BEFORE THE HEARING PANEL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of the applications by Energy Bay Limited to the Tararua District Council (202.2022.136.1) for resource consents to establish and operate a solar farm at 410 Managamaire Road, Pahiatua.

APPLICANT'S BUNDLE OF EVIDENCE AND ATTACHMENTS

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BEFORE THE TARARUA DISTRICT COUNCIL'S HEARING PANEL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of the applications by Energy Bay Limited to the Tararua District Council (202.2022.136.1) for resource consents to establish and operate a solar farm at 410 Managamaire Road, Pahiatua.

STATEMENT OF EVIDENCE OF ANDREW WILLIAM MORGAN ARCHIBALD FOR ENERGY BAY LIMITED

DATED 16 AUGUST 2023

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Introduction and Qualifications

[1] My full name is Andrew William Morgan Archibald.

[2] I serve as the Investment Director and Co-Founder for both Energy Bay Limited and Energy Bay Pty (referred to together here as **Energy Bay**), which are impact investment funds operating in New Zealand and Australia. I've held the position since 2021 and 2017 respectively. Energy Bay Limited is registered in New Zealand, and I am authorised to provide this evidence on behalf of Energy Bay.

[3] I hold a Bachelor of Commerce in Finance and Marketing and have previously been recognised in the Deloitte Technology Fast 50 and as a finalist of the Victorian Young Achiever of the Year. I have previously worked in a number of leadership roles in technology start-ups and established companies. I am the co-founder of and board member of Social Garden and a co-founder of Energy Bay Limited and Energy Bay Pty.

[4] I have been involved in all elements of the development of the Pahiatua solar farm project including configuration, design and technical reporting.

Scope of evidence

[5] My evidence is related to the operational and company matters relevant to this application and will cover:

(a) Energy Bay's role;

(b) The proposal;

(c) Site selection;

(d) Consultation; and

(e) Positive benefits.

Energy Bay's role and experience

[6] Energy Bay is a leading impact investment platform. That means Energy Bay provides the capability to finance, build and operate renewable energy

infrastructure, bridging the gap between organisations wanting to reduce emissions and the technical ability to do so.

[7] Energy Bay is developing, constructing, investing in and managing more than 350MW of distributed renewable energy projects across the Asia / Pacific. In New Zealand, this includes the following solar farms under development or operational (see Figure 1 below):

(a) Maungaturoto Solar farm (20.97MWdc) – partnering with Ryman Healthcare to supply retirement villages;

(b) Massey University Solar Farm (6MWdc) – partnering with Massey University for a combined solar and pastoral farming farm.

(c) Wiri Logistics Estate (1.02MWdc – operational) – partnering with Countdown supermarkets;

(d) Naseby Solar Farm (43MWdc) – partnering with a private landowner; and

(e) Planned farms at Albury Solar Farm (27MWdc) and Waimate Solar Farm (10MWdc).

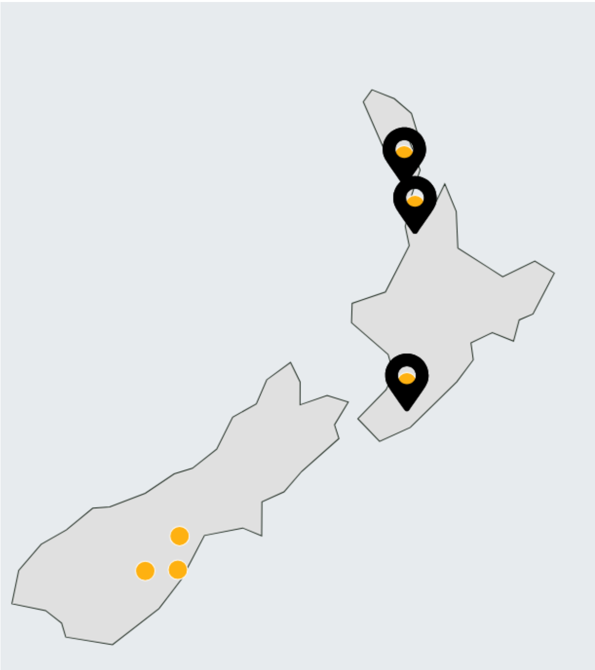

Figure 1: Map of Energy Bay projects in New Zealand.

The proposal

[8] Energy Bay proposes a solar farm across two sites in the Mangatainoka River valley across a 114.3169ha area (with a developed area of 86.93ha).

[9] While Energy Bay will retain its interest in the land, the land will be leased to Akuo New Zealand Limited (**Akuo**) who will develop and operate the solar power farm. Akuo was selected to collaborate with Energy Bay due to its worldwide experience in developing, operating and maintaining solar farms. Akuo has constructed more than 50 solar projects worldwide through its parent company. This project will be capably led by Greg Vissler who has 30 years experience in the energy sector.

Site selection

[10] In early 2020, Energy Bay initiated the process of identifying an ideal location in the Tararua region. We aimed to tackle an issue in the New Zealand energy market where businesses and producers were finding it challenging to compete due to excessively high energy costs.

[11] The search for an ideal solar farm site encompassed the lower North Island, particularly concentrating on the Tararua region. During this endeavour, Energy Bay pinpointed a suitable area near the Mangamaiere Road Substation, which provides crucial connectivity capabilities, flat and suitable land, access to the Powerco Network, and the potential for consistent generation of environmentally friendly electricity into the lower North Island grid. A willing seller of the land is also necessary. An essential element that confirmed the selected site's feasibility as a significant solar farm in New Zealand is its ability to generate renewable electricity for the lower North Island network reliably free from intermittent constraints stemming from upstream power generation.

[12] This location is considered the sole viable option in the lower North Island basin, and it possesses the financial viability required to support the establishment of a solar farm at the necessary scale. This solar farm is intended to offer more reasonable energy pricing to larger energy consumers and agricultural producers across New Zealand.

[13] Farming at the solar farm site will continue. The concept of agri-energy is important and it is intended the site will be grazed and cropped around the solar panels. It is considered this offers significant synergies - the sites can continue to be optimised in land-based primary production and ensure site maintenance for energy outputs.

Consultation

[14] It has been important to Energy Bay to consult with surrounding landowners and affected parties. Energy Bay and Akuo have undertaken community consultation with all affected parties and revised landscape mitigations and waterway protection to accommodate visual and ecological impacts. Most neighbouring parties have agreed to withdraw their submissions or otherwise have provided affected party approval as a result.

Positive benefits

[15] New Zealand has signed and ratified the Paris Agreement committing to reduce greenhouse gas emissions and the Zero Carbon Act has committed New Zealand to achieving zero greenhouse gas emissions by 2050. Further, New Zealand has joined the Powering Past Coal Alliance which commits the country to phase out the use of coal in electricity generation by 2030. To achieve all these commitments, renewable energy projects need to be developed now to meet these 2030 and 2050 goals.

[16] In tandem with this shift to renewables, electricity demand is projected to increase over the next 30 years, with an estimated doubling of electricity demand by 2050.[1] Part of this growth is the anticipated transition from stationary energy (such as on-site industrial boilers) to electrification. Comparative growth of renewable energy supply (rather than non-renewables) is vital to meet these challenges.

[17] The key benefit of this solar farm proposal is that it will assist New Zealand in reaching the current target of 100% renewable energy generation by 2030.

[1] *Transpower 2018: Te Mauri Hiko – Energy Futures white paper*

Projects such as this, which can power more than 10,000 homes, are key to ensuring a reliable and consistent supply of renewable energy across all regions of Aotearoa.

[18] This solar farm in particular has a functional efficiency due to its location adjoining the Mangamaire Substation. This will enable much greater efficiency of the power produced to distribution to the Tararua District and the wider region, with fewer transmission losses.

[19] The Project will involve approximately $70-80 Million in capital investment and provide infrastructure to improve economic and employment outcomes. It will generate approximately 60 direct full-time equivalent (FTE) jobs over a 12-15 month construction period and around 5 ongoing FTE jobs. Indirectly, there will be economic benefits to the community and the wider Tararua District. Construction, operation and maintenance works are anticipated to be sourced primarily from the local community feeding into the local economy.

[20] Further, the project is intended to enable agrivoltaic farming operations on solar farmland. That means agricultural activities such as stock grazing (which has the added benefit of maintaining the ground cover) will coincide with renewable energy production.

Conclusion

[21] Experienced operators will lead the Project in designing, financing, establishing and operating this scale of solar farm. This proposal is a well-designed project which has comprehensively assessed the potential effects and sought to implement mitigations as appropriate.

[22] The proposed solar farm will assist New Zealand in working towards the 100% renewable energy by 2030 goal and benefit the local economy without adversely affecting neighbours.

Andrew Archibald (Aug 16, 2023 13:22 GMT+10)

Andrew Archibald

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BEFORE THE TARARUA DISTRICT COUNCIL'S HEARING PANEL

IN THE MATTER	of the Resource Management Act 1991
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IN THE MATTER	of the applications by Energy Bay Limited to the Tararua District Council (202.2022.136.1) for resource consents to establish and operate a solar farm at 410 Mangamaire Road, Pahiatua.

STATEMENT OF EVIDENCE OF RORY MCLEAN LANGBRIDGE FOR ENERGY BAY LIMITED

DATED 16 AUGUST 2023

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Introduction

1 My full name is Rory McLean Langbridge. I am a landscape architect with the qualifications of BSc (Victoria University) and Bachelor of Landscape Architecture with Honours (Lincoln University). I have been a Registered Landscape Architect of the New Zealand Institute of Landscape Architects since 2005. I was previously on the executive council of the New Zealand Institute of Landscape Architects (NZILA) and am a past chair of the Nelson Marlborough branch of the NZILA.

2 I have over 25 years of experience as a landscape architect, specialising in site planning and detailed landscape design, as well as the preparation of visual impact assessments for both Council and Environment Court hearings.

3 I am currently employed as a Senior Landscape Architect with Rough Milne Mitchell, having previously been in private practice as Rory Langbridge Landscape Architect (RLLA) based in Nelson since April 1999.

4 I have now assessed the impact of 3 solar farms, including this application, which has given me a reasonable understanding of the issues and challenges arising with the development of solar farms.

Code of Conduct

5 Although this is a Council hearing, I confirm that I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2023. I have complied with the Code of Conduct in preparing this evidence and agree to comply with it while giving evidence.

6 Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

Scope of Evidence

7 My evidence is presented on behalf of Solar Bay Ltd, the Applicant, in these proceedings.

8 In preparing my evidence, I reviewed the following:

(a) The evidence of the following experts:

(i) Solar Bay – Tararua Glint/Glare Assessment Mangamaire Road, Tararua and attachments

(ii) Planning evidence of Catherine Boulton;

(b) The relevant parts of the Tararua District Council Operative District Plan.

(c) The Council Section 42A Report prepared by Andrew Bashford, with particular reference to the accompanying assessment by Landscape Architect Shannon Bray

9 Subject to any points of difference, clarification or addition detailed below, my evidence for this hearing comprises:

(i) the Proposal;
(ii) the Site;
(iii) the existing environment;
(iv) The landscape values of the receiving environment

(v) The assessment of landscape and visual effects;
(vi) the planning framework;
(vii) the submissions; and
(viii) provide a conclusion.

10 An A3 colour Graphic Attachment (**GA**) accompanies and forms part of my evidence. It contains information relevant to the proposed development, and I refer to this throughout my evidence.

The Proposal

11 The applicant proposes to locate an approximately 58-ha solar farm within the 81.78-ha Site, as illustrated on **GA Sheet 3** forming two discrete Sites Anand B as described below. The farm will be located on both sides of Mangamaire Road to the south and south-west of its intersection with Tutaekara Road.

12 The technical aspects of the Proposal are described fully in the application. From a landscape perspective, the relevant matters include the scale of the development, the proximity the Site has to public roads and neighbours, the visibility that the Site from roads and neighbours and the implications of any potential glare that can occur on occupants located within the surrounding landscape.

13 There will be no residential development associated with this development as once established; the Site will be managed remotely.

14 An area adjacent to the sub-station will be designed to accommodate the main switchgear. The exact location of the point of connection is to be determined, but it will be located within the existing sub-station. The solar farm will be connected to the PowerCo substation near to Site. The exact location of this connection within the substation is to be confirmed.

15 As part of the construction of the solar farm, all remnant macrocarpa trees internal to Site A and some of the remnant shelterbelts associated with Site B will be removed to avoid shading of the solar panels. A new security fence will be erected around the boundary of the farms. Due to setback requirements due to overhead electricity wires, Site A will be set back 22m from the western boundary of Mangamaire Road, and Site B will be set 11m back from the southern boundary of Tutaekara Road. New shelterbelts will be planted outside the security fence, as illustrated on **GA Sheet 5.**

16 The Applicant proposes to plant a Cypress or Totara hedge to provide screening for the farms. A clipped cypress hedge will achieve a screen within 2-3 years of planting, while a totara hedge will achieve the required screening within 5 years. The use of clipped hedges as shelterbelts is well established within this locality and contributes to some extent to the existing rural character of the area.

17 The application is spread over two adjacent sites on either side of Mangamaire Road. Existing land use over both sites is highly productive pasture grown for grazing by cattle. **(refer GA Sheets 12 & 13.)**

18 **<u>Site A:</u>** is on the northern side of Mangamaire Road and measures 48.86ha and is spread over 3 separate land titles. The farm site extends approximately 500-600m northwest from Mangamaire Road to the Wairarapa Rail line along its north-western boundary and approximately 900m north-east along Mangamaire Road. The northern extent of Site A ends about 500m south of the Substation site and the Tutaekara Road intersection.

19 The farm site envelopes a dwelling site on Mangamaire Road, which occupies a 1.2-ha site. This Site contains a single-story farmhouse dwelling that the applicant owns. Substantial shelter planting lines the southern boundary of this property.

20 Internal to the Site, the flat pastures are interrupted by a scattering of remnant shelterbelts, primarily macrocarpa trees, that remain in various locations and provide both vertical relief and contribute positive rural and natural character value to the Site. A feature of this Site is the views enjoyed of the hills that form an attractive backdrop to the Site forming its western edge. **(GA pgs 19 and 20)**

21 Overhead powerlines track north-east south-west parallel to the road and approximately 175m back from the Mangamaire Road boundary.

22 **Site B,** is spread over 3 titles, is 38.62ha in size. The Site is south of the intersection of Tutaekara Road, along its northern boundary, and Mangamaire Road, along its western boundary. The Site's southern boundary is an unnamed gravel public road that provides access to the interior of Site B and also provides access to an existing quarry site at the southernmost corner of the Site. A 1.5ha land area central to the Tutaekara Road boundary is excluded from the application site.

23 The eastern boundary of the development site is marked by an existing farm track above a minor terrace of the Mangatainoka River and set back approximately 180-200m from the riverbed itself. The riverbed is around 4-5m below the level of the Site.

24 Site B is a series of flat paddocks currently grazed by cattle that has been partitioned into a number of reasonably large rectangular paddocks each measuring around 1.5ha.

25 Site' Bs vegetation is highly modified due to historic farm practices. Site B mainly lacks any visible trees except for two remnant macrocarpa windbreaks, a 180m line along Mangamaire Road in the north-western corner and about 130m lining an existing farm track central to the Site.

26 Above ground powerline enters Site B at the north western corner nearest the Mangamaire Substation and then tracks south, following Mangamaire Road approximately 95m into the Site.

The Existing Environment

27 The receiving environment falls within the Wairarapa Bush locality and is located within the Mangatainoka River valley and sits near the intersection of Tutaekara Road and Mangamaire Road.

28 The subject sites are located on the historic river flats west of the Mangatainoka River approximately 8km south of Pahiatua. The Mangatainoka River itself is a medium-sized, highly rated and heavily fished river and protected by a conservation order[1].

29 Due to the low density of development and the predominance of verdant open pasture, the flat landscape that affords the longer views possible of the hills that enclose the valley, the expanse of sky visible, natural character values and landscape/rural character values are aesthetically high. The prominence of the substation structures within a limited visual catchment, detracts from these values.

30 Little local relief makes distant views of the bare grazed hills on either side of the valley a feature of this locality. Other vertical relief is provided by the vegetation associated with the Mangatainoka River and the remnant macrocarpa plantings that remain in the area. Several remnant shelterbelts form part of the receiving environment.

31 In this area, the Mangatainoka Valley measures approximately 3-3.5km wide, is oriented roughly northeast-south-west and includes SH2 along its eastern edge. The Mangatainoka River meanders up an incised channel in the middle, and the Wairarapa train line to Pahiatua runs adjacent to the Site along its western

[1] Mangatainoka River – nzfishing,com

edge at the base of an unnamed range of hills that separates the Mangatainoka and Mangahao valleys. The rural land is dominated by pasture, grazing stock, interspersed with established shelter trees and amenity planting around scattered dwellings.

32 Tutaekara Road is a busy connector road, that crosses the valley with a traffic count of 1415vpd[2]. It provides an important link for the residents within Mangahoa River valley and the village of Marima to SH2 and linking to Pahiatua. Mangamaire Road is a minor offshoot (114vpd)[3] that runs parallel with the valley and SH2.

33 The Mangamaire substation, the reason the solar farm is proposed in this location, is prominently located at the intersection of Tutaekara and Mangamaire Roads. **Refer to GA Sheets 18**. High voltage overhead powerlines extend from the substation south through both proposed sites on either side of Mangamaire Road and north towards Pahiatua. Overhead wires also extend southeast from this substation along the southern side of Tutaekara Road.

34 Substantial shelterbelts form part of the receiving environment and while generally absent on either of the application sites, to re-establish them in this area would be a permitted activity in this landscape[4].

35 The Wairarapa main rail line to Pahiatua runs along the valley's western edge; however, due to the flatness of the Site and the distance most observers are away from the line, it is not generally visible when not in use.

36 There is an active shallow quarry borrow pit set approximately 350m back from Mangamaire Road. A macrocarpa hedge around this excavation limits views of the quarry from the surrounding landscape.

Landscape Values of the Receiving Environment

37 The existing landscape and visual amenity values form the baseline, along with the policy provisions, for an assessment of landscape effects. Current practice reinforced by Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines, has reordered the Amended Pigeon Bay Criteria into three broad categories of landscape attributes focussing on:

Physical

38 *"**Physical** [5] means both the natural and human-derived features and the interaction of natural and human processes over time."* [6] Typical physical factors include geological, ecological, and biological elements within the landscape.

39 The receiving environment is a flat, expansive landscape that contributes high overall rural character values to the surrounding landscape with associated values of openness, expansiveness and huge sky, lack of built form, natural character and legibility. Due to the general absence of structures and the flat and

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[2] vehicle count August 2020

[3] vehicle count August 2018

[4] In the TDP, regulations for shelterbelts only relates to the potential shading of state highways that are not present in this location.

[5] *'Physical' means both natural and human features, whereas 'biophysical' is potentially problematic if it is taken to mean only the natural aspects of the landscape rather than both natural and human features/processes. 'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 79.*

[6] *'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 79.*

monocultural expanse of the receiving landscape, the absorption capacity[7] of this landscape for uncharacteristic development is very low.

40 The main natural feature of this Site is the Mangatainoka River, an order 5 river with a flooded width of 20-25m. The river environment has high natural character values; however, the vegetation lining the river in this vicinity is heavily modified and is now dominated by invasive willow and other exotic weed species. **(Refer to GA Photograph 11)** The riparian vegetation limits views out from the river's course.

41 Some buildings are scattered around this general area, including the Mangamaire Substation and associated electrical infrastructure.

42 The Mangamaire Substation is a prominent structure within the local landscape that adversely impacts on current local amenity values. However, the facilities limited visual catchment due to the flatness of the surrounding landscape and the impact of vegetation screening, which means the adverse impact only extends to 3-400m east and south with any visibility north and west largely screened.

43 There are 15 dwellings and twenty-three other farm buildings within 500m of the boundary of the two sites, with an additional 9 dwellings located within a kilometre of the site boundaries. Of these, it is considered that 9 of these dwellings 'overlook' the Site. 11 of these houses make up the Mangamaire Settlement.

44 Houses that are long-standing in this environment are identifiable by the protective measures that have been undertaken using planting and shelterbelts, to address the wind in this area.

45 The vegetation cover over the two sites is highly modified, with no remnant indigenous vegetation visible. Sporadic macrocarpa trees and remnant shelterbelts contribute rural and natural character values to Site A but are noticeably absent within Site B. As a result, the biophysical values of the receiving environment are highly modified. However, the productivity of the soils is high, and the aesthetic values of the Site are high and regionally typical.

46 Due to the flatness of the landscape, views of either the main Mangatainoka River or the minor Mangamaire Stream are only possible when immediately adjacent to them.

47 Beyond the northern corner of Site A, there is a remnant wetland that appears to have been separated from its source, the Mangamaire Stream, by the construction of Doughertys Road and the Wairarapa Line. The boundary and fence for Site A will run immediately adjacent to this natural feature.

Perceptual

48 **"*Perceptual*** *means both sensory experience and interpretation. Sensory appreciation typically occurs simultaneously with interpretation, knowledge, and memory."* [8] Typical perceptual factors relate to experiential and aesthetic qualities such as naturalness, visual coherence, legibility as well as transient aspects.

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[7] "*Visual absorption capacity*" is typically defined as the landscape's ability to absorb physical changes without transformation or change to its visual character and qualities. Such a consideration evaluates a landscape based on two groups of factors: The first includes physical changes that are caused by development features such as earthworks, buildings and structures, linear development (pipelines, roads etc.), outdoor recreation facilities and forest plantations, with the second factor concerned with vegetative characteristics of the area, the potential for vegetation renewal and the visual exposure of the area to observers.

[8] *'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 79.*

49 The hills on either side that contain the valley, the flat open expanse around the sites, the pasture, the grazing animals and remnant macrocarpa plantings combine to create an attractive, productive, aesthetically high and locally typical, working rural landscape for this area.

50 The absence of any distinct relief and/or patterns of vegetation within the landscape lends a high level of legibility to this landscape. The dominance of pasture and the absence of many visual interruptions, creates a monocultural impression. Many of the trees still standing appear to have been historic shelterbelt plantings that have now grown beyond that function due to the lack of ongoing management.

51 While development is limited, established dwellings provides an indication of the weather conditions experienced locally. Older houses are typically enveloped by extensive planting to mitigate the impact of wind in this environment, with newer houses showing new plantings that appear to seek the same end.

52 The settlement of Mangamaire (estimated to be around 11 houses) is a loose cluster of houses in the vicinity of a large and prominent electricity substation, a feature of this location.

53 This working landscape is not unique to this area. It is a relatively generic rural landscape commonly experienced in this part of the Wairarapa Bush locality. Nevertheless, the expansive views across the flat pastures to the surrounding hills conveys a visually coherent outlook that while typical, has high amenity and aesthetic value.

54 Transient values are associated with weather systems and light effects, which at times of the day / year emphasise the rolling landforms and distant hills. Deciduous vegetation within the Mangatainoka River provides some seasonal interest; however, due to the incised nature of the river, the effects are not prominent.

Associative

55 "***Associative*** *means the intangible things that influence how places are perceived – such as history, identity, customs, laws, narratives, creation stories, and activities specifically associated with a landscape."* [9] Typical Associative factors includes cultural (tangata whenua) and historic values as well as shared and recognised attributes such as recreational opportunities.

56 No cultural or historic sites of significance within the receiving environment are listed in the District Plan or apparent from site investigations. From discussions with representatives of Ngati Kahungunu, we are advised that while there are wahi tapu in the area, the Proposal will not impact adversely on them.

57 The Mangatainoka River is a well-known recreational river well known for its trout fishing. It is unknown whether the stretch of river that runs adjacent to Site B is a location popular with fishers.

Assessment of Visibility and Visual Effects

58 "*Visual effects are a subset of landscape effects. They are consequences of change on landscape values as experienced in views. They are one technique to understand landscape effects*."[10]

59 The visual assessment has been undertaken from a range of viewpoint locations within the receiving environment, which represent the visual effects that may arise from the proposed solar farms. The viewpoints were chosen from a desk top study and confirmed after site observations in addition to the three

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[9] *'Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 79.*

[10] *Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 79.*

public roads are primarily dictated by the location of the existing dwelling located on surrounding properties. Following an RFI from TDC, several additional more remote properties were identified for consideration and finally following submissions, additional 'potential' or 'speculative' sites were included within the assessment.

60 The flatness of the surrounding landscape in combination with the vegetation that lines the Mangatainoka River, the hills that line the western boundary, the slight contours that one experiences when travelling on Mangamaire Road towards the sites from the south and remnant shelter belts experienced when travelling towards the Site from the north, means the visual catchment of the Site is limited to the immediate surroundings of the two sites; for 1.4km along Tutaekara Road between the foothills and Mangatainoka River bridge west to east and approximately 2.3km from about 0.7km north of Tutaekara Road to approximately 1.6km south along Mangamaire Road.

61 Within this limited area, the two sites are highly visible from both public roads when within 2-300m of a farm site. The new sites will be variously visible from 9 residential dwellings proximate to or overlooking the proposed two sites.

62 The two sites and the Proposal will also be seen from the elevated paddocks of the farms to the west of the two sites. As there were no identifiable buildings sites within this area, views from this area were not initially considered, however following an RFI from TDC, an additional assessment was undertaken. Finally, following the receipt of submissions, further properties have been included. In all instances in a rural environment like this, more emphasis is placed on views from dwellings rather than paddocks, this is because they are frequented daily whereas some parts of rural properties are infrequently used. A detailed consideration of the farms visibility from surrounding properties appears later on in this evidence.

63 The sites will also be partially visible from some sites within the Mangamaire settlement and Site A and to a lesser extent Site B will be visible from trains using the Wairarapa Line.

64 The anticipated impacts of what is proposed on the different locations is considered in detail under the following headings:

Public Roads: Mangamaire and Tutaekara and Doughertys Roads

65 The solar farms will be visible to some extent from Tutaekara and Mangamaire and Doughertys Road.

66 When travelling west along **Tutaekara Road**, the busiest of the local roads and a popular connecter road connecting the Mangahao River valley to the town of Pahiatua. Site B will become visible on crossing the Mangatainoka River bridge, **refer to Viewpoint Location Photographs 1 - 3 and Figures 4 and 6)**. Initially the existing farmhouse and the associated activities will provide some screening. However, Site B will be prominent due to its 'rural industrial characteristics and vertical scale in this flat landscape.

67 On passing the farmhouse connected to the parent property **(GA Viewpoint 2),** Site B will be immediately adjacent to the road and prominent for a distance of around 380m until the road's intersection with Mangamaire Road. An evergreen Cyprus/totara hedge is proposed as screen planting along the initial 130m of the boundary. Evergreen shelterbelts form a historic component of the Wairarapa landscape as generations of farms have used them to manage the effects of wind. The hedge planting is to be managed in the long term at around 3-4m, with screening up to 2-3m being achieved within 3-5 years.[11]

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[11] It is anticipated that a cypress hedge will achieve a height of 3m within a time period of 3-4m while totara would reach a height of 2.0m after 5years.

68 Due to the flat nature of the Site and the impact of existing shelter belts, views south from Tutaekara Road do not extend far beyond the southern end of the Site.

69 Consideration has also been given to the potential of glint and/or glare causing concerns for drivers. I refer to the Glint and Glare report, where no glare is found to impact either of the two public roads even when not protected by the proposed shelterbelts.[12]

70 On approaching and reaching the intersection with Mangamaire Road **(Viewpoint Location Photographs 4, 7, and 8),** the Mangamaire Substation becomes prominent and dominates this landscape and its amenity values.

71 On passing the substation, the road passes a scattering of buildings that make up the Mangamaire settlement before entering the hills to the west and losing all views of the subject sites.

72 When travelling east on Tutaekara Road, the sites become partially visible at a distance of between 6-700m as one enters the valley, while Site A is partially visible between houses and remnant shelterbelts. **(Viewpoint Location Photographs 5 and 6).** The rural industrial quality of the structures, will be noticeable as locally unusual points of interest, but the structures will not dominate. After 3-5 years the shelterbelt planting along the northern edge of Site A and the native planting in the vicinity of the wetland will screen all views of the solar farm.

73 Once the road passes the substation and related infrastructure, views of the solar tables will be possible for a distance of 300m. Due to the shape of the application site, and the fact that the northern corner of Site B will not be used for solar panels, all visible solar tables will be set a minimum of 110m back from the road boundary. Due to the angles of the rows, this view will offer more extended views down the various rows where the pastoral land use will be more visible between and under the rows. The nature of the views will vary as the solar tables more and adjust through the day.

74 From Mangamaire Road, both solar farms will be visible at some point as they will be located adjacent to and on both sides of the road. A solar farm will be on either one or the other side of the road for 1.6km and on both sides for 165m, refer to Viewpoint Location Photographs 9 - 12. Site A will first become visible 1.8km south of the intersection with Tutaekara Road.

75 Mitigation planting is proposed on both sides of Mangamaire Road in locations beyond the protected corridors, specifically 22m back from the western road boundary and on the eastern boundary. With the planting of cypress/totara trees as proposed, visibility of the sites will gradually diminish over 2-5 years.

76 The local landscape and amenity values are aesthetically high but are not regionally unique. The visual catchment of what is proposed is restricted locally, electricity generation currently forms a prominent component within the local landscape and the amenity of the surrounding landscape, while high, is of a working rural landscape.

77 The surrounding landscape is flat, visually uniform and generally devoid of any screening vegetation with many of the existing trees internal to Site A needing to be removed to accommodate the layout of the solar farm. This lessens the absorption capacity of this landscape to what is essentially a change of land use.

78 Introducing built structures into this landscape will reduce the rural character values of the Site by removing open pasture and introducing a built form and landscape pattern that does not currently exist.

[12] 16/08/2023, 09:16 Existing and 3m mitigation planting - Roads - 2P Site Config

79 Due to the structures' height, the surrounding landscape's flatness and their proximity to the road boundaries, the structures and/or the mitigation planting will partly obscure views over a rural outlook, including longer views beyond the sites. It is noted the screening of, or interruption to, long views can occur with shelterbelts as a permitted activity. It is established as a reasonably common feature within the surrounding rural landscape.

80 The proposed development will inevitably change the conventional or familiar rural character values of the local area. However, with the setbacks that are now proposed and the rural aspects of the land use, in particular, the retention of the pasture for ongoing grazing and therefore traditional productivity values, will remain visible, maintaining some rural character values. While not a conventional rural land use, the solar farm can be considered a productive land use in the sense of capturing the sun's resource and converting it into power.

81 The use of a 1.8m high security fencing around both sites may appear anomalous and tend to reinforce a more industrial character. To mitigate this aspect, it is proposed to use the more traditional deer fencing with 'hot wires' to achieve the desired outcome. The erection of deer fencing in this rural area is a permitted activity, and so is not considered to contribute to the visual effects of the overall development. However, the required signage attached to the fence would not be 'typical', and the proposed mitigation planting will negate the impacts.

82 **Doughertys Road** extends approximately 1.4km north from its feeder Pukewhai Road. The road runs parallel along this length with the Wairarapa Rail line.

83 Due to the flatness of the surrounding land, Site A has the potential of being visible from this road, however, due to the scale of the landscape I do not consider it to be dominant. The southern boundary of the farm will be screened using shelter planting. At the northern end of Doughertys Road, one approaches the southern boundary of lot A and the solar panels adjacent to the rail line will become increasingly visible. Due to the isolated nature of this view

84 The proximity of the public roads to the two farm sites means that the land use change due to the development of the two sites will be prominent and unusual, novel or as described by Mr Bray, 'they will be noticed'. This change will be localised, and many of the qualities of the surrounding landscape, the vastness, the flatness, the containing hills and the dominant rural landuse will remain. Locally the short-term impact will be **moderate-high**, but reducing quickly to **moderate-low** or **low** over t a 2-5 year period until the shelter planting establishes.

Neighbouring Residences:

85 14 neighbouring properties are impacted to some degree by the Proposal with an additional 7 located within the Mangamaire Settlement. To date, six owners have provided affected party agreements to the application.

86 The officers' report has identified 21 properties that they considered to be potentially impacted on by the application. I will consider each in turn, using the plan references as shown on GA pg 3. From submissions, additional sites have raised concerns about the development and as a result additional assessments have been undertaken below.

87 Visual impacts have been undertaken with regard to the following properties Plan references are as per the officers' report;

(i)	A	451 Mangamaire Road
(ii)	B	431 Mangamaire Road
(iii)	D	391 Mangamaire Road
(iv)	F	154A Tutaekara Road,
(v)	K	500 Mangamaire Road
(vi)	L	Lot 2 DP 546734
(vii)	M	Lots 2 DP 67352
(viii)	N	239 Tutaekara Road
(ix)	O	Sec 90 Blk:X SD: Mangahao ;
(x)	P	3 Foughys Road
(xi)	Q	187 Tutaekara Road 189 Tutaekara Road 205 Tutaekara Road 209 Tutaekara Road 223 Tutaekara Road 229 Tutaekara Road Tutaekara Road
(xii)	Sch	192 Tutaekara Road
(xiii)	R	Sec 7 BLK XIV SD (Mangahao)
(xiv)	S	126 Tutaekara Road
(xv)	T	226 Tutaekara Road
(xvi)	U	Lot 2 DP 564748
(xvii)	V	465 Doughertys Road, Pahiatua

(xviii) W 321 Doughertys Road

88 Dealing with them in turn;

B 451 Mangamaire Road – Chesterman House

89 This house is owned by the Chesterman family and used to house workers on their farm. It is noted that the current occupiers of this property have approved the application.

90 The Site is located opposite Site A. Thick screen planting has been established to address the windy conditions along the road boundary, which will restrict all possible westerly views from the house. Due to existing shelterbelt planting, views of Site B will not be possible from this location.

91 Specific testing for 'glint and glare' (OP17 existing) from this location has found that there will be no adverse impacts on this locality from either Site A or Site B. The pink dots indicate the glint and glare testing sites.[13]

92 Due to the screening currently in place, and the additional screening provided by the proposed shelterbelts, the impact of the Proposal on views from the house will be **low**.

[13] 16/08/2023, 09:09 Tararua Rev5 - SAT - Exisiting Recep - 2P 3mSB Site Config pg15

A 431 Mangamaire Road – Taree Farm - Chesterman House

93 This house is also owned by the Chesterman family and is located opposite Site A across Mangamaire Road. The house appears to have a well-tended established garden of high amenity along the road boundary. While more detailed and tended than others, this planting will also screen most of the views possible looking west from this location. Due to some gaps in the planting, views of Site A from the house will be possible.

94 As the proposed shelterbelts become established over the first 3-5 years, views of the solar tables will gradually diminish to a point when they will not be visible from this property.

95 Specific testing for 'glint and glare' from this location (OP16 existing) has found that there will be no adverse impacts on this locality from either Site A or Site B[14].

96 The shelterbelts will impact amenity by limiting westerly views and rural character by impacting open space values. Considering that the establishment of shelterbelts in this landscape is a permitted baseline outcome, when comparing the losses with what can be undertaken as of right, the impact from this house will be moderate gradually reducing to low as the shelterbelts establish and views of the new farms diminish.

[14] 16/08/2023, 09:09 Tararua Rev5 - SAT - Exisiting Recep - 2P 3mSB Site Config pg15

D 391 Mangamaire Road – Hirock Limited

97 This house is owned by the adjacent quarry and is used to house workers. Discussions have been had with the tenants who have voiced support for the application.

98 The Site is located opposite from Site A and is immediately adjacent to the southern boundary of Site B. Limited vegetation currently exists around this dwelling, which means that views of new structures will be unimpeded until the shelterbelts become established.

99 Given the 22m setback of the shelterbelt from the Mangamaire Road and with the screen planting managed at a minimum of 3.0m height, once established, the new structures will be thoroughly screened. That will result in a partial loss of any view to the western hills. However, it is noted that this is a baseline effect in this area.

100 The property's northern boundary is shared with Site B. Solar panels extend to near the boundary. With the establishment of a shelter belt along this common boundary all views of the panels will be screened. While shading will occur from the shelterbelt, this is a permitted activity within this rural zone and therefore, the affects are considered part of the permitted baseline.

101 Specific testing for 'glint and glare' from this location (OP15 existing) has found no effect on this location from either Site A or Site B. When looking at potential sites OP 25 and 26, 19 and 15mins of green glare are registered with 1min of yellow glare anticipated[15]. with nothing registered from Site A[16].. The graphs for OP 25 and 26 (potential)[17] show the source area to be very limited and the shelterbelt proposed along the southern boundary of Site B is proposed to address this effect.

102 For this reason, I consider the changes anticipated from the Proposal to be **low**.

[15] Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config pg11&12

[16] Ibid pg 20

[17] Ibid pg19

F 154A Tutaekara Road

103 The house at 154A Tutaekara Road is visually separated from Site B by on-site vegetation. The house will not be impacted on by glint or glare stemming from the new structures on Site B.

104 The current residents of this property have expressed support for the Proposal. However while they have a familial connection with the owners they are not the registered owners of this property.

105 Due to existing onsite vegetation, the development on Site B will be in viewed across Section 7 Block XIV Mangahao SD when leaving or approaching the property only and seen at a distance of 140m.

106 The Site is located to the south of this property and so is not in any primary view. The impact of the Proposal on views from the house will be **low**.

K 500 Mangamaire Road

107 500 Mangamaire Road is a 2.2ha isolated section surrounded by a rural paddock with views of the hills, a feature towards the northwest. The primary view of the house and its outdoor areas is north towards Site A, as such, the new farm will be prominent within their view approximately 300m away.

108 Shelterbelt mitigation planting is proposed along the southern boundary of Site A, which, when established after 3-5 years, will screen any views of the solar panels. While a shelterbelt will impact on the extent of the hills that remain visible, this is a permitted baseline activity within this landscape, and therefore this effect can be discounted.

109 Specific testing for 'glint and glare' from this location (OP18 existing) has found that there is no effect on this location from either farm.[18]

110 Once the screen planting is established, the adverse effects of the development on the rural amenity values of this property will be considered **low**.

[18] 16/08/2023, 09:09 Tararua Rev5 - SAT - Exisiting Recep - 2P 3mSB Site Config pg12 & 16.

L Lot 2 DP 546734

111 This property is located immediately to the south of proposed Farm A. The impact of Farm A on this property would be heavily influenced by the intended land use. With regards to any form of **productive use**, any reverse sensitivity effect is not considered to be adverse.

