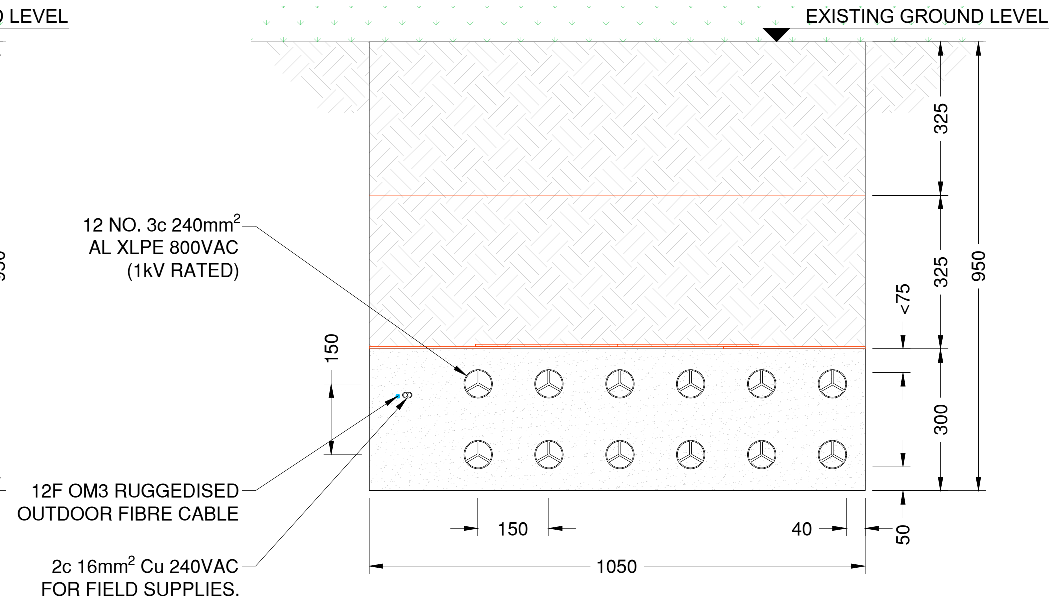


L | 12 CABLE AC TRENCH
- | Scale 1:16

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES UNO.
2. 800V AC CABLING TO BE ENCASED IN SAND OR FINES, MIN. 50mm TOP AND BOTTOM PRIOR TO BACKFILL WITH NATIVE SOIL.
3. AS/NZS 4702 POLYMERIC CABLE COVER OR MAGSLAB. TO EXTEND MINIMUM 40mm HORIZONTALLY BEYOND THE CABLE OR DUCT INSTALLED BELOW.
4. WHERE LARGE BOULDERS ARE PRESENT IN THE NATIVE SOIL, COVER DUCTS & CABLES WITH MIN.100mm SAND OR FINES TO PREVENT DAMAGE TO DUCTS DURING BACKFILLING AND COMPACTION.

PLOTTED: 8/10/2024 8:34 am

MASF-214.dwg

REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
A	FOR CONSENT	DM	GJ	MS	07.10.2024

CLIENT:

UNITS: mm | SHEET SIZE: A3 | SCALE: 1:16 (U.N.O.) | PROJECTION:

ADDITIONAL INFORMATION:

FOR CONSENT

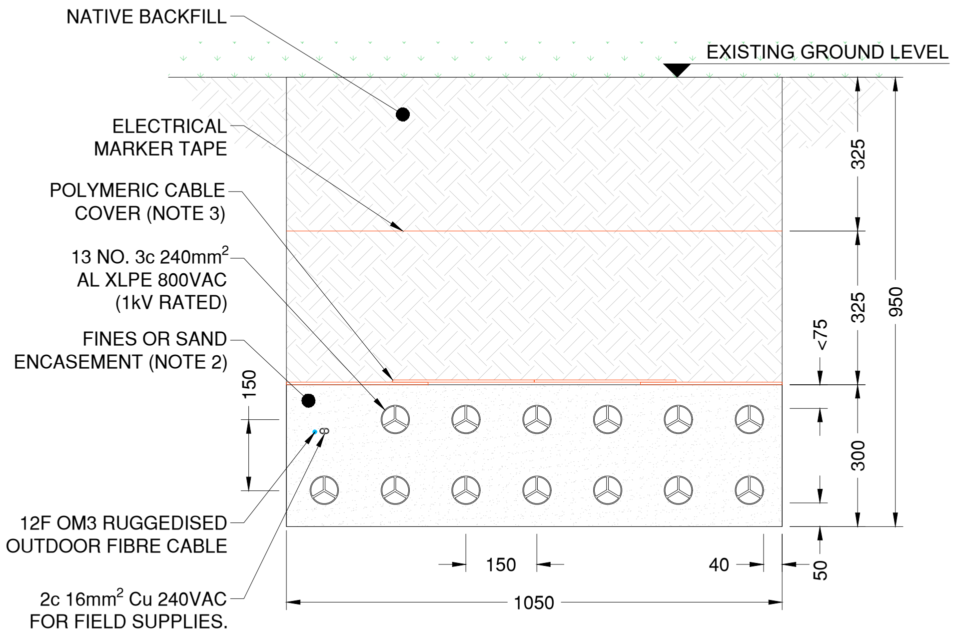
LIGHTYEARS SOLAR
AUCKLAND, NEW ZEALAND
www.lightyearssolar.co.nz

DESIGNED:	DM
DRAWN:	DM
DATE:	07.10.2024
CHECKED:	GJ
APPROVED:	MS

TITLE: MATAMATA SOLAR FARM
800V AC
TRENCH PROFILES - SHEET 2 of 3

DRG. NO.: MASF-214

REVISION: A



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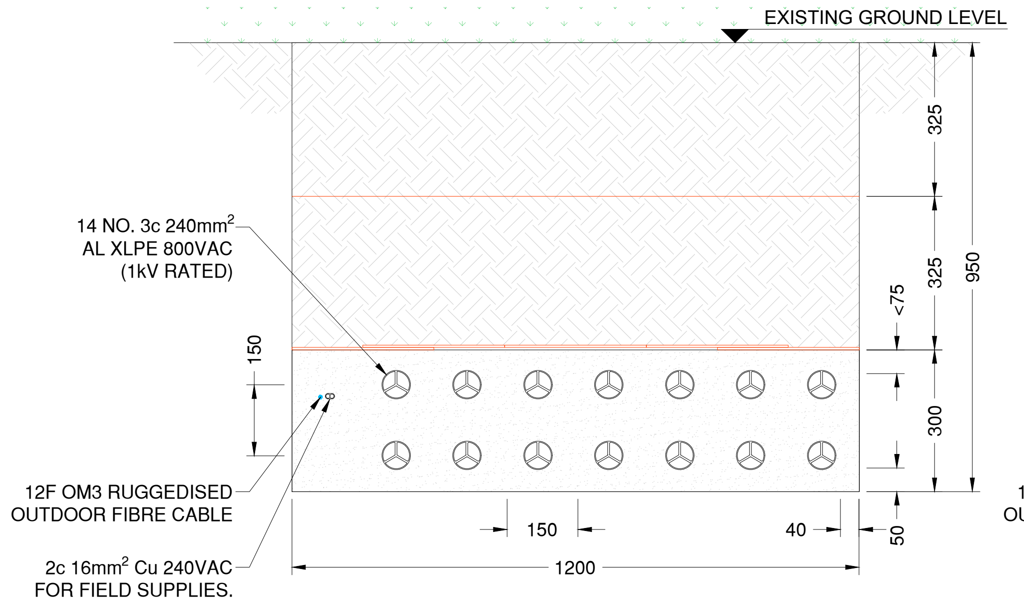
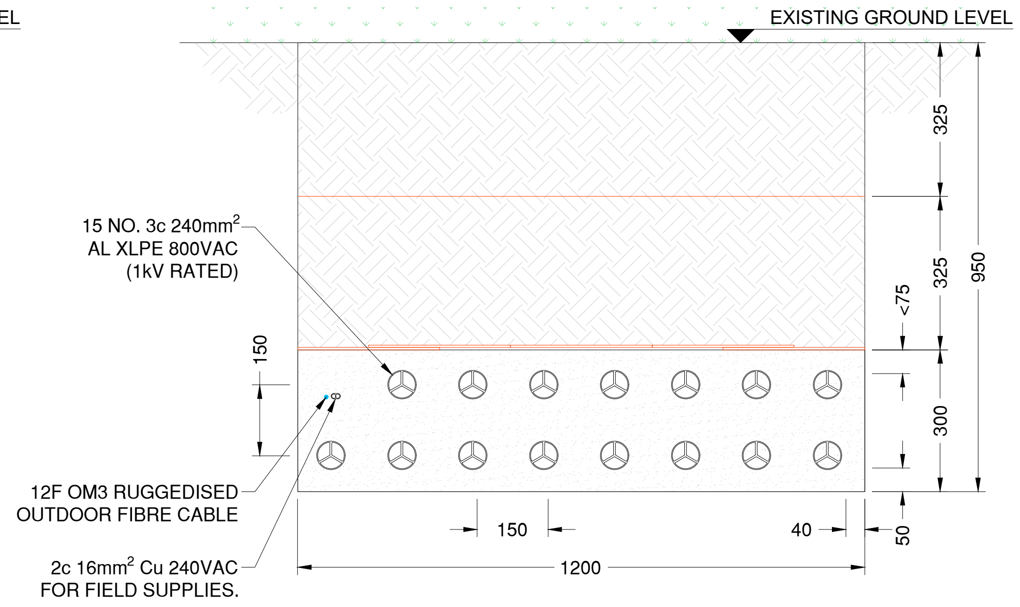


N | 14 CABLE AC TRENCH
- | Scale 1:16



O | 15 CABLE AC TRENCH
- | Scale 1:16

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES UNO.
2. 800V AC CABLING TO BE ENCASED IN SAND OR FINES, MIN. 50mm TOP AND BOTTOM PRIOR TO BACKFILL WITH NATIVE SOIL.
3. AS/NZS 4702 POLYMERIC CABLE COVER OR MAGSLAB. TO EXTEND MINIMUM 40mm HORIZONTALLY BEYOND THE CABLE OR DUCT INSTALLED BELOW.
4. WHERE LARGE BOULDERS ARE PRESENT IN THE NATIVE SOIL, COVER DUCTS & CABLES WITH MIN.100mm SAND OR FINES TO PREVENT DAMAGE TO DUCTS DURING BACKFILLING AND COMPACTION.

PLOTTED: 8/10/2024 8:34 am

REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
A	FOR CONSENT	DM	GJ	MS	07.10.2024

CLIENT:

UNITS: mm | SHEET SIZE: A3 | SCALE: 1:16 (U.N.O.) | PROJECTION:

ADDITIONAL INFORMATION:

FOR CONSENT

LIGHTYEARS SOLAR
AUCKLAND, NEW ZEALAND
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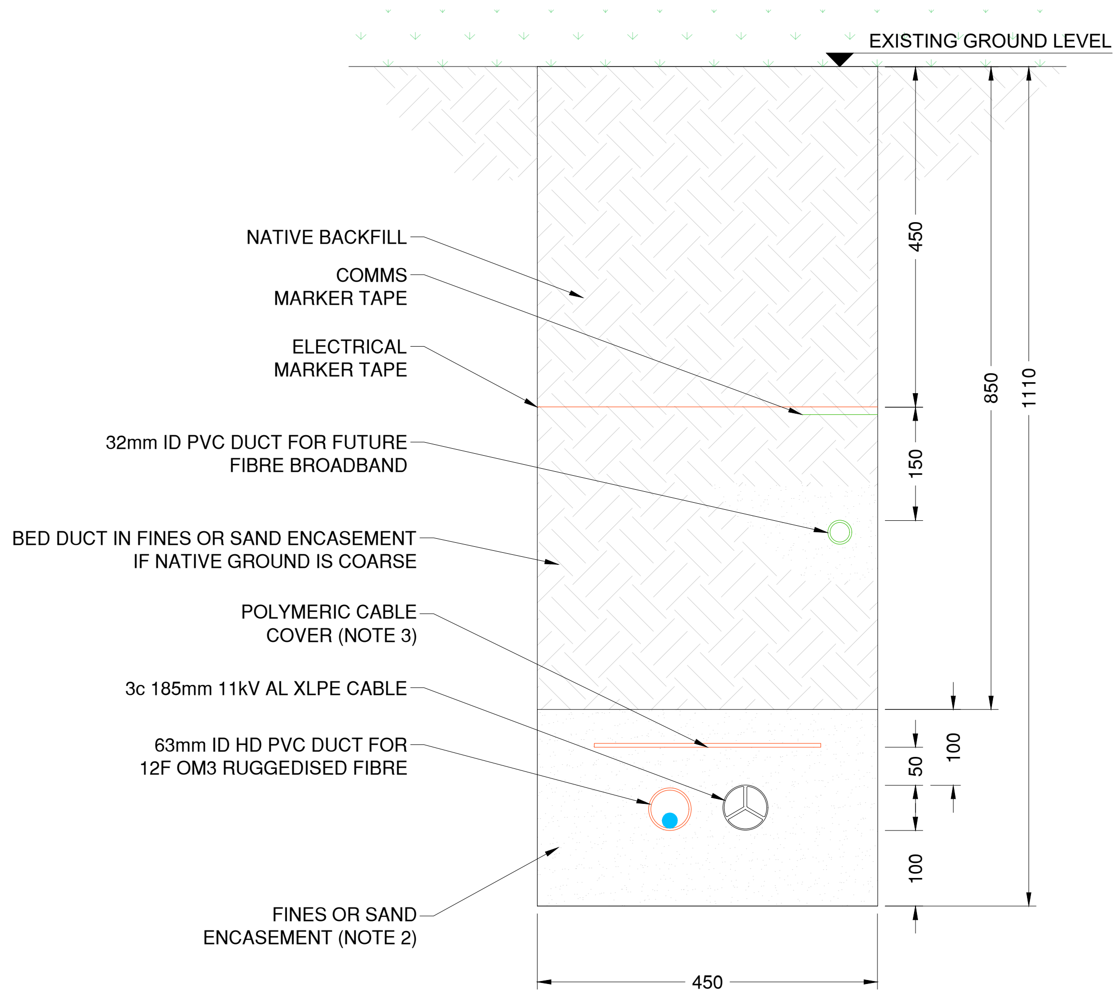
DESIGNED:	DM
DRAWN:	DM
DATE:	07.10.2024
CHECKED:	GJ
APPROVED:	MS