112 Regarding amenity from points within the farm, the impact would be similar to that experienced by road users. Initially, the impact will be high in the short term but less as the shelterbelt planting establishes.

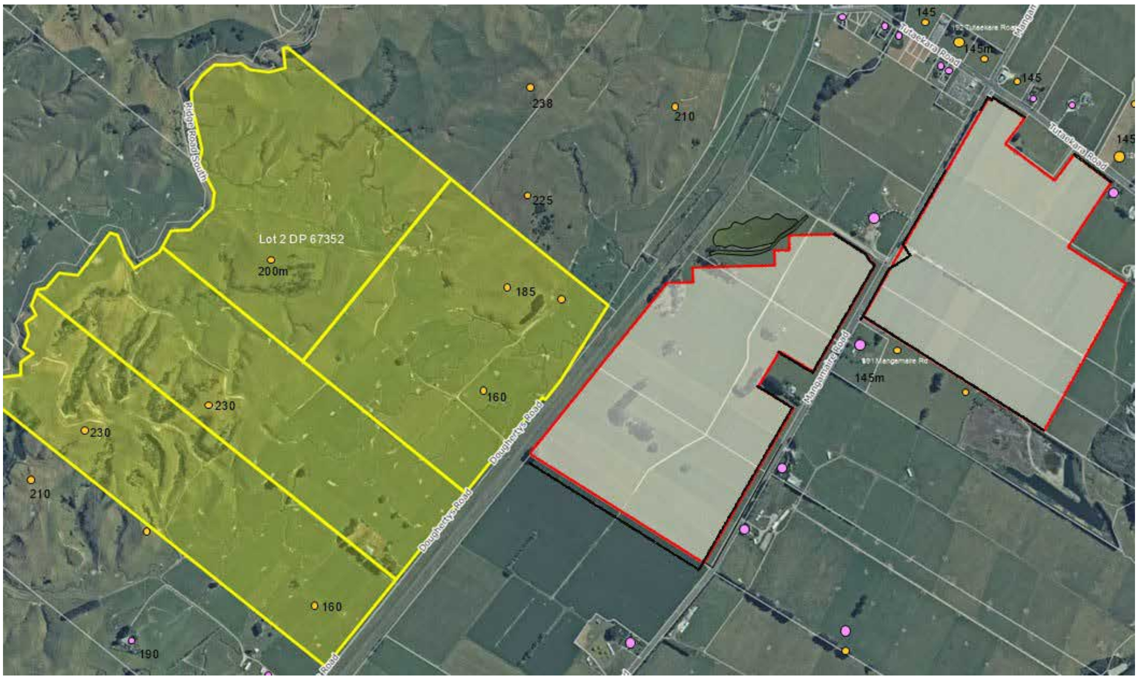
113 Should the long-term use include residential activity, the effect, if considered adverse, could be mitigated to an extent through the design and location of the house.

114 With residential development, it is reasonable to anticipate that planting around the house will be a priority to mitigate the effects of wind in this location.

115 Should this occur 3-5 years after the farm's establishment, then the farm's visual impact will be low.

116 While specific testing for glare was not undertaken on this Site, due to the similar proximity and relative location this Site has to Site A as 500 Mangamaire Road (OP18), it is assumed the outcomes of the glare testing will be the same.

M Lots 1&2 DP67352 Sec 63A 66 Blk XIV Mangahao – Moores



117 This cluster of titles is a working farm with a combined area of 162.7ha. The farm is located west of the application sites, separated from Site A by the Wairarapa Rail line.

118 The farm extends from the rail corridor west across the valley floor for half the Site before extending up 80-90m elevation over the hills to Ridge Road South. The cluster comprises 4 sections, and there is no evidence of a building site on any of the sections.

119 When on these elevated sites, one would enjoy expansive views of Site A with Site B located into the broader landscape. Due to the scale of the farms, the solar tables will be prominent in the views when looking towards the east.

120 As elevated views 1-2km from the sites, the farms will occupy the foreground of a wide and expansive landscape and project a working rural landscape with a particular pattern and aesthetic. The farms would form a prominent subset of this wider landscape. At distances of 1-2km, the industrial detail of the new structures would not be prominent.

121 In order to gauge the impact of glare on these properties, Glint Glare tests were undertaken on the existing residence, (OP20 existing) and a zero reading was returned for both farms.[19] In addition, a number of elevated speculative sites were identified and tested. The results correspond to test locations OP1, 4-10 (potential). Figure 1 below shows the results for 11 sites in different places on the Moore property due to glare emanating from Site B

Tararua Rev5 - SAT - Existing Recep - 2P 3mSB Site Config pg 12 & 16

SAT Array East potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	183	0
OP: OP 4	302	0
OP: OP 5	357	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	299	0
OP: OP 9	238	0
OP: OP 10	1071	208

Figure 1: Screen shot of test results for OP locations 1-10. OP1, and OP4-10 relate to the Moores property[20]

SAT Array West potential temporary after-image

tps://www.forgesolar.com/projects/12086/configs/97637/ 19/.

;/08/2023, 09:02 Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config | ForgeSolar

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	21	0
OP: OP 3	0	0
OP: OP 4	646	65
OP: OP 5	932	563
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	1556	0
OP: OP 9	863	1151
OP: OP 10	1630	1821

Figure 2: Screen shot of test results for OP locations 1-10. OP1, and OP4-10 relate to the Moores property[21]

122 Figure 2 above records the potential glare that could result from Site A on these locations. I will leave a detailed explanation of the implications of these readings to others. The impacts on the identified sites will occur from both sites in the early morning between 5 am and 7.30 am.

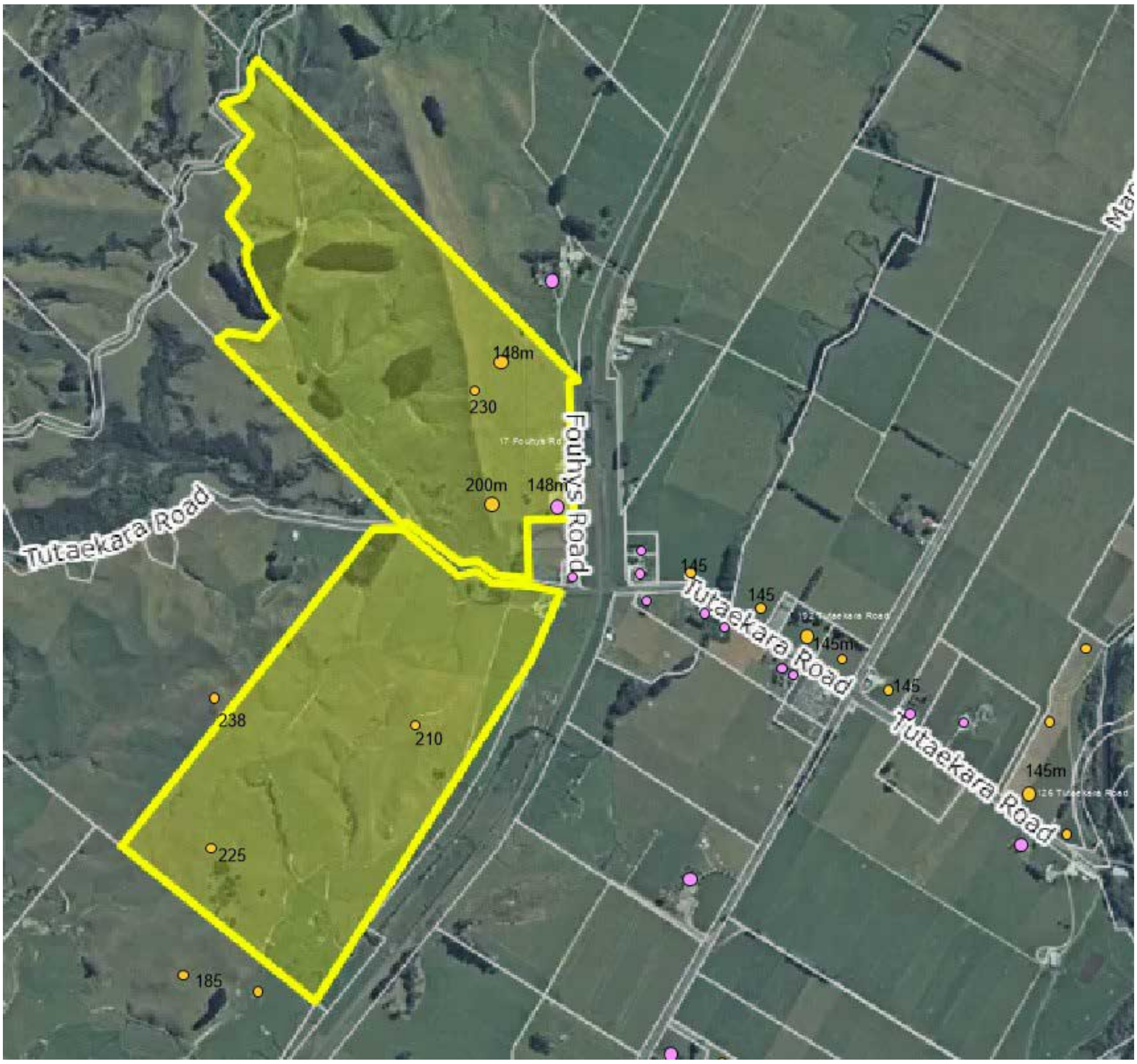
123 In the absence of glare, the aesthetic of the farms would add pattern and texture to the broader landscape and be a point of interest. The adverse impact of such a view on the broader views enjoyed of the surrounding expansive valley landscape would be **moderate-low**.

124 I note the comments made in the Section 42A report and agree with them. Should an elevated development site be considered in the future, the impact of the solar farms can easily be mitigated through the design and location of the new build.

[20] 16/08/2023, 09:02 Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config pg 11

[21] 16/08/2023, 09:02 Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config pg 19/20

N 17 Fouhys Road (239 Tutaekara Road)



125 It is noted that the owner of these sites is in support of the application.

126 The glint study tested 4 sites within the larger property, OP15 (potential) located on the ridge to the north of Tutaekara Road and OP10, 11 and 12 on random elevated locations to the west of Site A.

OP: OP 10	1071	208
OP: OP 11	1082	273
OP: OP 12	1100	209
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	166	0

Figure 2: Screen shot of test results for OP 15 measuring glare from Site B[22]

127 Sites OP 10, 11 and 12 all experience a similar impact from Site B, with a maximum of 19-22min of yellow glare experienced between 5 and 7am between the months of October to March, with yellow glare limited to November through to February[23].

[22] 16/08/2023, 09:02 Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config pg 11

[23] Ibid pg 15 , 16

OP: OP 10	1630	1821
OP: OP 11	0	0
OP: OP 12	1029	0

Figure 2: Screen shot of test results for OP 15 measuring glare from Site A[24]

128 OP10 will be most affected by yellow glare emanating from northern portion of Site A. I refer to Sat Array West OP10[25] ~~anticipated to be a maximum of 43min between 5 and 7am sporadically from October to mid-March. A similar impact will occur on OP12 between 5 and 6am but for a shorter period from mid November to late January.~~[26]

O Foughys Road (Sec90 Blk X SD Mangahao)

129 This property wraps around the back of an existing dwelling.

130 Due to the interference of both the neighbouring building and existing vegetation on the site's southern boundary, views of Site A are only possible from limited points along the Foughys Road boundary.

131 Views from this location towards the subject Site look down Foughys Road, across Tutaekara Road and along the Wairarapa Rail Line. Site A is over 700m away, and any views of Site B would be blocked by existing vegetation and buildings.

132 The glint study has identified that no glare will impact this location.

133 I consider the impact that the development would have on rural character and/or amenity values enjoyed from this location to be **very low**.

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[24] 16/08/2023, 09:02 Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config pg 20

[25] Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config pg24

[26] The time and duration of the glare occasions needs to be confirmed by a revision of the Glint and Glare Report that I have seen and which I reference in this document. pg 23

P 3 Fouhys Road (photo)

134 There is an existing dwelling located on this section. View from this location towards the subject site and look across Tutaekara Road and the Wairapa Rail Line.

135 Views of both sites are a potential; however there is a reasonable amount of visual interference provided by the existing elements within this landscape that are not impacted by the application.

136 Site A is over 650m away, and any views of Site B would be over 700m away.

137 The glint study on this location (OP3 existing) has identified that during the months of mid-November late May, and mid-August-mid September, 311min of green glare will impact on this location emanating from Site B. No glare will be experienced from Site A.[27] It is worth noting that the glare is only recorded from the northern tip of Site B where solar panels are not going to be located. Furthermore, when the shelterbelts have established, the reading for this location is zero

138 I consider the development's impact on rural character and amenity values enjoyed from this location to be **very low**.

[27] Tararua Rev5 - SAT - Exisiting Recep - 2P 3mSB Site Config pg 12

O Mangamaire Settlement

139 Glint and glare testing for these sites has returned a zero result for both farms.

- **187-189 Tutaekara Road**

140 This combined property is registered under a single owner and hence the assessment is addressed as a single property. The three sites contain two dwellings.

- **205 Tutaekara Road**

141 All the properties in this cluster are owned by the crown who have not submitted on this application.

142 Site B will not be visible from this location.

143 With the screening of part of the northern boundary of Site A as proposed, panels, when visible, will be at a distance of over 500m. Given the low amenity values of this location due to the proximity these sites have to the substation, the impact of a distant view of solar panels on the existing amenity values is considered **very low**.

- **209 Tutaekara Road**

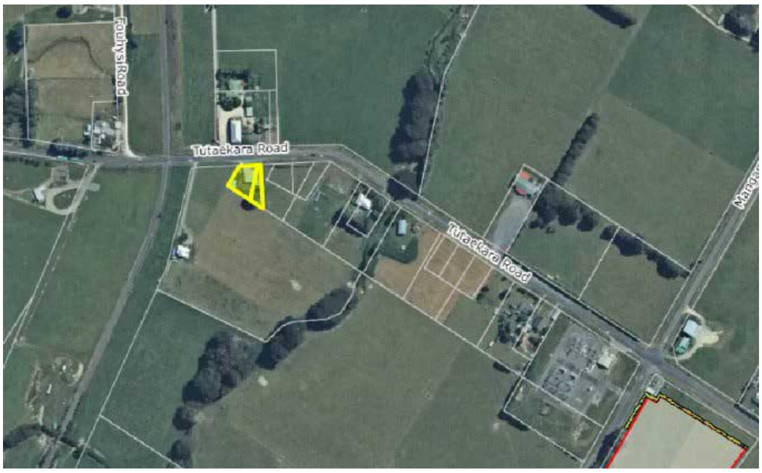
144 This cluster of properties is registered under the same owners.

145 Views of Site B are not possible.

146 Existing views of Site A are partially screened by the remnant planting that currently follows the stream bed. With the additional shelterbelt planting proposed in combination with the buffer planting that is proposed near the wetland, when developed, Site A will be substantially screened.

147 For the same reasons as set out for 187 and 189 Tutaekara Road, with the screening of part of the northern boundary of Site A as proposed, panels, when visible, will be at a distance of over 500m. The adverse impact due to the partial screening and separation distance, the impact of the development on the amenity of these properties will be **low**.

- **223 Tutaekara Road**



148 These two sites are under shared ownership.

149 Existing views of Site A are partially screened by the remnant planting that currently follows the stream bed. With the additional shelterbelt planting proposed in combination with the buffer planting that is proposed near the wetland, when developed, Site A will be further screened with only a small portion of the Site un-screened.

150 Due to the rural character values of the intervening land and the separation distance of over 500m, I would describe the impacts of the application on these sites to be **low**.

- **229 Tutaekara Road**

151 A house has been built in this section.

152 From this building site, it is possible to view both sites A – located 540m south of the existing building, and Site B located 500m south east. Both of these view corridors are partially screened by existing vegetation that is not threatened by the application. The views east are interrupted by substantial tree planting along the creek bed. The views south are more open.

153 With the mitigation planting proposed, both the buffer planting around the edge of the wetland and the shelterbelt planting to the north of Site A, a narrow portion of the Site will remain exposed.

154 This window is approximately 540m away, and the gap is about 80m. The implications of this view on the amenity values of this house site I consider to be **low**.

S 126 Tutaekara Road:

155 This property is located north of Tutaekara Road. The intervening land is flat and when visible, the eastern portion of Site B will be at a distance of between 60 and 400m.

156 The portion of Site B nearest the property will be screened from view by a 3-4m hedge.

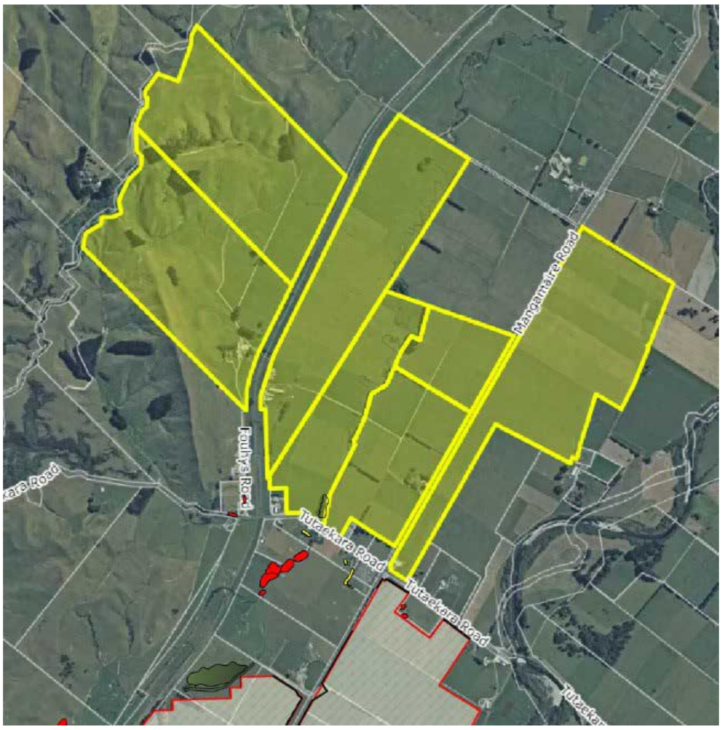
157 Views of Site B will be visible from points within this property at distances of over 300m when viewing across Part Lot 2 DP 83625, 154 Tutaekara Road and Section 7 Block XIV Mangahao SD.

158 A number of speculative locations (OP21, 22 and 23 potential) have been tested and these have all returned a zero result for both farms[28].

159 Should residential development be considered, it is reasonable to anticipate planting to be undertaken around the residence to mitigate the effect of the wind that blows in this area.

160 As a consequence of any such planting, the separation distance that exists and the unknown nature of land use within the intervening sections means that the anticipated impact of Site B on this lot would be **very low** after 3-5 years.

T 226 Tutukara Road



161 The highlighted cluster of properties falls under a single ownership. The farm spans both the area of flatter land on the historic Mangatainoka River flats before rising at its western end up steep slopes before terminating over the ridge at Ridge Road South.

162 Due to the elevation of the ridge, oriented and rising towards the north approximately 60-90m above the height of the farm, it is anticipated that both farms will be visible from points along this ridge. While development on this ridge would be restrictive and complicated, and with a dwelling already located on this title, with the proximity of the road, access to this location is feasible.

163 The glint and glare report prepared has tested an elevated location along this ridge (OP 14 potential). It is noted that no glare is anticipated from either farm.

[28] 16/08/2023, 09:02 Tararua Rev5 - SAT - Potential Recep - 2P 3mSB Site Config pg 11&20

164 On such an exposed site, planting to mitigate wind is highly likely, with an alternative being to place any building down just off the ridge. Either way, this has the potential to limit the views of the two farms in particular a view looking southeast.

165 Depending on the location of any dwelling, the two farms could be up to 1.8km away. In the absence of glare, the farms will be viewed in the context of a wide expanse of pasture and associated planting patterns and will be prominent. The industrial detail of the development would not be apparent.

166 Any new dwelling can design to its context, and should the views of the farms be considered unfavourable; they could easily be mitigated through design.

167 I consider the impact of the farms on a potential building site located prominently on the elevated ridge line to be **moderate-low** and should measures be taken to address the exposed nature of a building site, as a southeast view, this is likely to be lost in which case the impact of the farms on this area is **low**.

U Lot 2 DP 564748.

168 This property is currently without development.

169 The property is visually contained on its northeastern and southwestern boundaries by established planting to the northwest and a hedge row separating the Site from Tutaekara Road and screen the Site from the substation located opposite.

170 Currently, the Site is fully exposed to Mangamaire Road along its southeastern boundary, devoid of vegetation.

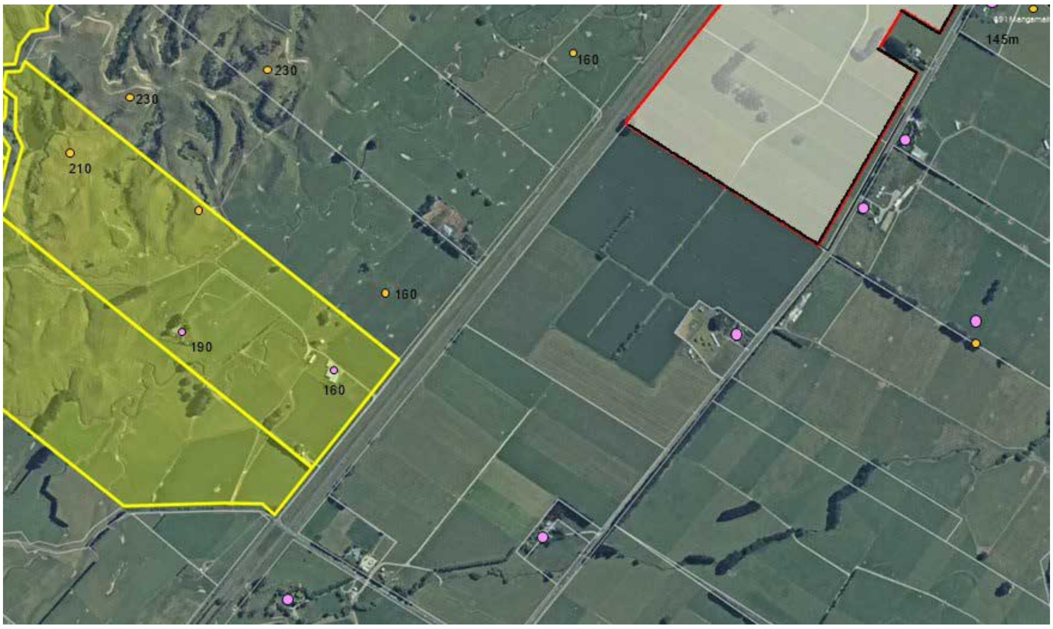
171 Views of Site B are currently possible across the intersection of Mangamaire and Tutaekara Roads. The farm buildings located on Lot 1 DP 369469 opposite and the switch station over Tutaekara Road are dominant within this view. (refer to Viewpoint Location Photograph 11)

172 The northern corner of Site B, closest to the intersection, will only be occupied when the Site is under construction, housing a variety of containers and small sheds, which will be removed when the project is completed. In the medium term, this corner will be an open paddock.

173 When the proposed shelter planting establishes, direct views from this property to the subject site will not be possible. The glint study has identified that no glare will impact this location (OP19 potential).

174 I consider the impact of the development of Site B on the amenity and outlook of Lot 2 DP 564748 will be **low**.

V 465 Doughertys Road, Pahiatua.



175 There is an existing farmhouse located on 465 Doughertys Road (OP20 existing), and glint and glare testing has found that this Site will not be affected[29].

176 Views of Site A from the existing dwelling are limited both by distance (at around 1.3-1.5km) and partial screening provided by existing remnant shelterbelts. With the dwelling site elevated above the plains by about 40-50m, the effect of the mitigation planting will be limited, and some extent of Site A will be visible. However, I do not believe it will be prominent. It will form a point of interest (colour and pattern) within a wider rural landscape; however, the visual distance will negate the industrial detail of the structures and panels.

177 I consider the visual impact of the farms to be **low.**

178 Two elevated sites on this farm, OP2 and OP3 (potential), were tested to gauge any effect from the higher points on the farm. It has been shown that OP3 will be impacted by 183min of green glare emanating from Site B ~~between 6.30 and 7.30 am~~ in late April and from mid-August to mid-September. ~~The duration of the potential glare is anticipated at 3min maximum per day and will comprise equal measures of yellow and green glare~~. The report also shows that OP2 (potential) will experience 21min of green glare from Site A.[30] The glare emanates from from the southern most corner of Site A and over a very limited period in late September.[31]

179 Based on the above, I consider the implications of the glare on the potential sites to be **low**.

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[29] 16/08/2023, 09:09 Tararua Rev5 - SAT - Existing Recep - 2P 3mSB Site Config pg12 & 16

[30] Ibid pg20

[31] Ibid pg21

W 321 Doughertys Road

180 An existing house is located in an elevated location (approx. 60m above the new farms. ~~Glare testing shows that this Site will not be affected~~. This site was not tested for glint and glare

181 Due to the site's elevation, partial views of Site A will be possible at a distance of 2-3km and while noticeable, the farms will not dominate but form a component of a wider rural landscape. The impact this would have on their amenity values would be **low** and reduced to **very low** as the structures become 'familiar'. ~~When assessed for glare, the results were negative.[32]~~

182 The **Wairarapa Rail** line runs up the western side of Site A for a distance of 620m before passing the Mangamaire settlement and crossing over Tutaekara Road. Because there is no passenger traffic along this line, the visual impact of the solar farms on users of this rail line is not considered important and so do not give further consideration as part of this assessment.

183 The **Mangatainoka River** runs east of Site B in an incised riverbed estimated to be 4-5m below the level of the subject pastures. Mangatainoka River runs east of Site B. The minor terraces and extent of riparian vegetation are evident in the Google image. **(Refer to GA photograph 11)**

184 The degree to which this part of the river is used for fishing is unknown. Vegetation lining the banks of the river restrict most views into and out of the river's course. Where gaps exist in this vegetation, offering potential views of the solar structures, the farm is set 170m back from the course of the river. This setback, combined with the depth of the incised river course, will screen the solar structures from users of the river and any impact on amenity or natural character values of the river will be low.

Summary of visual and landscape effects:

185 The significance of the visual effect is influenced by the visibility, distance and duration of the view, the scale, nature of the Proposal and its overall visual prominence, and finally, the effect, if any, the Proposal will have on the context in which it is seen. Where glare is present, this will exaggerate the visual effects of the farm in those particular instances.

~~16/08/2023, 09:02 Tararua Rev5 – SAT – Potential Recep – 2P 3mSB Site Config pg 12~~

186 Whether the Proposal is considered appropriate is determined by the visual effects it may have on the receiving environment, and whether the landscape values attributed to this setting are retained or whether, if adversely affected, effects can be satisfactorily avoided, remedied or mitigated.

187 In general, landscape values experienced visually include rural scenic outlook (views over rural landscape), the legibility of landforms, the general visual coherence of the expansive paddocks and views of the surrounding hills. It is noted that deer fencing proposed as boundary fencing for the property is a permitted activity and is not explicitly considered as a component of the application.

188 The development of a solar farm will introduce a 'rural industrial' component to this landscape however, the essential components of this rural landscape will not be adversely impacted on. While the Proposal will alter the landscape locally, the activity in my opinion remains fundamentally rural. As with other rural activities, scale is an important factor in the economics of any farm and for this reason, a solar farm typically requires a rural location to achieve a workable scale. It can be said that the Proposal represents a rural productive activity for this region that farms or utilises the sun (a natural resource) for the production of electricity.

189 While the patterns created by the solar tables are not 'natural' patterns, the patterns created by the solar arrays do represent a way in which people have manipulated a landscape resource to maximise productivity. The solar farm is, as its name suggests, a method of farming a resource. In this instance, the main difference is that the application will introduce an extensive built form to the Site by overlaying over the paddock landscape that currently exists.

190 However, the pastoral landcover within the application sites will be retained and grazed and in that sense the Site will retain some consistency with a rural character, in addition to this the setback strips that front the two farms onto the two roads, will retain rural character values both in terms of the grazing required to manage these areas as well as the use and familiarity of the shelterbelt planting.

191 It is noted that the solar component of the land use is additional to its primary production through grazing. Sheep grazing and any future primary production potential for the land area affected by the farms remains as the solar farm could be easily removed with no adverse consequences. Soil health and vitality will remain.

The Planning Framework

The Tararua District Council Operative District Plan

192 The Site is located within the Rural zone in the Operative Tararua District Plan (DP) The Site is not located within an Outstanding Natural Landscape (**ONL**) and it has not been identified as an ONL or equivalent within the District Plan.[33]

193 A significant issue identified by the plan is achieving an appropriate balance between rural and non-rural activities. The plan also "*acknowledges the benefits of the generation of electricity from renewable resources*" and recognises the potential visual and amenity effects that facilities such as these can have on their environment. This makes such an application a **discretionary activity**.[34]

194 The plan is motivated to ensure that any adverse effects stemming from development can be avoided, remedied, or mitigated, and to this end, establishes objectives and policies against which development proposals can be considered.

195 Under **Sustainable and Efficient Rural Landuse**[35], the plan sets out a range of objectives and policies, and those relevant to an application of this nature include;

***2.3.2.1 Objective**: To achieve sustainable rural land use and efficient use of resources*

2.3.2.2 Policies
(a) To promote sustainable land management community programs in order to achieve sustainable land use practices which are compatible with the inherent productive capabilities of the land.
(b) To avoid, remedy or mitigate significant irreversible losses of the productive capability of the District's Class I and II soils.

***2.3.3.1 Objective** To maintain the vitality and character of the District's rural areas.*

2.3.3.2 (b) To provide, in rural areas, for activities which require a rural location where their effects are compatible with the surrounding rural area and the environmental results sought for Rural Management Areas.

***2.3.4.1 Objective** To ensure a high level of environmental quality and amenity throughout the rural areas of the District.*

2.3.4.2 Policies
(a) To ensure that any actual or potential adverse environmental effects of activities are avoided, remedied or mitigated.
(b) To maintain and/or enhance the character, level of amenity and environmental quality of the District's rural areas.
(c) To reduce the potential for conflict between incompatible activities in rural areas, particularly in the rural-urban fringe, and between existing, lawfully established activities and new subdivision and development.

196 Under **Amenity and Environmental Quality**[36] the plan refers to Section 7 of the RMA that requires particular regard to given to *"the maintenance and enhancement of amenity values and the quality of the environment",* which is covered by Objective 2.6.2.1 "*To maintain and/or enhance amenity values and*

[33] Tararua District Council – Operative District Plan – Review No 1 – Appendix 3
[34] ibid Pg 2-14
[35] Ibid 2.3.2
[36] Ibid 2.6

environmental quality in the District, for present and future generations" and its related policy *"To manage the adverse effects of activities on amenity values by specifying minimum environmental standards for the development and maintenance of such activities."*

197 Under **Infrastructure,** the plan recognises the importance of renewable electricity generation and recognises the technical and practical constraints that apply to the industry, however, "*it is also in the community's interest that services be provided in an environmentally acceptable manner*."[37] To assist in this, the plan, through objective 2.8.2.1 and its policies, seek to enable the activities, provided that "*adverse environmental effects are avoided, remedied or mitigate"* and further "*To encourage the co-siting of network utility equipment where practicable*"[38] and finally "*To take into account the technical and operational requirements of network utilities and infrastructure in the assessment of resource consent applications for these activities*.[39]"

198 Under **Electricity Generation from Renewable Sources**.the plans objective is to recognise the districts potential for renewable electricity generation[40] while at the same time recognizing that they *"have the potential to cause significant adverse effects on the environment, particularly in respect of amenity values, landscape ecology, noise and traffic, and may therefore be inappropriate in some locations.[41]"* It is for this reason that the activity is considered as a **discretionary activity** and the assessment criteria include matters considering both the benefits and well as the potential adverse effects relating in this instance to amenity values and landscape values.[42]

199 The significance of the effects of an activity will vary depending on the nature of the area and so the District has been divided up into Management Areas on the basis of their existing characteristics and the environmental results sought for the area.

200 The application site is located within the **Rural Management Area**, which covers most of the district outside of the urban centers and the plan sets out a range of characteristics that are sought by the plan[43]. Those relevant to this LVA include:

(a) a predominance of rural activities;
(c) a range of other activities which:
(ii) are more appropriately located in a rural area than an urban area; and/or
(iii) provide social, economic, and/or environmental benefits to the District, Region and Nation;

(d) avoidance of activities that have the potential to give rise to adverse effects which are incompatible with the character of the surrounding rural area or which could adversely affect the ability of rural activities and other lawful land uses to function efficiently and effectively.

(e) development of buildings and properties which are in keeping with the low density, character and scale of the surrounding rural area.

(f) maintenance and/or enhancement of the amenity enjoyed by people living within the rural area or in adjoining urban areas.

[37] Ibid 2-68
[38] Ibid 2.8.2.2a)
[39] Ibid 2.8.2.2e)
[40] Ibid 2.8.4.1
[41] Ibid 2.8.4.2 b)
[42] Ibid 2.8.4.4 a)
[43] Ibid 3.2.1 Rural Management Areas

(k) protection of outstanding natural features and landscapes, and significant areas of indigenous natural vegetation and significant habitats of indigenous fauna from inappropriate subdivision, use and development.

201 Part 5 of the plan sets out the general development rules that are applicable throughout the district. The application would be considered a discretionary activity under 5.3.7 b) *"The construction, operation and maintenance of renewable electricity generation facilities, … not otherwise provided for as permitted activities*."

202 For a discretionary activity, the assessment criteria other than the purpose and principles of Part II of the RMA relate to the objectives, policies and anticipated environmental results in Part 2, the desired characteristics for the relevant Management Area in Part 3 and the rules and standards as set out in Part 5.

203 The relevant landscape criteria for assessment are covered in 5.3.7.4 (d) "*The visual and amenity effects of the facility with regard to the existing character of the area to which the proposal relates, the desired characteristics for the relevant Management Area as set out in Section 3.2 of this Plan, any significant landscapes or natural features identified in this Plan and/or any Regional Policy Statement and/or Regional Plan that applies to the area in which the site of the proposal is located*"

204 5.4.7 of the plan is concerned with any glare/lighting associated with a development, with the relevant standard being "*buildings are to be constructed and finished in such a manner as to ensure reflection (glare) from the … surfaces does not reflect into adjoining properties or adversely affect the vision of motorists on a street or road*." The criteria for assessment are listed in 5.4.7.4 and those relevant to this application include (e) *whether the level of brightness from the surface or lighting is such that it could create a traffic hazard or interfere with the operation of activities on properties outside the Site* and f) *whether the nature of activities on adjoining sites is such that any glare or lighting spill would not be noticeable and would not have a detrimental effect*.

205 Landscape screening is not a specified requirement within the Rural Management Area (RMA) however, it is a requirement in an industrial management area when it is located adjacent to or within 20m of a Rural management area. While this does not directly apply to the application, it is recognised that the Proposal has industrial characteristics and is located within the RMA. As such screen planting needs to be '*appropriate*' and stipulates *"The purpose of landscape treatment (such as dense planting of trees and/or shrubs or fences) is often to provide a visual barrier in order to reduce the potential or perceived adverse effects of an activity on the amenity of the surrounding area.*[44] *5.4.8.2b) stipulates that (b) In all Management Areas, where an activity detracts in a significant way from the visual amenity of the surrounding area (including exterior storage associated with home occupations, hobbies or other activities), effective screening of the activity from the road and neighbouring properties shall be provided in accordance with the standards for landscape treatment/screening below."*

206 When proposed the specified planting needs to be:

• located in the correct place.
• have sufficient depth to allow the vegetation to grow and provide an effective buffer.
• use plants that are suitable for the particular environment.
• have a maintenance program in place to ensure that plants survive and are replaced if necessary (i.e. should any plants die)

[44] Ibid 5.4.8.1

Summary of the effect on Statutory Requirements;

207 As a discretionary activity the Proposal constitutes both a sustainable **and** an efficient rural land use that can easily be removed. The Proposal is the epitome of renewable energy resource and due to the scale of this renewable activity, a rural location is considered essential along with the Site's proximity to an existing power station. As such both the activity and its location can be considered appropriate.

208 To mitigate the visual effects of this activity, generous setbacks from roads have been maintained and shelterbelt planting specified which will maintain to a reasonable degree rural character values on these sites. With the ongoing grazing of the paddocks, traditional rural productivity is maintained.

209 In my opinion what is proposed does not offend the identified objectives and policies of the plan.

Section 42A report:

210 A section 42A report has been prepared by Andrew Bashford with landscape input from Shannon Bray.

211 In his Peer Review of Landscape Assessment Report (12 March2023) the peer review concluded as follows:

> *"in my opinion the landscape effects (after full establishment of the flax shelterbelts) will be low-moderate. The farm represents a change in the activity and character of the Site and will certainly be perceived as different and unique. It contains built form that will diminish the pastoral character of the Site. However, it is located in an expansive, generally flat rural landscape that has been highly modified to achieve optimised production. At its core, it is no different to other farming activity, utilising the environmental resource as efficiently as possible, with the exception of the retention of grass under the panels to help retain a pastoral connection. The Proposal also contains some positive landscape outcomes, including the wetland restoration."*[45]

212 I wholly agree with this opinion.

213 When considering the effects of individual properties, I note that Mr Bray is in general agreement with the assessments that I have made with the exception of 1 property, 500 Mangamaire Road. My explanation for this is at the time I visited the Site, there was a substantial bank of vegetation along the northern boundary of the property which prevented views of the solar farms. This vegetation has subsequently been removed. With the removal I agree with the impact assessment of Mr Bray that the potential impact would be moderate to moderate high. In response to this assessment we are now proposing to plant a shelterbelt along the southern boundary of Site A which will be managed at a height of 3-4m. After a period of 3-5years, the panels will be screened, and the impact will be **low**.

214 A similar situation presents to the lot that wraps around #500. Currently there is no proposed building site to assess, and the proposed shelter belt will address any concerns that these owners may have. In addition, the future location and design of the house can provide further mitigation measures should these be required. I consider the impact to be **low**.

Submitters:

215 I have been supplied with a summary of the submissions made with regards this application and note the comments made by Mr Bray.

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[45] Proposed Mangamaire Road Solar Farm by Energy Bay Ltd Peer Review of Landscape Assessment Report by Rough Milne Mitchell Ltd Peer Review (15 March 2023) pg 7

216 A number of submitters have raised concerns with regards glare on potential future building sites and to try and answer those, a number of 'speculative' building site locations have been identified and tested using the appropriate software.

217 With regards concerns raise over the use of elevated locations (not yet identified) and their susceptibility to glare, (Submitters 4 & 5), I am in agreement with Mr Bray when he states that with all elevated sites, in the absence of specific development site, should views or glare be considered an issue, and with the temporary nature of the glare in particular, this issue can very easily be addressed within the design of the house.

218 Submitter 6 (Stewart Smith) owns Lot 2 DP 564748, any views of Site B will be from the southern boundary of the Site, and I consider the impacts of the application on this Site to be **low**.

219 With regards the concerns of using flax plants as a shelterbelt, like Mr Bray, I am not familiar with the concerns raised. However with the issues raised by the electricity lines company, the benefits of the flax plantings with regards height, no longer apply and to comply with the required setbacks we have alternatively opted for the use of managed shelterbelts. Shelterbelts using either Cypress or Totara are now preferred and as far as I am aware do not carry the same concerns with regards the harbouring of rodents.

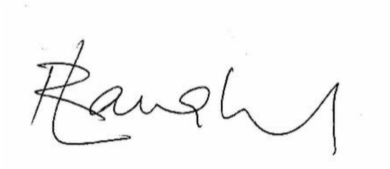
220 Mr Morris has raised concerns about the removal of the existing pines along the Mangamaire Road Site B boundary. Due to the fact that this northern portion of the Site will not now have solar panels in this area, the need to remove these trees no longer exists. They are however old and should they be retained, the retention should be subject to health and safety considerations of the individual trees.

221 I agree with the recommendation put forward by Mr Bray regarding the relative location of the security fence and the shelterbelt planting and this is what is proposed.

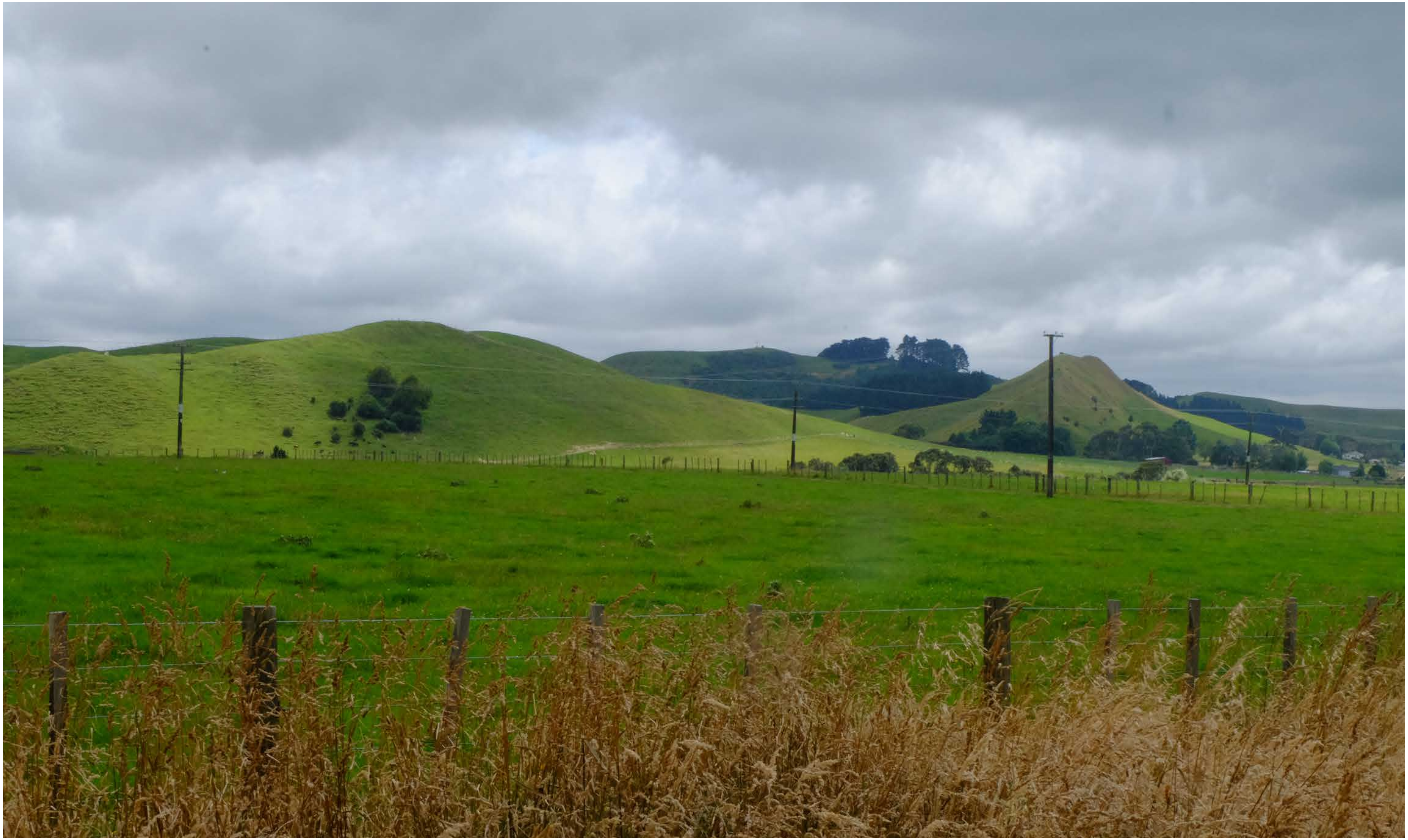
222 Given the anticipated time lag of the various shelterbelts, the screening effect of the shelterbelts will be gradual over a relatively short period of time, possibly as short as two years, to achieve a height at which it becomes effective. Boundary fencing and planting can be undertaken as part of the initial stage of the development which means that as the farm is installed, the shelterbelts are establishing themselves, and the visual effects are increasingly mitigated. I do not consider it critical that they be established in advance.

Attachment:

RORY LANGBRIDGE



Registered Landscape Architect
16th August 2023



Document Information

Project	
Proposed Solar Farm - Mangamaire Rd, Tararua	
Address	
Mangamaire Rd, Tararua	
Client	
Solar Bay Ltd	
Document	
Graphic Attachment to Landscape Assessment Report	
Status	
For Resource Consent	
Revision	
1	For Resource Consent 19.05.2022
2	For Resource Consent 20.12.2022
3	Statement of Evidence 16.08.2023
Prepared By	
Rough Milne Mitchell Landscape Architects Ltd	
Project Number: 22026	
Author: Rory Langbridge	
Peer Reviewed: Paul Smith	

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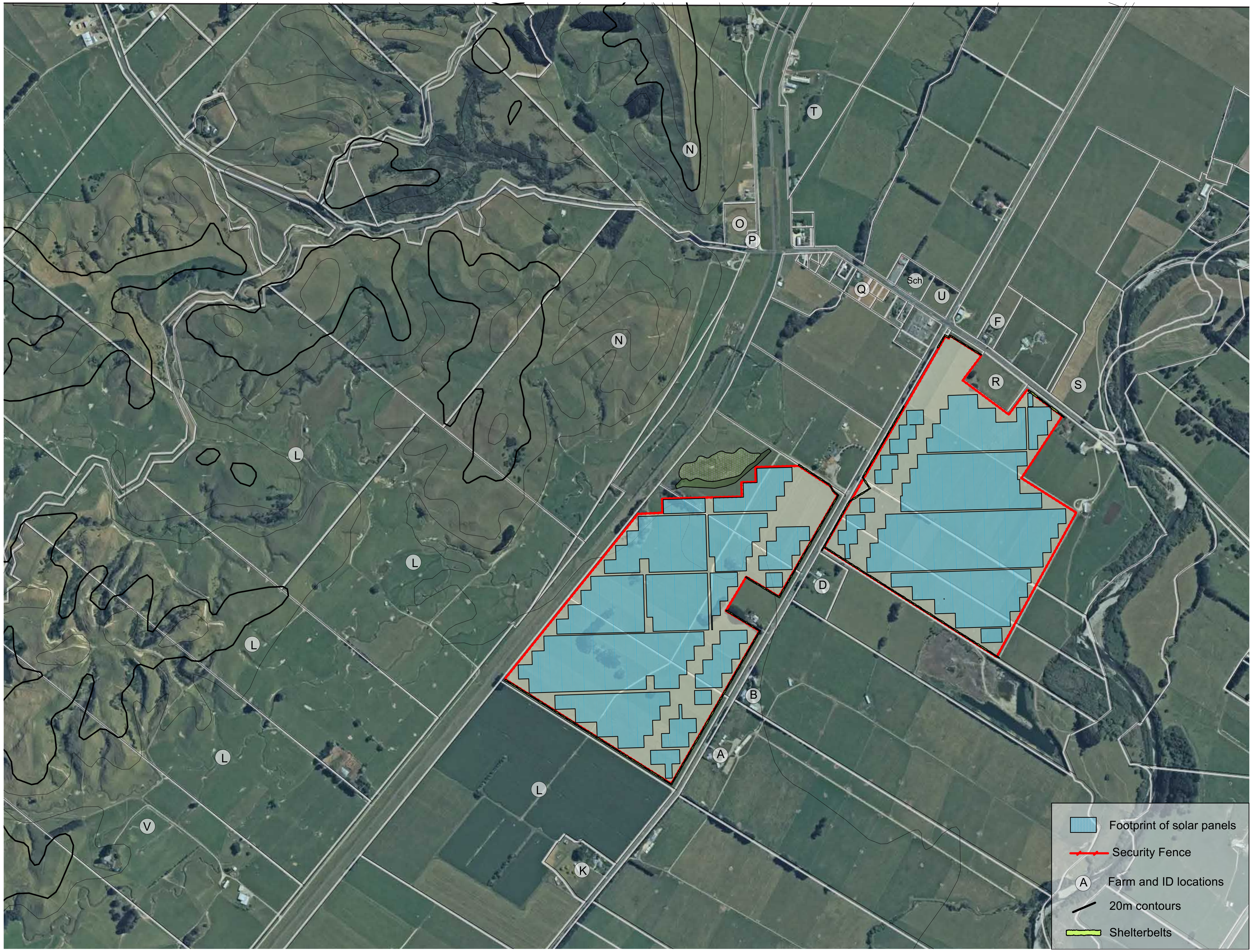
Contents

General Arrangement Plan

A. 451 Mangamaire Road
B. 431 Mangamaire Road
D. 391 Mangamaire Road
F. 154A Tutaekara Road
K. 500 Mangamaire Road
L. Lot 2 DP 546734
M. Lots 2 DP 67352
N. 239 Tutaekara Road
O. Sec 90 Blk:X SD: Mangahao
P. 3 Foughys Road
Q. 187 Tutaekara Road
189 Tutaekara Road
205 Tutaekara Road
209 Tutaekara Road
223 Tutaekara Road
229 Tutaekara Road
189 Tutaekara Road
Tutaekara Road
Sch. 192 Tutaekara Road
R. Sec 7 Blk: XIV SD (Mangahao)
S. 126 Tutaekara Road
T. 226 Tutaekara Road



Scale: 1 : 12,500

Proposed Landscape Mitigation Plan

Legend

Proposed security fence.

Single row of Cypress or Totara hedgerow planting at 1.5m crs

Wetland buffer plants, species and grade specied below, at an average density of 1.5m centres, and planted within the first planting season following the granting of resource consent.

Wetland Buffer Planting: 3140 m²

Botanical Name	Common Name	Grade	No.
Carex secta	Makura	RT	350
Austroderia richardii	Toetoe	RT	350
Juncus edgariae	Wiwi	RT	275
Juncus pallidus	Giant rush	RT	275
Phormium tenax	Harakeke	RT	150

General Notes

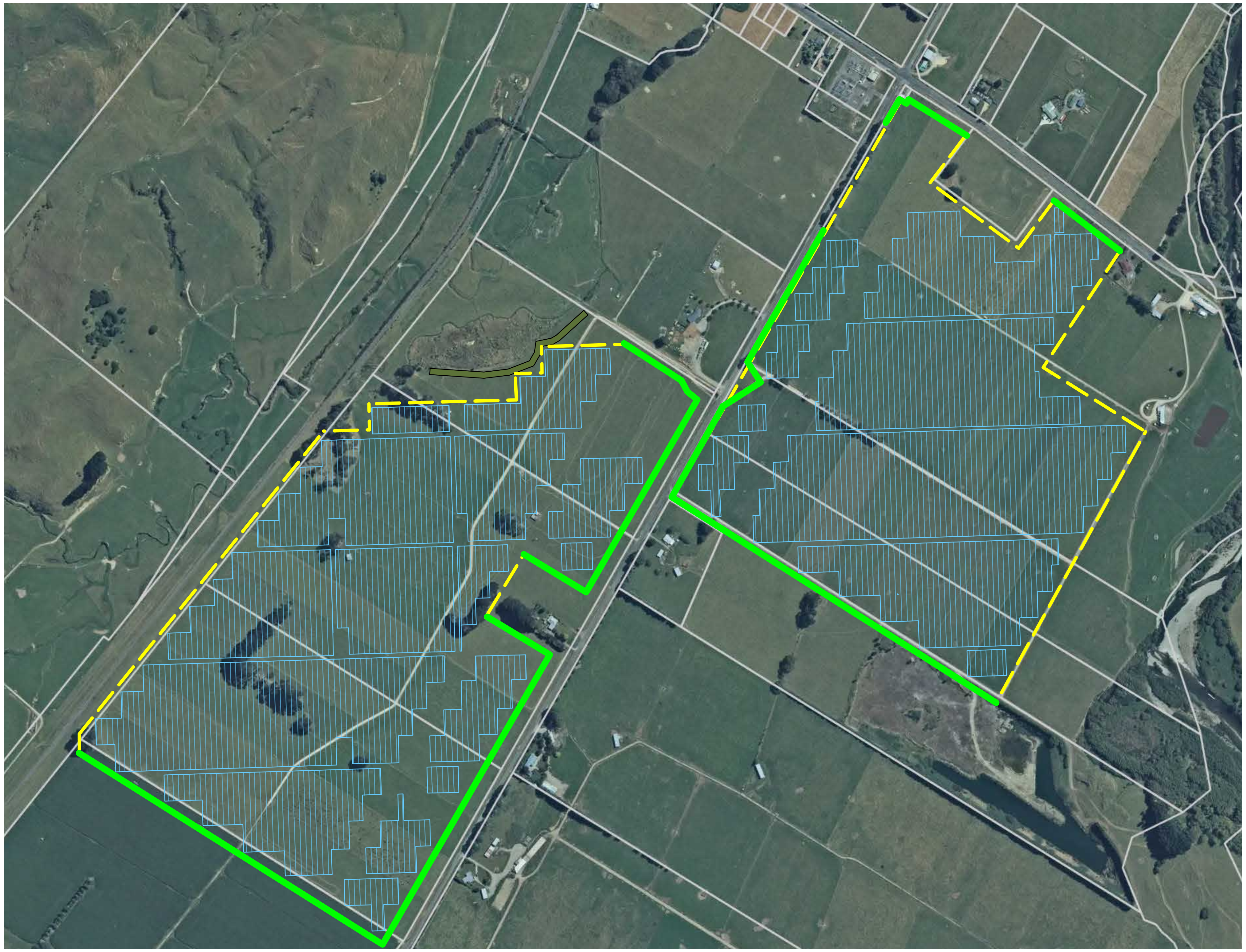
Plants will be sourced from a local nursery who specialises in the production of native species for revegetation.

The plants will be either open ground or Root Trainer (RT) stock.

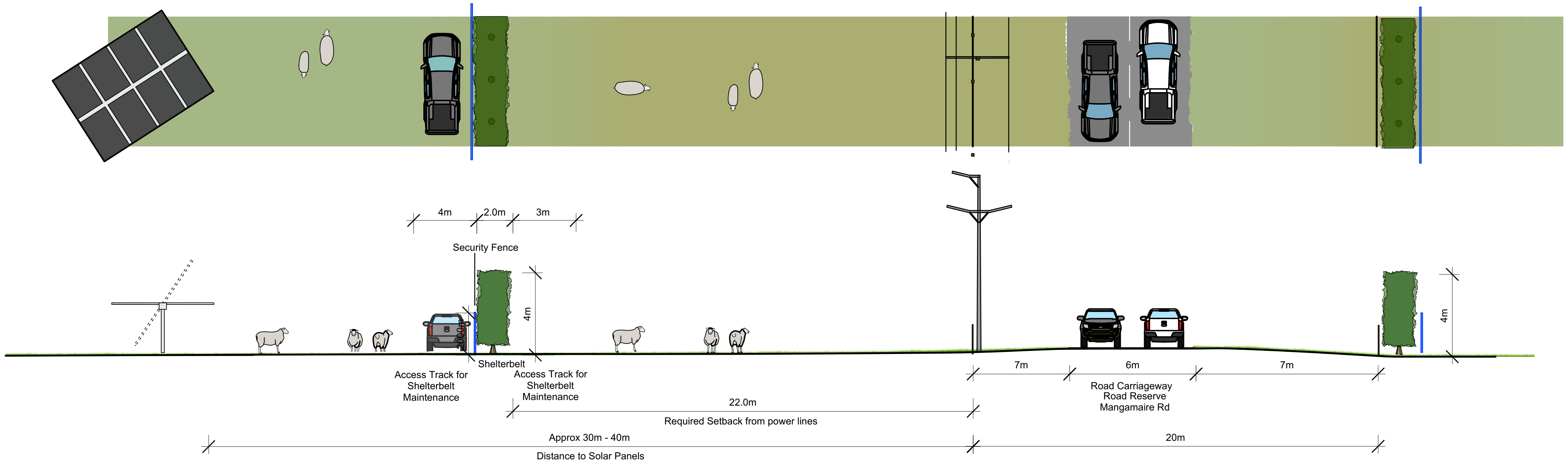
Plants will be planted within the first winter season once the resource consent has been approved and the security fence erected.

Scale: 1:7500 @ A3

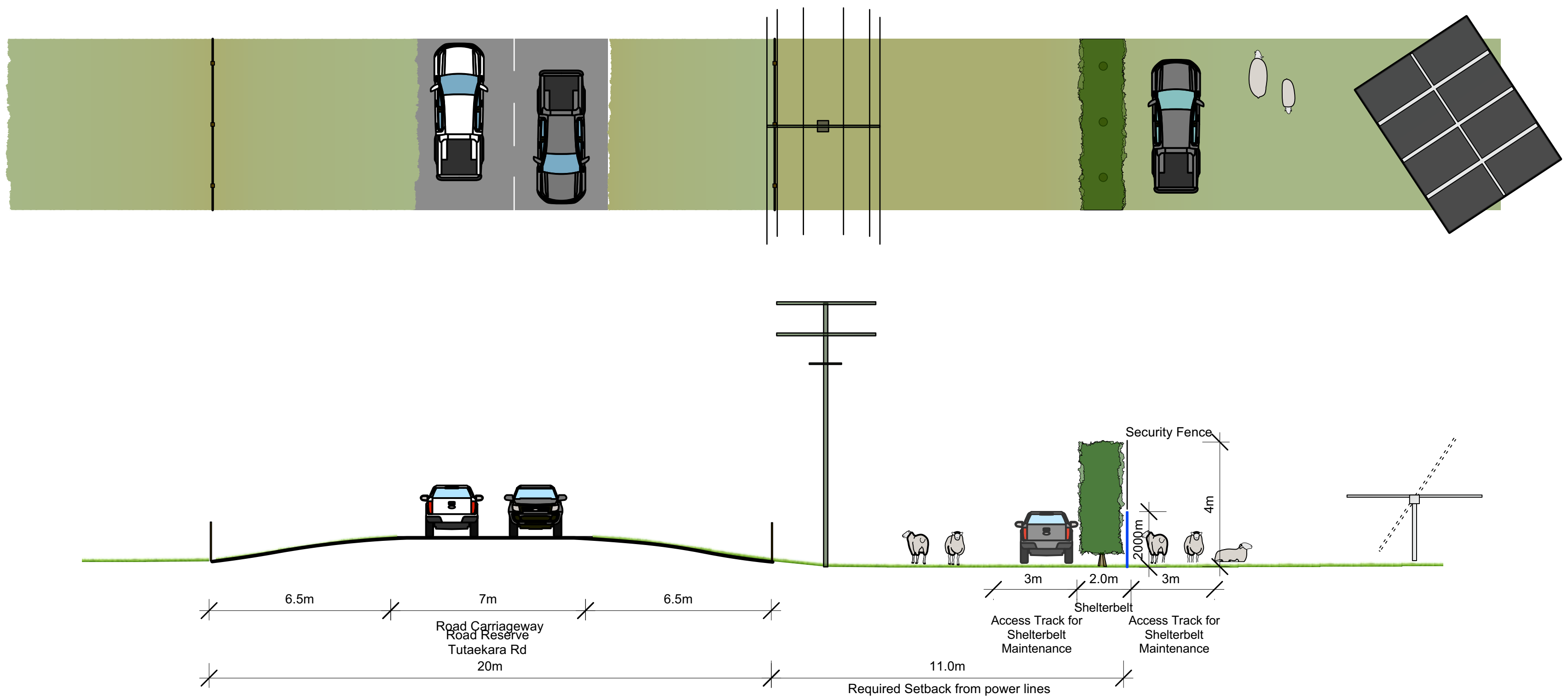
Data Source: Maps.grip.co.nz



Proposed Typical Boundary Treatments



1 Typical Section - Mangamaire Road
Scale: 1:250



2 Typical Section - Tutaikara Road
Scale: 1:250

Solar Panels Examplar Images

A Example of a similar Solar Farm in Marlborough
B Example of a similar Solar Farm in Kaitaia
C Example of a similar Solar Farm in Marlborough

A

B

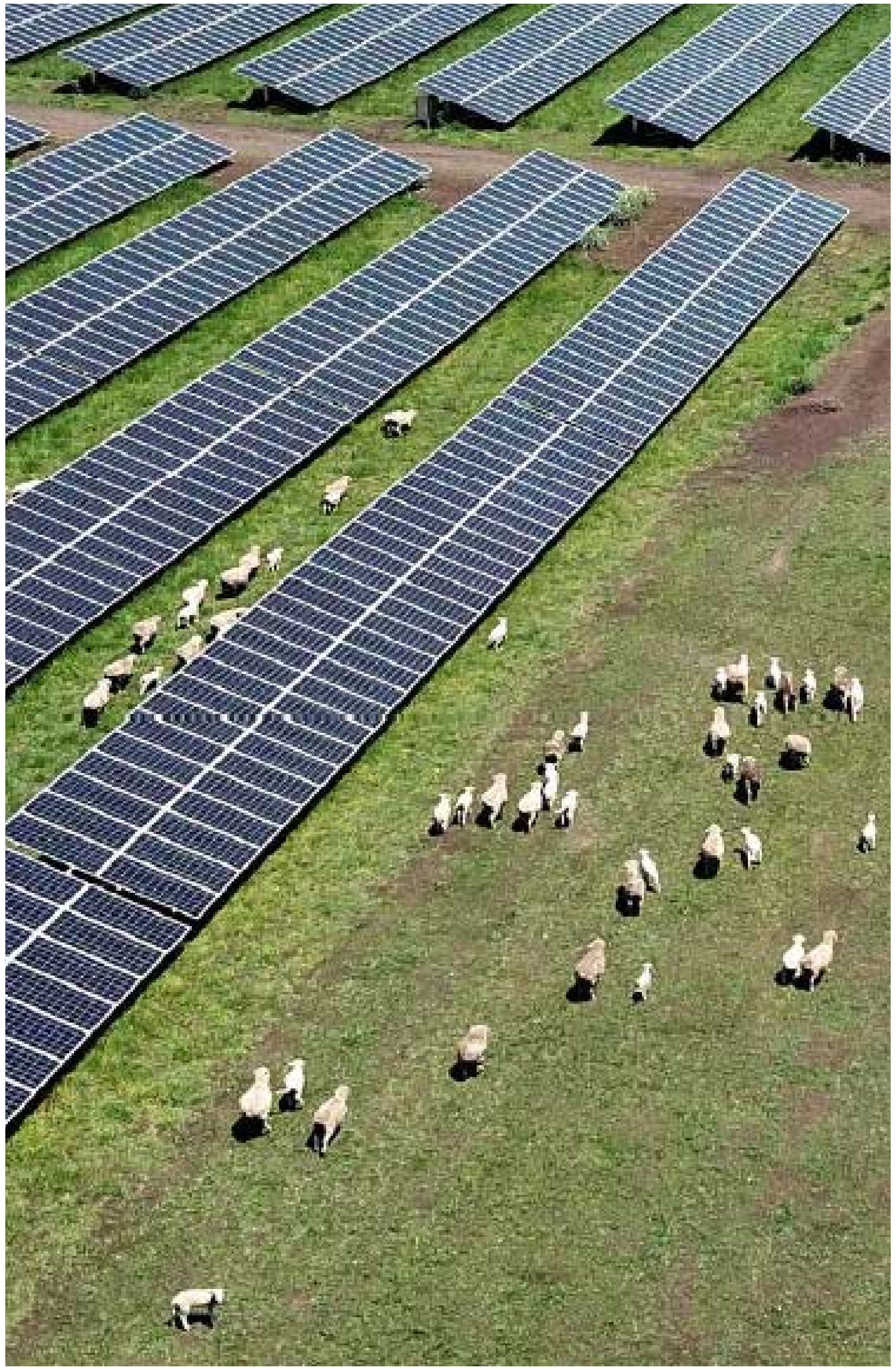
C

Solar Panels Examplar Images

A-C Example of a similar Solar Farm in Australia

A

B



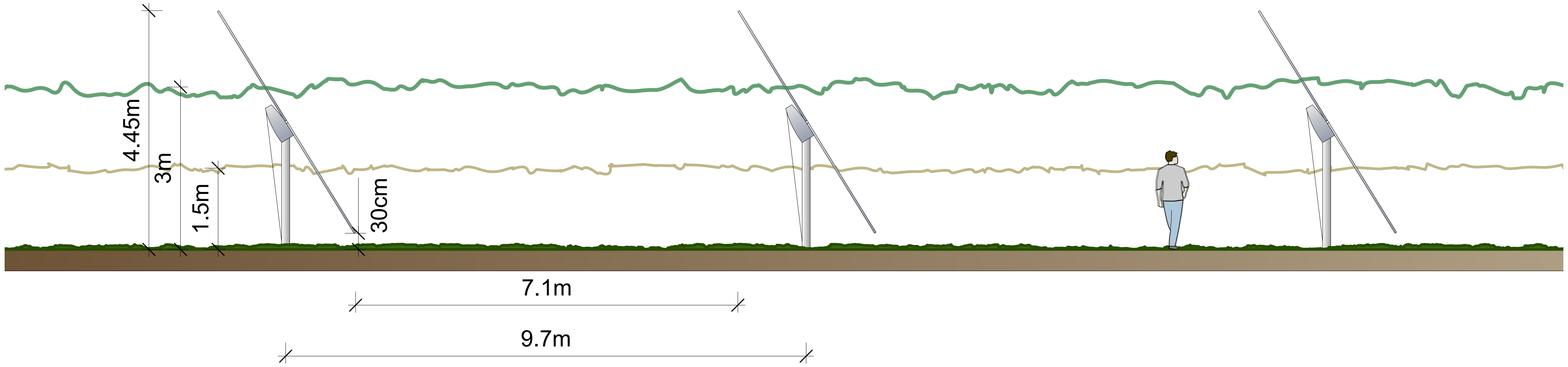
C

Indicative Cross Sections

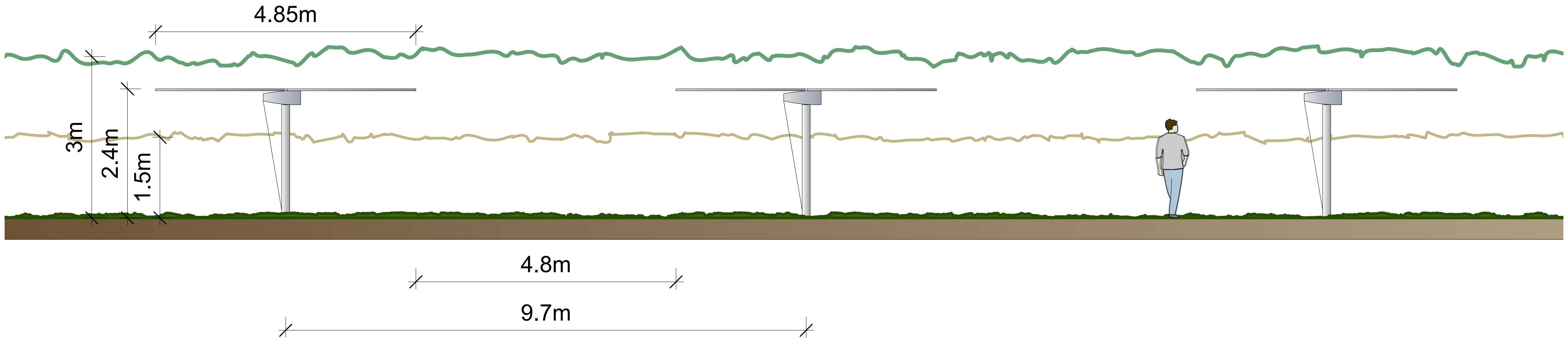
A Morning - Solar Tables at thier Maximum East Facing Extent
B Midday - Solar Tables Parallel to the Ground
C Afternoon - Solar Tables at thier Maximum East Facing Extent

Green line represents native shrub vegetation at 3m tall.
Yellow line represents low shrub/flax vegetation at 1.5m tall.

A



B



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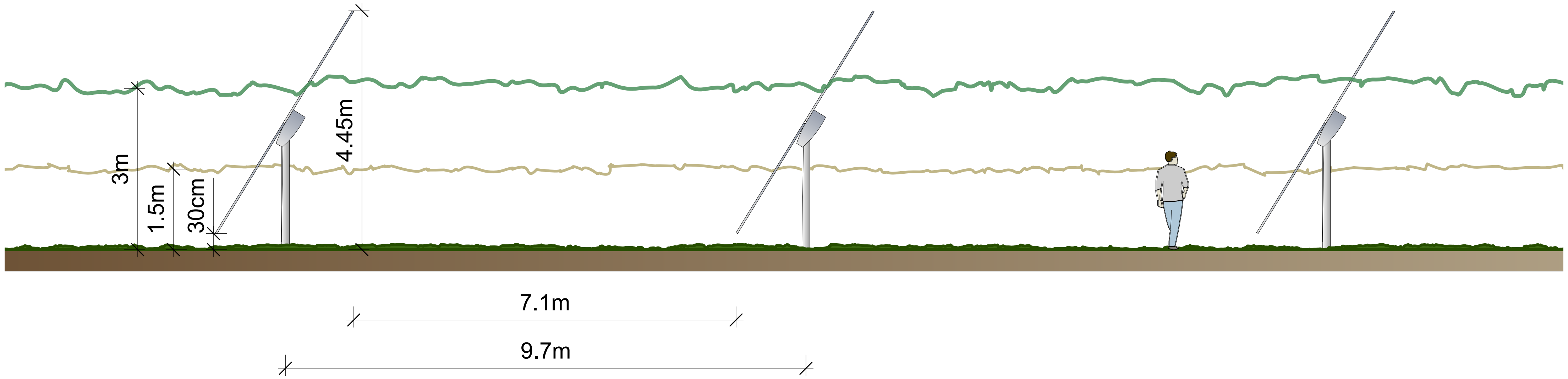
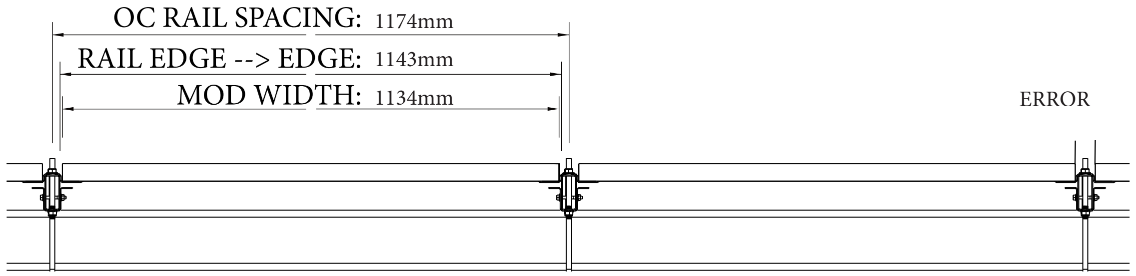


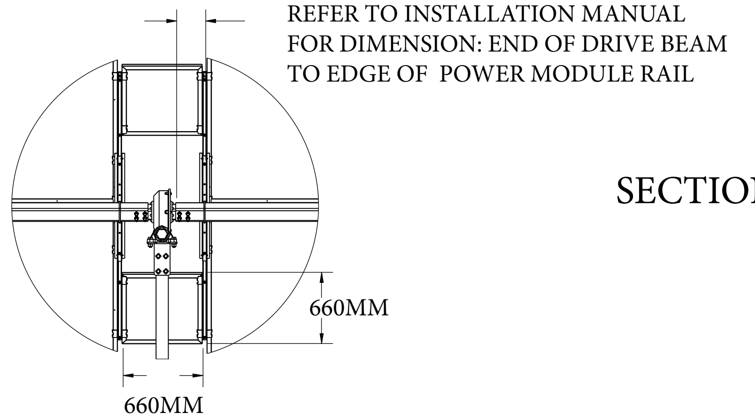
SCALE 1:100 @A3

Mechanical Layout Information

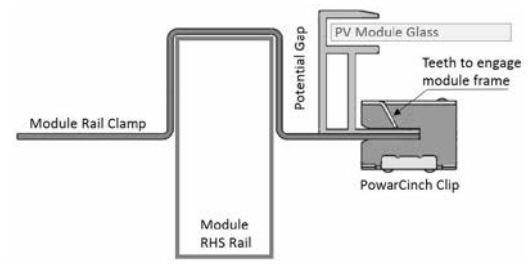
MODULE RAIL SPACING



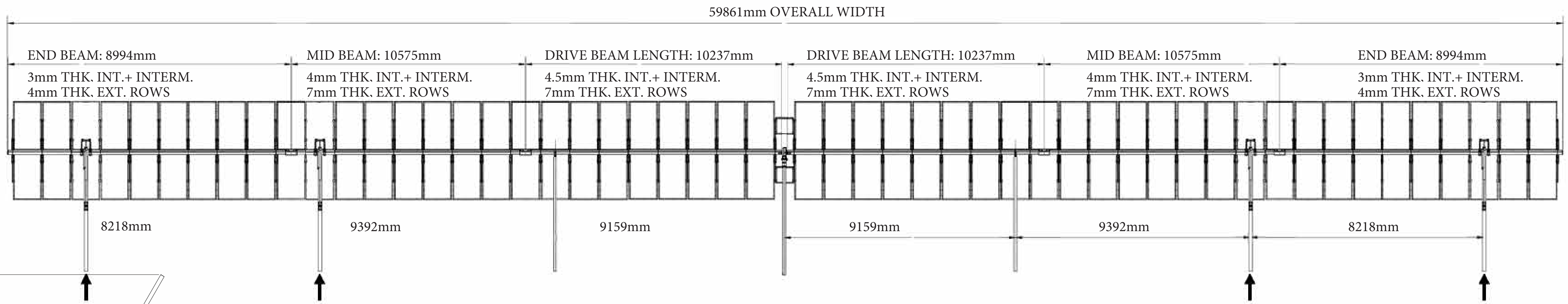
POWER MODULE DETAIL



SECTION VIEW: MODULE RAIL - POWARCINCH

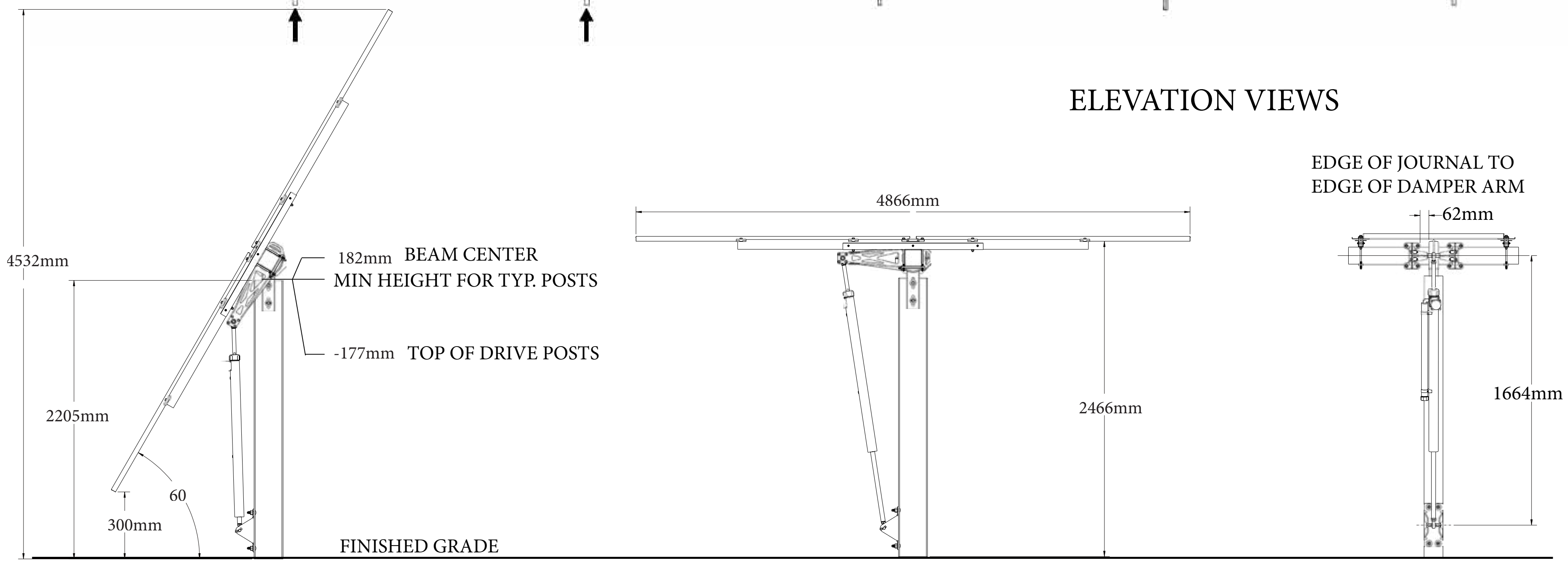


MECHANICAL LAYOUT



NOTE 9: DAMPER LOCATIONS

ELEVATION VIEWS



N-S ELEVATION @ MAX. TILT

N-S ELEVATION @ 0

E-W ELEVATION
DAMPER DETAIL

Not to Scale - To Fit Page

Data Source: Vector Powersmart Indicative Proposal

Solar Panel and Inverter Information

A Example of Solar Panels
B Mechanical Characteristics of Solar Panels
C Example of Inverter

Tiger Pro 7RL4-TV

565-585 Watt

BIFACIAL MODULE
TILING RIBBON (TR)

P-Type

Building **Your Trust** in Solar

A.