TITLE: MATAMATA SOLAR FARM
800V AC
TRENCH PROFILES - SHEET 3 of 3

DRG. NO.: MASF-215

REVISION: A

MASF-215.dwg



A 203 | 11kV TRENCH
Scale 1:10

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES UNO.
2. DIRECT BURIED 11kV AND 800V AC CABLING TO BE ENCASED IN SAND OR FINES, MIN. 50mm TOP AND BOTTOM PRIOR TO BACKFILL WITH NATIVE SOIL.
3. AS/NZS 4702 POLYMERIC CABLE COVER OR MAGSLAB. TO EXTEND MINIMUM 40mm HORIZONTALLY BEYOND THE CABLE OR DUCT INSTALLED BELOW.
4. WHERE LARGE BOULDERS ARE PRESENT IN THE NATIVE SOIL, COVER DUCTS & CABLES WITH MIN.100mm SAND OR FINES TO PREVENT DAMAGE TO DUCTS DURING BACKFILLING AND COMPACTION.

PLOTTED: 8/10/2024 8:34 am
MASF-225.dwg

REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
A	FOR CONSENT	DM	GJ	MS	07.10.2024

CLIENT:

UNITS: mm | SHEET SIZE: A3 | SCALE: 1:10 (U.N.O.) | PROJECTION:

ADDITIONAL INFORMATION:

FOR CONSENT

LIGHTYEARS SOLAR
AUCKLAND, NEW ZEALAND
www.lightyearssolar.co.nz

DESIGNED:	DM
DRAWN:	DM
DATE:	07.10.2024
CHECKED:	GJ
APPROVED:	MS

TITLE: MATAMATA SOLAR FARM MV CONNECTION TRENCH PROFILE

DRG. NO.: MASF-225

REVISION A

MATAMATA NORTHERN SOLAR FARM

Glint and Glare Assessment

DATE: 18TH October 2024

REVISION: 0

Contents

Quality Information

Document Matamata Ashbourne Northern SF Glint and Glare Report

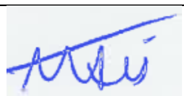
Ref Documents\Land - potential sites\Matamata\Glint & Glare

Date 18th October 2024

Prepared by DJ Unnikrishnan

Reviewed by Glen Jacobsen

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	18/10/2024	For Information	Matt Shanks / Development Manager	

1.0 Summary

Lightyears Solar Limited has conducted a thorough Glint and Glare Assessment for the proposed Northern Solar Farm located on the Northern end of 172 Station Road, Matamata, on behalf of Maven Associates. The assessment was undertaken utilising the advanced ForgeSolar Glare gauge tool and evaluated more than 39 receptors in the surrounding area.

The findings indicate that there are no impacts on these receptors, and therefore, no specific mitigation measures are necessary. Importantly, the solar farm has been shown to produce no glint or glare, with annual exposure recorded at a remarkable zero.

2.0 Glint and Glare Overview

Glint and glare are optical phenomena related to the reflection of sunlight. Glint is characterised by brief, intermittent flashes of bright light resulting from sunlight reflecting off surfaces like solar panels or water bodies. Glare, on the other hand, involves sustained and uncomfortable brightness, often causing visual discomfort or impairment due to intense and uncontrolled light sources, such as direct sunlight or reflections. In the context of a glint and glare report, particularly for projects like solar farms, it is crucial to assess and manage these phenomena to ensure safety and environmental compatibility.

The GlareGauge tool is designed to detect potential glare emanating from solar PV arrays and categorises them based on their ocular impact. It's important to clarify that this software does not consider view shedding, which involves blocking glare sources through buildings, terrain, or vegetation. Consequently, it represents a worst-case scenario.

The tool quantifies the ocular impact of solar glare into three categories, reflecting the effects on afterimages as given in Figure 1:

- Green indicates a low potential for causing after-image (flash blindness).
- Yellow suggests potential for temporary after-image.
- Red signals the potential for causing retinal burn, which may result in permanent eye damage.

Note that retinal burn is generally not a concern with PV glare because PV modules do not focus reflected sunlight. As PV modules are constructed to absorb as much solar irradiation as possible to increase their efficiency, their reflectivity is very low compared to many other common materials such as grass and house rooftops.

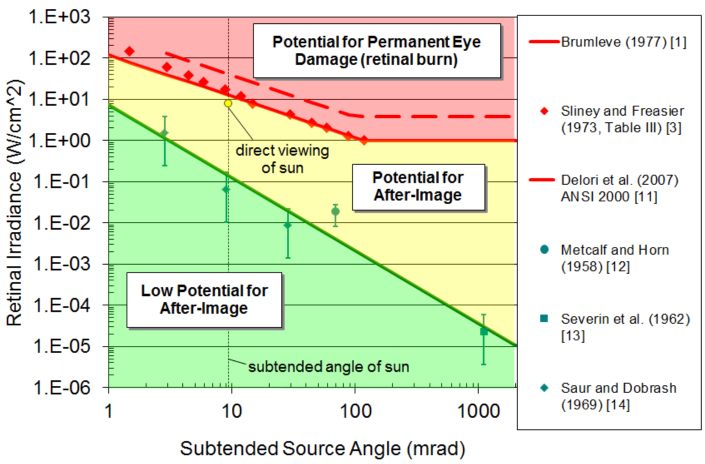


Figure 1 - Glare hazard plot defines ocular impact as function of retinal irradiance and subtended source angle (https://www.forgesolar.com/help/#ref-ho-2011-method)

3.0 Solar Farm Details

3.1 PV Arrays

The PV array was set-up in the model based on the boundaries given in Figure 2. The following parameters were used:

- Single axis trackers which follow the sun from East to West
- Tracker panel rows aligned in North – South configuration
- Maximum tracking angle 60°
- Ground Coverage Ratio: 0.48
- Module height above ground: 1.4m
- Modules made using smooth glass with anti-reflective coating.

Figure 2 - PV Array site coverage on the Northern end of 172 Station Road.

3.2 Obstruction Components

There will be planting strip around the perimeter of the solar farm as given in Figure 3. It will be grown and maintained to a height of 2.5m.

Figure 3 - Planting strip defined around the perimeter of the solar farm.

4.0 Receptors

4.1 Route Receptors

Four route receptors were identified around the proposed solar farm, each set at a height of 1.5 meters to simulate the view from a car. The names of the route receptors are provided below:

- Everad Avenue and James Avenue
- Highgrove Avenue
- Sheffield Street
- Station Road

An evaluation for all the receptors is given below in the following sections.

4.1.1 Everad Avenue and James Avenue

Everad Avenue and James Avenue are situated to the North-East of the proposed solar farm. These avenues form a residential area and can be characterised as having a significant number of residential properties as shown in Figure 4. This road was considered as the first route receptor and had the following parameters:

- Path type: Two-way Road
- Observer view angle: 50°

Figure 4- Route receptor 1 at Everad Avenue and James Avenue on the North – East of the proposed solar farm.

4.1.2 Highgrove Avenue

Highgrove Avenue is one-way road with few residential properties located on the Southern side of the proposed solar farm as shown in Figure 5. The route had the following parameters:

- Path type: One way Road
- Observer view angle: 50°

Figure 5- Route receptor 2 at Highgrove Road on the Southern side of the proposed solar farm.

4.1.3 Sheffield Street

Sheffield Street is a residential street that is located close to Matamata township and is situated on the eastern side of the proposed solar farm. The street has a significant number of residential properties as shown in Figure 6. The route had the following parameters:

- Path type: Two-way Road
- Observer view angle: 50°

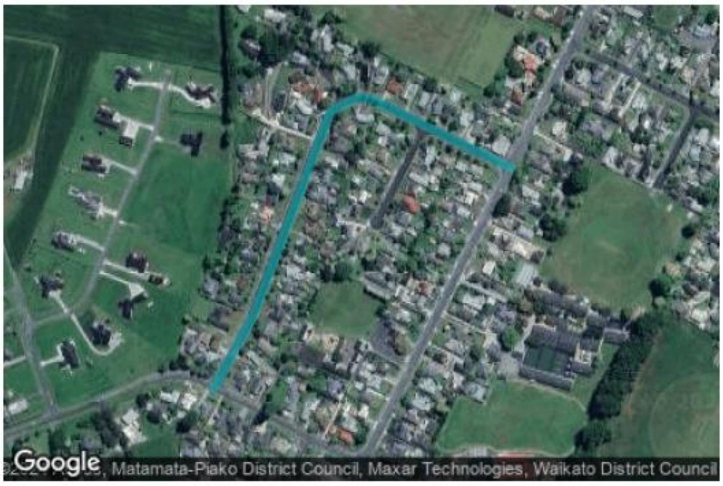


Figure 6- Route receptor 3 at Sheffield Street, located towards the East of the proposed solar farm.

4.1.4 Station Road

Station Road is the primary road running along the front of the proposed solar farm as shown in Figure 7. The route had the following parameters:

- Path type: Two – way road
- Observer view angle: 50°

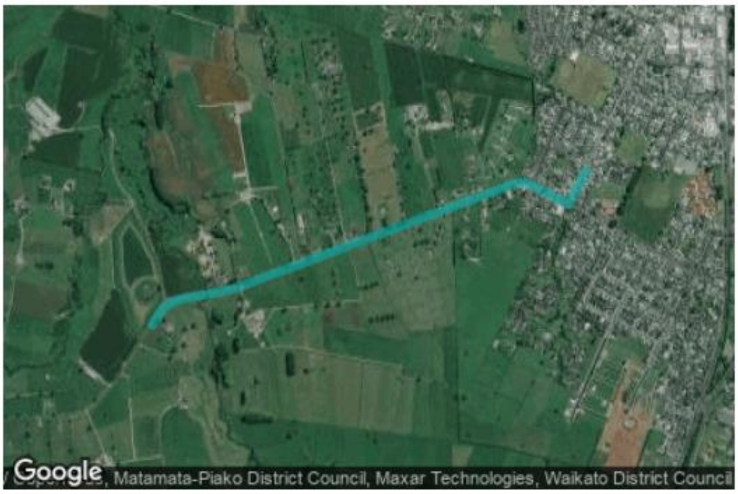


Figure 7- Route Receptor 4 at Station Road, located towards the South of the proposed solar farm.

4.2 Flight Path Receptors

To identify the flight paths necessary for the glint and glare assessment, a benchmark radius of 25 km around the proposed solar farm was established. The assessment found Matamata Aerodrome to be the only aerodrome in close proximity to the solar farm. Two regional airports—Hamilton (HZL) and Tauranga (TRG)—were noted, but their flight paths were not included in the analysis due to their locations being outside the benchmark radius, making them less relevant to potential impacts.

At Matamata Aerodrome, two flight paths were identified: FP1 and FP2 (refer to Figure 8 and Figure 9), each extending 2 miles on either side of the runway. Notably, the aerodrome does not have an Air Traffic Control Tower. The assessment concluded that there would be no significant glint or glare effects from the solar farm on Matamata Aerodrome.

Figure 8 - Flight Path 1 identified at Matamata Aerodrome.

Figure 9- Flight Path 2 identified at Matamata Aerodrome.

4.3 Discrete Observation Points

Thirty-nine discrete observation point receptors were identified, all of them represented residential properties within the surrounding areas of the proposed solar farm. Each of these points have a height set at 1.7m to simulate a view from an average person. These points are identified in Figure 10.