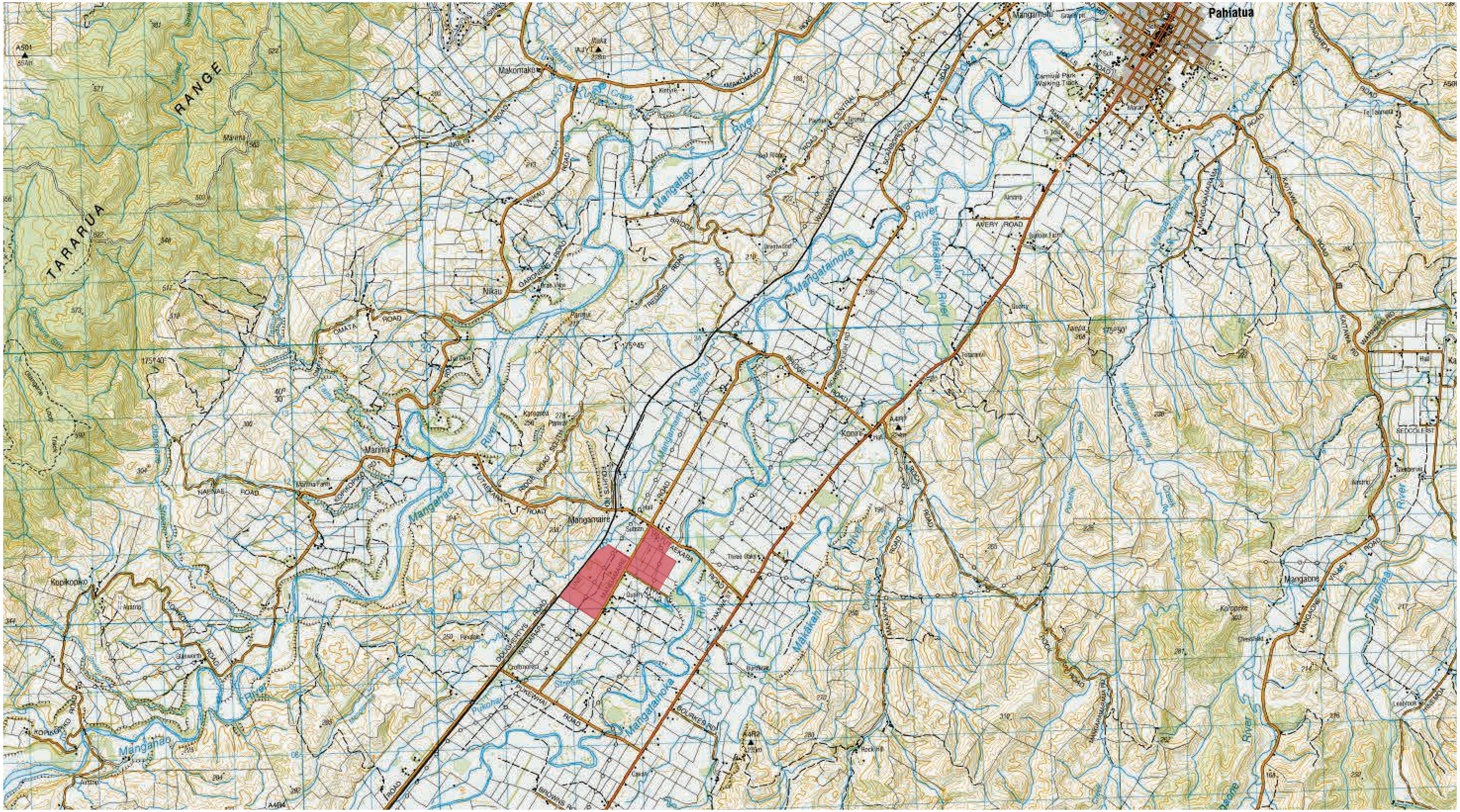
Mechanical Characteristics	
Cell Type	P type Mono-crystalline
No. of cells	156 (2×78)
Dimensions	2411×1134×35mm (94.92×44.65×1.38 inch)
Weight	30.6 kg (67.46 lbs)
Front Glass	3.2mm,Anti-Reflection Coating, High Transmission, Low Iron, Tempered Glass
Frame	Anodized Aluminium Alloy
Junction Box	IP68 Rated
Output Cables	TUV $1\times4.0mm^2$ (+): 400mm , (-): 200mm or Customized Length
Conector	JK03M/2B, genuine MC4 evo 2
Fire Rating	Class C

B.

Dimensions 2.815m (W) x 2.318m (H) x 1.588m (D)

C.

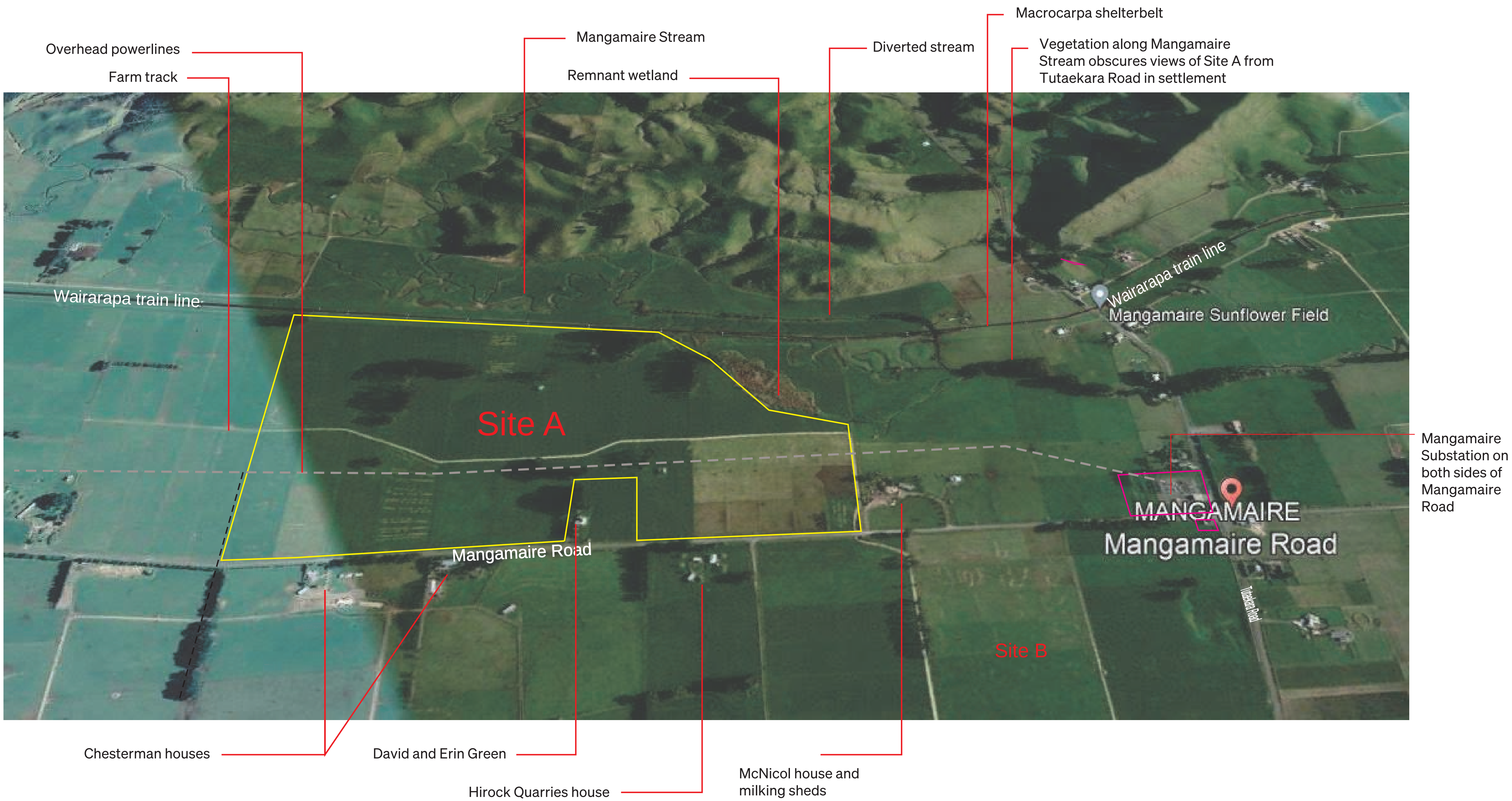
Wider Context Plan



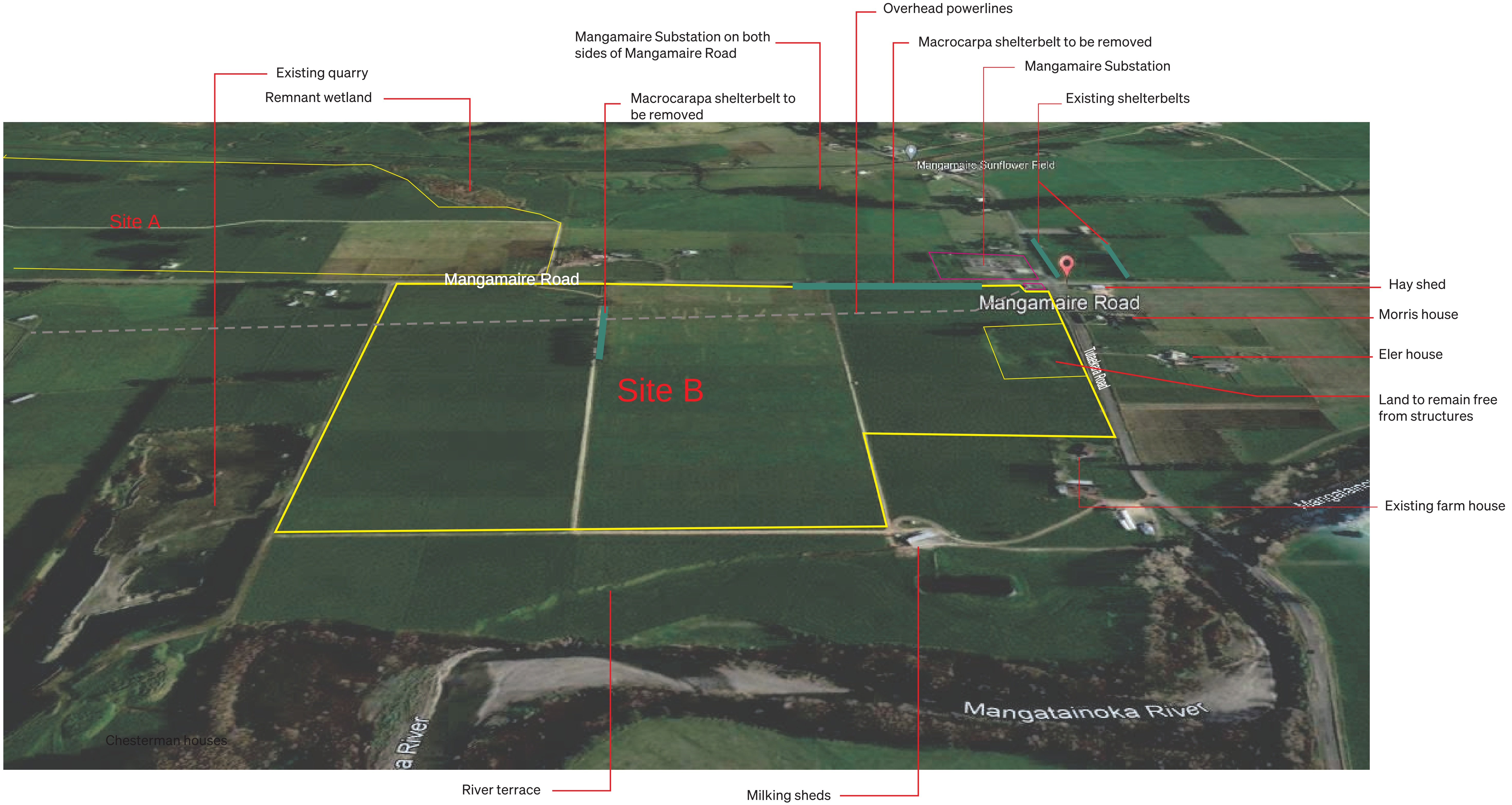
Not to Scale

Data Source: topomap.co.nz

Site A Context Plan



Site B Context Plan



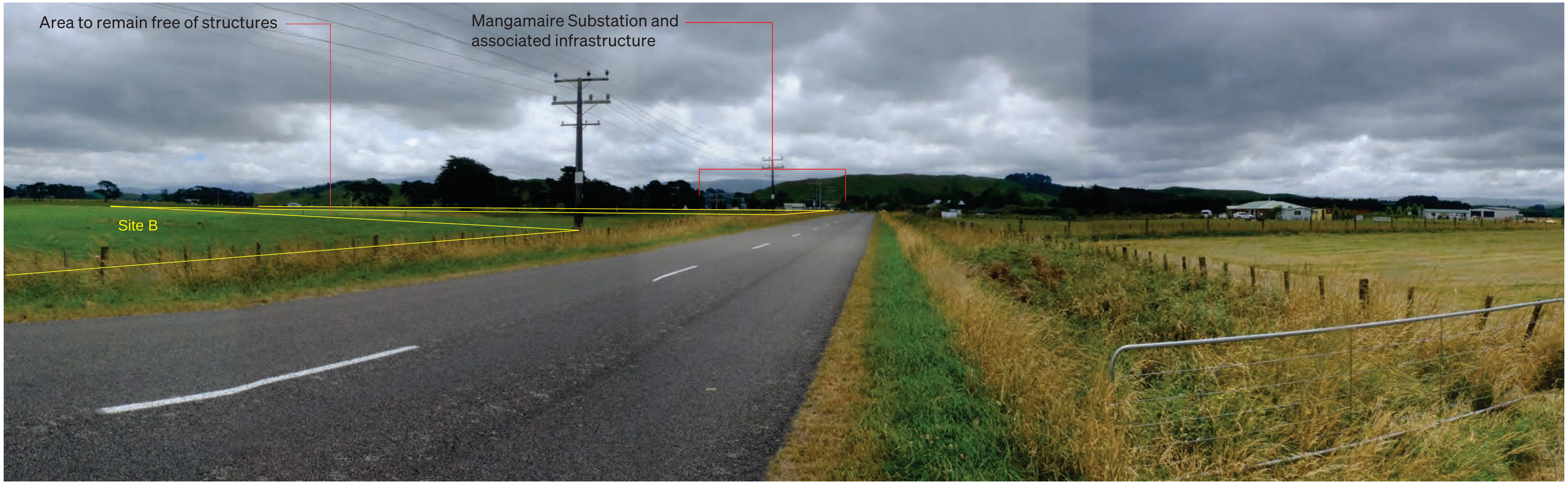
Viewpoint Location Plan

Viewpoint Location Photographs

Viewpoint Location Photograph 1: When crossing the Mangatainoka River bridge, while partially screened by the existing farm house and related activites, the solar table son site be will be visible and prominent due to their industrial like qualities and vertical scale in this flat landscape. The prominence of the panels will be reduce as the proposed shelter planting is established. The 11m set back from the road boundary that will be created will be grazed as pasture management which will retain visible traditional rural character values.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photograph 2: On passing the farm house, the solar structures will be fully visible until such time as the shelter belt becomes established (2-5 years) The shelterbelt set back and associated grazing will both screen the solar farm and provide visible rural character values.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

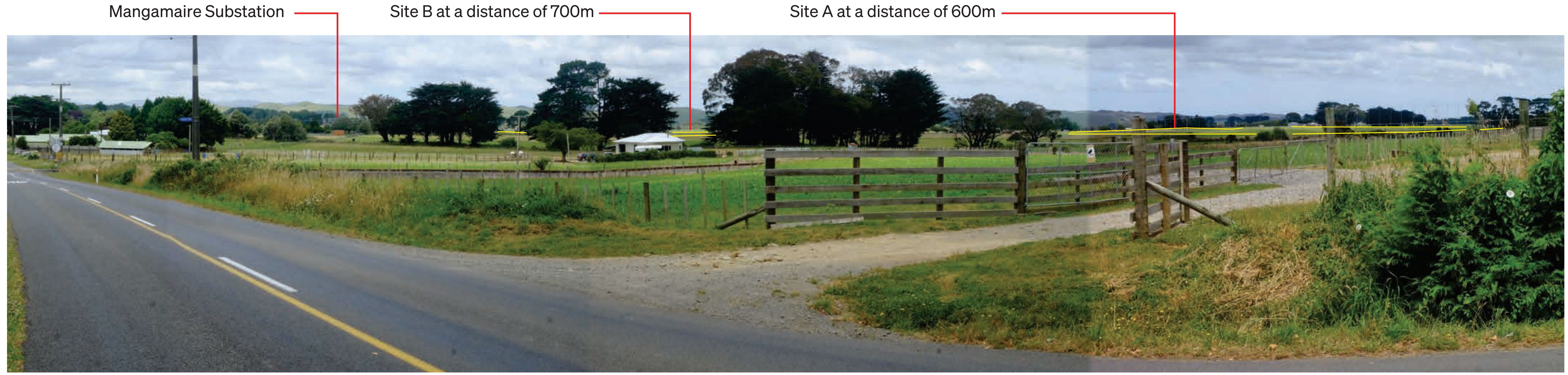
Viewpoint Location Photographs



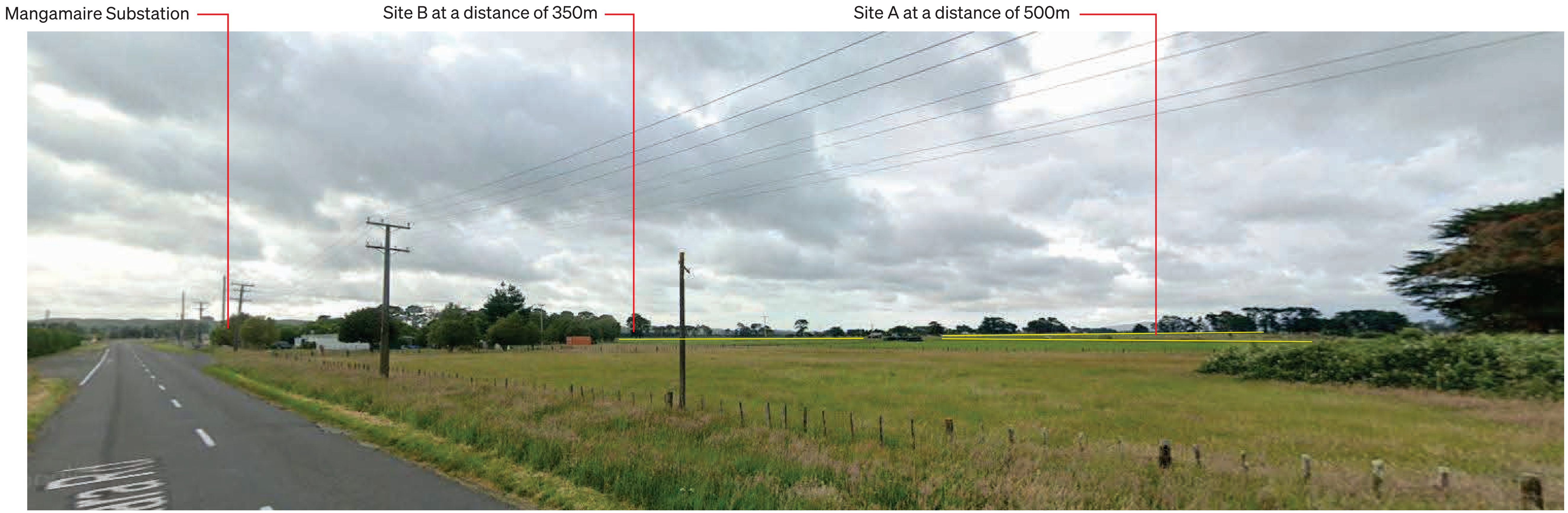
Viewpoint Location Photograph 3: Travelling west along Tutaekara Road, adjacent to Site B, approximately 400m from Mangamaire Substation. As one approaches the substation the prominence of both the substation and associated infrastructure becomes more apparent with increasing adverse effects on the landscape and amenity values of this location. Solar tables will be visible beyond the southern boundary of the LINZ reserve. After the initial construction, the land nearest the intersection will remain open and grazed.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photograph 4: The Mangamaire Substation extends to both sides of Mangamaire Road. The facility is locally prominent.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photographs



Viewpoint Location Photograph 5: Travelling east along Tutaekara Road, on entering the valley 600-700m from the farms, until the shelterbelts become established, glimpses of the new farms will be possible between trees and other existing dwellings.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.



Viewpoint Location Photograph 6: Travelling east along Tutaekara Road, approximately 350-500m from the farms, the farms would potentially be visible from within the Mangamaire Settlement. Site A will be fully screened by the proposed shelterbelts within 2-5 years, views of Site B will be partially visible below the remnant shelterbelt that will remain.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photographs

Viewpoint Location Photograph 7: Passing Mangamaire Substation travelling east 150m from Site B. Due to the proposed shelterbelt planting, the site will not be visible from this location in the medium term. No solar panels are anticipated in this corner of the property.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photograph 8: View of Site B from the intersection between Mangamaire and Tutaekara Roads. This corner of the property will only be used during the construction of the solar farm. This view is similar to the views of site B possible from adjacent Lot 2 DP 564748.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photographs

Viewpoint Location Photograph 9: Travelling north along Mangamaire Road, the site will first become visible as one passes #500 approximately 250m from the southern boundary of Site A. The dotted line is an approximation of a 4m hedge to illustrate the extent of view that would be affected. Establishing a shelter belt in this area is a permitted activity.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photograph 10: Looking northwest from the southern corner of Site A on Mangamaire Road. The proposed shelterbelt will be set 22m back from the road corridor boundary to accommodate the power lines. The distant views of the hills will be blocks by what is a permitted activity.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

Viewpoint Location Photographs

Viewpoint Location Photograph 11: A Google Streetview image of the Mangatainoka Road taken from the bridge over Tutaekara Road. The Mangatainoka River an order 5 river with a flooded width of 20-25m. The river environment has high natural character values however the vegetation lining the river in this vicinity is heavily modified and now dominated by invasive willow and other exotic weed species. Views out from the course of the river are limited by the riparian vegetation

Viewpoint Location Photograph 12: Looking north along Mangamaire Road. At this point the solar farms will be located on both sides of the road. All visible boundaries will be planted using shelterbelt planting that will fully screen the farms in 2-5 years. The 'corridor' effect will be reduced through the 22m setback required on the western boundary to accommodate the power lines.
Date: 09.01.2022 **Time:** Between 11:00am and 1:00pm.

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BEFORE THE HEARING PANEL

IN THE MATTER OF	**The Resource Management Act 1991**
AND	
IN THE MATTER OF	**An application (202.2022.136.1) for resource consents to establish and operate a solar farm at 410 Mangamaire Road, Pahiatua**
BETWEEN	**Energy Bay Limited**
AND	**Tararua District Council**

STATEMENT OF EVIDENCE OF MARY HAMILTON

1.0 INTRODUCTION

1.1 My full name is Mary Catherine Hamilton, and I am currently employed as an acoustician with the acoustical consulting practice of Marshall Day Acoustics.

1.2 I hold a degree of Bachelor of Science from the University of Otago (1991) and a degree of Master of Applied Science from James Cook University, Australia (1998). For 12 years I have worked in the field of acoustics, noise measurement and control in the United States and New Zealand. For the past 10 years I have been employed by Marshall Day Acoustics. My principal role is to undertake assessments for the environmental emission of noise and consider their impact against the relevant district plan requirements and the existing ambient environment. I have been involved in 15 solar farm resource consent applications.

1.3 I have been involved in this project since June 2022. I undertook site visits in June 2022, and prepared the original acoustic assessment for the proposal in July 2022.

1.4 I have read the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Note (2023) and I agree to comply with it. I can confirm that the issues addressed in this statement are within my area of expertise and that in preparing my evidence I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2.0 SCOPE OF EVIDENCE

2.1 My evidence will address noise matters related to the project.

2.2 My evidence is structed as follows:

- noise assessment summary
- response to comments raised by Councils' acoustic expert, Dr Stephen Chiles
- comments on submissions
- comments on the planning report, and
- recommended noise conditions.

2.3 My evidence updates and highlights key points from my report Rp 001 20220340 [dated 28 July 2022], a report prepared to form part of the AEE. In giving this evidence I refer to and confirm that report.

3.0 SUMMARY OF NOISE ASSESSMENT REPORT

3.1 I prepared my assessment in July 2022. This included an ambient noise survey and the calculation of noise from the key identified operational noise sources: 13 inverters and associated transformers, and 2100 tracker motors associated with the solar panel arrays. The inverters are the primary operational noise source. The assessment also addressed construction noise.

3.2 I provide a brief summary of operational noise, below.

3.2.1 The solar farm would operate during daylight hours. At certain times of year (notably summer), operating daylight hours could begin earlier and extend later than the District Plan prescribed daytime period of 7am to 7pm.

3.2.2 Noise limits during the District Plan prescribed night-time period (7pm to 7am) are the constraining limits. These are: 45dB $L_{Aeq\ (15\text{-}min)}$ and 75dB L_{AFmax}.

3.2.3 During times of lower solar gain (such as after 7pm), I expect inverter noise levels to be lower than during times of high solar gain. However, data detailing the relationship between inverter load and solar gain is not yet available from the manufacturer and therefore my assessment for the night-time period is conservatively based on the worst-case scenario (100% inverter load)[1].

3.2.4 Based on available manufacturers' data, the inverters are also expected to have appreciable directivity (i.e., one side is noisier). However, as positioning of the inverters for directivity considerations had not been finalised through detailed design, my assessment is conservatively based on a worst-case directivity scenario for all inverters.

[1] In my report I provided a scenario for 10% load on the inverter bridge circuit, however I understand that this data still allows for full fan speeds. It is typical for fan speeds to vary with ambient temperatures, thus at low ambient temperatures and low solar loads noise levels are likely to be much lower than I have set out in my report. There is normally a substantial difference between noise at 100% fan speed and at 60 to 70% fan speed.

3.2.5 I measured existing ambient and background noise levels over a three-day period that corresponded with stable weather conditions. Measured ambient (L_{Aeq}) and background (L_{A90}) noise levels are detailed as follows:

- Daytime (0700 to 1900 hours): ambient = 41 decibels (dB); background = 32 dB
- Night-time (1900 to 0700 hours): ambient = 35 dB; background = 27 dB

3.2.6 Under a worst-case scenario (worst case directivity and 100% inverter load), I calculated compliance with the District Plan noise limits.

3.2.7 Based on the measured ambient and background noise levels, I determined that there is risk that the solar farm could generate electro-mechanical noise at levels that appreciably exceed the existing night-time (evening/early morning) ambient and background noise levels at near receivers.

3.2.8 I recommended that attenuation of the inverters (through methods such as, selection, positioning for directivity, partial or full enclosure) be undertaken as part of detailed design to reduce the intrusiveness of any noise audible outside the solar farm, and as part of RMA Section 16 duties. I proposed a condition of consent in this regard. The condition was drafted with the intent of not being overly prescriptive and to allow refinement of the attenuation design on site during construction.

3.3 I provide a brief summary of construction noise, below.

3.3.1 My construction noise assessment identified setback distances from likely key construction activities (such as impact pile driving) to meet the long-term duration (greater than 20-weeks) daytime construction noise limits (70dB L_{Aeq} and 85dB L_{AFmax}), as defined in the construction noise standard (NZS 6803:1999).

3.3.2 Eight receivers were identified as being potentially within the setback distances of key construction activities.

3.3.3 I advised that depending on the final construction plan, resource consent may be required to breech the construction noise limits and/or a construction noise and vibration management plan (CNVMP) may be necessary to assess and manage construction effects on near receivers.

4.0 RESPONSE TO COMMENTS RAISED BY COUNCILS' ACOUSTIC EXPERT

4.1 I have reviewed Dr Stephen Chiles acoustic report, dated 1 August 2023 including the Appendix A Memorandum, dated 5 November 2022. Overall, there appears to be a broad level of agreement over most technical matters. Dr Chiles usefully raises some issues for further consideration by the hearing panel – I respond to these here.

4.2 In the section 'Sound and vibration levels', Dr Chiles states, "While, MDA includes cautious assumptions, there is inherent uncertainty associated with the prediction, particularly in relation to the assumed source levels in Table 3."

4.2.1 The source data for the inverters is based on data received from manufacturers. As I discussed in my report, I have referred to data from SMA as the most likely supplier of the inverters and used sound power levels that I consider representative of these inverters. My colleague contacted SMA recently to discuss the noise data they have available, and they confirmed the data used in my assessment is current based on the information they have available to provide.

4.2.2 Dr Chiles states there is inherent uncertainty in data. I agree that at resource consent stage it is necessary to utilise the best available dataset but recognise where the plant used in the final design could differ (either at commissioning or through eventual replacement of inverters, etc). Dr Chiles points out that my approach is cautious. I agree that I have taken a conservative approach. My expectation is that inverter noise levels will actually be appreciably lower than I have allowed for during early morning or evening as ambient temperatures in New Zealand are unlikely to mean that fans will need to run at 100%. However, as manufacturers are unable to provide this resolution of detail at this time, I have simply allowed for the worst case.

4.3 In the section 'Sound and vibration levels', Dr Chiles states, "A minor factor is that MDA has applied a 5 dB penalty for special audible characteristics (tonality), whereas under NZS6802 this could be 6 dB, increasing calculated levels by 1 dB."

4.3.1 Dr Chiles has usefully noted this matter. In my report, I addressed tonality but did not discuss the reference test method. The benefit of using modern, well-written standards is that they include provisions to assess these types of issues.

4.3.2 If a situation arose where very narrow tones occurred from inverters that were audible outside the solar farm, it might be reasonable to use the narrow band assessment method set out in NZS6802:2008 to identify them and penalise them appropriately. This would require a detailed measurement analysis that is not possible at resource consent stage as the manufacturer's data is not at a high enough resolution to undertake this type of analysis[2]. Dr Chiles is likely to agree that this detailed method could potentially be used in an assessment of compliance, should the need arise.

4.3.3 As Dr Chiles has stated, applying a six-decibel penalty would increase calculated levels by one decibel. This is a very small change. Noise levels that are one decibel different are not noticeably different to most people.

4.3.4 We understand that written approval has been provided by 129 Tutaekara Road, 154 Tutaekara Road, 346 Mangamaire Road and 410 Mangamaire Road. Therefore, even in a worst-case scenario, the application of a six-decibel penalty would not result in noise levels being above the District Plan night-time noise rule at any dwelling that has not given written approval to the project.

4.4 In the section 'Sound and vibration levels', Dr Chiles states, "MDA has not made a quantitative assessment of operational traffic noise, but states compliance with permitted activity standards based on an assumption of limited traffic and no heavy vehicle movements at night."

4.4.1 I consider that a qualitative assessment is reasonable in this case as very few light vehicle movements are anticipated, and no truck movements are anticipated in the night period. However, I have since undertaken a calculation to confirm this assumption. I have calculated that up to 80 vehicles per day (including 20 truck movements) would comply with the

[2] It would be very unusual for any manufacturer of any type of mechanical plant to provide narrow band noise level data. Most fans, transformers, boilers, etc manufacturers would, at best, provide data in 1/3 octaves. My assessment for this project is based on 1/3 octave noise data.

daytime noise limit at the receivers nearest to the identified access roads. Given that there should be few or no routine vehicle movements to an operational solar farm at night, I am confident compliance will occur. Note that based on MDA's experience with other solar farms, I anticipate that the likely number of vehicle movements per day would be about 12.

4.5 In the section 'Sound and vibration levels', Dr Chiles states, "Vibration: The MDA report (and wider application) does not address operational or construction vibration. From experience with other types of similar equipment and based on the solar farm equipment described by MDA, operational vibration is expected to be negligible beyond the site boundary. From experience with other projects and based on the description of construction activity in the MDA report, construction vibration might exceed the district plan permitted activity standard."

4.5.1 I agree that operational vibration would be negligible beyond the site boundary.

4.5.2 As Dr Chiles noted, I did not address construction vibration in my report. The main likely source of construction vibration would be piling, likely using a Vermeer-type pile driver. This is a high frequency, short-throw hammer pile rig which is quite different in scale to a large drop hammer piling rig (which are often used in large construction projects). The experience of my colleague who has visited a solar farm construction site (is that construction vibration is only perceptible fairly close to the piling rig. Ground vibration was not typically perceptible at 30 metres, even when lying in direct contact with the ground.

4.5.3 I consider that construction vibration could be effectively managed through a Construction Noise and Vibration Management Plan (CNVMP), which would take into account recommended setback distances and other mitigation measures, as needed.

4.6 In his section 'Potential noise effects', Dr Chiles summarises my conclusions regarding the effects of operational noise and generally agrees with my findings, further commenting that the potential noise effects could be largely avoided by adopting the best practicable option in the solar farm layout and equipment design, generally as laid out in my report. However, Dr Chiles also raises a question regarding the tracker motors. Dr Chiles states, "From the MDA report it is unclear whether regular cycles of the tracker motors would be audible and potentially cause greater annoyance due to the intermittent characteristics not represented by the predictions of average sound levels."

4.6.1 Tracker motors will generate noise levels of around 25 dBA at 90 metres when in operation, however operation only occurs intermittently, for short period to reorient the arrays. In general, the tracker motors do not contribute significantly to the rating sound level as it is the inverters that generate the most noise. It is possible that DC motors may be audible when in operation during periods of low background noise, however overall DC motor noise is expected to be low.

4.7 In his section 'Potential noise effects', Dr Chiles comments on construction noise and vibration and states that a Construction Noise and Vibration Management Plan (CNVMP) could be used to result in temporary construction effects that should be acceptable for most people in the nearest houses. As discussed, in my noise assessment and in Section 4.5.1 (above), I also recommend the use of a CNVMP to minimise and manage construction noise and vibration effects. However, in the main body of his evidence (Paragraph 10), Dr Chiles notes that Solar Bay have advised that they are confident that the construction noise standards will not be breached.

4.8 It would certainly be possible to comply with NZS6803 at all times, however this may involve the selection of an alternative piling method, or effective piling method such as a shroud or dolly, or (in the worst case if the above is not practicable) an avoidance of piling in specific areas close to dwellings. MDA's correspondence with piling contractors is that they are not yet willing to provide certainty that they can use shrouds or dollies in Vermeer-type piling rigs.

4.9 In my view, an exceedance of the NZS6803:1999 guidelines can be addressed through the diligent implementation of a noise management plan. Any exceedances are likely to be brief and effects can likely be mitigated through careful planning and communication (e.g., by piling during the least sensitive times). I agree that it needs to be clear whether the construction noise rule of the District Plan is proposed to be exceeded.

4.10 In the section ‘Conditions’, Dr Chiles recommends modifications and some additions to my recommended conditions of consent. In general, I agree with Dr Chiles comments and have redrafted the recommended conditions accordingly in Section 7.0 (below).

5.0 COMMENTS ON SUBMISSIONS

5.1 I have read the seven submissions. Four submissions raised noise as an issue and are discussed below.

5.2 Submission 2 from Amy Blackwell at 2226 Tutaekara Road, raised noise as an issue, generally. General noise matters have been addressed in my report and in my evidence.

5.3 Submission 4 from Patricia, Terrence and John Moore, owners of 162-ha on Dougherty Road, raised noise as an issue, specifically asking “With regard to noise levels from the inverters. Is the noise going to be constant or only during daylight hours? At night-time the noise could be quite irritating and invasive. E.g. if you are having a BBQ with friends, or relaxing at the end of the day enjoying the evening.”

5.3.1 My response is that the inverters will generate noise only during daylight hours and are likely to generate lower noise levels during times of lower solar gain (such as early morning and evening[3]). Also, the intention of the recommend Noise Conditions 4 and 5 (See Section 7.0, below) is to minimise/eliminate irritating noise characteristics (such as tonal character) at compliance locations (nearby homes).

5.4 Submission 6 from Stewart and Karen Smith at 126 Tutaekara Road, raised noise as an issue generally and specifically asked, “will construction generate more noise than the expected forward operative noise?”

5.4.1 My response is that construction noise will be louder than operational noise during the piling phase and potentially at times during earthworks and preparation. Construction piling near any one dwelling is typically only for a short period as piling progresses quickly across the farm.

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[3] Noting that my assessment has considered the worst-case scenario as I previously discussed.

5.5 Submission 7 from Wayne Morris, 154A Tutaekara Road, raised noise as an issue stating, “Secondly the noise and dust so close to our house will affect us (it won’t be a quick job).”

5.5.1 The solar farm will generate noise during construction but the recommended noise conditions of consent (see Section 7.0, below) are intended to manage noise to a level that is reasonable. Construction piling near any one dwelling is typically only for a short period as piling progresses quickly across the farm.

6.0 COMMENTS ON THE PLANNING REPORT

6.1 I have read The Section 42A Planning Report prepared by Andrew Bashford and dated 9 August 2023. Mr Bashford discusses noise effects in Sections 58 to 66. Mr Bashford summarises the conclusions of my noise assessment and points raised by Dr Chiles (and discussed in Section 4.0, above).