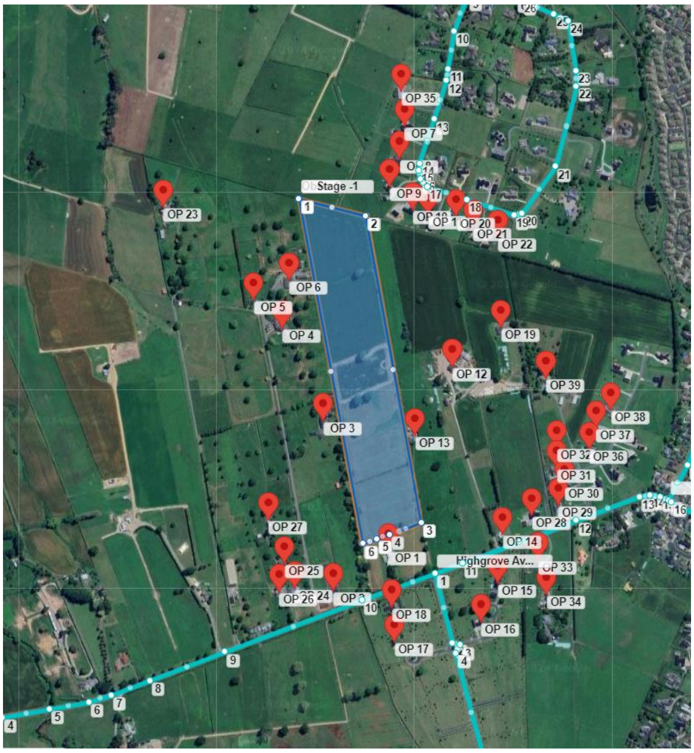


Figure 10 - All identified discrete observation points around the proposed solar farm.

5.0 Glare Analysis Results

The glint and glare analysis provided results for all 39 receptors included in the simulation. Notably, there were no glares recorded at any of the receptors, with both green and orange glare exposures consistently registering at zero. This indicates no risk of after-images and confirms that the solar farm poses no glare-related concerns for any of the observation points evaluated.

Results from every receptor showing the annual green and orange glare is given in Figure 11 and Figure 12.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0

Figure 11- Glint and Glare results – 30 Receptors.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

Figure 12- Glint and Glare results – 15 Receptors

6.0 Conclusions and Observations

The results indicate that none of the receptors are at risk of glare. The assessment confirmed no exposure at any receptor, demonstrating no potential for after-images or flash blindness. Overall, the findings show no ocular impact from solar glare.

It should be noted the software simulation uses clear sky weather data where glint and glare is not reduced due to atmospheric conditions or clouds, which provides a worst-case scenario. In reality, clouds, fog and other atmospheric conditions will result in less glare than simulated in this report.

Appendix A: ForgeSolar Glare Analysis Results

FORGESOLAR GLARE ANALYSIS

Project: **Matamata Stage 1**

A high-level Glint & Glare assessment for Stage -1 solar farm in Matamata by Maven

Site configuration: **Stage -1 Matamata**

Client: Maven Associates

Created 15 Oct, 2024
Updated 15 Oct, 2024
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 5 MW to 10 MW
Site ID 131255.22386

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

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
Stage -1	SA tracking	SA tracking	0	0.0	0	0.0	18,420,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

Component Data

PV Arrays

Name: Stage -1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.48
Rated power: 8361.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.809940	175.750598	59.00	1.40	60.40
2	-37.810318	175.752443	59.00	1.40	60.40
3	-37.817046	175.753986	60.00	1.40	61.40
4	-37.817293	175.753102	59.00	1.40	60.40
5	-37.817392	175.752754	59.00	1.40	60.40
6	-37.817493	175.752358	59.00	1.40	60.40

Route Receptors

Name: Everad and James Ave
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.803037	175.756742	61.00	1.50	62.50
2	-37.803185	175.756708	61.00	1.50	62.50
3	-37.803289	175.756697	61.00	1.50	62.50
4	-37.804978	175.756762	61.06	1.50	62.56
5	-37.805505	175.756792	61.00	1.50	62.50
6	-37.805524	175.756590	61.00	1.50	62.50
7	-37.805267	175.755783	61.00	1.50	62.50
8	-37.805310	175.755472	61.00	1.50	62.50
9	-37.805475	175.755268	60.07	1.50	61.57
10	-37.806266	175.754890	60.00	1.50	61.50
11	-37.807089	175.754737	60.00	1.50	61.50
12	-37.807350	175.754686	60.00	1.50	61.50
13	-37.808197	175.754342	60.00	1.50	61.50
14	-37.809155	175.753940	60.00	1.50	61.50
15	-37.809302	175.753910	60.00	1.50	61.50
16	-37.809488	175.753949	60.00	1.50	61.50
17	-37.809664	175.754142	60.00	1.50	61.50
18	-37.809947	175.755244	60.00	1.50	61.50
19	-37.810296	175.756553	60.00	1.50	61.50
20	-37.810251	175.756789	61.00	1.50	62.50
21	-37.809226	175.757721	61.00	1.50	62.50
22	-37.807470	175.758298	61.00	1.50	62.50
23	-37.807130	175.758267	61.00	1.50	62.50
24	-37.806030	175.758052	61.00	1.50	62.50
25	-37.805876	175.757670	61.00	1.50	62.50
26	-37.805577	175.756770	61.00	1.50	62.50
27	-37.805502	175.756791	61.00	1.50	62.50

Name: Highgrove Ave
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.818146	175.754363	60.00	1.50	61.50
2	-37.819663	175.754854	60.00	1.50	61.50
3	-37.819721	175.755052	61.00	1.50	62.50
4	-37.819897	175.754936	61.00	1.50	62.50
5	-37.822491	175.755815	62.00	1.50	63.50

Name: Sheffield St
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.816554	175.760839	63.00	1.50	64.50
2	-37.815772	175.761375	63.00	1.50	64.50
3	-37.813598	175.762411	63.00	1.50	64.50
4	-37.813448	175.762765	63.58	1.50	65.08
5	-37.813464	175.762978	64.00	1.50	65.50
6	-37.814195	175.764836	64.00	1.50	65.50

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

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.822385	175.740858	65.00	1.50	66.50
2	-37.821691	175.741423	64.00	1.50	65.50
3	-37.821413	175.741958	63.00	1.50	64.50
4	-37.821307	175.742354	62.00	1.50	63.50
5	-37.821121	175.743658	60.00	1.50	61.50
6	-37.820969	175.744745	59.00	1.50	60.50
7	-37.820815	175.745380	59.00	1.50	60.50
8	-37.820497	175.746437	58.00	1.50	59.50
9	-37.819875	175.748533	58.00	1.50	59.50
10	-37.818741	175.752353	59.00	1.50	60.50
11	-37.817917	175.755139	60.00	1.50	61.50
12	-37.816983	175.758285	62.00	1.50	63.50
13	-37.816459	175.760056	63.00	1.50	64.50
14	-37.816422	175.760338	63.00	1.50	64.50
15	-37.816458	175.760599	63.00	1.50	64.50
16	-37.816582	175.760930	63.00	1.50	64.50
17	-37.817345	175.762812	64.00	1.50	65.50
18	-37.815979	175.763727	64.00	1.50	65.50

Flight Path Receptors

Name: FP 1
Description:
Threshold height: 15 m
Direction: 130.4°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-37.734772	175.736675	49.00	15.24	64.24
Two-mile	-37.716037	175.708797	42.00	190.92	232.92

Name: FP 2
Description:
Threshold height: 15 m
Direction: 298.3°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-37.740837	175.749043	50.00	15.24	65.24
Two-mile	-37.754531	175.781282	50.00	183.92	233.92

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.817665	175.753051	59.00	1.70
OP 2	2	-37.818551	175.751529	59.00	1.70
OP 3	3	-37.814814	175.751263	59.00	1.70
OP 4	4	-37.812785	175.750115	59.00	1.70
OP 5	5	-37.812181	175.749326	59.00	1.70
OP 6	6	-37.811740	175.750305	59.00	1.70
OP 7	7	-37.808353	175.753511	60.00	1.70
OP 8	8	-37.809069	175.753377	60.00	1.70
OP 9	9	-37.809683	175.753088	60.00	1.70
OP 10	10	-37.810188	175.753731	60.00	1.70
OP 11	11	-37.810304	175.754165	60.00	1.70
OP 12	12	-37.813634	175.754841	60.00	1.70
OP 13	13	-37.815145	175.753803	60.00	1.70
OP 14	14	-37.817314	175.756229	61.00	1.70
OP 15	15	-37.818372	175.756098	61.00	1.70
OP 16	16	-37.819230	175.755636	61.00	1.70
OP 17	17	-37.819674	175.753226	60.00	1.70
OP 18	18	-37.818912	175.753170	59.84	1.70
OP 19	19	-37.812770	175.756177	60.00	1.70
OP 20	20	-37.810337	175.754933	60.00	1.70
OP 21	21	-37.810556	175.755411	60.00	1.70
OP 22	22	-37.810801	175.756097	60.00	1.70
OP 23	23	-37.810145	175.746819	59.00	1.70
OP 24	24	-37.818499	175.750458	58.61	1.70
OP 25	25	-37.817953	175.750181	58.00	1.70
OP 26	26	-37.818557	175.750026	58.00	1.70
OP 27	27	-37.816988	175.749723	58.00	1.70
OP 28	28	-37.816903	175.757046	61.00	1.70
OP 29	29	-37.816674	175.757779	61.00	1.70
OP 30	30	-37.816263	175.757956	61.00	1.70
OP 31	31	-37.815852	175.757730	61.00	1.70
OP 32	32	-37.815420	175.757730	61.00	1.70
OP 33	33	-37.817870	175.757216	61.00	1.70
OP 34	34	-37.818641	175.757458	61.08	1.70
OP 35	35	-37.807597	175.753416	60.00	1.70
OP 36	36	-37.815450	175.758628	62.00	1.70
OP 37	37	-37.814967	175.758822	62.00	1.70
OP 38	38	-37.814577	175.759235	62.00	1.70
OP 39	39	-37.813886	175.757423	61.00	1.70

Obstruction Components

Name: Planting Strip
Top height: 2.5 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-37.809938	175.750596	59.00
2	-37.810317	175.752444	59.00
3	-37.817046	175.753987	60.00
4	-37.817391	175.752750	59.00
5	-37.817496	175.752355	59.00
6	-37.809938	175.750596	59.00

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
Stage -1	SA tracking	SA tracking	0	0.0	0	0.0	18,420,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

PV: Stage -1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

Stage -1 and Route: Everad and James Ave

No glare found

Stage -1 and Route: Highgrove Ave

No glare found

Stage -1 and Route: Sheffield St

No glare found

Stage -1 and Route: Station Road

No glare found

Stage -1 and FP: FP 1

No glare found

Stage -1 and FP: FP 2

No glare found

Stage -1 and OP 1

No glare found

Stage -1 and OP 2

No glare found

Stage -1 and OP 3

No glare found

Stage -1 and OP 4

No glare found

Stage -1 and OP 5

No glare found

Stage -1 and OP 6

No glare found

Stage -1 and OP 7

No glare found

Stage -1 and OP 8

No glare found

Stage -1 and OP 9

No glare found

Stage -1 and OP 10

No glare found

Stage -1 and OP 11

No glare found

Stage -1 and OP 12

No glare found

Stage -1 and OP 13

No glare found

Stage -1 and OP 14

No glare found

Stage -1 and OP 15

No glare found

Stage -1 and OP 16

No glare found

Stage -1 and OP 17

No glare found

Stage -1 and OP 18

No glare found

Stage -1 and OP 19

No glare found

Stage -1 and OP 20

No glare found

Stage -1 and OP 21

No glare found

Stage -1 and OP 22

No glare found

Stage -1 and OP 23

No glare found

Stage -1 and OP 24

No glare found

Stage -1 and OP 25

No glare found

Stage -1 and OP 26

No glare found

Stage -1 and OP 27

No glare found

Stage -1 and OP 28

No glare found

Stage -1 and OP 29

No glare found

Stage -1 and OP 30

No glare found

Stage -1 and OP 31

No glare found

Stage -1 and OP 32

No glare found

Stage -1 and OP 33

No glare found

Stage -1 and OP 34

No glare found

Stage -1 and OP 35

No glare found

Stage -1 and OP 36

No glare found

Stage -1 and OP 37

No glare found

Stage -1 and OP 38

No glare found

Stage -1 and OP 39

No glare found

Assumptions

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

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

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

MATAMATA SOUTHERN SOLAR FARM

Glint and Glare Assessment

DATE: 18TH October 2024

REVISION: 0

Contents

Quality Information

Document Matamata Ashbourne Southern SF Glint and Glare Report

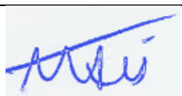
Ref Documents\Land - potential sites\Matamata\Glint & Glare

Date 18th October 2024

Prepared by DJ Unnikrishnan

Reviewed by Glen Jacobsen

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	18/10/2024	For Information	Matt Shanks / Development Manager	

1.0 Summary

Lightyears Solar Limited has conducted a thorough Glint and Glare Assessment for the proposed Southern Solar Farm located on the Southern end of 247 Station Road, Matamata, on behalf of Maven Associates. The assessment was undertaken utilising the advanced ForgeSolar Glare gauge tool and evaluated more than 40 receptors in the surrounding area.

The findings indicate that there are no impacts on most receptors, with the exception one route receptor. The route receptor on Station Road indicates that there will be annual green glare of 95 minutes (or 1.6 hours) and orange glare of 6 minutes (or 0.1 hour), which means there may be a potential for temporary after – image. The duration of the glare was estimated to be less than 5 minutes and would happen only in 3 months – March, September and November. The potential for temporary after image is expected to happen during the mornings between 5AM till 7AM. The after image could be mitigated by providing a secondary planting strip / barrier.

The overall impact on the receptors are minimal and this ensures that the solar farm will operate harmoniously within the region, providing clean energy without affecting the local environment.

2.0 Glint and Glare Overview

Glint and glare are optical phenomena related to the reflection of sunlight. Glint is characterised by brief, intermittent flashes of bright light resulting from sunlight reflecting off surfaces like solar panels or water bodies. Glare, on the other hand, involves sustained and uncomfortable brightness, often causing visual discomfort or impairment due to intense and uncontrolled light sources, such as direct sunlight or reflections. In the context of a glint and glare report, particularly for projects like solar farms, it is crucial to assess and manage these phenomena to ensure safety and environmental compatibility.

The GlareGauge tool is designed to detect potential glare emanating from solar PV arrays and categorises them based on their ocular impact. It's important to clarify that this software does not consider view shedding, which involves blocking glare sources through buildings, terrain, or vegetation. Consequently, it represents a worst-case scenario.

The tool quantifies the ocular impact of solar glare into three categories, reflecting the effects on afterimages as given in Figure 1:

- Green indicates a low potential for causing after-image (flash blindness).
- Yellow suggests potential for temporary after-image.
- Red signals the potential for causing retinal burn, which may result in permanent eye damage.

Note that retinal burn is generally not a concern with PV glare because PV modules do not focus reflected sunlight. As PV modules are constructed to absorb as much solar irradiation as possible to increase their efficiency, their reflectivity is very low compared to many other common materials such as grass and house rooftops.

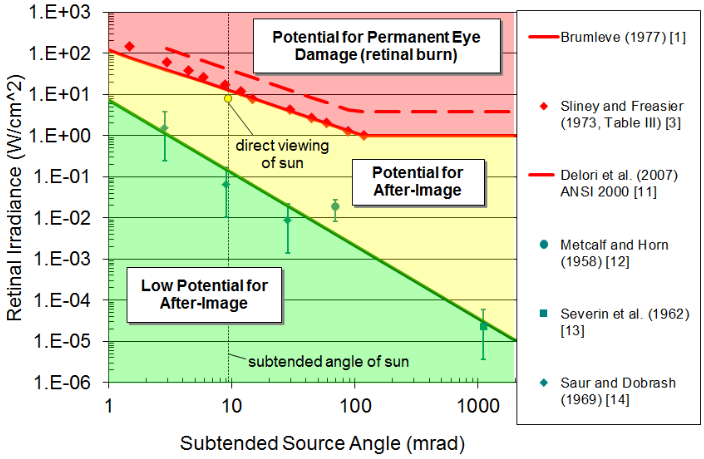


Figure 1-Glare hazard plot defines ocular impact as function of retinal irradiance and subtended source angle (https://www.forgesolar.com/help/#ref-ho-2011-method)

2.1 PV Arrays

The PV array was set-up in the model based on the boundaries given in Figure 2. The following parameters were used:

- Single axis trackers which follow the sun from East to West
- Tracker panel rows aligned in North – South configuration
- Maximum tracking angle 60°
- Ground Coverage Ratio: 0.48
- Module height above ground: 1.4m
- Modules made using smooth glass with anti-reflective coating.

Figure 2- PV Array site coverage on the Northern end of 247 Station Road.

2.2 Obstruction Components

There will be planting strip around the perimeter of the solar farm as shown in Figure 3. It will be grown and maintained to a height of 2.5m.

Figure 3- Planting strip defined around the perimeter of the solar farm

3.0 Receptors

3.1 Route Receptors

Five route receptors were identified around the proposed solar farm, each set at a height of 1.5 meters to simulate the view from a car. The names of the route receptors are provided below:

- Eldonwood Road
- Highgrove Avenue
- Hinuera Road
- Jellicoe Road and Peakedale Drive
- Station Road

An evaluation for all the receptors is given below in the following sections.

3.1.1 Eldonwood Road

Eldonwood Road is located on the North-East of the proposed solar farm and is a residential road, with a significant number residential properties as shown in Figure 4. This road was considered as the first route receptor and had the following parameters:

- Path type: One-way Road
- Observer view angle: 50°

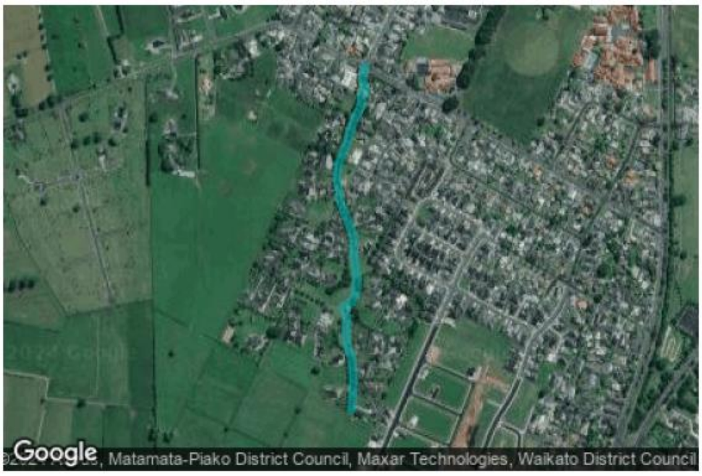


Figure 4- Route receptor 1 at Eldonwood Road on the North – East of the proposed solar farm.

3.1.2 Highgrove Avenue

Highgrove Avenue is one-way road with few residential properties located on the Northern side of the proposed solar farm as shown in Figure 5. The route had the following parameters:

- Path type: One way Road
- Observer view angle: 50°

Figure 5 - Route receptor 2 at Highgrove Road on the Northern side of the proposed solar farm.

3.1.3 Hinuera Road

Hinuera Road is primary road that connects to Matamata Township via SH27. There are few residential properties along the road and limited vegetation that could provide screening for the proposed solar farm, therefore, this road was considered in the assessment. The road is located on the Eastern side of the proposed solar farm as shown in Figure 6.The route had the following parameters:

- Path type: Two-way Road
- Observer view angle: 50°

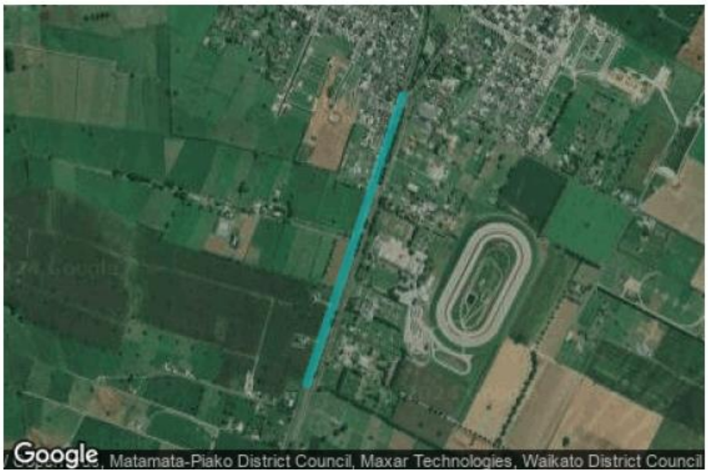


Figure 6- Route receptor 3 at Hinuera Road, located towards the East of the proposed solar farm.

3.1.4 Jellicoe Road and Peakedale Drive

Jellicoe Road and Peakedale Drive is part of a single no-exit road comprised of only residential properties in the area. The road is located on the Eastern side of the proposed solar farm as shown in Figure 7. The route had the following parameters:

- Path type: One – way road
- Observer view angle: 50°

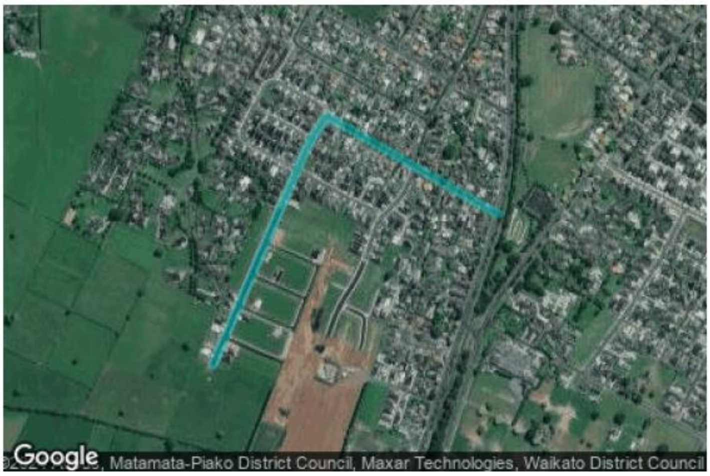


Figure 7- Route receptor 4 at Jellicoe Road and Peakedale Drive, located towards the East of the proposed solar farm.

3.1.5 Station Road

Station Road is the primary road running along the front of the proposed solar farm as shown in Figure 8. The route had the following parameters:

- Path type: Two – way road
- Observer view angle: 50°

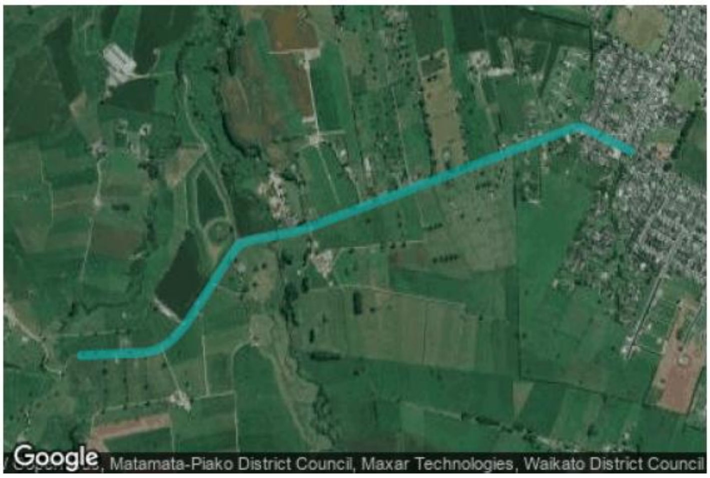


Figure 8- Route receptor 5 at Station Road, located in front of the proposed solar farm.

3.2 Flight Path Receptors

To identify the flight paths necessary for the glint and glare assessment, a benchmark radius of 25 km around the proposed solar farm was established. The assessment found Matamata Aerodrome to be the only aerodrome in close proximity to the solar farm. Two regional airports—Hamilton (HZL) and Tauranga (TRG)—were noted, but their flight paths were not included in the analysis due to their locations being outside the benchmark radius, making them less relevant to potential impacts.

At Matamata Aerodrome, two flight paths were identified: FP1 and FP2 (refer to Figure 9 and Figure 10), each extending 2 miles on either side of the runway. Notably, the aerodrome does not have an Air Traffic Control Tower. The assessment concluded that there would be no significant glint or glare effects from the solar farm on Matamata Aerodrome.

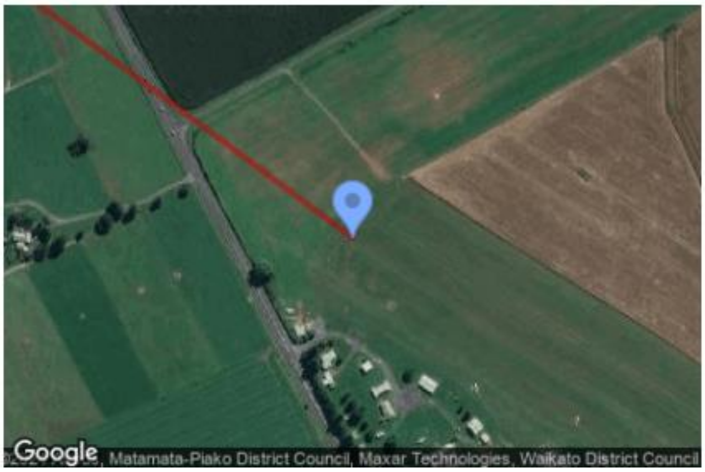


Figure 9- Flight Path 1 identified at Matamata Aerodrome.

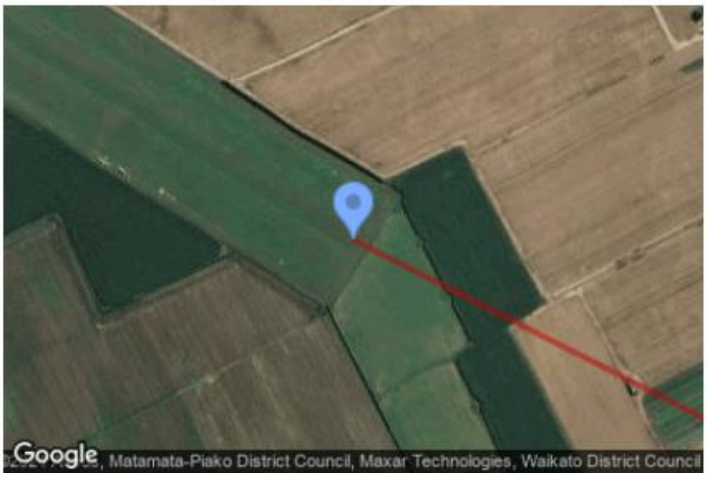


Figure 10- Flight Path 2 identified at Matamata Aerodrome.