6.2 I agree with Mr. Bashford’s summary of my noise assessment and Dr Chiles comments. The only sections of the planning report that I need to discuss are Sections 63 and 65, regarding construction noise.

6.3 Sections 63 and 65 state that the applicant has confirmed that they will comply with the construction noise limits and expects the limit to be set as a condition of consent.

6.3.1 The construction noise standard (NZS 6803: 1999) is effectively a best practice guideline and the limits set in the standard should be met as far as practicable. However, it is not always possible to meet the limits in the standard. If limits cannot be met, they are managed through mitigation measures, detailed in a Construction Noise and Vibration Management Plan. Therefore, if the applicant did propose to breech the limits, I consider it appropriate that the condition regarding the construction noise standard should be written to reflect this uncertainty (refer to my comments in Section 4.7 and 4.8 and to recommended Noise Condition 3, below).

6.3.2 If the applicant accepts that they will comply with NZS6803:1999 at all times, then a Construction Noise and Vibration Management Plan is still recommended.

7.0 CONDITIONS

7.1 It is recommended that the following noise conditions are imposed on any consent granted.

1. The noise level from all operation of the solar farm shall meet the following District Plan noise limits at the notional boundary of any existing dwellings (refer to Map XX) on another site in the *Rural* zone as follows:
   - 55 dB $L_{Aeq(15\text{-}min)}$ from 0700 to 1900 hours
   - 45 dB $L_{Aeq(15\text{-}min)}$ and 70dB L_{AFmax} from 1900 to 0700 hours.
2. Noise levels shall be measured and assessed in accordance with *NZS 6801:2008 Acoustics - Measurement of Environmental Sound* and *NZS 6802:2008 Acoustics – Environmental Noise.*
3. Noise and vibration from construction activities shall, as far as practicable, not exceed the limits recommended in, and shall be measured and assessed in accordance with, the following standards, NZS 6803: 1999 *Acoustics – Construction Noise [noise]* and German Standard DIN 41503:2016 *Vibrations in buildings – Part 3: Effects on structures [vibration].* Construction noise and vibration shall be managed through a Construction Noise and Vibration Management Plan (CNVMP). All practicable attenuation measures shall be implemented. The CNVMP shall be provided to Council prior to construction.
4. Detailed design of the project shall include an attenuation design for the inverters. The attenuation design shall consider selection, orientation, and acoustic screening (though barriers), enclosure, lined ducting, or other measures as appropriate. The attenuation design shall minimise overall sound levels and eliminate intrusive sound characteristics (such as tonality (as defined by NZS 6802:2008)) at receiver/compliance locations, where it is practicable to do so. The attenuation design shall aim to achieve noise levels that are appreciably below the District Plan night-time noise limits when measured at compliance locations. The attenuation design should be undertaken by a recognised acoustician and a report detailing the recommended attenuation option(s) for each inverter shall be submitted to council prior to commencement of construction. It is recognised that the attenuation design may require commissioning works on site during construction to suitably refine and improve the attenuation design.

5. During the first daylight savings period after the solar farm becomes operational, compliance monitoring shall be undertaken to confirm compliance with the limits specified in Condition 1 and to assess the effectiveness of the attenuation design specified in Condition 4. Monitoring shall be undertaken by an experienced acoustician. It is likely that measurements will need to be taken close to the inverters as well as at compliance locations, and when the solar farm is operational during the prescribed night-period (i.e. in the evening after 7pm). Within 10 working days of the monitoring, a report shall be provided to Council detailing the compliance results and certifying that measures required under Condition 4 have been implemented and that intrusive sound characteristics have been minimised at compliance locations. In the event that intrusive sound characteristics are present at compliance locations, additional attenuation options shall be implemented, as appropriate. The effectiveness of any additional attenuation options shall be confirmed via additional monitoring and reporting to Council.

Mary Hamilton

16 August 2023

BEFORE THE TARARUA DISTRICT COUNCIL'S HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the applications by Energy Bay Limited to the Tararua District Council (202.2022.136.1) for resource consents to establish and operate a solar farm at 410 Managamaire Road, Pahiatua.

STATEMENT OF EVIDENCE OF PETER HAYMAN FOR ENERGY BAY LIMITED

DATED 16 AUGUST 2023

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Introduction and Qualifications

[1] My full name is Peter Russell Trevethan Hayman. I am employed as an Associate Consultant with SLR Consulting Australia Pty Ltd.

[2] I have a Bachelor's Degree in Aerospace Engineering with Honours from RMIT University, Melbourne.

[3] I have 13 years of experience as a consultant with SLR Consulting. In total I have undertaken 41 solar photovoltaic (PV) glare assessments across Australia, New Zealand, Canada and Chile as well as reviews of others' glare assessments. These assessments include investigations of the glare impacts on road users, residential amenity, railway operations and aviation operations.

[4] I have been engaged by Energy Bay Limited to review the Vector Powersmart glint and glare assessment reports of the proposed Mangamaire Road, Tararua solar facility and its associated modelling and to provide additional comments as appropriate regarding potential glint and glare impacts from the proposed facility. In preparing this evidence I have reviewed the following documents

(a) The Tararua Glint and Glare Assessment by Vector Powersmart dated 11 August 2023.

(b) The appendices associated with report mentioned above.

(c) Additional modelling output provided by Vector Powersmart.

Acknowledgment of Practice Notice

[5] I have read and agree to comply with the Code of Conduct for Expert Witnesses as contained in the Environment Court's Consolidated Practice Note (2023). My qualifications are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Review of Glare Assessment

[6] The proposed site for the solar farm is located approximately 10 kilometres south-southwest of the town of Pahiatua.

[7] The initial report (SOLAR BAY – TARARUA – Glint/Glare Assessment, Version V20230811) found that there would be up to 398 minutes of glare annually that could leave an after image for an observer at five of the modelled existing observer locations and no glare for the modelled roads. Modelling for the potential receiver locations showed up to 3660 minutes of glare potential for an after image at one location and at least some minutes of glare at 12 of the 26 locations chosen.

[8] It is noted that these assessments included natural obstructions and planned shelterbelts between four and 10 metres in height.

[9] A secondary round of modelling was conducted by Vector Powersmart with the following changes to the modelled parameters.

(a) Array height increased to 2.4 metres.

(b) Road user height increased to simulate small to medium trucks.

(c) Railway line to the west of the project included.

[10] A third round of modelling was conducted by Vector Powersmart with the planned shelterbelt heights reduced from four to three metres.

[11] The results of the additional modelling found no glare for the railway line, no glare for the road users when planned mitigation was included, no glare with the potential for an after image for the existing observer locations and a reduction in the minutes of glare with potential for an after image at some potential (ie possible future) observer locations. The third round showed the same results as the conclusions of the second round except for potential (ie possible future) observer locations where there was a small increase in the minutes of glare with the potential for an after image though this was still less than the amount found in the original models mentioned in Point [7].

Comments

[12] Firstly, it is worth noting that that solar PV panels are designed to capture (absorb) the maximum possible amount of light within the layers below the front (external) surface (and both surfaces for bi-facial PV panels). Consequently, solar PV panels are designed to minimise reflections off the surface of each panel in order to maximise the energy available for conversion.

[13] There is no known existing planning guidance within New Zealand for the quantification of impacts associated with solar reflections from solar panels towards roads, dwellings, or aviation activity.

[14] The Solar Glare Hazard Analysis Tool (SGHAT), developed by Sandia Labs, used for the modelling and assessment is widely used in the industry and was originally designed to quantify the glare impacts on landing aircraft. It classifies glare into three bands - GREEN: low potential to cause "after image", YELLOW: potential to cause temporary "after image" and RED: potential to cause retinal burn (permanent eye damage). Since its inception it has been expanded to incorporate "line" receptors (eg roadways and rail lines) and stationary observer locations.

[15] "After Image" is the term applied to a common retinal phenomenon that most people have experienced at some point, such as the effect that occurs when a photo with flash is taken in front of a person who then sees spots in front of their eyes for a few seconds. A more extreme example of "after image" occurs when staring at the sun. "After image" (also known as "photo bleaching") occurs because of the de-activation of the cells at the back of the eye's retina when subjected to a very bright light.

[16] SGHAT RED zone glare is not possible for standard solar arrays and will generally only occur at concentrated solar facilities.

[17] At SLR we interpret the results of the SGHAT modelling when considering residential amenity using the New South Wales (NSW) Large Scale Solar Energy Guideline (LSSEG, 2022) which provides assessment criteria for

residential dwellings and classifies glare by minutes per day and hours per year.

[18] Under the United States Federal Aviation Administration guidelines used in the SGHAT modelling, GREEN zone glare is allowable for pilots while on final approach. With this in mind, SLR discounts SGHAT GREEN zone glare for road users and residential observers.

[19] This leaves the SGHAT YELLOW zone glare which the NSW LSSEG can be applied to. The existing receivers in the report mentioned in Point [7] showed maxima between 10 and 30 minutes per day which falls into the moderate impact category and requires consideration of mitigation. Potential receivers had maxima above 30 minutes per day at some locations and one location had greater than 30 hours per year (high impact category) though most were between 10 and 30 hours per year requiring consideration of mitigation or avoidance.

[20] All the glare conditions found occur very close to sunrise or sunset meaning that an observer experiencing these reflections would also be looking almost directly at the sun. SLR does not consider this situation to be glare, when the difference in angle between an incoming direct solar ray and its associated reflected ray is less than 10 degrees, as the sun will dominate the field of vision.

[21] Elimination of these reflection conditions can be achieved by either (a) the addition of screening along relevant perimeters of the proposed facility (typically this is evergreen vegetation), or (b) controlling the rest angle of the tracking system, which can effectively prevent the glare from occurring in the first place, or (c) a combination of both of these strategies, where for example back-tracking rest angle control could be used while screening is established and develops to the target shielding height. The operational software controlling modern single-axis back-tracking systems can implement rest angle mitigation to any desired parts of the solar facility array at the times of the year when the glare conditions occur, thus optimising both glare control and facility energy yield.

Conclusion

[22] Some glare with the potential to leave an after image was found to occur at existing and potential residential observer locations around the proposed solar farm as shown by the reviewed modelling. It is my opinion that these refection conditions can be mitigated or eliminated using the methods mentioned in Point [21].

Peter Hayman

August 2023

Before a Hearing

Commissioner Appointed by

Tararua District Council

In the Matter	of the Resource Management Act 1991
And	
In the Matter	of the application by Energy Bay Limited to the Tararua District Council for resource consent to establish and operate a solar farm at 410 Mangamaire Road, Paihiatua.

Statement of Evidence of

Catherine Boulton

for Energy Bay Limited

Dated: 16 August 2023

1. INTRODUCTION

Qualifications and Experience

1.1. My full name is Catherine Mary Louise Boulton. I am a Consultant Planner at Planz Consultants in Christchurch. I hold a Bachelor of Science (Geography) and Bachelor of Arts (Honours) from Canterbury University and a Master of Resource and Environmental Planning from Massey University. I am an Associate member of the New Zealand Planning Institute.

1.2. I have over sixteen years experience working as a planner, which has included a wide range of resource consent application preparation and processing experience for private consultancies and public sectors in the United Kingdom and New Zealand. The current application is one of three solar farm developments I am working on directly with Energy Bay Limited. I have also indirectly been involved with two further Energy Bay solar farms.

Involvement in Proposal

1.3. I have been involved with Energy Bay's solar farm proposal ("Proposal") since January 2022. Initial involvement in the project included a site visit, a pre-application meeting with the Tararua District Council and providing advice to Energy Bay and respective experts on the consent application. I have visited the Site on two further occasions for iwi consultation and am familiar with the surrounding area.

1.4. I prepared the Assessment of Environmental Effects ("AEE") and this was internally reviewed at Planz Consultants.

1.5. I have subsequently been involved in numerous discussions with Council's planning team, including Mr Bashford, Council's Consultant Planner for this application. I have coordinated expert input and prepared responses to Council's initial further information request on the application. I have been involved in correspondence with Transpower regarding setbacks from their transmission lines and have made contact with submitters on this application.

2. CODE OF CONDUCT

2.1. I confirm that I have read the Code of Conduct for Expert Witnesses 2014 contained in the Environment Court Practice Note and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

3. SCOPE OF EVIDENCE

3.1. My evidence is given on behalf of Energy Bay Limited on planning matters relating to the establishment of a new solar farm at Mangamaire Road.

3.2. My evidence provides a summary of the following:

(a) Site and surrounding area description, summary of the Proposal (as notified) and any changes since notification of the application;

(b) The matters for which resource consent is sought from the Tararua District Council;

(c) The associated potential environmental effects (both positive and adverse);

(d) The relevant policy framework applicable to this application.

(e) Key matters raised in the section 42A report, which has been prepared by Mr Andrew Bashford;

(f) Addresses the submissions on the application that raise specific planning issues; and

(g) A response to the draft proposed conditions of consent as they currently stand.

3.3. My conclusions have been informed by the opinion of the following experts who are also presenting for the applicant:

- Mr Rory Langbridge, Landscape Architect, Rough Milne Mitchell Landscape Architects
- Ms Mary Hamilton, Acoustician, Marshall Day Acoustics,
- Mr Peter Hayman, Associate Consultant, SLR Consulting

4. SUMMARY OF THE PROPOSAL

The site and Surrounding Area

4.1. A detailed description of the Site and surrounding area is contained in the AEE and in the Landscape Assessment Report attached as Appendix 2 of the AEE. I will not repeat this detailed description but will provide a short summary below.

4.2. The Site is located across 6 titles, with three on the western side of Mangamaire Road ('Farm A') and three on the eastern side ('Farm B'). The combined title area is approximately 114ha, but Farms A and B do not extend across the whole of the title area. Instead they cover an area of approximately 86ha with the area of the solar farms being approximately 60ha.

4.3. Both Farm A and B are a series of flat pasture paddocks with little vegetation due to historic farm practices except for scatterings of remnant shelterbelts, primarily macrocarpa. Farm A has overhead powerlines tracking northeast, southwest parallel to the road and approximately 175m back from the Mangamaire Road boundary. It also bounds the Wairarapa Railway Line (it is understood that no regular services currently run along this Masterton to Pahiatua section) and contains a wetland area in the northern part of this site Farm B has overhead powerlines running through the Site approximately 150m back from the Mangamaire Road frontage and alongside its Tutaekara Road frontage. It also adjoins a quarry to the south.

4.4. The Site is located within the Mangatainoka River valley on an elevated river terrace between the Mangatainoka River to the east and the Wairarapa railway line to Pahiatua to the west before the range of hills that separates the Mangatainoka and Mangahao valleys.

4.5. The surrounding area is characterised by its agricultural use, a quarry, the PowerCo and Transpower substations and their associated lines and the cluster of houses along Tutaekara Road.

Proposal Description as Notified

4.6. The solar farm comprises approximately 88,500 solar panels spread across about 885 bases split between Farms A and B the solar panels have a thick glass surface with an anti-reflection coating which acts to minimise the amount of light that is reflected away from the solar panel. That maximises the solar panel's efficiency.

4.7. The solar panels are fixed atop a solar table consisting of a steel structure attached to the ground by seven steel poles centralised along its length. The solar tables proposed are tracking solar tables meaning that the structure is designed to move relative to the sun's angle. In the morning, the solar panels face east; during the day (as the sun moves), they pivot towards the west in the afternoon. The solar tables can be programmed to be stowed or rested at a particular position during night-time hours. The stow and resting position will also be dependent on wind conditions.

4.8. Each solar table comprises 52 panels long by 2 panels wide (totalling 104 solar panels per solar table). The dimensions of each solar table are approximately 60m long by 4.9m wide.

4.9. When parallel with the ground, the top of the solar table is approximately 2.46m above ground level. When the solar tables are facing as far east or west as they can rotate, the top of the tables is approximately 4.55m above ground level, while the bottom of the solar tables is approximately 30cm above ground level.

4.10. The solar tables are spaced apart so they do not shade one another. The centre of the rows of solar tables are approximately 9.7m apart. When the solar tables are facing directly upwards (i.e. flat) there is a 4.8m gap between the rows of solar tables. When they are facing as far east or west as possible, there is a 7.1m gap between the rows of solar tables.

4.11. Eleven inverters will also be located across Farms A and B. These convert the DC current from the solar panels to an AC Current so this power source can enter the Power Co substation. The inverters are approximately 2.8m long, 1.6m wide and 2.3m high and are white/off white in colour.

4.12. This solar farm is estimated to generate approximately 72.69 MWh in its first year, based on an average annual usage of 7,000kwh/NZ home equates to the power needs of around 10,384 homes.

4.13. Site preparation works are also proposed involving earthworks for access tracks, cable trenching to establish the wiring and import of clean fill for HV trenching for the inverter bases and recontouring of the site

4.14. The external boundaries of Farms A and B will be fenced with a security deer-type fence surrounding it.

4.15. Shelterbelt planting is proposed alongside the Mangamaire Road frontages of Farms A and B, alongside the Tutaekara Road frontage of the Site and along the southern boundary of Site B. Wetland buffer plans are also proposed at the North-Western corner of Site A.

4.16. Farms A and B will continue to be grazed by stock under and around the panels. This will likely be either sheep or calves.

4.17. The proposed development requires resource consent from the Tararua District Council as a discretionary activity for the following reasons:

(a) The proposal is for renewable electricity generation, which was not operational when the District Plan became operative.

(b) Earthworks required for the establishment of the solar far exceed the permitted volume of earthworks.

(c) Glare from the solar panels will occur.

Change to the Proposal post notification

4.18. An amendment is proposed to the description of the fencing, following the lodgement of the application. TDC was advised of a proposed change in the fence to a 1.8m chain mesh netting fence with barbed wire lines above, extending it to a height of 2m. This fence is now proposed to revert back to the deer fencing originally proposed. This fencing will be setback so that it is setback 22m outside the Transpower transmission line setbacks and 11m from the Powerco lines.

4.19. An amendment is proposed to the shelterbelt planting at the boundaries. This planting is also to be setback so that it is located outside of the required electricity line setbacks. The planting at the shelterbelt is now proposed to be either cypress or totara hedgerow instead of flax and is to be either and will be planted adjacent to additional areas near the site boundaries to address glare.

5. CONSENTS REQUIRED FROM TARARUA DISTRICT COUNCIL

5.1. The application was lodged with the Tararua District Council on 23rd September 2022, with consent being sought for a Discretionary Activity for the following matters:

(a) Standard 5.3.7.2(b) is not met as the Proposal is for a new solar farm which was therefore not in existence when the Plan became operative. Solar farms' construction, operation and maintenance are otherwise not provided for in the Plan. Consent is sought for a discretionary activity under Rule 4.1.6.1(b).

(b) The Proposal exceeds the permitted standard for earthworks of $1000m^3$. Therefore, consent is sought for a discretionary activity under Rule 5.1.5.3.

(c) The Proposal cannot meet Standard 5.4.7.2 as the solar panels will result in glare at Managamaire Road between October to March each year. Therefore, consent is sought for a discretionary activity under Rule 5.4.7.3.

6. SUBMISSIONS

6.1. I have read and considered the submissions received on the application. I summarise below the issues raised by the submitters:

Name of submitter	Address/ Location	Position	Summary
Abbe Hoare	17 Fouhys Road	Support	
Amy Blackwell	192 Tutaekara Road	Oppose	Noise Glare – shelterbelts take time to grow.
HiRock Limited,	Quarry at 391	Oppose	Incompatible with consented quarry operations.

c/- Josua Grobler	Mangamaire Road		Further consultation requested to see if a mitigation plan acceptable to all parties can be developed. Reverse sensitivity – dust concerns.
Patricia, Terrence and John Moore	Doughertys Road Lots 1 & 2 DP 67352 and Sections 63A, 65, & 66 Block XIV Mangahao	Oppose	Devaluation of land. Landscape effects (visual effects) Glint/glare/sunstrike each evening. Noise concerns. Planting – phormium tenax (NZ flax) will become a breeding ground for rats and stoats. Concerned they hadn't been advised of the application before.
Ken and Steph Norman	Doughertys Road Lot 2 DP 67352	Oppose	Visual – views Glare especially as some trees are to be removed. No consultation. Devalue property and of blocks leased.
Stewart Smith Karen Smith	126 Tutaekara Road	Oppose	Further consultation requested. Require more information on proposed signage, landscaping and construction methodology (including access for

			construction, noise and length of construction period. Landscape (visual effects). Potential noise impact. Concerned with saleability and value of their land. Concerned they hadn't been advised of the application before.
Wayne Morris	154A Tutaekara Road	-	Devaluation of land. Landscape (visual effects) Construction effects including noise, traffic, dust and power cuts. Time for mitigation shelterbelts to establish. Pests – rats and stoats living in shelterbelt.

6.2. All planning matters raised in the submissions are considered in Section 7 below. Concerning the submission points related to the devaluation of property values I note that this matter cannot be considered as part of this process. I agree with Mr Bashford's consideration of this in Paragraph 38 of his report.

7. SECTION 104(1)(A) ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

7.1. Section 104(1)(a) of the RMA requires that when considering an application for resource consent and any submissions received the consent authority must consider, amongst other things, any actual and potential effects on the environment of allowing the activity including its positive effects.

7.2. An assessment of the effects of the proposal on the environment has been reported on in Section 9 of the AEE and in Mr Bashford's s42A report. Mr Bashford's assessment concludes that he is confident that the potential or actual effects can be mitigated to levels where they are minor overall. I have read through Mr Bashford's report, and agree with his conclusions and his recommendations reached. My summary on the key consideration of effects is as follows:

Landscape and visual amenity

Landscape Effects

7.3. "A landscape effect is a consequence of changes in a landscape's physical attributes on that landscape's values. Change is not an effect: landscapes change constantly. It is the implications of change on landscape values that is relevant"[1].

7.4. Mr Langbridge and Mr Bray both detail that the Site and receiving environment has open rural landscape values made up by the flat expansive and productive working rural landscape. The lack of built form in the landscape aside from scattered rural dwellings, farm buildings and electricity infrastructure means that any changes to the landscape are likely to be easily noticed.

7.5. While the Proposal will change the physical environment of the Site from a largely open landscape to a predominantly 'rural industrial' character with an underlying primary production activity, it will over time become well screened from the surrounding environment by shelterbelt planting and will overall become less dominant in the landscape.

7.6. The rural environment is a working environment and valued as such. Agrivolatic production is essentially a cluster of production activities approriately located in the Rural Management Area of the Tararua District and not therefore an incongruous element either in terms of the Plan expectations or by reasons of its essential character. It results in change but is not adverse. This is powerfully seen in the Tararuas where more prominent landscapes are altered by large windmills and are accepted and endorsed as efficient and effective elements of a working landscape.

[1] *Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 61.*

7.7. In my opinion, when all considerations are taken into account such as the need for the facility to locate adjacent to or close to a substation, to be located in a rural environment due to scale, the dual use of the Site and ability for it to continue to be used for productive purposes, the current drive and demand for sustainable and renewable energy generation which informs the publics views of the activity, the fleeting views as vehicles move past the sites associated with the limited amount of traffic and local benefits that will accrue the associated landscape effects reach a point where they are no more than minor.

Visual Effects

7.8. "Visual effects are a subset of landscape effects. They are consequences of change on landscape values as experienced in views. They are one technique to understand landscape effects."[2]

Neighbouring Properties

7.9. There is general agreement between Mr Langbridge and Mr Bray that at the majority of neighbouring properties where a complete Affected Party Approval had not been provided, the extent of visual effects will be **low-very low** translating to **less than minor**.

7.10. The properties where there is a difference of opinion between the two landscape architects are at:

- 391 Mangamaire Road
- 500 Mangamaire Road
- Lot 2 DP 546734 (the property that wraps around 500 Mangamaire Road).
- Lots 1 & 2 DP67352
- 226 Tutaekara Road

I discuss each of these properties in turn below.

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[2] *Te Tangi a te Manu: Aotearoa New Zealand Landscape Assessment Guidelines'. Tuia Pita Ora New Zealand Institute of Landscape Architects, July 2022. Page 79.*

391 Mangamaire Road

7.11. This property is owned by HiRock Limited where quarrying activities take place but where there is also a dwelling located on the Site currently tenanted. Notably, Affected Party Approval was provided from the tenants and included with the application. A submission in opposition has been received from HiRock, but no submission points related to landscape or visual effects.

7.12. Mr Bray considers the visual effects on this property will be **moderate,** translating to more than minor[3] , but with the establishment of screen planting (assessed as flax), Mr Bray considers the visual effects will reduce to low-moderate[4] , translating to **minor.**

7.13. Mr Langbridge notes that there is currently limited vegetation around the dwelling and that views of the solar farm will be unimpeded until the shelterbelts become established[5]. Once the shelterbelts are established, Mr Langbridge considers that the structures will be thoroughly screened. This, in turn will result in a partial loss of view to the western hills and will result in some shading from the shelterbelt which is in line with a permitted baseline of shelterbelt planting[6] within a rural environment. Mr Langbridge considers that with mitigation, visual effects on this property will be **low[7]** , which translates to less than minor. This assessment is based on the mitigation achieved from the 22m shelterbelt setback from Mangamaire Road and screen planting managed at a minimum of 3m in height. Once the screen planting is established, Mr Langbridge considers that the solar farm will be fully screened.

500 Mangamaire Road

7.14. Mr Langbridge identifies that the primary view of the house and outdoor areas at 500 Mangamaire Road is towards Farm A, which is approximately 300m to the north[8]. Once the screen planting is established, Mr Langbridge considers the effects on this property will be low[9].

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[3] Landscape Evidence – Shannon Bray para [11]
[4] Landscape Evidence – Peer Review of Landscape assessment Report by Rough Milne Mitchell Ltd
[5] Landscape Evidence – Mr Langbridge Para [98]
[6] Landscape Evidence – Rory Langbridge [Para99 and 100]
[7] Landscape Evidence – Rory Langbridge [Para 102]
[8] Landscape Evidence – Rory Langbridge [Para 107]
[9] Landscape Evidence – Rory Langbridge [Para 110]

7.15. Mr Bray similarly commented on the open views across the neighbouring paddock to the Site and that the visual effects on this property will be moderate-high[10]. When Mr Bray made his assessment, no planting was proposed along the southern boundary of Farm A, but this has subsequently been included in the Proposal.

7.16. I note that no submission was received on the Proposal from the owners or occupiers of this property.

Lot 2 DP 546734 (the property that wraps around 500 Mangamaire Road)

7.17. This property has a rural productive use and has not been built upon. Should a residential activity be established on the site, Mr Langbridge considers that the extent of visual effects could be mitigated through shelterbelt planting and the design and location of the house and planting around the house. He considers if residential activity were established on this property 3-5 years after the establishment of the solar farm, then visual impact would be low[11].

7.18. Mr Bray considers the visual effects of the proposal on this property will be moderate-high, equating to more than minor given the unrestricted views across to the solar farm Site A. As with 500 Mangamaire Road, I note that shelterbelt planting now forms part of the Proposal along the southern boundary of Site A.

7.19. I note that no submission was received from the owners or occupiers of this property.

Lots 1 & 2 DP67352

7.20. This is the Moore's property which is elevated above the subject site. This property has a rural productive use and has not been built upon, although I note that through submissions, Ken and Steph Norman (who lease the land for farming purposes) hope to be future owners of the property and build upon it. As such, I understand that no application for building consent has been made at this time.

7.21. Mr Langbridge considers that the solar farm could add pattern and texture to the broader landscape and be a point of interest but that the adverse impact

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[10] Landscape Evidence – Shannon Bray
[11] Landscape Evidence – Rory Langbridge [Para 115]

of such a view on the broader views of the surrounding valley landscape would be moderate-low[12]. However, both Mr Langbridge and Mr Bay consider it possible to design and build a house that mitigates the effects of the solar farm[13].

226 Tutaekara Road

7.22. Mr Langbridge considers a potential location for a new dwelling on this property as being located on an elevated ridge line, although considers a location such as this restrictive and complicated but feasible. At this location, the impact of the solar farm Farms A and B would be moderate-low, but measures could be taken to address the exposed nature of such a location through planting and building design.

7.23. This is a speculative location, and I consider that there could be several other locations where a dwelling could be built upon. Mr Bray considers the visual effects on this property to be very low (less than minor)[14].

Public Locations

7.24. There is agreement between Mr Langbridge and Mr Bray that due to the proximity to Mangamaire and Tutataekara Roads the solar farm will result in a prominent, unusual, novel change and 'they will be noticed'. The effects of this change will however be localised due to the limited height of the panels when compared with say a windfarm. In the short term, the impact will be moderate-high but reduce quickly over the time it takes the shelter planting to establish, which is anticipated to be 2-5 years.

Summary of evaluative conclusions on Visual Effects

7.25. Considering Mr Langbridge's and Mr Bray's expert evidence and applying an evaluative lens, my opinion is:

7.25.1. Mitigation is an appropriate response to the direction of the Plan concerning this aspect of amenity; and

7.25.2. The localised visual effects of the solar farm can be appropriately mitigated through shelterbelt planting around the edges.

[12] Landscape Evidence – Rory Langbridge [Para 122]
[13] Landscape Evidence – Rory Langbridge and Shannon Bray
[14] Landscape Evidence – Shannon

7.25.3. While it is purely speculation on land which have not yet been built upon but may do so in the future, any future dwelling could be designed, built and landscaped to ensure that it does not have views of the solar farm. By that stage, and assuming the solar farm has been constructed, those buildings on such sites will have the option of orientating and/or screening themselves from the solar farm should they choose so. In other words they will have the ability to mitigate the effects at their property. the effects on that property are less than minor.

7.26. Mr Langbridge states that the boundary fencing and planting can be undertaken as part of the initial stage of the development. As the farm is installed, the shelterbelt planting is already establishing itself, and the visual effects are increasingly mitigated. However, it is his opinion that it is not critical that this planting is established in advance.[15]

7.27. Pre-construction planting at the boundary has already been volunteered as a condition of consent, and therefore I consider it appropriate that this is a requirement of consent. I note that Mr Bashford's draft condition 8a. requires this, and while I agree with this timing, with a proposed change to the plant species to be established, I would prefer to see this condition revised so that it is not specific to Phormium tenax (Harakeke).

Glint and Glare

7.28. The glint and glare effects are described in the evidence of Mr Langbridge and Mr Hayman and are based off modelled results from Vector. The consideration of effects is also based on modelled results for existing and potential receivers as requested as further information by Mr Bashford following the close of the submission period. Further assessment was sought on the following specific properties:

(a) 17 Fouhys Road – The model results show yellow glare at this property.

(b) 126 Tutaekara Road – The model results show no glare on this property.

[15] Landscape Evidence Para [218]

(c) Dougherty's Road – Lot 2 DP 67352 – The model results show yellow glare at this property.

(d) 192 Tutaekara Road – The model results show no glare at this property

(e) 391 Mangamaire Road – The model results show between 15 and 19 minutes of green glare at this property and 1 minute of yellow glare.

(f) 154A Tutaekara Road – The model results show no glare on this property.

7.29. Importantly solar panels are designed to minimise reflections off the surface of each panel to maximise the energy available for conversion to electricity. When glare is present it is classified into:

- Green: low potential to cause "after image" – SLR discounts green zone glare for road users and residential observers because its low level of effect.
- Yellow: potential to cause temporary "after image" – Receivers of yellow glare fall into the moderate impact category. In this instance consideration of mitigation is required.
- Red: potential to cause retinal burn (permanent eye damage) – Red glare is not possible from a standard solar array[16].

7.30. Yellow glare has been modelled at the existing receivers. At these receivers the maximum glare falls between 10 and 30 minutes per day[17].

7.31. Yellow glare has also been modelled at potential (speculative) receivers, potential receivers of yellow glare had maximums above 30 minutes per day and one location had greater than 30 hours per year though most were between 10 and 30 hours per year requiring mitigation or avoidance[18].

7.32. All glare modelled is very close to sunrise or sunset, at these times a receiver experiencing these reflections would also be looking almost directly at the sun. SLR does not consider this situation to be glare. When the difference in angle

[16] Evidence of Mr Hayman
[17] Evidence of Mr Hayman
[18] Evidence of Mr Hayman

between an incoming direct solar ray and its associated reflected ray is less than 10 degrees as the sun will dominate the field of vision.

7.33. Elimination of reflection conditions can be achieved through mitigation measures:

a) Screening along relevant perimeters of the proposed facility typically with evergreen vegetation; or

b) Controlling the rest angle of the tracking system which can effectively avoid glare from occurring in the first place; or

c) Combining both mitigation measures. For example the rest angle could be controlled until the screening is established.

Summary of evaluative conclusions on Glint and Glare

7.34. My conclusions based on the evidence of Mr Langbridge and Mr Hayman is the following:

7.34.1. Any effects of green glare are not considered because the effect is low.

7.34.2. Many of the identified locations are not the site of existing dwellings, and on-site mitigation is feasible by planting and design. Mitigation at the solar farm is also possible through the resting angle of the panels and through shelterbelt planting.

7.34.3. The amenity impacts are low.

Noise

7.35. Consideration of noise has been given to the operational noise and construction noise associated with the development. Concerning the operational noise, both Ms Hamilton and Mr Chiles agree that noise expected to be generated from the solar farm will be within the noise limits of the District Plan at all sensitive receivers during daytime and nighttime hours without any attenuation or mitigation.

7.36. In terms of construction noise, Mr Chile's evidence considers this to remain unresolved, given that an update or amendment to the Assessment of Noise Effects had not been provided, substantiating that construction noise standards will not be breached. Ms Hamilton's evidence shows that New Zealand Standard NZS 6803: 1999 Acoustics – Construction Noise can be met but could require alternative construction methods at some locations to ensure that noise and vibration comply with the standard. Therefore, I agree that draft Condition 10 e. of Mr Bashford's report is appropriate to mitigate potential effects of construction noise. I also agree with the recommended conditions of consent of Ms Hamilton on noise to address this.

Summary of evaluative conclusions on Noise

7.37. My opinion based on the evidence of Ms Hamilton is the following:

7.37.1. Operational noise will be compliant with the District Plan provisions at all receivers without mitigation resulting in less than minor effect.

7.37.2. The applicant has committed to meeting the Construction Noise requirements this may require alternative construction methods near close receivers site. With compliance of the drafted conditions of consent, the effect will be less than minor.

Safe and Efficient Operation of the Road Network

7.38. Transport effects are discussed in Mr Bashford's evidence with his assessment being that the effects on the safe and efficient operation of the roading network will be less than minor. I agree with this assessment noting that the most traffic to the site will be during the temporary construction period, when earthmovers and construction workers will travel to the site and when the solar infrastructure is delivered. Post-construction, the Proposal will not generate a large volume of traffic, with approximately 2 vehicles per month for general checks, 2 car per day over 4 weeks annually for scheduled maintenance, 2 cars per day over 4 weeks for unscheduled maintenance and 8 cars per day for 4 weeks for module cleaning.

7.39. Existing access points onto the site for construction or operational traffic from Mangamaire Road will be utilised for the Proposal. At these locations, Mangamaire Road is sealed, straight and has good visibility in either direction.

7.40. Mr Bashford's drafted conditions 24-27 address and will mitigate potential effects on the safe and efficient operation of the road network by ensuring that the loading and unloading of trucks is carried out within the application site, that all construction traffic accesses the site from Mangamaire Road only which is the road with the lowest traffic volumes and that debris tracked onto Mangamaire Road from construction traffic is cleared away immediately. I agree with Mr Bashford that these conditions are appropriate.

Summary of evaluative conclusions on transportation effects

7.41. My opinion on transportation effects remains the same as in my AEE. That is:

7.41.1. The effect on the surrounding road network will be less than minor due to the condition of the road which is straight, sealed with good visibility in either direction and due to the low traffic environment of the area.

7.41.2. The draft conditions of consent can further mitigate potential effects on the safe and efficient operation of the road network.

Reverse Sensitivity

7.42. Hirock Quarries have submitted in opposition to the Proposal due to the potential for reverse sensitivity effects to arise. I recognise that quarrying activities can generate dust from their excavations but also from truck movements and that dust can potentially affect the ability of the solar panels to absorb solar rays.

7.43. Activities within the solar farm can also generate dust/dirt on the solar panel, such as sheep rubbing against the panels or dust/dirt from the ground or cropping activities. This means that the operator is required to undertake regular monitoring of the solar panels and cleaning when required as part of their operations..

7.44. The Proposal includes the establishment of shelterbelt planting, which will aid in mitigating the potential effects of dust. This planting has been revised and is now proposed to be a single row of Cypress or Totara hedgerow planting along the road boundaries of Farms A and B and along the southern boundary of Farm B adjacent to the HiRock quarry access road. The second mitigation measure proposed to address HiRock’s reverse sensitivity concerns is the volunteering of a no-complaints covenant. volunteered condition is as follows but also set out in Section 13 below.

That a Land Covenant be prepared by the applicant's lawyer and registered at the applicant's expense. The covenant shall read as follows:

Where gravel quarrying activities undertaken in the surrounding area by Hirock Quarries or their successor are carried out in accordance with the relevant District Plan requirements, or the conditions of resource consent (Insert reference to current consent here RMXXXX) the property owner and solar farm operator shall not:

Bring any proceedings for damages, negligence, nuisance, trespass or interference arising from the use of that land; or

Make nor lodge, nor;
Be party to, nor;
Finance nor contribute to the cost of

Any application, proceeding or appeal (either pursuant to the Resource Management Act 1991 or otherwise) designed or intended to limit, prohibit or restrict the continuation of the operations of the Hirock Quarries or their successor which are carried out under the terms of their resource consent (Insert reference to current consent here RMXXXX).

Summary of evaluative conclusions on reverse sensitivity effects

7.45. Considering the mitigation measures proposed, I consider that reverse sensitivity effects will be less than minor.

Natural Hazards

7.46. Mr Bashford's assessment of natural hazard risk in his evidence agrees with my assessment set out in Section 9 of the AEE. In terms of the identified flooding overlay located across a small part of both Farm A and B, the solar farm infrastructure will be located outside areas prone to flooding given the setback proposed to the wetland and the setback and elevation above the Mangatainoka River. Furthermore, earthworks will not change the contour of the land and soil permeability will be retained given the site will retain pasture cover and/or be planted in crops to ensure that flood risk will not be spread onto other properties.

7.47. The proposal will also not exacerbate an earthquake or liquefaction risk, given the proposal is not for habitable buildings.

Summary of evaluative conclusions on hazards

7.48. Overall, I consider that natural hazard effects will be less than minor.

Cultural

7.49. Mr Langbridge and myself had an initial meeting, followed by a site visit with representatives of both Rangitāne o Tamaki nui-ā-Rua (RoTnaR) and Ngāti Kahungunu ki Tāmaki-nui-a-Rua who represent the mana whenua of this locality on the 11th and 12th July 2022. Further correspondence with these representatives has been undertaken since that time, and the application was submitted with support from Mr Kendrick of Ngati Kahungunu. No submission has been received on the application from Ngati Kahungunu.

7.50. Likewise, no submission has been received on the application from Rangitāne o Tamaki nui-ā-Rua. However, I acknowledge that they did supply TDC with recommendations when the application was initially received. These recommendations proposed an Accidental Discovery Protocol, to achieve a 20m setback from the wetland, for RoTnaR to undertake cultural monitoring of the wetland and to plant eco-sourced native planting preferably before construction begins.

7.51. In terms of sites of cultural significance it is noted that there are no known or recorded wahi tupuna or wahi tapu (sites of significance) within this specific location. Mr Bashford also makes this observation, stating that there are no sites of significance listed in the District Plan within or adjacent to the site. RoTnaR have advjsed that historical/customary information acknowledges that Rangitāne tupuna (ancestors) were present in this area with their settlements nearby and that although the land has been modified due to farming, there is a possibility of unearthing or disturbing signs of occupation in the form of archaeological findings or Wahi Tupuna and Wahi Tapu sites of significance during earthworks[19]. Mr Bashford has included the RoTnaR recommendation for an Accidental Discovery Protocol (ADP) to apply to all earthworks for this application as Draft Condition 28. I agree with this condition.

7.52. Regarding the wetland setback, a 10m setback is proposed between the wetland and the fence. This meets the requirements of the National Environmental Standard for Freshwater; therefore, I consider this setback to be appropriate. The applicant is also proposing planting locally appropriate plants, which will aid in filtering any runoff from the site, improving the water

[19] Rangitāne Cultural and Environmental assessment

flow into the wetland. Mr Bashford has included a draft condition (Condition 8b.) to ensure that this planting is undertaken following the Proposed Landscape Mitigation Plan before construction of the solar farm commences. Under draft Condition 9, Mr Bashford requires evidence of the planting, including photos, to be submitted to TDC within one week of planting completion. I agree with draft Conditions 8b and 9.

7.53. Regarding the cultural monitoring of the wetland, I agree with Mr Bashford's assessment that this is a matter to be considered outside of the consenting process.

Summary of evaluative conclusions on cultural effects

7.54. I consider tangata whenau are acutely aware of the need for renewable energy projects and support appropriate development as they have done for wind farms.

7.55. The proposal is consistent with the ethic of kaitiakitanga based on my assessment of tangata whenua views.

Effects on the Soil Resource

7.56. As set out in my AEE, utility-scale solar farms are a relatively new activity emerging within New Zealand, but they have been around internationally for some time now.

7.57. The solar farm panels sit on solar tables above the ground, and it is only the supports that occupy the soil resource along with the other solar infrastructure, such as inverters. This means that for the most part the land upon which the solar farm is located retains its ability to be used for primary production purposes.

7.58. The solar panels are designed to track the sun meaning that they pivot east to west as the sun moves across the sky. When the tables are facing directly upwards there is a gap between the rows of solar tables and when they are at their maximum eastern or western tilt there is a larger gap. These gaps ensure that both sunlight and rain will continue to reach the soil resource therefore enabling the growth of pasture.

7.59. Earthworks will be minimal due to the footprint of the solar tables, inverters, storage buildings and associated cables. Earthworks predominantly involve excavation and refilling with a small degree of respreading the soil. Due to the extent of earthworks required, it is considered that topsoil at the site will remain intact and capable of sustaining pasture cover.

7.60. The Proposal will represent a small amount of the land resource being lost (equating to less than 1% of the Site) which when considered over the wider rural resource area will be even more insignificant. The land will continue to be used for primary production as this also provides benefits to the applicant.

7.61. Internationally, ‘agriviolitics’ or ‘agrisolar’ in the form of ‘solar grazing’ is a common form of co-land use due to its benefits for both energy companies and farmers. In my further information response from 20th February 2022 is information taken from ‘The Australian Guide to Agrisolar for Large-Scale Solar’. This guide refers to research which sets out that crop selection is important under the solar panels with grass/clover being identified as suitable to grow under the elevated solar panels. In the guide's research the growth rate of certain crops (including grass) was not reduced under the panels, and that performance of some plants was improved. Possible reasons for improved outcomes were identified as being:

1. The reduced exposure of plants to sun and extreme weather events.
2. The solar panels also provide stock with protection from the elements.
3. Improves water use efficiency of crops/vegetation and runoff from panels.
4. Soil moisture and temperature.
5. Ambient temperature.

7.62. Given that the New Zealand solar setting is relatively new, research here is just getting started with initial findings from Massey University on older panels indicating that grass growth underneath the panels was reduced between the panels it was increased with the two balancing each other out.

Summary of evaluative conclusions on highly productive soils

7.63. In my opinion the Proposal will result in less than minor adverse effect on the soil resource given it can continue to be used for primary production purposes and only a small amount of the soil resource will be occupied directly by structures.

Effects on existing electricity infrastructure

7.64. The proposal's effects on existing electricity infrastructure have been further considered through the consent processing process. I have corresponded with Transpower regarding the Proposal and potential effects on their 110kV transmission lines that run along the Mangamaire Road corridor.

7.65. Together with Transpower, the applicant has agreed upon a set of conditions which we volunteered to TDC as part of the Proposal. Mr Bashford has included these conditions under draft conditions 36-41.

7.66. Consequently, a change is necessary to the site layout and landscaping plan so that these conditions can be met. That is that a separation distance is achieved from MGM-MST-A National Grid transmission line to the security fence, vegetation and solar infrastructure. This revised plan with greater setbacks achieved is provided in Mr Langbridge’s Graphic Attachment to his evidence.

Summary of evaluative conclusions on effects on electricity infrastructure

7.67. In my opinion potential effects on the existing electricity infrastructure can be suitably mitigated through the volunteered conditions agreed to with Transpower.

Positive Effects

7.68. I have described the positive effects in my AEE, which relate to harnessing the renewable solar energy resource rather than a finite resource for electricity generation. This Proposal will provide positive effects on the well-being of people locally, regionally and nationally by assisting in diversifying electricity generation within the District, increasing the electricity generation capacity and increasing the security of electricity supply at local, regional and national levels (wherever electricity is most needed at any one time).

7.69. The Proposal will also contribute towards addressing the effects of climate change through its assistance in achieving the NPS-REG national target of 90% renewable energy production capacity by 2025 and the reduction of net emissions of all greenhouse gases (except biogenic methane) to zero by 2050.

7.70. The site has historically been used as a dairy farming operation. As such, I consider that it is reasonable to expect there to be a reduction in environmental effects commonly attributed to dairy farming, such as ground and surface water contamination from nitrate leaching, excess nutrient losses, larger emissions of greenhouse gases, particularly methane and nitrous oxide from animal waste and effects on biodiversity.

Effects Conclusion

7.71. I consider there are less than minor adverse effects associated with the following:

(a) Glint and glare

(b) Noise

(c) The safe and efficient operation of the road network

(d) Reverse sensitivity

(e) Natural hazards

(f) Cultural effects

(g) The soil resource

(h) Existing electricity infrastructure

7.72. I consider that there will be temporary effects that are more than minor concerning landscape and visual amenity, but that these will reduce to minor or less than minor with mitigation and over time.

7.73. I consider the positive effects of the proposal to include: diversifying electricity generation, adding to electricity generation capacity and increasing the security of supply. The proposal will also assist in meeting New Zealand's climate change targets.

8. SECTION 104(B)(VI) ASSESSMENT OF OBJECTIVES AND POLICIES – THE PLAN

Chapter 2.3 Rural Land Use Management & Chapter 2.6 Amenity and Environmental Quality

8.1. The relevant provisions of Chapters 2.3 and 2.6 are similarly worded, so they are considered together. These are **Objective 2.3.2.1** and attendant **Policy 2.3.2.2**, **Objective 2.3.4** and attendant **Policy 2.3.4.2** and **Objective 2.6.2.1** and **Policy 2.6.2.2.**

8.2. **Objective 2.3.2.1** and **Policy 2.3.2.2** collectively seek to achieve sustainable rural land use practices and an efficient use of resources.

8.3. I consider that the Proposal **is consistent** with these provisions as it is sustainable in that the solar farm will generate electricity from a renewable energy source while protecting the valuable land resource of the LUC 2 land underneath for future generations. The proposal also represents an efficient use of resources in that it optimises the capability of the site to be used for dual purposes (electricity generation and farming).

8.4. **Objective 2.3.4** and **2.6.2.1** and **Policies 2.3.4.2** and **2.6.2.2** seek to ensure that a high level of environmental quality and amenity throughout the rural area of the District is maintained. A high level of environmental quality (not restricted to the site or surrounding context) will be achieved through the proposal given that solar energy, as a clean renewable source of electricity plays an important role in powering New Zealand’s Zero Carbon Emissions Goal. In terms of amenity, it is considered that landscape and visual effects can be suitably mitigated through setbacks and shelterbelt planting. These mitigation measures ensure that the effects once shelterbelts have been established will be no more than minor.

8.5. I consider the Proposal is consistent with Objective **2.3.4** and **2.6.2.1** and **Policies 2.3.4.2** and **2.6.2.2.**

Chapter 2.4 Subdivision and Development

8.6. I consider the Proposal **is consistent** with the aims of **Objective 2.4.3.1** and the supporting **Policy 2.4.3.2**. The objective seeks to promote a pattern of subdivision and land use resulting in an efficient use and development of natural and physical resources. This is achieved through the dual use of the site for renewable electricity generation and primary production. **Policy 2.4.3.2 (c)** is relevant to the Proposal as it seeks to protect network utilities and infrastructure from adverse effects associated with subdivision and land use activities. There is a key operational and functional need to collocate solar farms with substations therefore it is also essential that the existing network utilities, the Transpower and Powerco substations and their lines are protected from adverse effects associated with the development. The Proposal has been revised with greater setbacks to the lines achieved from the fence, planting and setback of the solar tables to ensure the development does not result in adverse effect on these network utilities.

Chapter 2.5 – Natural Hazards

8.7. **Objective 2.5.2.1** and **Policy 2.5.2.2** seek to reduce the risks imposed by and effects of natural hazards on people property and infrastructure. This can be done by (b) which seeks to reduce the risk of natural hazards through minimising the intensity of development in hazard prone areas and implementing mitigation measures and response procedures as appropriate. The Proposal **is consistent** with the above Objective and Policy as the solar farm is proposed to be setback from the area identified as being a flood risk, avoiding risk in relation to flooding.

Chapter 2.8 Infrastructure

8.8. **Objective 2.8.2.1** and supporting **Policies 2.8.2.2** seeks to maintain and develop the District's infrastructure while avoiding, remedying or mitigating adverse environmental effects. Policy (c) has particular relevance as it seeks to encourage the co-siting of network utility equipment where practicable. This co-location is a specific locational and operational requirement for solar farms which need to be located near an existing substation, transmission towers and lines. I consider the Proposal to be **consistent** with this Objective and Policy.

8.9. **Objective 2.8.4.1** seeks to recognise the potential of Tararua's Rural Management Area for renewable electricity generation. The attendant **Policies 2.8.4.2** seek to recognise the local, national and regional benefits and to remedy, mitigate, or avoid, when possible the actual and potential adverse effects particularly in respect of amenity values, landscape ecology, noise and traffic. The applicant recognised the potential of Tararua's Rural

Management Area for renewable electricity generation. In particular, the site displays key geographic features – being located close to electricity infrastructure (substations, transmission towers and lines), it is relatively flat which is important for reducing potential shading effects on the panels and, in turn their ability to absorb solar rays and there are a suitable amount of sunshine hours. The establishment and operation of the solar farm will result in local, national and regional benefits as it will increase electricity generation capacity assisting in achieving the national target of generating 100% of electricity from renewable energy sources by 2030. The diversification of electricity generation within the District will increase electricity generation capacity and increase the security of electricity supply at local, regional and national levels (wherever the electricity is most needed at any one time). The Proposal will mitigate actual and potential adverse effects on the environment, as I outline in Section 7 above. I also agree with Mr Bashford's statement that the assessment of effects needs to be weighed with the benefits derived from renewable electricity generation. I consider the Proposal to be **consistent** with this Objective and Policy.

Chapter 2.10 Treaty of Waitangi and Maor Resource Management Values

8.10. **Objective 2.10.3.1** seeks to recognise and provide for Maori values. Attendant **Policy 2.10.3.2(a)** recognises the connection to tangata whenua and their culture and traditions with land, water sites, waahi tapu and other taonga having particular regard to kaitiakitanga. Rory Langbridge and I met with Rangitane o Tamaki nui-a-Rua representatives and Ngati Kahungunu ki Tamaki-nui-a-Rua at the site. The representatives supported the project, with a key consideration being the proposed setback and planting to the potential wetland. I agree with an archaeological discovery protocol condition being imposed on the consent and overall consider the Proposal to be **consistent** with this objective and policy.

9. SECTION 104(1)(B)(I) NATIONAL ENVIRONMENTAL STANDARDS

9.1. I have considered the Proposal against the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (2011)("NES-CS'). I have addressed this matter in the AEE and concluded that the NESCS is not relevant; Mr Bashford has agreed with this in his section 42 report. I also note that Mr Bashford's draft condition 23 requires that if potential contamination is identified during works, then a suitably qualified and experience persons is to assess the nature of new material and reassess the potential risk to human health and/or the environment. I am in agreement with this condition.

9.2. I have also considered the Proposal against the National Environmental Standards for Freshwater 2020(NESF) in the AEE and consider the application can comply and no consent is required.

10. SECTION 104(1)(B)(III) NATIONAL POLICY STATEMENTS

National Policy Statement for Renewable Electricity Generation 2011

10.1. The National Policy Statement for Renewable Electricity Generation 2011 (NPS REG) came into effect on 13 May 2011 and has played a significant role in promoting renewable energy developments. The Tararua District Plan gives effect to the NPS-REG through its objectives and policies promoting renewable energy development[20].

10.2. The Statement's preamble sets out that New Zealand must confront two major energy challenges as it meets growing energy demand. The first is to respond to the risks of climate change by reducing greenhouse gas emissions caused by the production and use of energy and the second is to deliver clean, secure, affordable energy while treating the environment responsibly. The strategic target set by government is that 90 per cent of electricity generated in New Zealand should be derived from renewable energy sources by 2025 (based on delivered electricity in an average hydrological year), providing this does not affect security of supply[21]. Policy A of the NPS-REG requires decision-makers to recognise and provide for the national significance of renewable electricity generation activities, including national, regional and local benefits.

10.3. The NPS-REG target in Policy B is clear, that to meet or exceed the national target of 90% renewable energy production for electricity demand, significant development of renewable electricity generation will be required.

[20] Tararua District Plan (Section 1.3.1)
[21] NPS REG Preamble.

10.4. Policy C acknowledges the practical constraints associated with the development, operation, maintenance and upgrading of new and existing renewable electricity generation activities.

10.5. Policy C of NPS-REG provides insight into the functional and operational requirements specific for renewable energy development as follows:

> ***"C. Acknowledging the practical constraints associated with the development, operational, maintenance and upgrading of new and existing renewable electricity generation activities***
>
> *POLICY C*
>
> *Decision-makers shall have particular regard to the following matters:*
>
> *a) The need to locate the renewable electricity generation activity where the renewable energy resource is available;*
>
> *b) Logistical or technical practicalities associated with developing, upgrading, operating or maintaining the renewable electricity generation activity;*
>
> *c) The location of existing structures and infrastructure including, but not limited to, roads, navigation and telecommunication structures and facilities, the distribution network and the national grid in relation to the renewable electricity generation activity, and the need to connect renewable electricity generation activity to the national grid".*

10.6. With regard to the above, the site has been selected as it is a large piece of relatively flat land in an area where there are suitable sunshine hours. Importantly the site is located where there is an existing distribution network with Transpower and Power Co substations, transmission towers and lines at and alongside the site which provides both logistical and technical practicalities of being located alongside.

10.7. In my opinion the Proposal is significant and meets the intent of the NPS-REG which weights in its favour.

National Policy Statement for Highly Productive Land (NPS-HPL)

10.8. The NPS-HPL came into force on 17 October 2022. It requires councils to avoid inappropriate use or development of highly productive land (HPL) that is not land-based primary production. HPL must be identified and mapped by regional councils, but until such time as that is done, if it is already referenced as LUC 1, 2 or 3, it must be considered as HPL. The Site has an LUC 2 category.

10.9. I considered the objectives and policies of NPS HPL in my AEE, concluding that the proposed development does not represent an ‘inappropriate use or development of the site, and it will not generate reverse sensitivity effects that are likely to constrain land-based primary production activities within the receiving environment.

Is the Proposal an Inappropriate Use?

10.10. Clause 3.9 Protecting highly productive land from inappropriate use and development of the NPS HPL refers to territorial authorities taking measures to achieve the matters referred to in subclause 3.9(3).

10.11. Excluded from the definition of inappropriate use under Clause 3.9(2) is item 3.9(2)(j)(i) which reads:

> *“(j) it is associated with one of the following, and there is a functional or operational need for the use or development to be on the highly productive land:*
>
> *i. The maintenance, operation, upgrade, or expansion of specified infrastructure.”*

10.12. The Proposal is for ‘specified infrastructure’. This infrastructure is recognised as regionally or nationally significant in a National Policy Statement, New Zealand Coastal Policy Statement, Regional Policy Statement or Regional Plan. Renewable Energy developments are recognised as regionally and/or nationally significant under the NPS-REG and, NPS-ET and they are also recognised in the One Plan Mo te iti – mo te rahi (the consolidated Regional Policy Statement, Regional Plan and Regional Coastal Plan for the Manawatu-Wanganui Region).

10.13. There is also a "functional and operational" need for the Proposal to be located on the highly productive land where it is to be sited. Note that the NPS HPL does not require consideration of an alternative location.

10.14. The term "functional need" is not defined in the NPS-HPL, but it is defined in the National Policy Statement for Indigenous Biodiversity NPS-IB as:

> *"**Functional need** means the need for a proposed activity to traverse, locate or operate in a particular environment because that activity can only occur in that environment".*

10.15. The term "functional need" is not defined in the NPS-HPL, but it is defined in the National Policy Statement for Indigenous Policy C of NPS-REG provides insight into the functional and operational requirements specific for renewable energy with the particular locational requirements demonstrating a functional and operational need to be located upon the highly productive land at the site. As such, I consider the Proposal to be **consistent** with **Clause 3.9(2)(j)** of the NPS-HPL and overall that the Proposal is not an inappropriate use.

Measures for use or development on highly productive land

10.16. Clause 3.9(3) sets out that:

> *"Territorial authorities must take measures to ensure that any use or development on highly productive land:*
>
> *a) Minimises or mitigates any actual loss or potential cumulative loss of the availability and productive capacity of highly productive land in their district; and*
>
> *b) Avoids, if possible, or otherwise mitigates, any actual or potential reverse sensitivity effects on land-based primary production activities from the use or development.*

10.17. It is noted that the Tararua District Council has not yet developed measures to achieve clause 3.9(3) using the RMA, Schedule 1 process and that the reference to measures in this clause does not refer to the performance of discretions under RMA, s104 nor do they refer to measures at an ad hoc site level rather it is at the broader district level. As these measures have not yet been developed, I make the following comments in a broad sense:

10.18. Clause 3.9(3)(a) does not require an avoidance of availability or productive capacity of HPL. Availability is not defined in the NPS-HPL, but Productive capacity is as:

*“**productive capacity**, in relation to land, means the ability of the land to support land-based primary production over the long term, based on an assessment of:*

a) Physical characteristics (such as soil type, properties, and versatility); and

b) Legal constraints (such as consent notices, local authority covenants, and easements); and

c) The size and shape of existing and proposed land parcels”.

10.19. I consider that there will be a small loss of availability of land, but this will be minimal. The posts for the solar tables will occupy an area of approximately 231m^2. The site will also consist of approximately 10 inverter stations, each with a minimum 1m buffer around the container. The total area for the inverters is calculated as being approximately 130m^2 in area. Three buildings are associated with electricity transmission with an area of 240m^2. Overall, this is 0.7% (601m^2) of the 86ha area of the site. While I do not know the extent of highly productive land in the District, when considered over a wider area, this will be even more insignificant. Furthermore, this area is no more than what could reasonably be expected for on-farm infrastructure such as a farmhouse, woolshed, dairy shed or associated farm buildings. I consider the extent of productive land occupied by the support structures, and inverters to be ‘minimal’.

10.20. Notwithstanding the above, the land is proposed to have a dual use. This is likely to be sheep grazing under and around the panels but could be used equally for crop growing or market gardening. As such, I consider that the Site can support land-based production over the long term and that the Proposal will not affect the land’s productive capacity.

10.21. Clause (3)(b) seeks to avoid, if possible, or otherwise mitigate, any actual or potential reverse sensitivity effects on land-based primary production from development use.

10.22. This is addressed at Section 7 of my evidence. Primary production activities can potentially reduce the performance of the solar panels through the generation of dust and/or spray or fertilizer drift. Primary production activities to be undertaken at the site equally have the potential to reduce the performance of the solar panels, for example through dust generation and/or dirt from sheep rubbing against the panels. The Proposal's activities will be mitigated through regular cleanliness checks of the panels and cleaning of the panels being undertaken when required. This must be undertaken with or without adjacent dust, fertilizer or spray drift-generating activities. In my opinion, the potential for reverse sensitivity effects from primary production activities will be avoided through the planting proposed alongside boundaries and through the setbacks achieved to other land-based primary production alongside the maintenance regime.

10.23. There are no legal constraints such as consent notices, local authority covenants or easements which would prevent this land from having a productive use alongside the solar farm over the long term.

10.24. The size and shape of the site, alongside the remainder of the land parcels, enables the efficient and contiguous operation of land-based primary production.

Is there a conflict between the NPS-HPL and NPS-REG

10.25. I do not consider that the NPS-REG and NPS-HPL conflict. The NPS-REG seeks to support the establishment and expansion of renewable energy generation and takes provenance from s7(i) and (j) of the RMA. The NPS-HPL seeks to protect HPL from inappropriate uses and developments and takes provenance from s7(b) and (g) of the RMA but provides a pathway for specified infrastructure (such as the Proposal).

10.26. This pathway is through consideration of Clause 3.9.3(a) above, and my opinion is that there will be a very limited 'minimal' loss of availability of HPL and no actual or potential cumulative loss of productive capacity. I also consider that the Proposal will avoid any actual or potential reverse sensitivity effects on surrounding land-based primary production activities.

11. SECTION 104(1)(B)V) REGIONAL POLICY STATEMENT

11.1. I consider that the District Plan has been competently prepared to achieve Part 2 and gives effect to the relevant provisions of the Regional Policy Statement (RPS). That said, below, I provide an assessment of provisions of the RPS, which I consider to have particular relevance to this Proposal. I agree with Mr Bashford that these are contained within Chapter 2 (Te Ao Maori) and Chapter 3 (Infrastructure, Energy, Waste, Hazardous Substances and Contaminated Land) of the RPS).

Chapter 2: Te Ao Māori

11.2. **Objective 2-1 Resource management** requires regard to the mauri of natural and physical resources and to Kaitiakitanga and the relationship of hapu and iwi with their ancestral lands, water, sites, wahi tapu and other taonga. Attending **Policy 2-1(c)(i)** encourages resource consent applicants to consult directly with hapu or iwi where it is necessary to identify the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, wahi tapu and other taonga and **(ii)** the actual and potential adverse effects of proposed activities on those relationships.

11.3. I consider that the application for the Proposal is consistent with Objective 2-1 and Policies 2-1(c)(i and ii). As set out in Section 6 above, Mr Langbridge (Landscape Architect) and I met with representatives of both Rangitāne o Tamaki nui-ā-Rua (Rangitāne) and Ngāti Kahungunu ki Tāmaki-nui-a-Rua who represent the mana whenua of this locality on the 11th and 12th July 2022. Further consultation with these representatives was had before the application was made. The application was submitted with the support from Mr Kendrick of Ngāti Kahungunu.

11.4. The iwi representative for Rangitāne provided general support for the project with recommendations centred around the potential wetland with a setback, native planting and cultural monitoring of the wetland recommended. The application provides for a 10m setback in accordance with the NPS-FW rather than the 20m setback recommended, native planting sourced locally but not necessarily eco-sourced, and no provision is made for cultural monitoring of the wetland as part of this consent process, but this is not necessarily precluded. The recommendation for an accidental discovery protocol, while necessary through the Heritage New Zealand Pouhere Taonga Act (2014), can be easily adopted, as such, I agree with Mr Bashford's draft condition of consent 28.

11.5. I note that Rangitāne were notified as part of the limited notification process, and no submission was made. While the Proposal does not fully adopt the Rangitāne recommendation to its full extent, I consider that the Proposal adequately addresses the outcomes sought by the recommendations.

11.6. Overall, I consider the Proposal to be **consistent** with **Objective 2-1** and **Policies 2-1(c)(i and ii).**

11.7. Attendant **Policy 2-2 Wāhi tapu, wāhi tūpuna and other sites of significance** to Maori identified in the regional or district plans as historic reserves, Maori reserves, sites recorded in the New Zealand Archaeological Associations site recording scheme and as registered sites under the Historic Places Act must be protected. There are no recorded sites of significance at or near the Site.

11.8. Iwi representatives have also confirmed that there are no known sites of significance of waahi tapu and other taonga. Should an accidental discovery of a site of significance occur during the development of the site, the applicant will be required to follow an accidental discovery protocol, I consider this to be necessary.

11.9. I consider the Proposal to be **consistent** with **Policy 2-2**.

Chapter 3: Infrastructure, Energy, Waste, Hazardous Substances and Contaminated Land

11.10. **Objective 3-1 Infrastructure and other physical resources of regional or national importance** requires regard be given to the benefits of infrastructure and other physical resources of regional or national importance by recognising and providing for their establishment, operation, maintenance and upgrading. **Objective 3-2 Energy** has not been recognised in Mr Bashford's report but I consider this also to have particular relevance to the Proposal as it requires an improvement in the efficiency of the end use of energy and an increase in the use of renewable energy resources within the Region.

11.11. **Policy 3-1(a)** lists the infrastructure that must be recognised as having regional or national importance with **(a)(i)** listing facilities for the generation of more than 1 MW of electricity and its supporting infrastructure where the electricity is supplied to the electricity distribution and transmission networks.

11.12. The Proposal exceeds the 1MW minimum and is therefore required to be considered as being infrastructure of regional or national importance given it will generate approximately 75,642MW an hour in its first year which is significantly more than the 1 MW threshold of this policy**.**

11.13. **Policy 3-1(c)** requires that for the establishment, operation, maintenance or upgrading of infrastructure and other resources of regional or national importance have regard to the benefits derived from those activities. The positive effects/benefits of this Proposal are considered in Section 7 above for the Commissioner to have regard to.

11.14. **Policy 3-2** requires the Regional Council and Territorial Authorities to ensure that adverse effects on infrastructure and other physical resource of regional or national importance from other activities are avoided as far as reasonably practicable. This is relevant to the Proposal in relation to the existing Transpower and PowerCo electricity distribution network so that clause (a) the current infrastructure and infrastructure corridors are identified and had regard to in resource making decision-making. Safe separations are to be maintained under clause (e) giving effect to the New Zealand Code of Practice for Electrical Safe Distances (NZECP 34:2001) prepared under the Electricity Act 1992 and the Electricity (Hazards from trees) Regulations 2003 prepared under the Electricity Act 1992. Planting is not to interfere with existing infrastructure under clause (g) giving effect to the Electricity (Hazards from trees) Regulations 2003. The applicant has revised the site layout and landscaping proposed to adequately provide safe separation distances to the existing infrastructure and to ensure the proposed landscaping does not present a hazard to that infrastructure. An agreed set of conditions with Transpower have been volunteered, these have been included as draft conditions 36-41. I consider the Proposal to be **consistent** with **Policy 3-2.**

11.15. **Policy 3-3 Adverse effects of infrastructure and other physical resources of regional or national importance on the environment** provides local authorities with guidance on managing any adverse environmental effects arising from the establishment, operation, maintenance and upgrading of infrastructure or other physical resources of regional or national importance. Clause 3(b) requires local authorities to allow minor adverse effects arising from the establishment of new infrastructure of regional or national importance. As set out in Section 6 above, I do not consider that the effects of the Proposal will be more than minor. Therefore, I consider there to be a clear direction set by this Clause 3(b) that this Proposal should be allowed. Clause 3(c) relates to avoiding, remedying or mitigating more than minor adverse effects arising from the establishment of new infrastructure. In terms of landscape effects I note that while these may be more than minor in the short term they will be mitigated to no more than minor with the establishment of a shelterbelt.

11.16. I consider the Proposal to be **consistent** with **Policy 3-3.**

11.17. **Policy 3-6: Renewable energy** is relevant to the Proposal. It sets out:

(a) The Regional Council and Territorial Authorities must have particular regard to:

(i) the benefits of the use and development of renewable energy resources including:

A. contributing to reduction in greenhouse gases,

B. reduced dependency on imported energy sources,

C. reduced exposure to fossil fuel price volatility, and

D. security of supply for current and future generations,

(ii) the Region's potential for the use and development of renewable energy resources, and

(iii) the need for renewable energy activities to locate where the renewable energy resource is located, and

(iv) the benefits of enabling the increased generation capacity and efficiency of existing renewable electricity generation facilities, and

(v) the logistical or technical practicalities associated with developing, upgrading, operating or maintaining an established renewable electricity generation activity

.

11.18. Regarding Policy 3-6 I consider that the establishment of a solar farm will contribute to the benefits identified under Clause (a)(i) and (iv). In this regard I also note the NPS-REG preamble which states, *"the contribution of renewable electricity generation, regardless of scale, towards addressing the effects of climate change plays a vital role in the wellbeing of New Zealand, its people and the environment"*[22]. With regard to Clauses (ii), (iii) and (v), I consider that the Site has potential to be used and developed for a renewable energy resource given it has a large generally open and flat area, with little internal vegetation. The site is also located within an area with suitable sunshine hours and where the surrounding topography or built features will not result in shading upon the panels affecting their ability to absorb the solar rays. The Site is also located near to two substations and electricity transmission lines which is a key requirement for site selection, Without this co-location of infrastructure I understand the cost of establishing a solar farm of this size is likely to be prohibitive to the project becoming established.

11.19. In my opinion the Proposal is **consistent** with **Policy 3-6.**

12. SECTION 104(1)(C) OTHER MATTERS

12.1. Section 11 of my AEE sets out other matters 'climate change' which I consider to be relevant to the Proposal with particular regard to The Climate Change Response (Zero Carbon) Amendment Act. The Amendment Act which

[22] RPS REG Preamble

provides a framework for New Zealand to develop and implement clear and stable climate change policies that contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5 degrees above pre-industrial levels and to allow New Zealand to prepare for and adapt to the effects of climate change. The Amendment Act sets a new domestic greenhouse gas emissions reduction target for New Zealand to zero by 2050.

12.2. This energy demand context arising from these amendments has implications for the need for regions to contribute according to their resources to renewable energy generation and for decision-makers to recognise the practical constraints associated with the development of renewable energy generation.

12.3. As I have already canvassed in this evidence, the site has been identified as having a unique opportunity to be used to produce energy generated from a renewable energy source particularly because the site receives a good amount of sunshine hours, it is close to existing electricity infrastructure negating the need to establish and provide further substations, transmission towers and overhead power transmission lines and because it is in a limited visual catchment.

12.4. The Proposal will contribute positively towards climate change response whilst also retaining the underlying pastoral use and soil resource at the site. In relation to landscape values, I consider that there is a point when the value of a landscape is moderated by broader issues such as the provision of renewable resources and contribution made to climate change mitigation and long-term sustainability. Overall, I consider that the proposal will assist in New Zealand meeting its energy demand in a location where a solar farm can be appropriately located.

13. PART 2

13.1. The various statutory documents referred to above have recognised, provided for, or given effect to the Purpose and Principles of the Act. As set out in the AEE that I do not believe recourse to Part 2 to be necessary. However for completeness I summarised the key provisions under Part 2 relevant to this Proposal. The summary with some additional comment is:

(a) There are no s6 Matters of national importance relevant to this application.

(b) In relation to s7(b), the Proposal will enable the efficient use and development of natural and physical resources. For this proposal, I consider this to be twofold as solar energy, an inexhaustible natural resource is proposed to be used for electricity generation. In utilising the available solar energy, the natural land and soil resource will be occupied by solar infrastructure but the land around the support structures and poles can continue to be used for primary production purposes.

(c) In relation to s7(c), amenity values will be maintained in accordance with the expectations set out in the District Plan. Mitigation of the Proposal through the generous setbacks from roads, the shelterbelt planting and ongoing grazing or other primary production will ensure amenity values are maintained.[23]

(d) In relation to s7(f) the Proposal provides for the maintenance and enhancement of the environment in accordance with the relevant planning documents.

(e) In relation to s7(g) there is no finite characteristic associated with natural solar energy. It is considered that highly productive land is a resource with finite characteristics and long-term values for land-based primary production. The development of solar infrastructure on this soil resource would mean the removal of a small amount of the land resource for the supporting structures, but primarily the land resource will remain and can continue to be used for primary production purposes.

(f) Concerning s7(j) the Proposal provides benefits in terms of the development and use of renewable energy.

[23] Landscape evidence at [204]

(g) Concerning Section 8, both Rangitāne o Tamaki nui-ā-Rua and Ngāti Kahungunu ki Tāmakinui-a-Rua have advised that the site is located within an area of significance to Maori, however, the site itself does not contain any known sites of significance.

14. PROPOSED CONDITIONS OF CONSENT

14.1. I generally agree with the conditions of consent proposed but have the following recommendations:

a) Update Condition 1 to reflect that a change is made to the General Arrangement Plan to achieve a greater setback distance to electricity transmission lines and to the Landscape Mitigation Plan, which has a greater amount of shelterbelt planting proposed and a change in plant species.

b) Update Condition 8 to reflect that a change is made to the planting at the site's boundary from flax to either totara or cypress hedgerow.

c) Delete Conditions 17 and 34 in relation to a Pest Control Plan if a change from flax shelterbelt planting to totara or cypress hedgerow is approved.

d) Include a new condition of consent to address HiRock's concerns regarding reverse sensitivity as follows:

That a Land Covenant be prepared by the applicant's lawyer and registered at the applicant's expense. The covenant shall read as follows:

Where gravel quarrying activities undertaken in the surrounding area by Hirock Quarries or their successor are carried out in accordance with the relevant District Plan requirements or the conditions of resource consent (Insert reference to current consent here RM XXXX) the property owner and solar farm operator shall not:

Bring any proceedings for damages, negligence, nuisance, trespass or interference arising from the use of that land; or

Make nor lodge, nor;
Be party to, nor;

Finance nor contribute to the cost of

Any application, proceeding or appeal (either pursuant to the Resource Management Act 1991 or otherwise) designed or intended to limit, prohibit or restrict the continuation of the operations of the Hirock Quarries or their successor which are carried out under the terms of their resource consent (Insert reference to current consent here RM XXXX).

e) Include the recommended revisions and additions of consents on noise from Ms Hamilton's evidence[24]

15. CONCLUSION

15.1. I have assessed the Proposal against the relevant statutory provisions and planning documents.

15.2. I consider that the effects of the proposal will be less than minor for glint and glare, noise, the safe and efficient operation of the road network, reverse sensitivity, natural hazards, cultural effects, the soil resource and upon existing electricity infrastructure. I consider that there will be temporary effects which are more than minor concerning landscape and visual amenity, but these will reduce to minor or less than minor with mitigation of the shelterbelt planting at the boundary.

15.3. I consider that there are also positive effects associated with the proposal including a diversification of electricity generation, adding to electricity generation capacity and increasing security of supply. The proposal will also assist in meeting New Zealand's climate change targets. Ultimately, while there are impacts associated with landscape and visual effects, these are of a temporary duration and will reduce to a point where they are no more than minor when the shelterbelt planting is established.

15.4. The Proposal will be consistent with the Objectives and Policies of the Tararua District Plan.

[24] Evidence of M Hamilton -

15.5. The Proposal is consistent with the NPS-REG, which significantly promotes renewable electricity generation. It provides directional solid support for establishing new renewable electricity generation activity.

15.6. The Proposal is consistent with the NPS-HPL and is not considered an inappropriate use or development of HPL. The Proposal will allow HPL to continue to be used for primary production now and future generations.

15.7. The Proposal is consistent with the RPS, which provides a robust framework for promoting renewable energy development to implement NPS-REG.

15.8. I generally agree with the recommended conditions of consent but have some suggested revisions and am offering up a further condition of consent to address reverse sensitivity concerns by HiRock.

Catherine Boulton

16 August 2023

SOLAR BAY – TARARUA
Glint/Glare Assessment

MANGAMAIRE ROAD, TARARUA

Date of issue: 11/08/2023

Document Version

Version	Date	Revision Notes
V20230811	10/08/2023	Draft – for internal review and comment

Document Contributors

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Approval

Contributor Type	Name	Position	Date
Document Author	Michael Robinson	Engineer	11/08/2023
Technical Reviewer	Andrew Murdoch	Engineer	11/08/2023

Related Documents

Document Type	Document Title (Number & Title)
ForgeSolar Report	APPENDIX I - Tararua SAT Existing V20230811
ForgeSolar Report	APPENDIX II - Tararua SAT Potential V20230811
Architects Document	APPENDIX III - Tararua Receptor Locations
Architects Document	APPENDIX IV - Tararua Planting Mitigation

Stakeholder Consultation

Name	Position

1. Executive Summary

Vector PowerSmart (**VPS**) was engaged by Solar Bay (**SB**) to prepare a Glint and Glare Assessment at Tararua, Mangamaire Road, Tararua.