3.3 Discrete Observation Points

Forty discrete observation point receptors were identified, all of them represented residential properties within the surrounding areas of the proposed solar farm. Each of these points have a height set at 1.7m to simulate a view from an average person. These points are identified in Figure 11.

Figure 11- All identified discrete observation points around the proposed solar farm.

4.0 Glare Analysis Results

The glint and glare analysis provided results for all 40 and above receptors included in the simulation. Notably, there were no glares recorded at any of the receptors, except on route receptor 8 which is Station Road.

Station Road route receptor showed an annual green glare of 95 minutes (or 1.6 hours) and orange glare of 6 minutes (or 0.1 hour), as shown in Figure 12, which means there will be a potential for temporary after – image . All the other receptors register an annual green and yellow glare exposures as zero.

While this indicates a minimal risk of after-images, it confirms that mitigation measures may be required to eliminate the risk of after-images on the northwestern side of the solar farm.

Results from every receptor showing the annual green and orange glare is given in Figure 12 and Figure 13 .

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Station Road	95	1.6	6	0.1
Eldonwood Road	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Hinuera Road	0	0.0	0	0.0
Jellicoe Rd - Peakedale Drive	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0

Figure 12 - Glint and Glare results – 37 Receptors.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

Figure 13- Glint and Glare results – 10 Receptors.

4.1 Route Receptor: Station Road Results

The results from route receptor Station Road stated the following:

- Green glare or Low potential for temporary after image: 95 minutes
- Yellow glare or Potential for temporary after image: 6 minutes

Predicted glare occurrence and duration: The predicted instances of green glare are anticipated to occur between November and early February, again in mid-March, and from mid-September to early October, as illustrated in Figure 14. In contrast, yellow glare is expected to occur only three times a year: late September, late November, and mid-March. All predicted exposures to temporary afterimages are projected to last less than 5 minutes each day and will occur exclusively between 5 AM and 7 AM Figure 15.

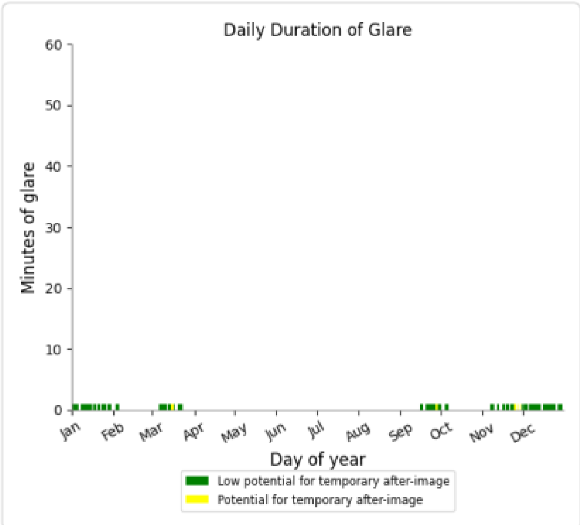


Figure 14- Daily duration of glare.

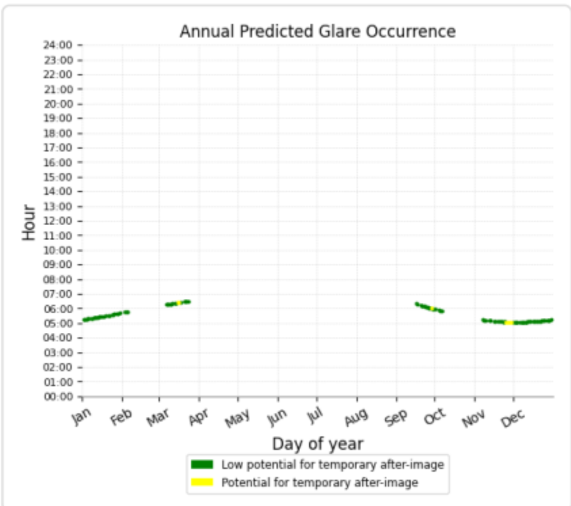


Figure 15- Annual predicted glare occurrence

Hazard Plot: The hazard plot uses orange plot points to represent the intensity of the glare. The results show they are mainly in green zone except a couple of them in yellow zone as shown in Figure 16 .

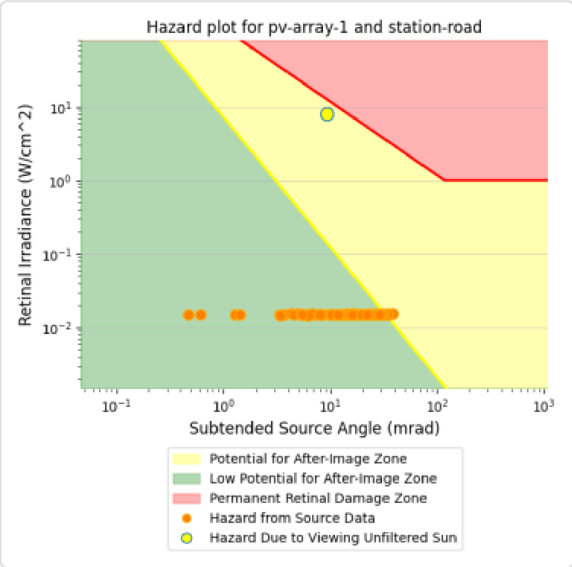


Figure 16- Hazard Plot for PV Array and Station Road.

Position along path receiving glare: Figure 17 shows the position along the path that receives the glares.

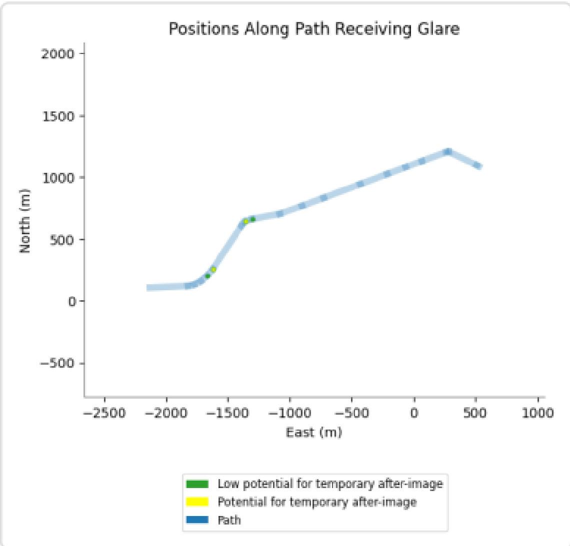


Figure 17- Positions along the path receiving glare

Annual glare reflections on the PV footprint: Figure 18 examines the annual pattern of glare reflections on the area covered by photovoltaic panels. The Southern and Eastern sides are predicted to create a mix of green and yellow glares.

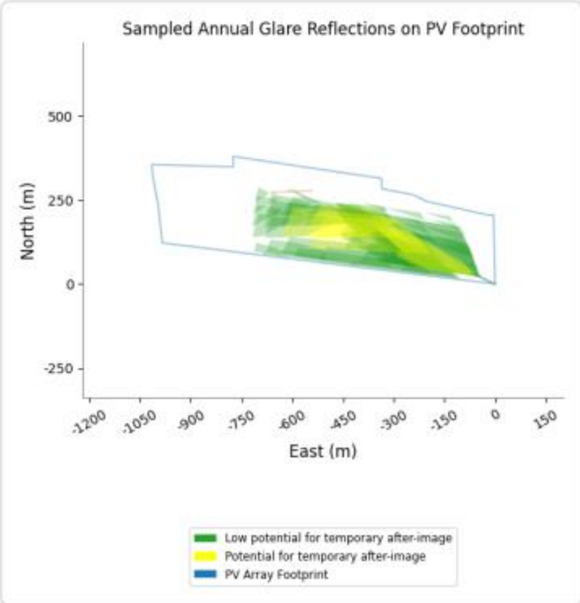


Figure 18- Sampled annual glare reflections on PV Array

Estimated glare per month: In Figure 19, the monthly estimates for green and yellow glare are presented. Notably, during December and January, the green glare exceeds 20 minutes each month. Meanwhile, in March, September, and November, the yellow glare is minimal, lasting less than 3 minutes throughout the entire month.

Distinct glare per month

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pv-array-1 (green)	24	3	13	0	0	0	0	0	12	4	12	27
pv-array-1 (yellow)	0	0	2	0	0	0	0	0	1	0	3	0

Figure 19 - Estimated glare per month from the proposed solar farm.

5.0 Potential Solution

To mitigate the issue of after images caused by yellow glare, a secondary planting strip / barrier 5-meters high, offset by 5-meters from the northern and western boundaries of the proposed solar farm could be established, as illustrated in Figure 20. This approach aims to eliminate the impact of yellow glare and its associated after images entirely, while also reducing green glare to 27 minutes (or 0.5 hours). Furthermore, this measure would decrease the duration of glare from 7 months a year to just 3 months (March, September, and October), as shown in Figure 21.

Figure 20 - Secondary planting strip barrier along the North and West side of the proposed solar farm.

Distinct glare per month

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pv-array-1 (green)	0	0	13	0	0	0	0	0	10	4	0	0
pv-array-1 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0

Figure 21 - Estimated glare per month from the proposed solar farm after 5m barrier is placed

Predicted glare occurrence and duration: The predicted instances of green glare are anticipated to occur between mid-September and early October, again in mid-March as illustrated in Figure 22. In contrast, yellow glare is not expected to occur at all. All predicted exposures to low potential for temporary afterimages are projected to last less than 5 minutes each day and will occur exclusively between 5 AM and 7 AM Figure 23.

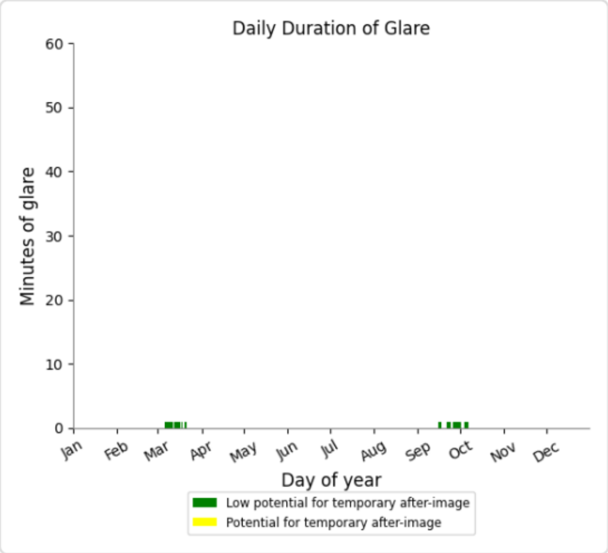


Figure 22 - Daily duration of glare.

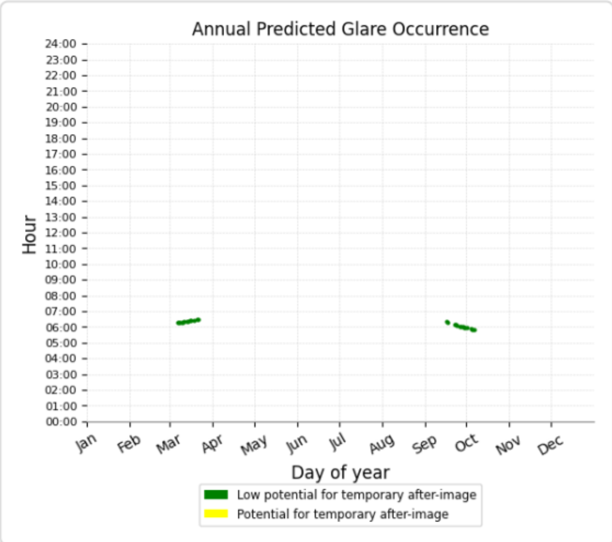


Figure 23- Annual predicted glare occurrence

Hazard Plot: The hazard plot uses orange plot points to represent the intensity of the glare. The results show they are only in green zone as shown in Figure 24.

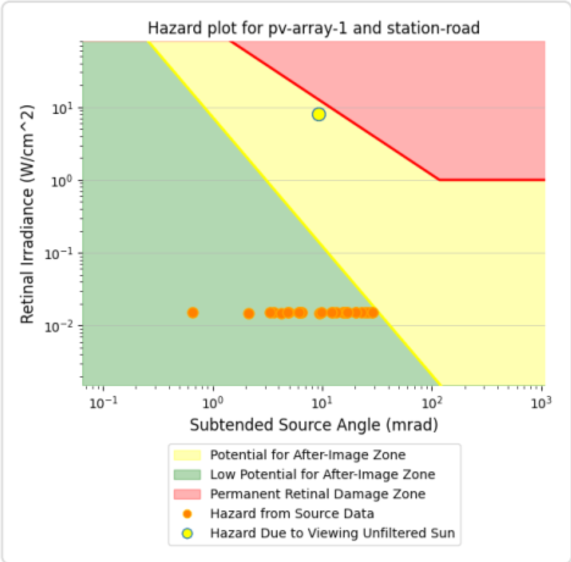


Figure 24- Hazard Plot for PV Array and Station Road.

Position along path receiving glare: Figure 25 shows the position along the path that receives the glares.

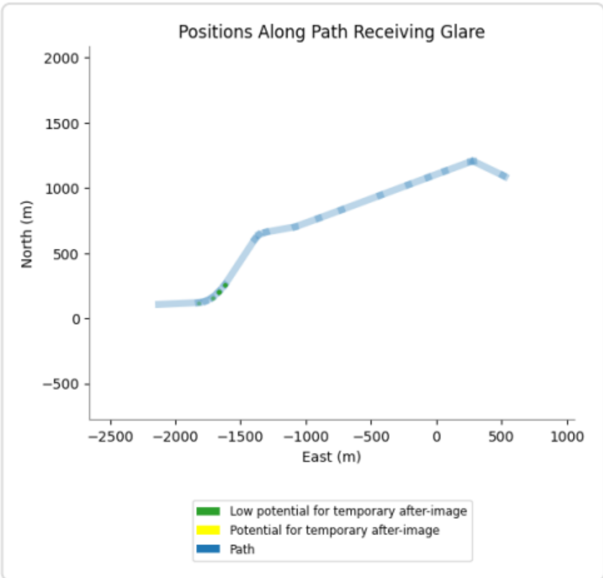


Figure 25- Positions along the path receiving glare

Annual glare reflections on the PV footprint: Figure 26 examines the annual pattern of glare reflections on the area covered by photovoltaic panels. The Southern and Eastern sides are predicted to create minimal green glares.

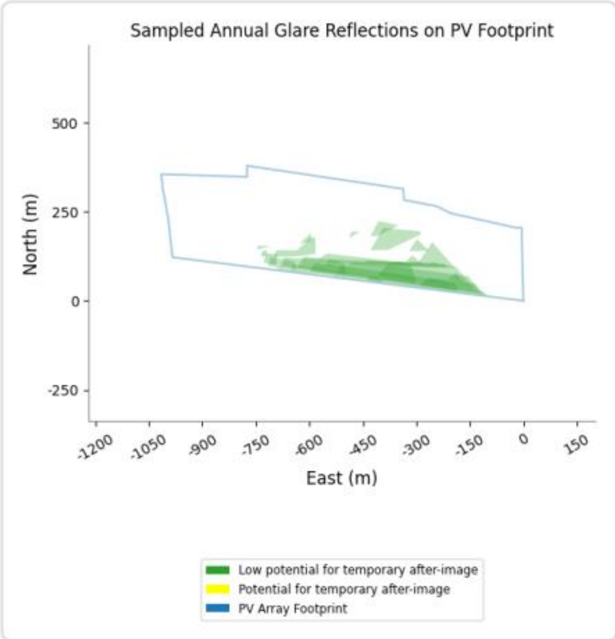


Figure 26- Sampled annual glare reflections on PV Array

6.0 Conclusions and Observations

The results show that all receptors, apart from one, experience no risk of glare. The potential for a temporary after image (yellow glare) is estimated at 6 minutes. Additionally, the low potential for afterimages is expected to last less than 5 minutes. The results are shown in **Appendix A.**

To mitigate the issue of after images caused by yellow glare, a secondary planting strip / barrier 5-meters high, offset by 5-meters from the northern and western boundaries of the proposed solar farm could be established. This enhancement would eliminate the risk of yellow glare and reduce green glare to just 27 minutes per year. Detailed results of this additional barrier's impact are presented in **Appendix B**.

It should be noted the software simulation uses clear sky weather data where glint and glare is not reduced due to atmospheric conditions or clouds, which provides a worst-case scenario. In reality, clouds, fog and other atmospheric conditions will result in less glare than simulated in this report.

Appendix A: ForgeSolar Glare Analysis Results

FORGESOLAR GLARE ANALYSIS

Project: **Matamata Stage - 2**

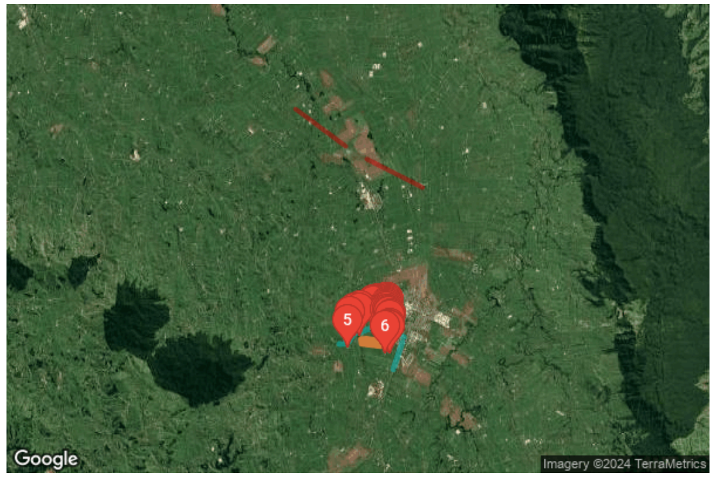
High-level Glint & Glare analysis for Stage - 2 Solar Farm for Maven Associates

Site configuration: **Matamata Stage - 2**

Client: Maven Associates

Created 15 Oct, 2024
Updated 17 Oct, 2024
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 MW to 100 MW
Site ID 131335.22403

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



Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	95	1.6	6	0.1	56,990,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Eldonwood Road	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Hinuera Road	0	0.0	0	0.0
Jellicoe Rd - Peakedale Drive	0	0.0	0	0.0
Station Road	95	1.6	6	0.1
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Description: Solar Farm Stage - 2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.48
Rated power: 20863.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.827269	175.757125	65.00	1.40	66.40
2	-37.825417	175.757071	64.00	1.40	65.40
3	-37.825430	175.756921	64.00	1.40	65.40
4	-37.825057	175.754813	63.00	1.40	64.40
5	-37.824879	175.754351	63.00	1.40	64.40
6	-37.824722	175.753327	62.00	1.40	63.40
7	-37.824442	175.753300	62.00	1.40	63.40
8	-37.823856	175.748324	60.00	1.40	61.40
9	-37.824136	175.748330	61.00	1.40	62.40
10	-37.824072	175.745594	61.00	1.40	62.40
11	-37.824382	175.745631	61.00	1.40	62.40
12	-37.825191	175.745814	62.00	1.40	63.40
13	-37.826170	175.745949	63.00	1.40	64.40

Route Receptors

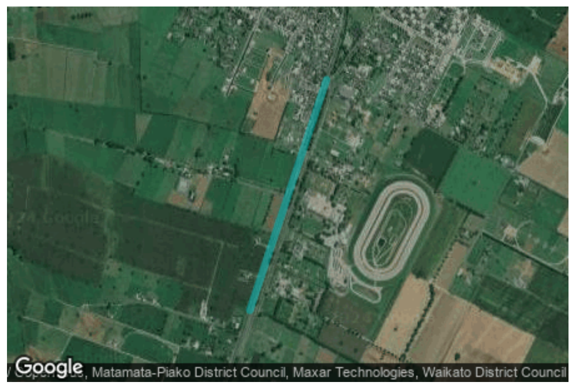
Name: Eldonwood Road
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.817355	175.762833	64.00	1.50	65.50
2	-37.817578	175.762750	64.00	1.50	65.50
3	-37.817922	175.762844	64.00	1.50	65.50
4	-37.817964	175.762718	64.00	1.50	65.50
5	-37.818046	175.762715	64.00	1.50	65.50
6	-37.818129	175.762750	64.00	1.50	65.50
7	-37.818572	175.762484	64.00	1.50	65.50
8	-37.819006	175.762323	64.00	1.50	65.50
9	-37.819494	175.762074	64.00	1.50	65.50
10	-37.819765	175.762047	64.00	1.50	65.50
11	-37.820218	175.762109	64.00	1.50	65.50
12	-37.820483	175.762227	64.00	1.50	65.50
13	-37.821049	175.762503	64.62	1.50	66.12
14	-37.821383	175.762500	65.00	1.50	66.50
15	-37.821873	175.762575	65.00	1.50	66.50
16	-37.822021	175.762600	65.00	1.50	66.50
17	-37.822288	175.762562	65.00	1.50	66.50
18	-37.822509	175.762444	65.00	1.50	66.50
19	-37.822595	175.762227	65.00	1.50	66.50
20	-37.822680	175.762235	65.00	1.50	66.50
21	-37.822788	175.762331	65.00	1.50	66.50
22	-37.823203	175.762288	65.00	1.50	66.50
23	-37.823449	175.762334	65.00	1.50	66.50
24	-37.823714	175.762457	65.00	1.50	66.50
25	-37.824207	175.762502	66.00	1.50	67.50
26	-37.824838	175.762443	66.00	1.50	67.50

Name: Highgrove Ave
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.818141	175.754360	60.00	1.50	61.50
2	-37.819654	175.754851	60.00	1.50	61.50
3	-37.819720	175.755072	61.00	1.50	62.50
4	-37.819906	175.754939	61.00	1.50	62.50
5	-37.822470	175.755806	62.00	1.50	63.50

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



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.825577	175.769801	67.00	1.50	68.50
2	-37.837445	175.764788	68.00	1.50	69.50
3	-37.838072	175.764525	68.00	1.50	69.50

Name: Jellicoe Rd - Peakedale Drive
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.826398	175.762982	66.57	1.50	68.07
2	-37.821690	175.765546	66.00	1.50	67.50
3	-37.821071	175.766050	66.00	1.50	67.50
4	-37.821078	175.766199	66.00	1.50	67.50
5	-37.823123	175.770719	67.00	1.50	68.50
6	-37.823136	175.770794	67.00	1.50	68.50

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

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.826315	175.732966	76.00	1.50	77.50
2	-37.826186	175.736431	73.00	1.50	74.50
3	-37.826087	175.737032	72.00	1.50	73.50
4	-37.825837	175.737636	71.00	1.50	72.50
5	-37.825439	175.738194	70.00	1.50	71.50
6	-37.824958	175.738719	70.00	1.50	71.50
7	-37.821801	175.741342	64.00	1.50	65.50
8	-37.821494	175.741690	63.00	1.50	64.50
9	-37.821312	175.742323	62.00	1.50	63.50
10	-37.820947	175.744850	59.00	1.50	60.50
11	-37.820356	175.746897	58.00	1.50	59.50
12	-37.819772	175.748884	58.00	1.50	59.50
13	-37.818769	175.752256	59.00	1.50	60.50
14	-37.818037	175.754723	60.00	1.50	61.50
15	-37.817531	175.756426	61.00	1.50	62.50
16	-37.817096	175.757895	61.00	1.50	62.50
17	-37.816446	175.760118	63.00	1.50	64.50
18	-37.816421	175.760384	63.00	1.50	64.50
19	-37.817394	175.762930	64.00	1.50	65.50
20	-37.817481	175.763126	64.00	1.50	65.50

Flight Path Receptors

Name: FP 1
Description:
Threshold height: 15 m
Direction: 126.6°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-37.734826	175.736655	49.00	15.24	64.24
Two-mile	-37.717584	175.707274	43.00	189.92	232.92

Name: FP 2
Description:
Threshold height: 15 m
Direction: 296.9°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-37.740754	175.748994	50.00	15.24	65.24
Two-mile	-37.753853	175.781626	50.00	183.92	233.92

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.821506	175.745846	59.00	1.70
OP 2	2	-37.822769	175.744894	60.00	1.70
OP 3	3	-37.822562	175.741806	64.00	1.70
OP 4	4	-37.824595	175.739427	68.00	1.70
OP 5	5	-37.828128	175.738313	71.00	1.70
OP 6	6	-37.830802	175.760130	67.00	1.70
OP 7	7	-37.830744	175.762974	68.00	1.70
OP 8	8	-37.829795	175.762964	68.00	1.70
OP 9	9	-37.830395	175.761841	68.00	1.70
OP 10	10	-37.818901	175.753203	60.00	1.70
OP 11	11	-37.819646	175.753225	60.00	1.70
OP 12	12	-37.819278	175.755655	61.00	1.70
OP 13	13	-37.818340	175.756083	61.00	1.70
OP 14	14	-37.819182	175.757474	62.00	1.70
OP 15	15	-37.824534	175.761959	65.79	1.70
OP 16	16	-37.823805	175.762050	65.00	1.70
OP 17	17	-37.823517	175.761616	65.00	1.70
OP 18	18	-37.823190	175.761627	65.00	1.70
OP 19	19	-37.823339	175.761015	65.00	1.70
OP 20	20	-37.823250	175.760682	65.00	1.70
OP 21	21	-37.823330	175.759733	64.00	1.70
OP 22	22	-37.822436	175.760441	64.00	1.70
OP 23	23	-37.822411	175.760071	64.00	1.70
OP 24	24	-37.822262	175.759556	64.00	1.70
OP 25	25	-37.821572	175.760171	64.00	1.70
OP 26	26	-37.820964	175.760718	64.00	1.70
OP 27	27	-37.820438	175.760997	64.00	1.70
OP 28	28	-37.820027	175.761072	64.00	1.70
OP 29	29	-37.819667	175.761281	64.00	1.70
OP 30	30	-37.819315	175.761399	64.00	1.70
OP 31	31	-37.818845	175.761705	64.00	1.70
OP 32	32	-37.818421	175.761817	64.00	1.70
OP 33	33	-37.818196	175.761614	64.00	1.70
OP 34	34	-37.818074	175.761426	63.00	1.70
OP 35	35	-37.817993	175.761270	63.00	1.70
OP 36	36	-37.817896	175.761034	63.00	1.70
OP 37	37	-37.817840	175.760911	63.00	1.70
OP 38	38	-37.817768	175.760712	63.00	1.70
OP 39	39	-37.826116	175.762772	66.00	1.70
OP 40	40	-37.825505	175.763115	66.00	1.70