Conclusions:

- Two ForgeSolar Glint and Glare reports were produced, the first for existing receptors and a second for potential receptors.
- Both the eastern and western arrays are expected to produce yellow glare on several of the existing and potential OPs with minimal green glare.
- As yellow glare is present, further consultation may need to be undertaken to determine if extra mitigation is required.
- No red glint and/or glare is predicted in any of the scenarios.
- If a stow alarm occurs due to an isolated event such extreme weather or failure of equipment, the mounting system may stow into a manufacturer determined angle and orientation to protect the array.

2. GlareGauge Glint and Glare Assessment Report

2.1. Glint and Glare from PV Modules

Light reflects off all surfaces with the potential of causing glint (a momentary flash of bright light) and glare (a continuous source of bright light) and can possibly occur when reflected of a surface. Both phenomena can cause a brief loss of vision and a potential for after imaging. After image is define as an impression of a vivid image retained by the eye after viewing of the light source has ceased. Glint is usually experienced from moving reflectors whereas glare may occur when the reflector is slow or stationary.

As PV modules are constructed from light-absorbing material to absorb as much solar irradiation as possible to increase their efficiency and often include an anti-reflective coating therefore reflectivity is low compared to many other common materials such as vegetation and equal to water. This can be seen in Figure 1 below:

Figure 1: Chart indicating reflectivity of common surfaces. https://www.forgesolar.com/help/

The position of the PV modules relative to the sun has the largest effect on the module's reflectivity. As shown in Figure 2 below, the larger the angle of incidence the higher the percentage of light is reflected.

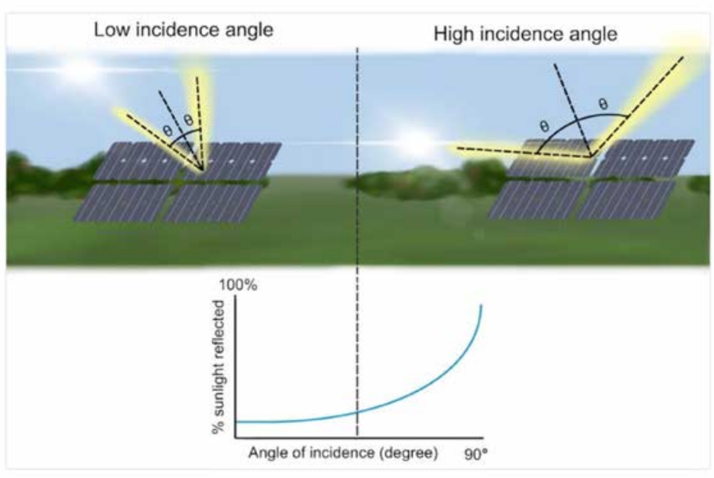


Figure 2: Angle of incidence effect on PV module reflectivity. https://www.forgesolar.com/help/

Single axis tracking systems tend to have a smaller angle of incidence as they follow the sun therefore reflecting less light than fixed-tilt systems that are stationary. As fixed-tilt systems are stationary the angle of incidence varies throughout the day (higher reflectivity generally occurs during sunrise and sunset) and will often reflect more light than single axis tracking systems.

2.2. GlareGauge Glint and Glare Assessment Tool

As it is possible for PV modules to create glint and glare, a comprehensive analysis was undertaken by Vector PowerSmart (VPS). There is currently no guidance from New Zealand's Civil Aviation Authority (CAA) or any other local organisations around assessment methods for glint and glare caused by solar farms however the American Federal Aviation Administration (FAA) previously recommended the Solar Glaze Hazard Analysis Tool (SGHAT). This tool has since been developed into GlareGauge by ForgeSolar.

The GlareGauge tool identifies possible glare from PV arrays and classifies them regarding their ocular impact. It should be noted that this software doesn't consider view shedding, (the blocking of the glare source from buildings, terrain, or vegetation, therefore representing a worst-case scenario unless stated otherwise).

The ocular impact of solar glare is quantified into three categories showing effect of after image:

- Green - low potential to cause after-image.
- Yellow - potential to cause temporary after-image.
- Red - potential to cause retinal burn.

If any glare occurs in the model, it is classified into the three colour-coded categories as seen in Figure 3 below:

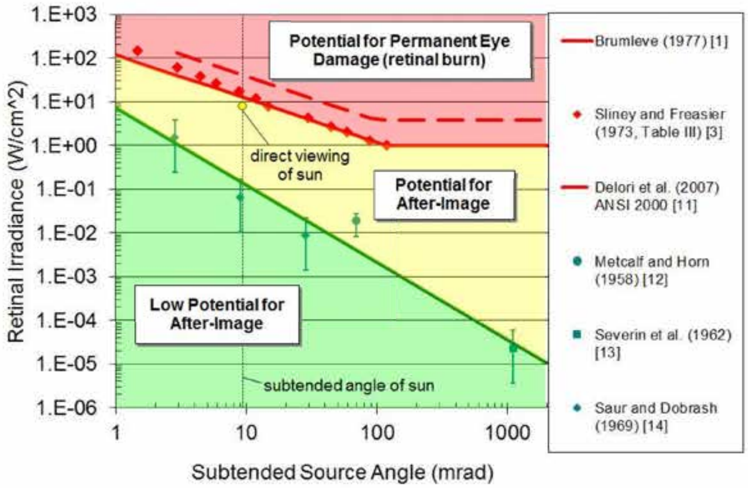


Figure 3: Sample glare hazard plot showing after image potential. https://www.forgesolar.com/help/#ref-ho-2011-method.

Essentially if the simulation predicts glare, the ocular impact of the glare is plotted onto the graph shown in Figure 3 to determine the category it belongs to.

The subtended source angle represents the size of the object producing glare (in this case the PV array) viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles (closer to the array) can result in glare of high intensity, even if the retinal irradiance is low. The further away the observer is to the array, the smaller the subtended angle will be thus decreasing the glare intensity.

It is important to note that the GlareGauge simulation uses "Clear Sky" model for simulation which is the worst-case scenario i.e., does not include clouds or other atmospheric conditions which would reduce glint and glare.

2.2.1. Impact Significant Definition

Table 1 below presents the recommended definition of 'impact significance' and the requirement for mitigation.

Impact Significance	Definition	Mitigation Requirement
No Impact	The assessed receptor will not experience any solar reflection due to lack of visibility.	No mitigation is necessary.
Low/Green	The assessed receptor may have a small visual impact from solar reflection, but it is considered insignificant.	No mitigation is necessary.
Moderate/Yellow	The assessed receptor may experience solar reflection, which is visible and considered to have a moderate impact.	Further analysis and consultation should be conducted to determine if mitigation measures are required.
High/Red	The assessed receptor will experience a significant impact from solar reflection.	Mitigation measures and consultation are strongly recommended. If the proposed development is to proceed it is highly likely mitigation will be necessary.

Table 1: Impact Significant Definition

2.3. FAA Glare Requirements

In 2013 the FAA released the "Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports"[1] which endorsed and required a SGHAT tool (now GlareGauge) analysis of the ocular impact of a proposed solar energy system on federally obligated airport. The FAA adopted the Glare Hazard Plot shown in Figure 3, and required the following standards to be met:

1. No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATCT) cab, and
2. No potential for glare or ''low potential for after-image'' (shown in green in Figure 3) along the final approach path for any existing landing threshold or future landing thresholds.

To summarize, the FAA allows the construction of a PV array that may produce green glare that can impact the pilots or other airport personal unless there is an impact on the ATCT. The FAA will not allow a PV array that produces "potential for after-image" (shown in yellow in Figure 3).

As there is no guidance from the CAA or Waka Kotahi, it is assumed the FAA guidance applies to Glint and Glare analysis in New Zealand. Therefore, predicted green glare should not require mitigation whereas yellow glare potentially would.

Note: the 2013 "Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports" was replaced in 2021 by the "Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally Obligated Airports"[2] which no longer recommends or requires a SGHAT tool (GlareGauge) analysis. Stating "The tool is no longer available to all users at no cost. There are several glint and glare analysis tools available to airport sponsors on the open market." Instead, the FAA requires the sponsor to confirm they have completed a glint and glare analysis and determined there is no impact on an ATCT.

[1] Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports: https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

[2] Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports: https://www.federalregister.gov/documents/2021/05/11/2021-09862/federal-aviation-administration-policy-review-of-solar-energy-system-projects-on-federally-obligated

2.4. Sample Graph Cluster

Figure 4 below is a sample graph cluster, these graphs are the visual representation of the predicted glare effecting a receptor caused by the Solar Farm. Each OP or Route will have a graph cluster for each array that produces glare:

Note: Figure 4 only shows yellow glare. If red or green glare is present, it would also be represented on this example.

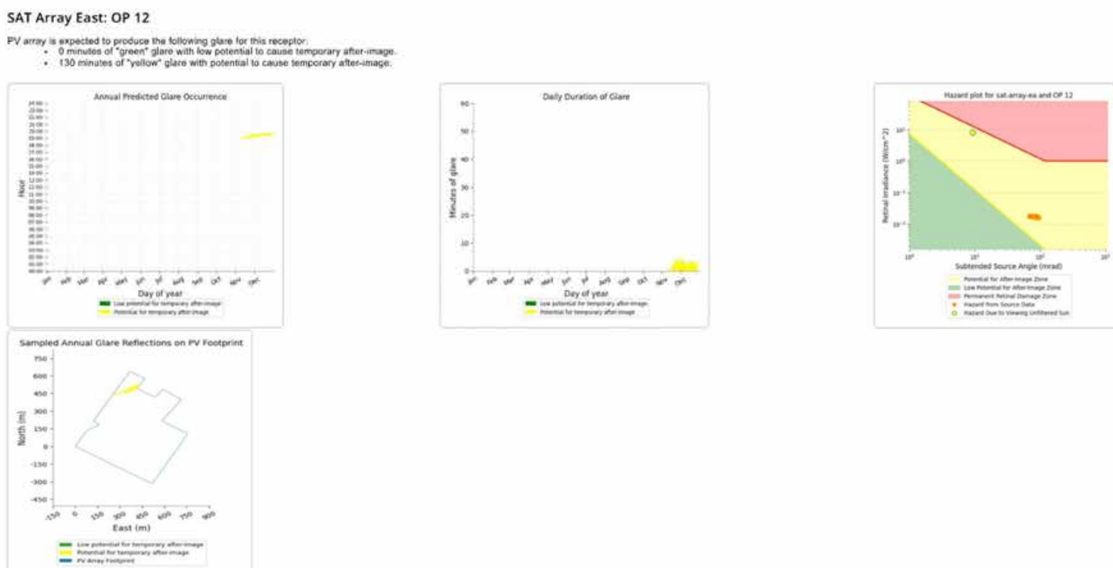


Figure 4: Sample Graph Cluster

Annual Predicted Glare Occurrence: This graph shows the time of day that glare occurs throughout the year. In this example, yellow is predicted between 7pm and 8pm during late September through to mid-March.

Daily Duration of Glare: This graph shows the duration of predicted glare in minutes throughout the year of which the longest period is approximately 5 minutes.

Hazard Plot for sat-array-ea and OP 12: Utilizes the same graph shown in Figure 3. As shown on the hazard plot in Figure 4, the orange plot points represent the intensity of the glare by the zone the plot appears in. In this case the glare is predicted to be yellow.

Sampled Annual Glare Reflections on PV Footprint: The blue outline shows the Solar Farm footprint. The area of the PV footprint that produces the received glare is represented by the colour spread across the footprint (either yellow or green glare). This example shows yellow glare is produced on the northern area across the array.

2.5. ForgeSolar Report

VPS used the ForgeSolar software tool to evaluate the potential for and duration of glare for receptors surrounding the proposed solar arrays. The receptors and obstructions were identified by Rough Milne Mitchell Landscape Architects, the receptors were further classified as the following:

- Existing: these are receptors mainly consisting of existing residences surrounding the arrays that could be affected if the arrays were operational at the present time, this also includes the two route receptors Mangamaire Road and Tutaekara Road.
- Potential: areas that are not currently inhabited but have the potential to be developed and settled in the future.

Two ForgeSolar reports were generated, the first for existing receptors and the second for potential. These reports can be found attached as Appendices I and II. The obstructions and PV array footprint is the same in both reports, the only variables are the OPs and route receptors.

Figure 5 below shows the site configuration Appendix I, existing receptors showing following information:

- SAT Array East and SAT Array West
- Existing Observation Points (OP) 1 to 20 located around both arrays.
- Route receptors Mangamaire Road and Tutaekara Road
- Various Obstructions located around both arrays, these obstructions include existing planting and proposed shelterbelts found in Appendix III and IV.

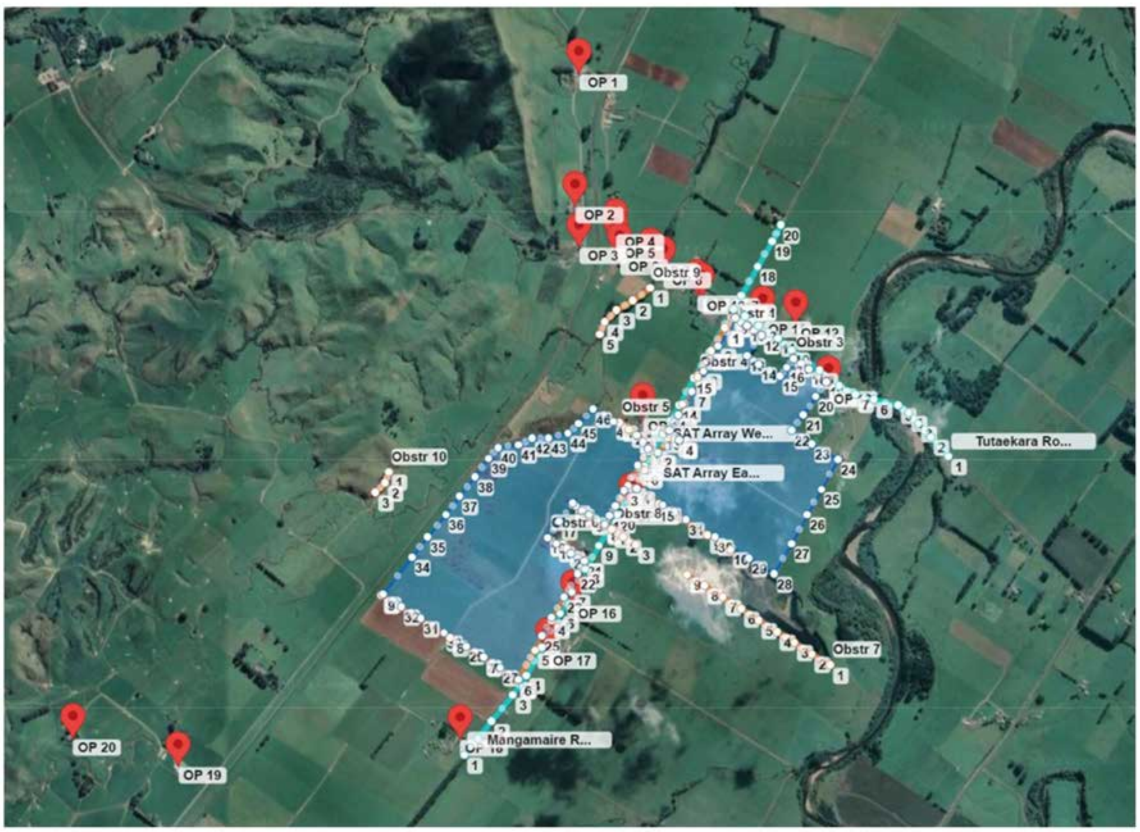


Figure 5: Site Configuration of Tararua Solar Farm with Existing Receptors

Figure 6 below shows the site configuration Appendix II, potential receptors showing following information:

- SAT Array East and SAT Array West
- Potential Observation Points (OP) 1 to 26 located around both arrays.
- Various Obstructions located around both arrays, these obstructions include existing planting and proposed shelterbelts found in Appendix III and IV.

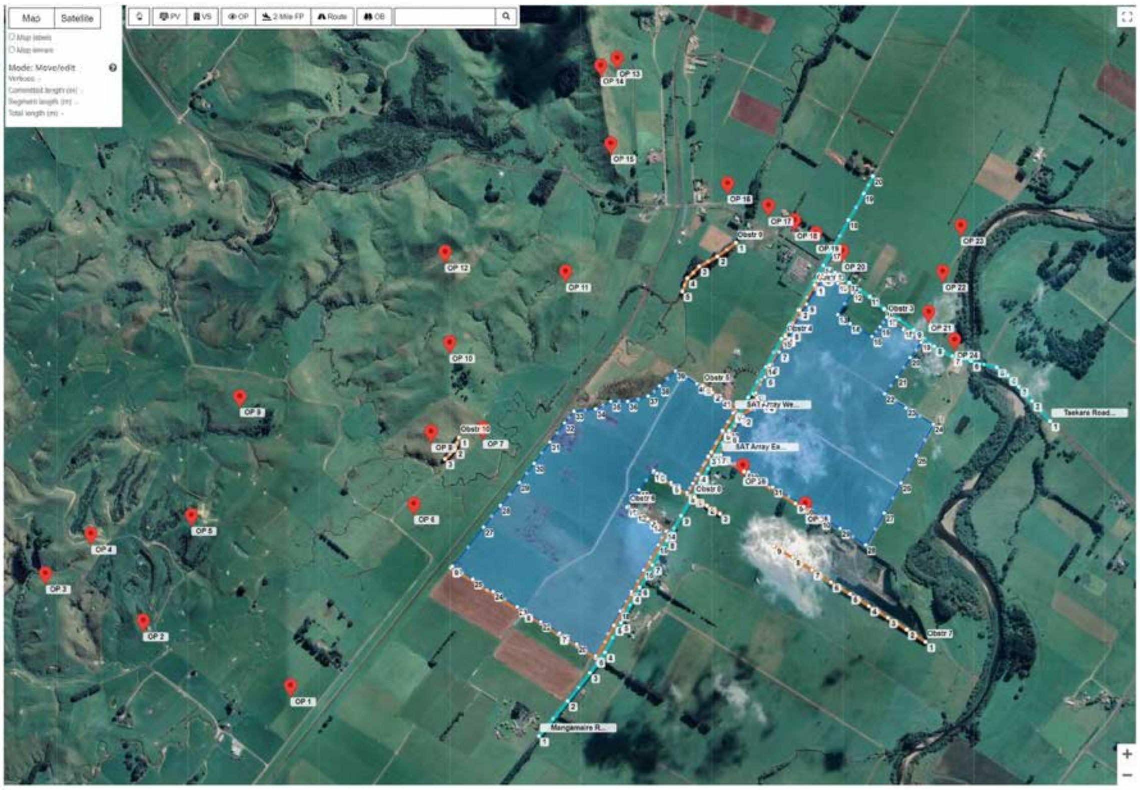


Figure 6: Site Configuration of Tararua Solar Farm with Potential Receptors

Note: OP1 for Appendix I existing receptors does not correspond to OP1 for Appendix II potential receptors, the same is true to all OPs. All OPs in Appendix I are separate to OPs in Appendix II.

3. Reported Glare

Full results are available in attached Appendices I and II.

Note: Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour. This software does not include viewshed analysis (therefore not accounting for terrain, buildings or vegetation blocking the glare source) thus representing a worst-case scenario.

3.1. Single Axis Tracker Existing Receptors Results

Table 2 below reports the predicted glare for **SAT Array East** based on the observations in Appendix I, existing receptors. Yellow glint/glare is reported at several of the OP's, no glare is predicted for the Route Receptors as shown in table 3:

OP	Time (Hours)	Duration (Month of year)	Max. Minutes of Glare per day	Glare		Total Minutes Annually
				Green	Yellow	
OP1	No Glare found					
OP2	No Glare found					
OP3	5am-5.30am	Mid-November to mid-December & early January	13	0	267	267
OP4	No Glare found					
OP5	No Glare found					
OP6	5am-5.30am	Late November to early January	10	0	271	271
OP7	No Glare found					
OP8	No Glare found					
OP9	No Glare found					
OP10	No Glare found					
O11	No Glare found					
OP12	7pm-8pm	Mid-November to late December	6	0	130	130
OP13	7pm-8pm	Mid-November to late December	4	0	111	111
OP14	No Glare found					
OP15	5am-7am	Early February to mid-March, late August to mid-October, early November to mid-	11	0	398	398

		December & early January				
OP16	No Glare found					
OP17	No Glare found					
OP18	No Glare found					
OP19	No Glare found					
OP20	No Glare found					

Table 2: Total annual glare predicted per existing receptor caused by SAT Array East.

Route Receptors	Time (Hours)	Duration (Month of year)	Max. Minutes of Glare per day	Glare		Total Minutes Annually
				Green	Yellow	
Route: Mangamaire Road	No Glare found					
Route: Tutaekara Road	No Glare found					

Table 3: Total annual glare predicted per existing Road Receptor caused by SAT Array East.

Table 4 below reports the predicted glare for **SAT Array West** based on the observations in Appendix I, existing receptors. No glint/glare is reported at all OP's, no glare is predicted for the Route Receptors as shown in table 5:

OP	Time (Hours)	Duration (Month of year)	Max. Minutes of Glare per day	Glare		Total Minutes Annually
				Green	Yellow	
OP1	No Glare found					
OP2	No Glare found					
OP3	No Glare found					
OP4	No Glare found					
OP5	No Glare found					
OP6	No Glare found					
OP7	No Glare found					
OP8	No Glare found					
OP9	No Glare found					
OP10	No Glare found					
O11	No Glare found					
OP12	No Glare found					
OP13	No Glare found					
OP14	No Glare found					
OP15	No Glare found					
OP16	No Glare found					
OP17	No Glare found					
OP18	No Glare found					
OP19	No Glare found					
OP20	No Glare found					

Table 4: Total annual glare predicted per existing receptor caused by SAT Array West.

Route Receptors	Time (Hours)	Duration (Month of year)	Max. Minutes of Glare per day	Glare		Total Minutes Annually
				Green	Yellow	
Route: Mangamaire Road	No Glare found					
Route: Tutaekara Road	No Glare found					

Table 5: Total annual glare predicted per existing Road Receptor caused by SAT Array West.

3.2. Single Axis Tracker Potential Receptors Results

Table 6 below reports the predicted glare for **SAT Array East** based on the observations in Appendix II, potential receptors. Green and yellow glint/glare is reported at several of the OP's.

OP	Time (Hours)	Duration (Month of year)	Max. Minutes of Glare per day	Glare		Total Minutes Annually
				Green	Yellow	
OP1	No Glare found					
OP2	No Glare found					
OP3	6.30am-7.30am	Late April & mid-August to mid-September	3	37	40	77
OP4	6.30am-7.30am	April, late August & late September	10	4	152	156
OP5	6am-7.30am	April & September	10	0	257	257
OP6	No Glare found					
OP7	No Glare found					
OP8	5.30am-7.30am	Late February to early March, April, late August & late September to late October	9	0	167	167
OP9	5.30am-7am	Late February to early March, early April & October	7	0	77	77
OP10	5am-7am	Sporadic from mid-September to early April	19	0	826	826
OP11	5am-7am	Sporadic from mid-September to late March	22	0	753	753
OP12	5am-7am	Sporadic from October to mid-March	22	0	706	706
OP13	No Glare found					
OP14	No Glare found					
OP15	5am-6am	Late November & late December to early January	10	0	174	174
OP16	No Glare found					

OP17	No Glare found					
OP18	No Glare found					
OP19	No Glare found					
OP20	No Glare found					
OP21	No Glare found					
OP22	7pm-8pm	Early & late November, January to early February	4	0	63	63
OP23	7pm-8pm	Early December to late January	5	0	170	170
OP24	No Glare found					
OP25	5am-6am	Early January	5	0	19	19
OP26	No Glare found					

Table 6: Total annual glare predicted per potential receptor caused by SAT Array East.

Table 7 below reports the predicted glare for **SAT Array West** based on the observations in Appendix II, potential receptors. Yellow glint/glare is reported at several of the OP's.

OP	Time (Hours)	Duration (Month of year)	Max. Minutes of Glare per day	Glare		Total Minutes Annually
				Green	Yellow	
OP1	No Glare found					
OP2	No Glare found					
OP3	6am-7am	Early March & mid-September to early October	4	0	80	80
OP4	6am-7am	March & September to mid-October	12	0	375	375
OP5	5.30am-7.30am	Sporadic late January to mid-March & late August to early November	21	0	1212	1212
OP6	No Glare found					
OP7	No Glare found					
OP8	5am-7am	Sporadic late August to mid-April	17	0	1669	1669
OP9	5am-7am	Sporadic early October to late March	25	0	1512	1512
OP10	5am-7am	Sporadic October to mid-March	43	0	3660	3660
OP11	No Glare found					
OP12	5am-6am	Sporadic mid-November to late January	47	0	1034	1034
OP13	No Glare found					
OP14	No Glare found					
OP15	No Glare found					
OP16	No Glare found					
OP17	No Glare found					
OP18	No Glare found					

OP19	No Glare found
OP20	No Glare found
OP21	No Glare found
OP22	No Glare found
OP23	No Glare found
OP24	No Glare found
OP25	No Glare found
OP26	No Glare found

Table 7: Total annual glare predicted per potential receptor caused by SAT Array West.

3.3. Stow Alarm

At times during situations such as isolated extreme weather events or failure of certain equipment a stow alarm will cause the mounting system to stow at a predetermined orientation and angle (often 0°) to protect the array. Due to such an event, there may be additional glare produced outside of the ForgeSolar predictions.

It is important to note that the Glint and Glare simulation uses “Clear Sky” model for simulation which is the worst-case scenario i.e., does not include clouds or other atmospheric conditions which would reduce glint and glare. The fact that typically high wind >= 55km/hour events are predominant with clouds/storms rather than cloudless, with isolated events where high wind prevail in a cloudless scenario, the actual glare at the receptors should be less than the simulation suggests.

Stow alarm conditions are determined by the mounting system manufacturer.

4. Conclusions and Observations

To conclude, both east and west arrays are predicted to produce glare for several of the existing and potential receptors. Glare is not predicted to effect either Mangamaire Road or Tutaekara Road. These results are based on analysis with the inclusion of existing and proposed shelterbelts.

No red glare was predicted in any of the scenarios.

Due to the absence of New Zealand guidance documentation (CAA or Waka Kotahi) or prior examples of acceptance criteria relating to glint and glare, the American FAA guidelines have been applied. Based on those guidelines, some mitigation may be required based on the presence of yellow glint and/or glare, more consultation may be required. Examples of further mitigation could include screening via additional shelterbelts.

If a stow alarm occurs due to an isolated event such extreme weather or failure of equipment, the mounting system may stow into a manufacturer determined angle and orientation to protect the array. This rare event could produce unforeseen glint or glare depending on stow angle and orientation.

Simulation uses “Clear Sky” weather data where glint and glare are not reduced due to atmospheric conditions or clouds obstructing the sun, essentially providing a worst-case scenario.

Appendices

APPENDIX I - Tararua SAT Existing V20230811

APPENDIX II - Tararua SAT Potential V20230811

APPENDIX III - Tararua Receptor Locations

APPENDIX IV - Tararua Planting Mitigation

ForgeSolar

2945 - Tararua

Tararua Rev 3 - SAT - Existing Receptors

Client: Solar Bay

Created Aug 09, 2023
Updated Aug 11, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97323.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **Off**

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

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
SAT Array East	SA tracking	SA tracking	0	1,177	-
SAT Array West	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 826,410 m^2

Name: SAT Array East
Footprint area: 375,328 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.523131	175.748672	157.00	1.50	158.50
2	-40.521914	175.749605	154.00	1.50	155.50
3	-40.521488	175.750568	153.00	1.50	154.50
4	-40.521488	175.750568	153.00	1.50	154.50
5	-40.521159	175.750142	152.00	1.50	153.50
6	-40.520645	175.750533	151.00	1.50	152.50
7	-40.519854	175.751129	149.96	1.50	151.46
8	-40.519198	175.751628	148.00	1.50	149.50
9	-40.518333	175.752266	147.00	1.50	148.50
10	-40.517389	175.753038	146.00	1.50	147.50
11	-40.517662	175.753580	146.00	1.50	147.50
12	-40.517964	175.754197	146.00	1.50	147.50
13	-40.518659	175.753564	147.00	1.50	148.50
14	-40.518953	175.754079	147.00	1.50	148.50
15	-40.519357	175.755013	148.00	1.50	149.50
16	-40.519055	175.755345	147.00	1.50	148.50
17	-40.518745	175.755627	147.00	1.50	148.50
18	-40.519126	175.756308	147.00	1.50	148.50
19	-40.519540	175.757072	147.62	1.50	149.12
20	-40.520034	175.756627	148.00	1.50	149.50
21	-40.520658	175.756053	149.00	1.50	150.50
22	-40.521188	175.755549	150.00	1.50	151.50
23	-40.521624	175.756439	150.00	1.50	151.50
24	-40.522146	175.757587	150.00	1.50	151.50
25	-40.523155	175.756874	151.00	1.50	152.50
26	-40.524022	175.756225	152.62	1.50	154.12
27	-40.524986	175.755533	153.78	1.50	155.28
28	-40.525995	175.754760	154.08	1.50	155.58
29	-40.525482	175.753671	155.00	1.50	156.50
30	-40.524776	175.752164	155.92	1.50	157.42
31	-40.524160	175.750855	156.00	1.50	157.50
32	-40.523685	175.749841	156.96	1.50	158.46

Name: SAT Array West
Footprint area: 451,083 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.521784	175.749185	154.00	1.50	155.50
2	-40.522361	175.748739	155.71	1.50	157.21
3	-40.523179	175.748136	157.20	1.50	158.70
4	-40.523727	175.747712	158.67	1.50	160.17
5	-40.524043	175.747488	159.00	0.00	159.00
6	-40.524043	175.747488	159.00	0.00	159.00
7	-40.524043	175.747488	159.00	0.00	159.00
8	-40.524043	175.747488	159.00	0.00	159.00
9	-40.524043	175.747488	159.00	0.00	159.00
10	-40.524043	175.747488	159.00	0.00	159.00
11	-40.524043	175.747488	159.00	0.00	159.00
12	-40.524043	175.747488	159.00	0.00	159.00

13	-40.524343	175.747245	159.00	1.50	160.50
14	-40.524017	175.746564	160.00	1.50	161.50
15	-40.523723	175.745985	160.00	1.50	161.50
16	-40.523633	175.745840	160.00	1.50	161.50
17	-40.524241	175.745244	160.00	1.50	161.50
18	-40.524791	175.744735	161.00	1.50	162.50
19	-40.524985	175.745113	161.00	1.50	162.50
20	-40.525305	175.745778	160.00	1.50	161.50
21	-40.525560	175.746352	160.00	1.50	161.50
22	-40.525996	175.746038	160.00	1.50	161.50
23	-40.526791	175.745443	160.00	1.50	161.50
24	-40.527483	175.744912	161.00	1.50	162.50
25	-40.528100	175.744451	161.00	1.50	162.50
26	-40.529542	175.743423	163.00	1.50	164.50
27	-40.529164	175.742624	163.00	1.50	164.50
28	-40.528802	175.741902	163.00	1.50	164.50
29	-40.528441	175.741127	164.00	1.50	165.50
30	-40.527980	175.740135	163.00	1.50	164.50
31	-40.527487	175.739124	163.00	1.50	164.50
32	-40.527095	175.738265	162.00	1.50	163.50
33	-40.526687	175.737420	161.00	1.50	162.50
34	-40.525436	175.738721	160.00	1.50	161.50
35	-40.524746	175.739419	160.00	1.50	161.50
36	-40.524017	175.740223	160.00	1.50	161.50
37	-40.523405	175.740835	159.00	1.50	160.50
38	-40.522728	175.741511	157.02	1.50	158.52
39	-40.522125	175.742101	156.99	1.50	158.49
40	-40.521749	175.742519	157.00	1.50	158.50
41	-40.521668	175.743421	158.67	1.50	160.17
42	-40.521439	175.744054	157.00	1.50	158.50
43	-40.521439	175.744762	156.00	1.50	157.50
44	-40.521260	175.745631	155.00	1.50	156.50
45	-40.520942	175.746103	154.00	1.50	155.50
46	-40.520449	175.746763	152.39	1.50	153.89
47	-40.520864	175.747658	153.00	1.50	154.50
48	-40.521350	175.748667	153.55	1.50	155.05

Route Receptor(s)

Name: Mangamaire Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.532089	175.741029	166.00	1.30	167.30
2	-40.530972	175.742230	164.00	1.30	165.30
3	-40.530083	175.743175	163.00	1.30	164.30
4	-40.529427	175.743797	162.00	1.30	163.30
5	-40.528477	175.744462	161.00	1.30	162.30
6	-40.527351	175.745272	160.00	1.30	161.30
7	-40.526634	175.745792	160.00	1.30	161.30
8	-40.525847	175.746393	160.00	1.30	161.30
9	-40.525068	175.746994	159.16	1.30	160.46
10	-40.524008	175.747799	159.00	1.30	160.30
11	-40.523143	175.748437	157.00	1.30	158.30
12	-40.522365	175.749027	155.00	1.30	156.30
13	-40.521305	175.749820	153.00	1.30	154.30
14	-40.520319	175.750565	151.00	1.30	152.30
15	-40.519425	175.751204	149.00	1.30	150.30
16	-40.518516	175.751912	147.00	1.30	148.30
17	-40.516640	175.753296	145.00	1.30	146.30
18	-40.515645	175.754031	144.00	1.30	145.30
19	-40.514813	175.754669	143.00	1.30	144.30
20	-40.514259	175.755055	142.00	1.30	143.30

Name: Tutaekara Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.522049	175.762475	147.00	1.30	148.30
2	-40.521413	175.761724	147.00	1.30	148.30
3	-40.520956	175.761166	147.00	1.30	148.30
4	-40.520597	175.760715	147.00	1.30	148.30
5	-40.520336	175.760243	147.00	1.30	148.30
6	-40.520141	175.759170	147.00	1.30	148.30
7	-40.519978	175.758377	147.45	1.30	148.75
8	-40.519668	175.757626	147.37	1.30	148.67
9	-40.519146	175.756767	147.00	1.30	148.30
10	-40.518477	175.755523	147.00	1.30	148.30
11	-40.518085	175.754922	146.00	1.30	147.30
12	-40.517645	175.754064	146.00	1.30	147.30
13	-40.517319	175.753463	145.77	1.30	147.07
14	-40.517090	175.752969	145.00	1.30	146.30

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-40.509167	175.746093	156.64	1.70	158.34
OP 2	-40.513637	175.745921	152.00	1.70	153.70
OP 3	-40.515007	175.746114	151.00	1.70	152.70
OP 4	-40.514551	175.747723	146.72	1.70	148.42
OP 5	-40.514909	175.747723	147.00	1.70	148.70
OP 6	-40.515350	175.747895	147.00	1.70	148.70
OP 7	-40.515529	175.749268	145.00	1.70	146.70
OP 8	-40.515816	175.749825	145.00	1.70	146.70
OP 9	-40.516591	175.751343	145.00	1.70	146.70
OP 10	-40.516709	175.751558	145.00	1.70	146.70
OP 11	-40.517476	175.754245	145.86	1.70	147.56
OP 12	-40.517625	175.755716	145.60	1.70	147.30
OP 13	-40.519819	175.757191	148.00	1.70	149.70
OP 14	-40.520749	175.748919	152.00	1.70	153.70
OP 15	-40.523791	175.748425	158.00	1.70	159.70
OP 16	-40.527047	175.745839	160.00	1.70	161.70
OP 17	-40.528654	175.744734	161.00	1.70	162.70
OP 18	-40.531566	175.740810	166.00	1.70	167.70
OP 19	-40.532505	175.728347	170.00	1.70	171.70
OP 20	-40.531551	175.723669	181.00	1.70	182.70

Obstruction Components

Name: Obstruction 1
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.23

Name: Obstruction 3
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.68
7	-40.523141	175.748573	157.00
8	-40.523663	175.749651	157.00
9	-40.524683	175.751802	156.00
10	-40.525188	175.752853	155.00

Name: Obstruction 4
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.67
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.74
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.88
9	-40.526722	175.737353	161.00

Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.522574	175.737690	165.21
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	0	1,177	-	
SAT Array West	SA tracking	SA tracking	0	0	-	-

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
sat-array-ea (green)	0	0	0	0	0	0	0	0	0	0	0	0
sat-array-ea (yellow)	25	74	75	0	0	0	0	9	140	58	209	390

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	267
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	271
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	130
OP: OP 13	0	111
OP: OP 14	0	0
OP: OP 15	0	398
OP: OP 16	0	0
OP: OP 17	0	0

OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

SAT Array East: OP 1

No glare found

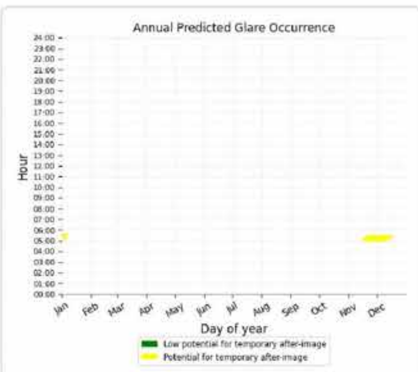
SAT Array East: OP 2

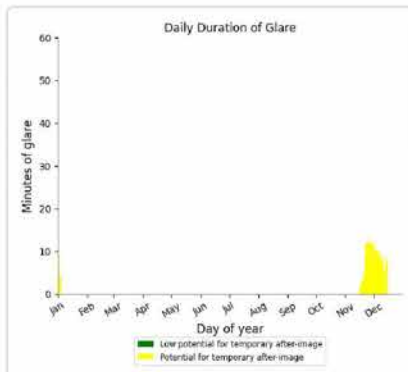
No glare found

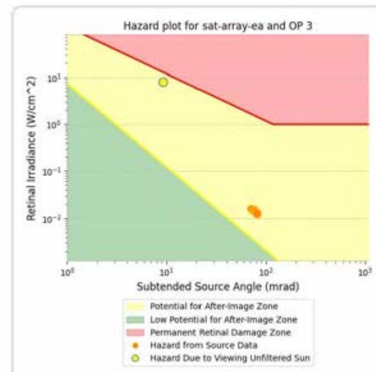
SAT Array East: OP 3

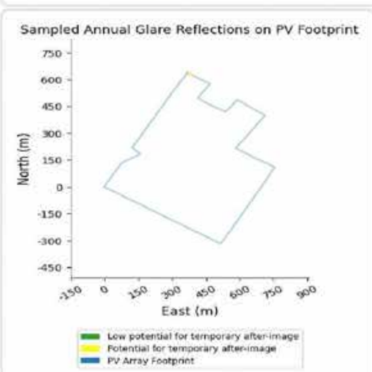
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 4

No glare found

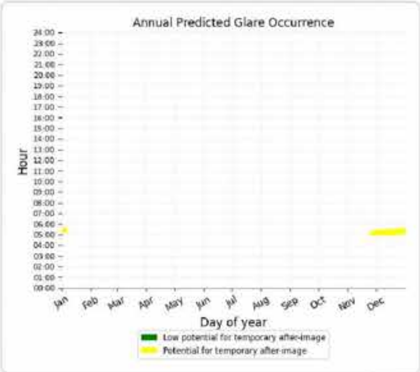
SAT Array East: OP 5

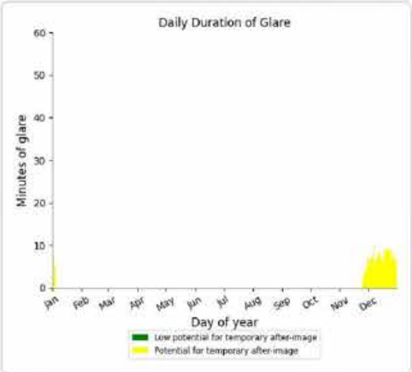
No glare found

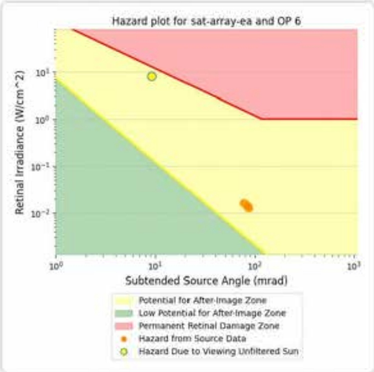
SAT Array East: OP 6

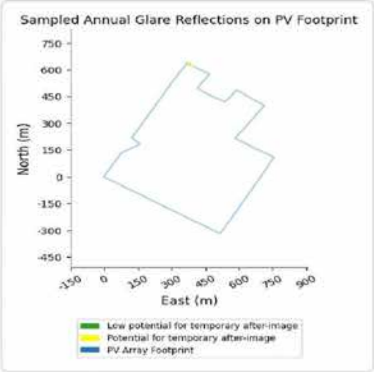
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 7

No glare found

SAT Array East: OP 8

No glare found

SAT Array East: OP 9

No glare found

SAT Array East: OP 10

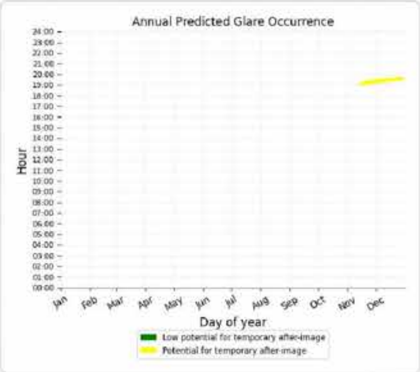
No glare found

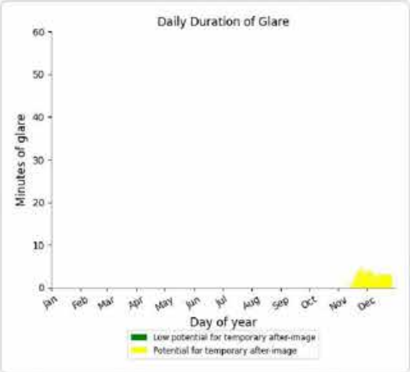
SAT Array East: OP 11

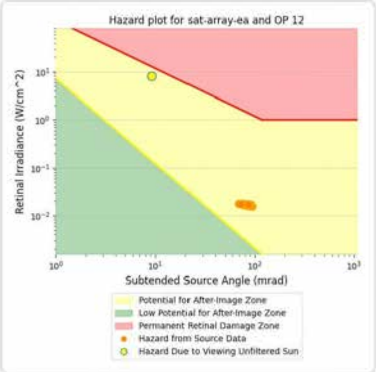
No glare found

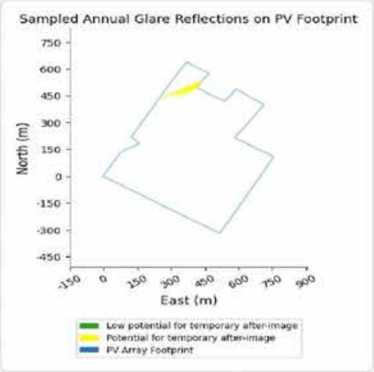
SAT Array East: OP 12

PV array is expected to produce the following glare for this receptor:
- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 130 minutes of "yellow" glare with potential to cause temporary after-image.