Obstruction Components

Name: Planting Strip
Top height: 2.5 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-37.824072	175.745586	61.00
2	-37.826181	175.745933	63.00
3	-37.827281	175.757140	65.00
4	-37.825405	175.757079	64.00
5	-37.824855	175.754360	63.00
6	-37.824703	175.753347	62.00
7	-37.824419	175.753309	62.00
8	-37.823850	175.748314	60.00
9	-37.824131	175.748322	61.00
10	-37.824067	175.745582	61.00

Glare Analysis Results

Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	95	1.6	6	0.1	56,990,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Eldonwood Road	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Hinuera Road	0	0.0	0	0.0
Jellicoe Rd - Peakedale Drive	0	0.0	0	0.0
Station Road	95	1.6	6	0.1
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

PV: PV array 1 potential temporary after-image

Receptor results ordered by category of glare

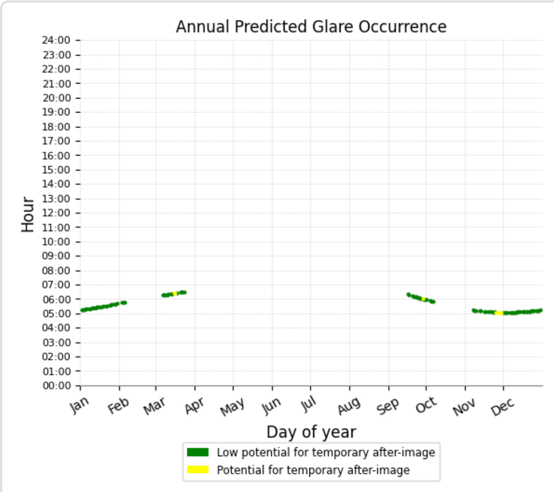
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Station Road	95	1.6	6	0.1
Eldonwood Road	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Hinuera Road	0	0.0	0	0.0
Jellicoe Rd - Peakedale Drive	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0

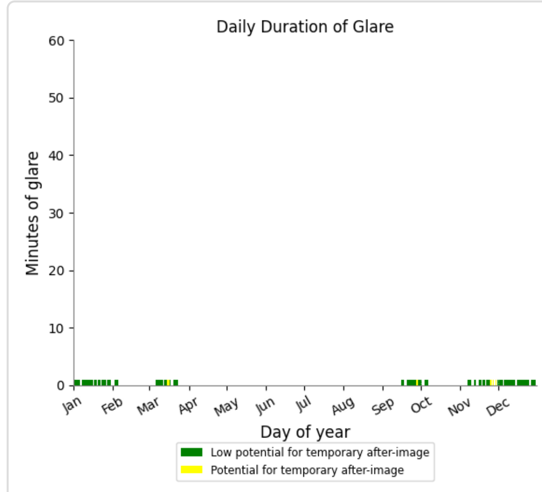
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

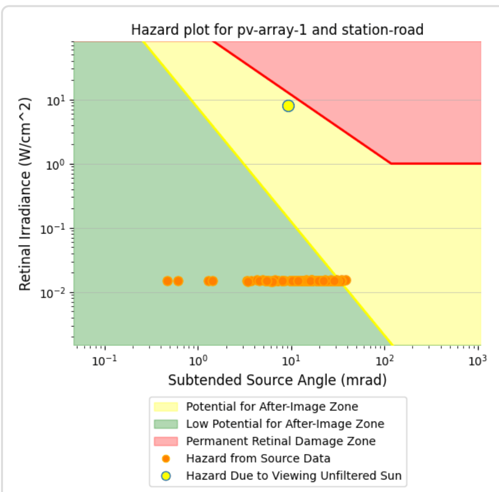
PV array 1 and Route: Station Road

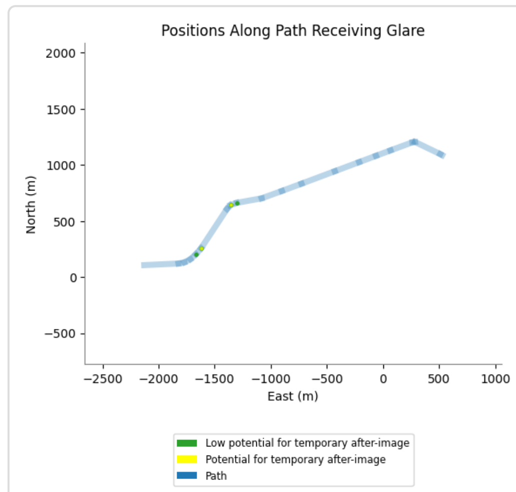
Yellow glare: 6 min.

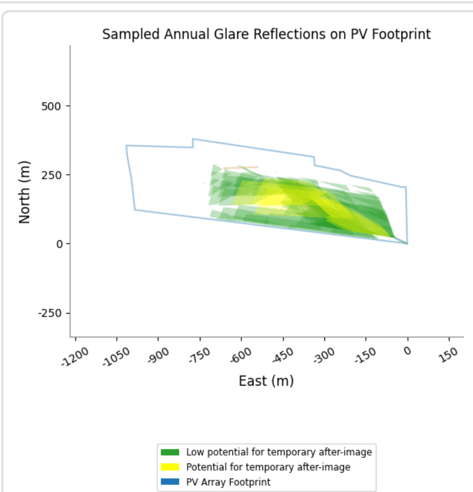
Green glare: 95 min.











PV array 1 and Route: Eldonwood Road

No glare found

PV array 1 and Route: Highgrove Ave

No glare found

PV array 1 and Route: Hinuera Road

No glare found

PV array 1 and Route: Jellicoe Rd - Peakedale Drive

No glare found

PV array 1 and FP: FP 1

No glare found

PV array 1 and FP: FP 2

No glare found

PV array 1 and OP 1

No glare found

PV array 1 and OP 2

No glare found

PV array 1 and OP 3

No glare found

PV array 1 and OP 4

No glare found

PV array 1 and OP 5

No glare found

PV array 1 and OP 6

No glare found

PV array 1 and OP 7

No glare found

PV array 1 and OP 8

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

PV array 1 and OP 12

No glare found

PV array 1 and OP 13

No glare found

PV array 1 and OP 14

No glare found

PV array 1 and OP 15

No glare found

PV array 1 and OP 16

No glare found

PV array 1 and OP 17

No glare found

PV array 1 and OP 18

No glare found

PV array 1 and OP 19

No glare found

PV array 1 and OP 20

No glare found

PV array 1 and OP 21

No glare found

PV array 1 and OP 22

No glare found

PV array 1 and OP 23

No glare found

PV array 1 and OP 24

No glare found

PV array 1 and OP 25

No glare found

PV array 1 and OP 26

No glare found

PV array 1 and OP 27

No glare found

PV array 1 and OP 28

No glare found

PV array 1 and OP 29

No glare found

PV array 1 and OP 30

No glare found

PV array 1 and OP 31

No glare found

PV array 1 and OP 32

No glare found

PV array 1 and OP 33

No glare found

PV array 1 and OP 34

No glare found

PV array 1 and OP 35

No glare found

PV array 1 and OP 36

No glare found

PV array 1 and OP 37

No glare found

PV array 1 and OP 38

No glare found

PV array 1 and OP 39

No glare found

PV array 1 and OP 40

No glare found

Assumptions

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

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

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

Appendix B: ForgeSolar Glare Analysis Results with Planting Barrier

FORGESOLAR GLARE ANALYSIS

Project: **Matamata Stage - 2**

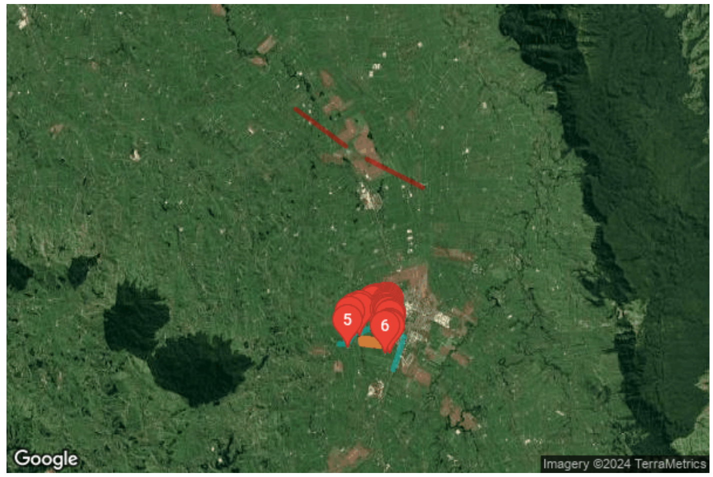
High-level Glint & Glare analysis for Stage - 2 Solar Farm for Maven Associates

Site configuration: **Matamata Stage - 2**

Client: Maven Associates

Created 15 Oct, 2024
Updated 17 Oct, 2024
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 MW to 100 MW
Site ID 131577.22403

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



Summary of Results Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	27	0.5	0	0.0	56,990,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Eldonwood Road	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Hinuera Road	0	0.0	0	0.0
Jellicoe Rd - Peakedale Drive	0	0.0	0	0.0
Station Road	27	0.5	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

Component Data

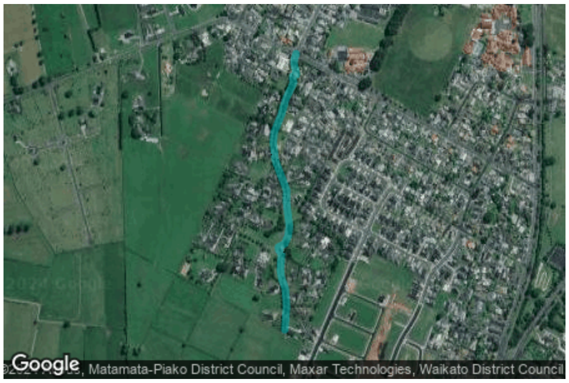
PV Arrays

Name: PV array 1
Description: Solar Farm Stage - 2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.48
Rated power: 20863.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.827269	175.757125	65.00	1.40	66.40
2	-37.825417	175.757071	64.00	1.40	65.40
3	-37.825430	175.756921	64.00	1.40	65.40
4	-37.825057	175.754813	63.00	1.40	64.40
5	-37.824879	175.754351	63.00	1.40	64.40
6	-37.824722	175.753327	62.00	1.40	63.40
7	-37.824442	175.753300	62.00	1.40	63.40
8	-37.823856	175.748324	60.00	1.40	61.40
9	-37.824136	175.748330	61.00	1.40	62.40
10	-37.824072	175.745594	61.00	1.40	62.40
11	-37.824382	175.745631	61.00	1.40	62.40
12	-37.825191	175.745814	62.00	1.40	63.40
13	-37.826170	175.745949	63.00	1.40	64.40

Route Receptors

Name: Eldonwood Road
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

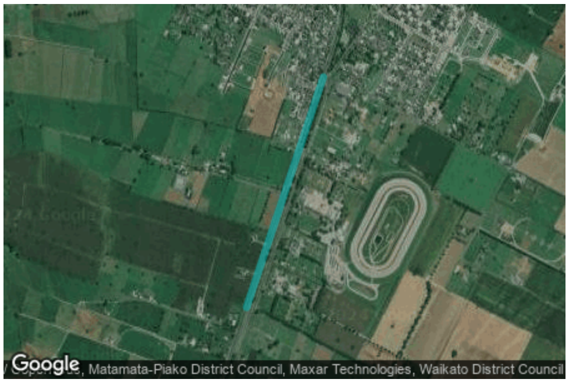


Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.817355	175.762833	64.00	1.50	65.50
2	-37.817578	175.762750	64.00	1.50	65.50
3	-37.817922	175.762844	64.00	1.50	65.50
4	-37.817964	175.762718	64.00	1.50	65.50
5	-37.818046	175.762715	64.00	1.50	65.50
6	-37.818129	175.762750	64.00	1.50	65.50
7	-37.818572	175.762484	64.00	1.50	65.50
8	-37.819006	175.762323	64.00	1.50	65.50
9	-37.819494	175.762074	64.00	1.50	65.50
10	-37.819765	175.762047	64.00	1.50	65.50
11	-37.820218	175.762109	64.00	1.50	65.50
12	-37.820483	175.762227	64.00	1.50	65.50
13	-37.821049	175.762503	64.62	1.50	66.12
14	-37.821383	175.762500	65.00	1.50	66.50
15	-37.821873	175.762575	65.00	1.50	66.50
16	-37.822021	175.762600	65.00	1.50	66.50
17	-37.822288	175.762562	65.00	1.50	66.50
18	-37.822509	175.762444	65.00	1.50	66.50
19	-37.822595	175.762227	65.00	1.50	66.50
20	-37.822680	175.762235	65.00	1.50	66.50
21	-37.822788	175.762331	65.00	1.50	66.50
22	-37.823203	175.762288	65.00	1.50	66.50
23	-37.823449	175.762334	65.00	1.50	66.50
24	-37.823714	175.762457	65.00	1.50	66.50
25	-37.824207	175.762502	66.00	1.50	67.50
26	-37.824838	175.762443	66.00	1.50	67.50

Name: Highgrove Ave
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.818141	175.754360	60.00	1.50	61.50
2	-37.819654	175.754851	60.00	1.50	61.50
3	-37.819720	175.755072	61.00	1.50	62.50
4	-37.819906	175.754939	61.00	1.50	62.50
5	-37.822470	175.755806	62.00	1.50	63.50

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



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.825577	175.769801	67.00	1.50	68.50
2	-37.837445	175.764788	68.00	1.50	69.50
3	-37.838072	175.764525	68.00	1.50	69.50

Name: Jellicoe Rd - Peakedale Drive
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.826398	175.762982	66.57	1.50	68.07
2	-37.821690	175.765546	66.00	1.50	67.50
3	-37.821071	175.766050	66.00	1.50	67.50
4	-37.821078	175.766199	66.00	1.50	67.50
5	-37.823123	175.770719	67.00	1.50	68.50
6	-37.823136	175.770794	67.00	1.50	68.50

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

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.826315	175.732966	76.00	1.50	77.50
2	-37.826186	175.736431	73.00	1.50	74.50
3	-37.826087	175.737032	72.00	1.50	73.50
4	-37.825837	175.737636	71.00	1.50	72.50
5	-37.825439	175.738194	70.00	1.50	71.50
6	-37.824958	175.738719	70.00	1.50	71.50
7	-37.821801	175.741342	64.00	1.50	65.50
8	-37.821494	175.741690	63.00	1.50	64.50
9	-37.821312	175.742323	62.00	1.50	63.50
10	-37.820947	175.744850	59.00	1.50	60.50
11	-37.820356	175.746897	58.00	1.50	59.50
12	-37.819772	175.748884	58.00	1.50	59.50
13	-37.818769	175.752256	59.00	1.50	60.50
14	-37.818037	175.754723	60.00	1.50	61.50
15	-37.817531	175.756426	61.00	1.50	62.50
16	-37.817096	175.757895	61.00	1.50	62.50
17	-37.816446	175.760118	63.00	1.50	64.50
18	-37.816421	175.760384	63.00	1.50	64.50
19	-37.817394	175.762930	64.00	1.50	65.50
20	-37.817481	175.763126	64.00	1.50	65.50

Flight Path Receptors

Name: FP 1
Description:
Threshold height: 15 m
Direction: 126.6°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-37.734826	175.736655	49.00	15.24	64.24
Two-mile	-37.717584	175.707274	43.00	189.92	232.92

Name: FP 2
Description:
Threshold height: 15 m
Direction: 296.9°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-37.740754	175.748994	50.00	15.24	65.24
Two-mile	-37.753853	175.781626	50.00	183.92	233.92

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.821506	175.745846	59.00	1.70
OP 2	2	-37.822769	175.744894	60.00	1.70
OP 3	3	-37.822562	175.741806	64.00	1.70
OP 4	4	-37.824595	175.739427	68.00	1.70
OP 5	5	-37.828128	175.738313	71.00	1.70
OP 6	6	-37.830802	175.760130	67.00	1.70
OP 7	7	-37.830744	175.762974	68.00	1.70
OP 8	8	-37.829795	175.762964	68.00	1.70
OP 9	9	-37.830395	175.761841	68.00	1.70
OP 10	10	-37.818901	175.753203	60.00	1.70
OP 11	11	-37.819646	175.753225	60.00	1.70
OP 12	12	-37.819278	175.755655	61.00	1.70
OP 13	13	-37.818340	175.756083	61.00	1.70
OP 14	14	-37.819182	175.757474	62.00	1.70
OP 15	15	-37.824534	175.761959	65.79	1.70
OP 16	16	-37.823805	175.762050	65.00	1.70
OP 17	17	-37.823517	175.761616	65.00	1.70
OP 18	18	-37.823190	175.761627	65.00	1.70
OP 19	19	-37.823339	175.761015	65.00	1.70
OP 20	20	-37.823250	175.760682	65.00	1.70
OP 21	21	-37.823330	175.759733	64.00	1.70
OP 22	22	-37.822436	175.760441	64.00	1.70
OP 23	23	-37.822411	175.760071	64.00	1.70
OP 24	24	-37.822262	175.759556	64.00	1.70
OP 25	25	-37.821572	175.760171	64.00	1.70
OP 26	26	-37.820964	175.760718	64.00	1.70
OP 27	27	-37.820438	175.760997	64.00	1.70
OP 28	28	-37.820027	175.761072	64.00	1.70
OP 29	29	-37.819667	175.761281	64.00	1.70
OP 30	30	-37.819315	175.761399	64.00	1.70
OP 31	31	-37.818845	175.761705	64.00	1.70
OP 32	32	-37.818421	175.761817	64.00	1.70
OP 33	33	-37.818196	175.761614	64.00	1.70
OP 34	34	-37.818074	175.761426	63.00	1.70
OP 35	35	-37.817993	175.761270	63.00	1.70
OP 36	36	-37.817896	175.761034	63.00	1.70
OP 37	37	-37.817840	175.760911	63.00	1.70
OP 38	38	-37.817768	175.760712	63.00	1.70
OP 39	39	-37.826116	175.762772	66.00	1.70
OP 40	40	-37.825505	175.763115	66.00	1.70

Obstruction Components

Name: Planting Strip
Top height: 2.5 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-37.824072	175.745586	61.00
2	-37.826181	175.745933	63.00
3	-37.827281	175.757140	65.00
4	-37.825405	175.757079	64.00
5	-37.824855	175.754360	63.00
6	-37.824703	175.753347	62.00
7	-37.824419	175.753309	62.00
8	-37.823850	175.748314	60.00
9	-37.824131	175.748322	61.00
10	-37.824067	175.745582	61.00

Name: Planting Strip - Barrier
Top height: 5.0 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-37.824105	175.750862	61.00
2	-37.823806	175.748283	60.00
3	-37.824100	175.748291	61.00
4	-37.824038	175.745531	61.00
5	-37.825854	175.745826	62.06

Glare Analysis Results

Summary of Results Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	27	0.5	0	0.0	56,990,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Eldonwood Road	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Hinuera Road	0	0.0	0	0.0
Jellicoe Rd - Peakedale Drive	0	0.0	0	0.0
Station Road	27	0.5	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

PV: PV array 1 low potential for temporary after-image

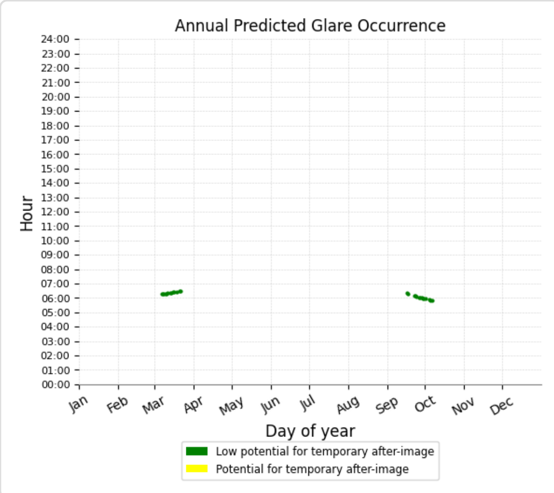
Receptor results ordered by category of glare

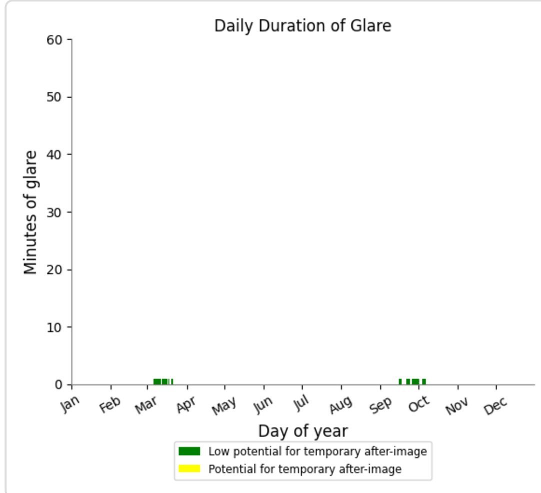
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Station Road	27	0.5	0	0.0
Eldonwood Road	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Hinuera Road	0	0.0	0	0.0
Jellicoe Rd - Peakedale Drive	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0

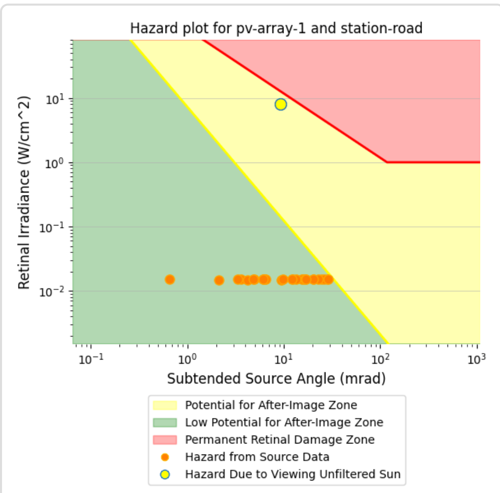
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

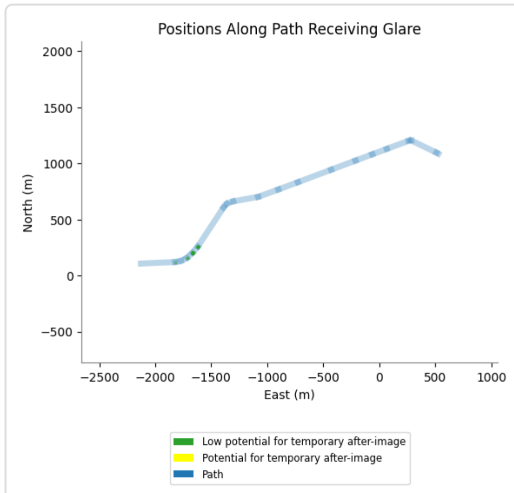
PV array 1 and Route: Station Road

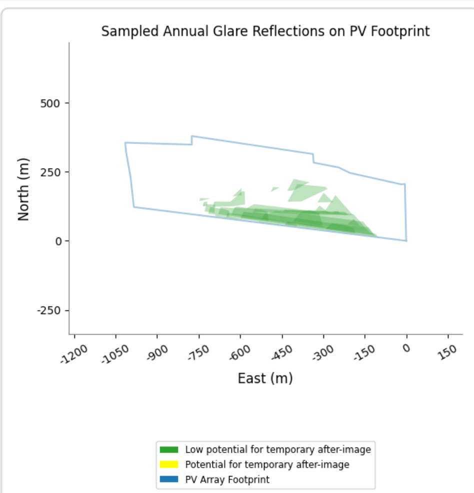
Yellow glare: none
Green glare: 27 min.











PV array 1 and Route: Eldonwood Road

No glare found

PV array 1 and Route: Highgrove Ave

No glare found

PV array 1 and Route: Hinuera Road

No glare found

PV array 1 and Route: Jellicoe Rd - Peakedale Drive

No glare found

PV array 1 and FP: FP 1

No glare found

PV array 1 and FP: FP 2

No glare found

PV array 1 and OP 1

No glare found

PV array 1 and OP 2

No glare found

PV array 1 and OP 3

No glare found

PV array 1 and OP 4

No glare found

PV array 1 and OP 5

No glare found

PV array 1 and OP 6

No glare found

PV array 1 and OP 7

No glare found

PV array 1 and OP 8

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

PV array 1 and OP 12

No glare found

PV array 1 and OP 13

No glare found

PV array 1 and OP 14

No glare found

PV array 1 and OP 15

No glare found

PV array 1 and OP 16

No glare found

PV array 1 and OP 17

No glare found

PV array 1 and OP 18

No glare found

PV array 1 and OP 19

No glare found

PV array 1 and OP 20

No glare found

PV array 1 and OP 21

No glare found

PV array 1 and OP 22

No glare found

PV array 1 and OP 23

No glare found

PV array 1 and OP 24

No glare found

PV array 1 and OP 25

No glare found

PV array 1 and OP 26

No glare found

PV array 1 and OP 27

No glare found

PV array 1 and OP 28

No glare found

PV array 1 and OP 29

No glare found

PV array 1 and OP 30

No glare found

PV array 1 and OP 31

No glare found

PV array 1 and OP 32

No glare found

PV array 1 and OP 33

No glare found

PV array 1 and OP 34

No glare found

PV array 1 and OP 35

No glare found

PV array 1 and OP 36

No glare found

PV array 1 and OP 37

No glare found

PV array 1 and OP 38

No glare found

PV array 1 and OP 39

No glare found

PV array 1 and OP 40

No glare found

Assumptions

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

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

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