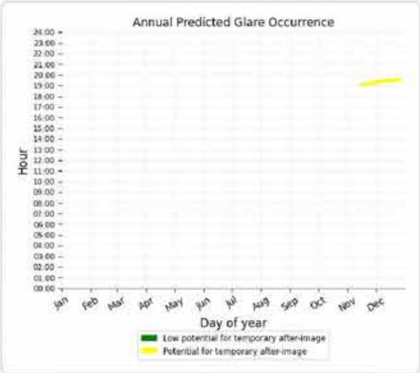


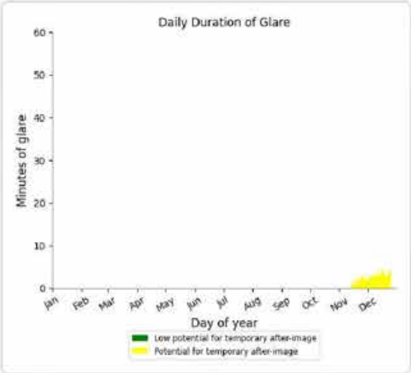


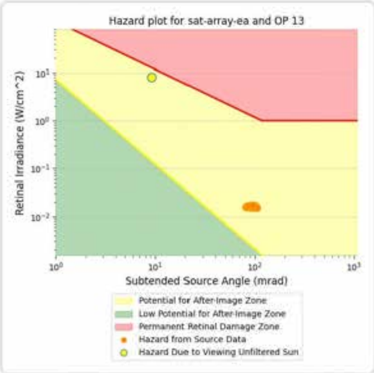
SAT Array East: OP 13

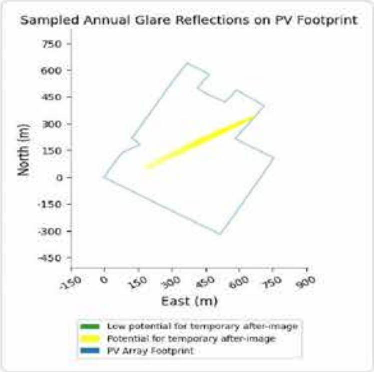
PV array is expected to produce the following glare for this receptor:

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









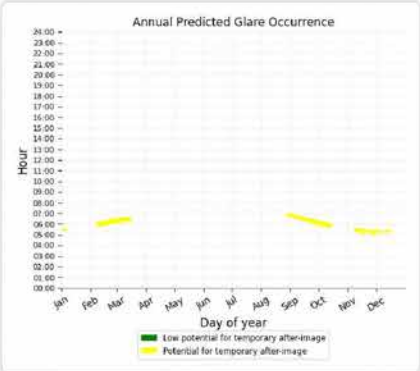
SAT Array East: OP 14

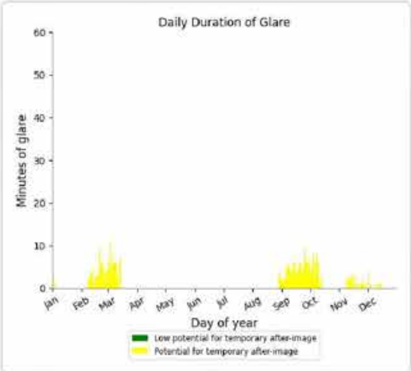
No glare found

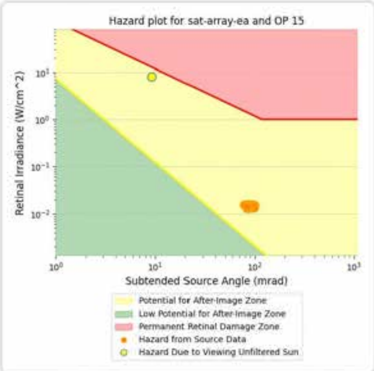
SAT Array East: OP 15

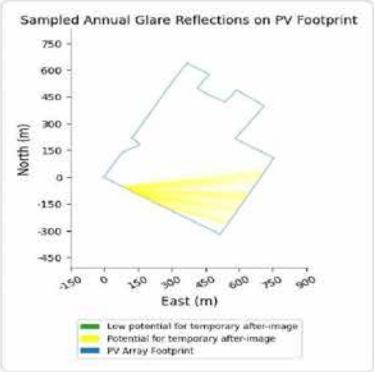
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 16

No glare found

SAT Array East: OP 17

No glare found

SAT Array East: OP 18

No glare found

SAT Array East: OP 19

No glare found

SAT Array East: OP 20

No glare found

SAT Array East: Mangamaire Road

No glare found

SAT Array East: Tutaekara Road

No glare found

SAT Array West no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- 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.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Tararua Rev 3 - SAT - Potential Receptors

Client: Solar Bay

Created Aug 09, 2023
Updated Aug 10, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97328.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **Off**

Summary of Results

Glare with potential for temporary after-image predicted

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
SAT Array East	SA tracking	SA tracking	41	3,404	-
SAT Array West	SA tracking	SA tracking	0	9,542	-

Component Data

PV Array(s)

Total PV footprint area: 829,671 m^2

Name: SAT Array East
Footprint area: 375,328 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.523131	175.748672	157.00	1.50	158.50
2	-40.521914	175.749605	154.00	1.50	155.50
3	-40.521488	175.750568	153.00	1.50	154.50
4	-40.521488	175.750568	153.00	1.50	154.50
5	-40.521159	175.750142	152.00	1.50	153.50
6	-40.520645	175.750533	151.00	1.50	152.50
7	-40.519854	175.751129	149.96	1.50	151.46
8	-40.519198	175.751628	148.00	1.50	149.50
9	-40.518333	175.752266	147.00	1.50	148.50
10	-40.517389	175.753038	146.00	1.50	147.50
11	-40.517662	175.753580	146.00	1.50	147.50
12	-40.517964	175.754197	146.00	1.50	147.50
13	-40.518659	175.753564	147.00	1.50	148.50
14	-40.518953	175.754079	147.00	1.50	148.50
15	-40.519357	175.755013	148.00	1.50	149.50
16	-40.519055	175.755345	147.00	1.50	148.50
17	-40.518745	175.755627	147.00	1.50	148.50
18	-40.519126	175.756308	147.00	1.50	148.50
19	-40.519540	175.757072	147.62	1.50	149.12
20	-40.520034	175.756627	148.00	1.50	149.50
21	-40.520658	175.756053	149.00	1.50	150.50
22	-40.521188	175.755549	150.00	1.50	151.50
23	-40.521624	175.756439	150.00	1.50	151.50
24	-40.522146	175.757587	150.00	1.50	151.50
25	-40.523155	175.756874	151.00	1.50	152.50
26	-40.524022	175.756225	152.62	1.50	154.12
27	-40.524986	175.755533	153.78	1.50	155.28
28	-40.525995	175.754760	154.08	1.50	155.58
29	-40.525482	175.753671	155.00	1.50	156.50
30	-40.524776	175.752164	155.92	1.50	157.42
31	-40.524160	175.750855	156.00	1.50	157.50
32	-40.523685	175.749841	156.96	1.50	158.46

Name: SAT Array West
Footprint area: 454,343 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.521784	175.749185	154.00	1.50	155.50
2	-40.522361	175.748739	155.71	1.50	157.21
3	-40.523179	175.748136	157.20	1.50	158.70
4	-40.523727	175.747712	158.67	1.50	160.17
5	-40.524043	175.747488	159.00	0.00	159.00
6	-40.524343	175.747245	159.00	1.50	160.50
7	-40.524017	175.746564	160.00	1.50	161.50
8	-40.523723	175.745985	160.00	1.50	161.50
9	-40.523633	175.745840	160.00	1.50	161.50
10	-40.524241	175.745244	160.00	1.50	161.50
11	-40.524791	175.744735	161.00	1.50	162.50
12	-40.524985	175.745113	161.00	1.50	162.50

13	-40.525305	175.745778	160.00	1.50	161.50
14	-40.525560	175.746352	160.00	1.50	161.50
15	-40.525996	175.746038	160.00	1.50	161.50
16	-40.526791	175.745443	160.00	1.50	161.50
17	-40.527483	175.744912	161.00	1.50	162.50
18	-40.528100	175.744451	161.00	1.50	162.50
19	-40.529542	175.743423	163.00	1.50	164.50
20	-40.529164	175.742624	163.00	1.50	164.50
21	-40.528802	175.741902	163.00	1.50	164.50
22	-40.528441	175.741127	164.00	1.50	165.50
23	-40.527980	175.740135	163.00	1.50	164.50
24	-40.527487	175.739124	163.00	1.50	164.50
25	-40.527095	175.738265	162.00	1.50	163.50
26	-40.526687	175.737420	161.00	1.50	162.50
27	-40.525436	175.738721	160.00	1.50	161.50
28	-40.524746	175.739419	160.00	1.50	161.50
29	-40.524017	175.740223	160.00	1.50	161.50
30	-40.523405	175.740835	159.00	1.50	160.50
31	-40.522728	175.741511	157.02	1.50	158.52
32	-40.522125	175.742101	156.99	1.50	158.49
33	-40.521749	175.742519	157.00	1.50	158.50
34	-40.521668	175.743421	158.67	1.50	160.17
35	-40.521439	175.744054	157.00	1.50	158.50
36	-40.521439	175.744762	156.00	1.50	157.50
37	-40.521260	175.745631	155.00	1.50	156.50
38	-40.520942	175.746103	154.00	1.50	155.50
39	-40.520449	175.746763	152.39	1.50	153.89
40	-40.520864	175.747658	153.00	1.50	154.50
41	-40.521350	175.748667	153.55	1.50	155.05

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-40.530849	175.730612	169.00	1.70	170.70
OP 2	-40.528772	175.724436	180.54	1.70	182.24
OP 3	-40.527277	175.720330	201.00	1.70	202.70
OP 4	-40.526006	175.722248	222.40	1.70	224.10
OP 5	-40.525407	175.726448	221.35	1.70	223.05
OP 6	-40.525060	175.735779	160.00	1.70	161.70
OP 7	-40.522646	175.738676	151.00	1.70	152.70
OP 8	-40.522760	175.736509	182.89	1.70	184.59
OP 9	-40.521635	175.728484	197.40	1.70	199.10
OP 10	-40.519922	175.737281	221.00	1.70	222.70
OP 11	-40.517645	175.742153	202.45	1.70	204.15
OP 12	-40.517025	175.737089	224.15	1.70	225.85
OP 13	-40.510847	175.744292	189.00	1.70	190.70
OP 14	-40.511092	175.743605	220.96	1.70	222.66
OP 15	-40.513572	175.744034	198.33	1.70	200.03
OP 16	-40.514844	175.748934	146.00	1.70	147.70
OP 17	-40.515545	175.750651	144.00	1.70	145.70
OP 18	-40.516018	175.751745	144.85	1.70	146.55
OP 19	-40.516418	175.752657	145.00	1.70	146.70
OP 20	-40.516989	175.753741	145.00	1.70	146.70
OP 21	-40.518938	175.757367	147.00	1.70	148.70
OP 22	-40.517650	175.757968	145.00	1.70	146.70
OP 23	-40.516182	175.758719	143.35	1.70	145.05
OP 24	-40.519819	175.758472	147.00	1.70	148.70
OP 25	-40.525033	175.752206	156.00	1.70	157.70
OP 26	-40.523826	175.749578	157.00	1.70	158.70

Obstruction Components

Name: Obstruction 1
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.23

Name: Obstruction 3
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.68
7	-40.523141	175.748573	157.00
8	-40.523663	175.749651	157.00
9	-40.524683	175.751802	156.00
10	-40.525188	175.752853	155.00

Name: Obstruction 4
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.67
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.74
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.88
9	-40.526722	175.737353	161.00

Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.522574	175.737690	165.21
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	41	3,404	-	
SAT Array West	SA tracking	SA tracking	0	9,542	-	

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
sat-array-ea (green)	0	0	0	2	0	0	0	16	2	0	0	0
sat-array-ea (yellow)	205	206	327	213	1	0	0	55	199	412	208	395
sat-array-we (green)	0	0	0	0	0	0	0	0	0	0	0	0
sat-array-we (yellow)	1064	714	377	54	0	0	0	15	246	725	926	1167

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	37	40
OP: OP 4	4	152
OP: OP 5	0	257
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	167
OP: OP 9	0	77
OP: OP 10	0	826
OP: OP 11	0	753
OP: OP 12	0	706
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	174

OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	0	63
OP: OP 23	0	170
OP: OP 24	0	0
OP: OP 25	0	19
OP: OP 26	0	0

SAT Array East: OP 1

No glare found

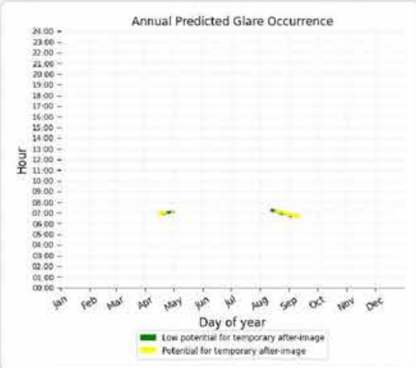
SAT Array East: OP 2

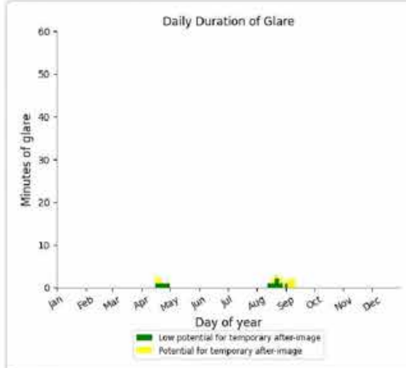
No glare found

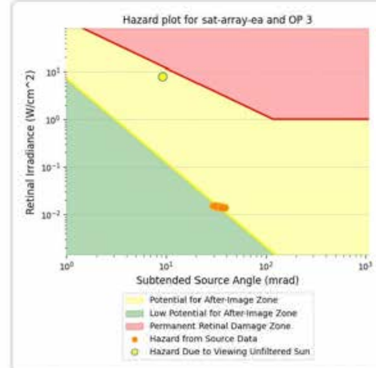
SAT Array East: OP 3

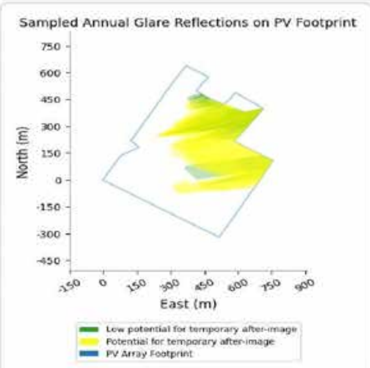
PV array is expected to produce the following glare for this receptor:

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





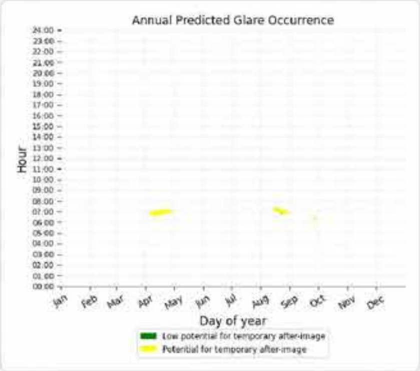


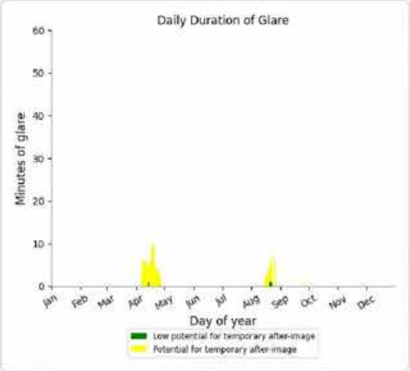


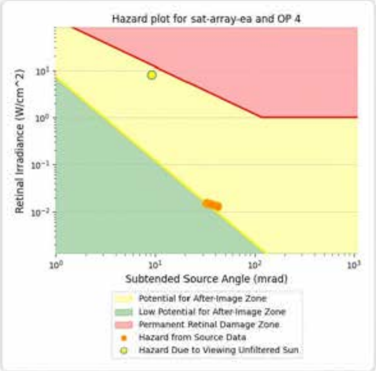
SAT Array East: OP 4

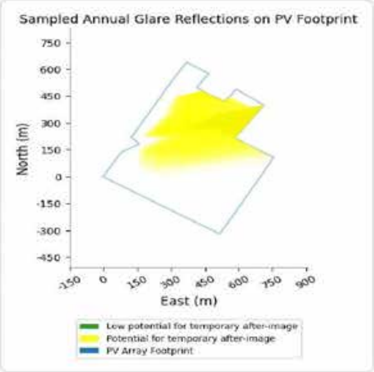
PV array is expected to produce the following glare for this receptor:

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





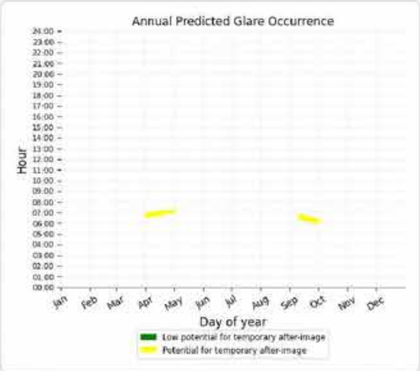


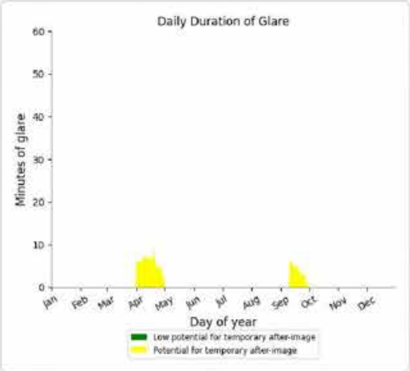


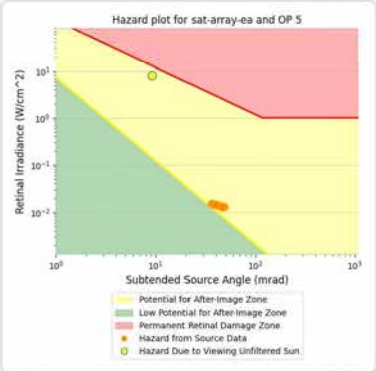
SAT Array East: OP 5

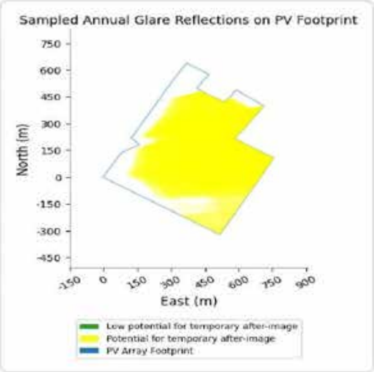
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 6

No glare found

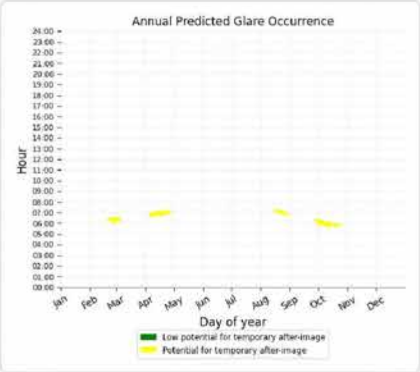
SAT Array East: OP 7

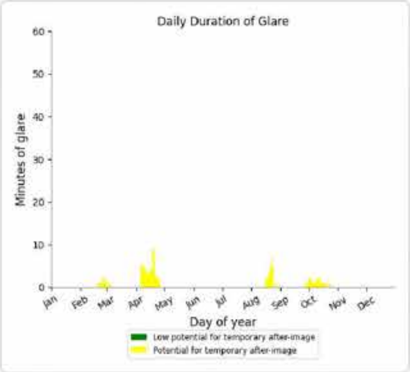
No glare found

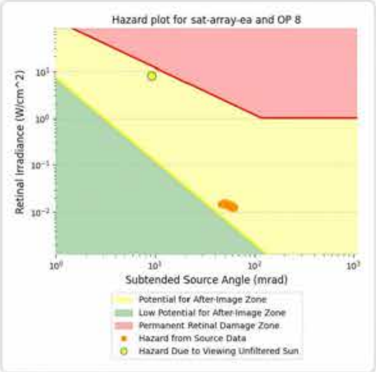
SAT Array East: OP 8

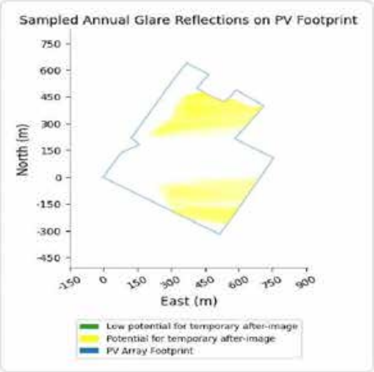
PV array is expected to produce the following glare for this receptor:

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





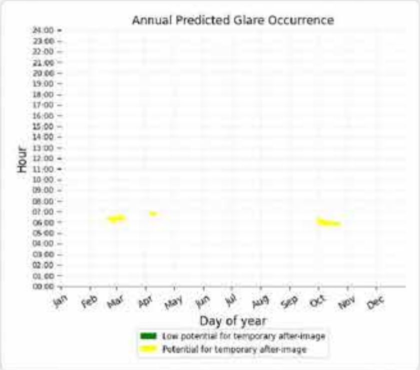


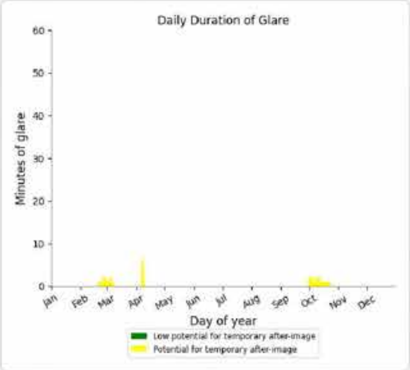


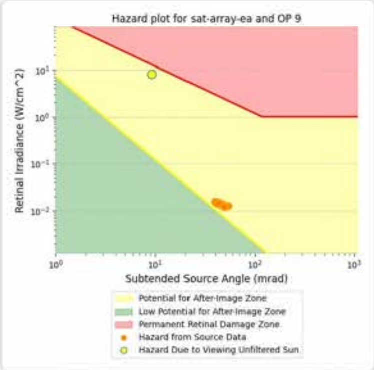
SAT Array East: OP 9

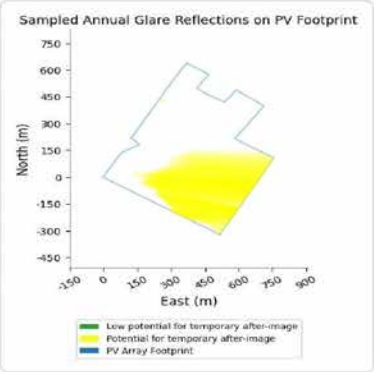
PV array is expected to produce the following glare for this receptor:

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





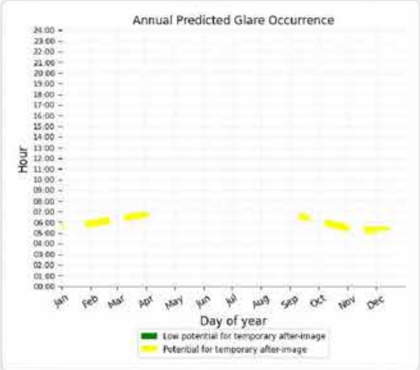


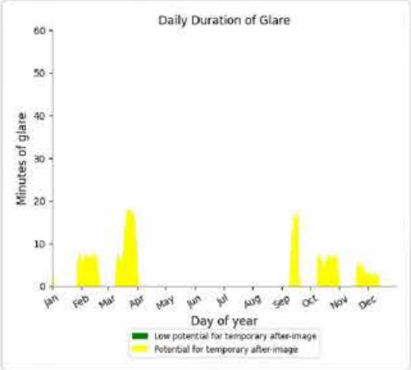


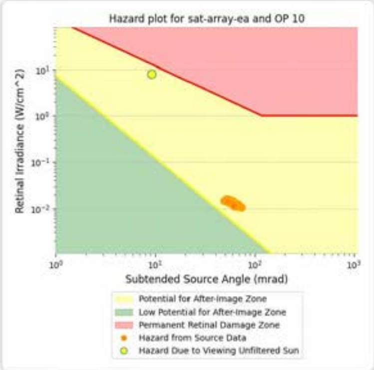
SAT Array East: OP 10

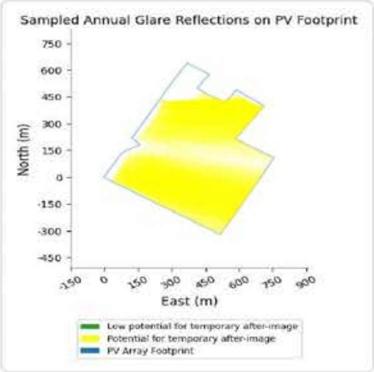
PV array is expected to produce the following glare for this receptor:

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





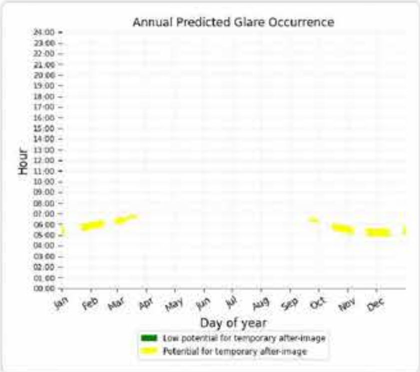


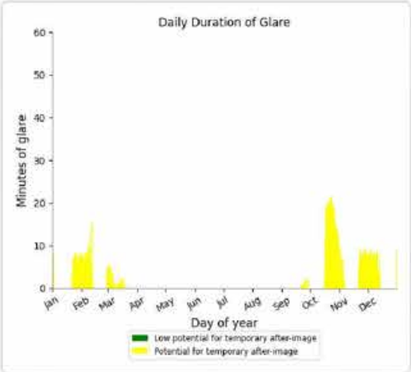


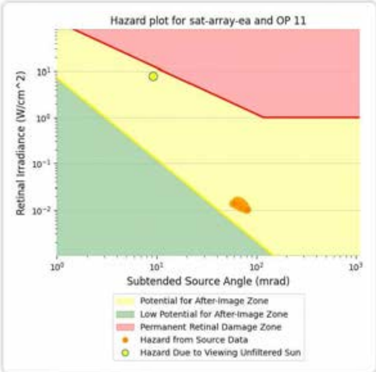
SAT Array East: OP 11

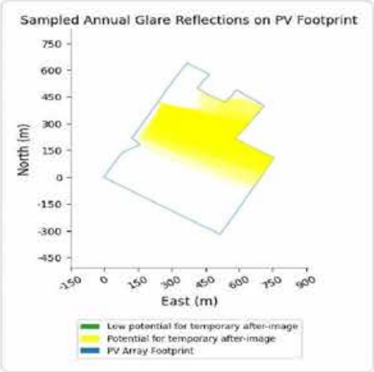
PV array is expected to produce the following glare for this receptor:

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





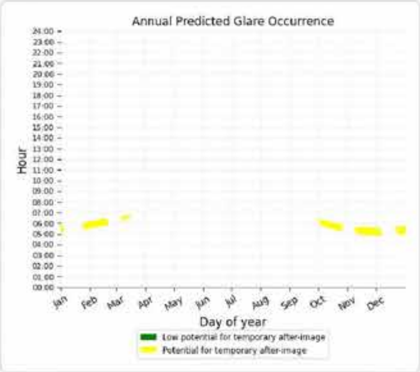


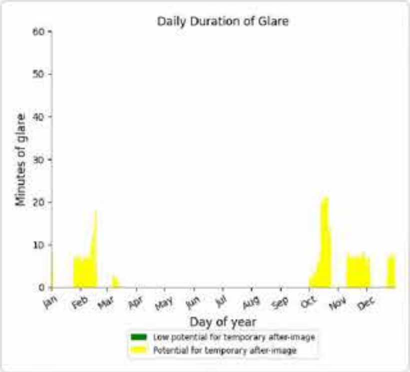


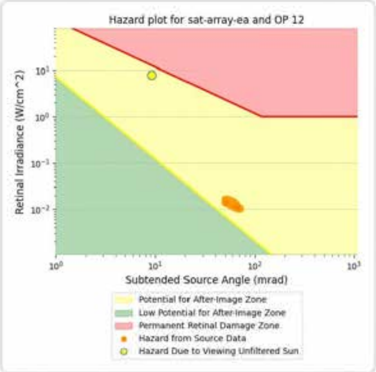
SAT Array East: OP 12

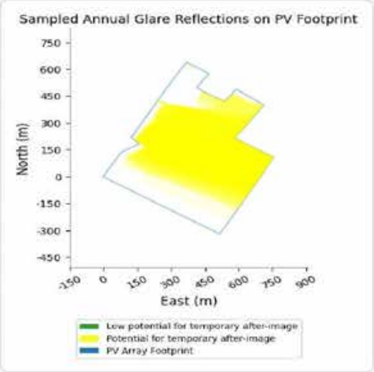
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 13

No glare found

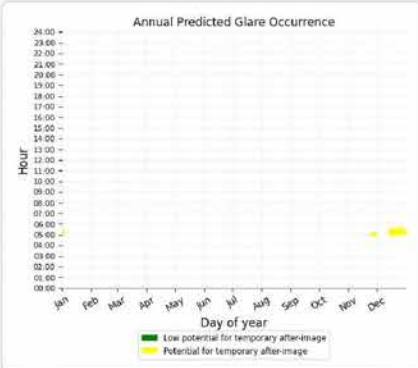
SAT Array East: OP 14

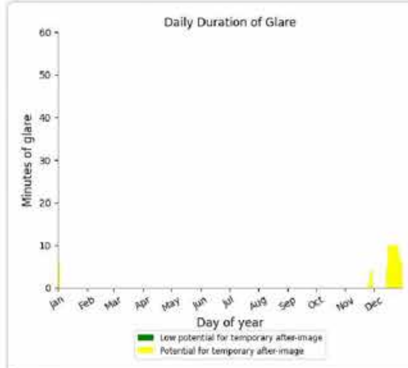
No glare found

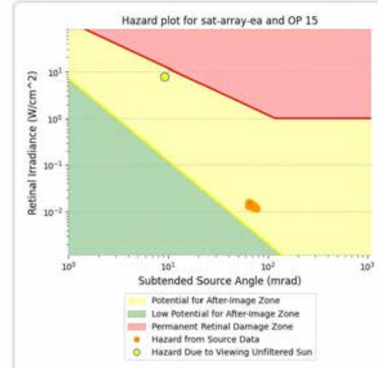
SAT Array East: OP 15

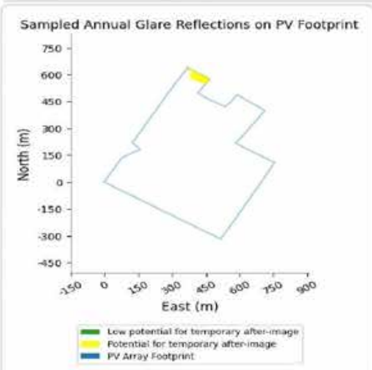
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 16

No glare found

SAT Array East: OP 17

No glare found

SAT Array East: OP 18

No glare found

SAT Array East: OP 19

No glare found

SAT Array East: OP 20

No glare found

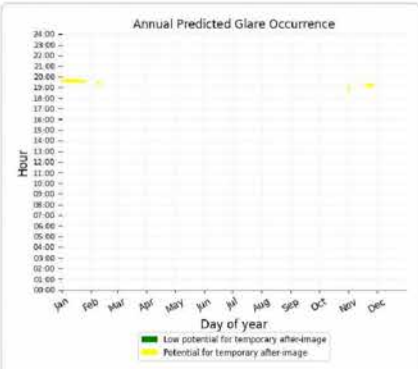
SAT Array East: OP 21

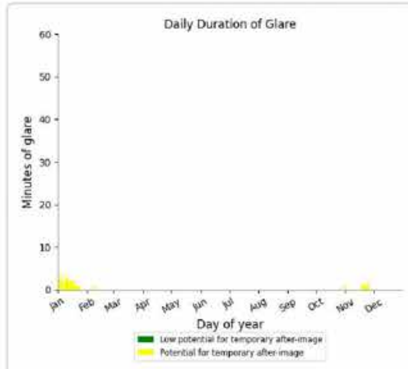
No glare found

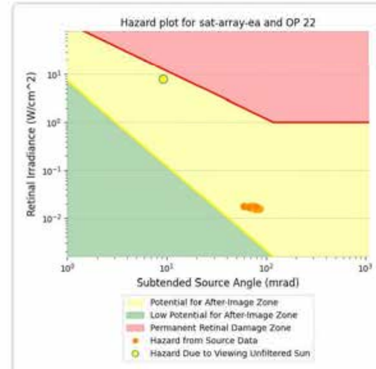
SAT Array East: OP 22

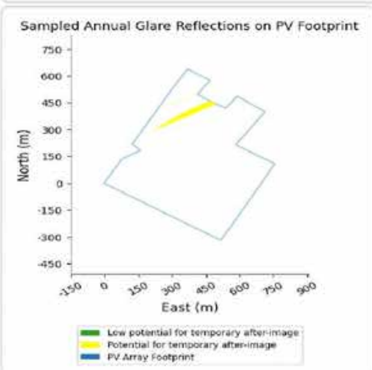
PV array is expected to produce the following glare for this receptor:

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





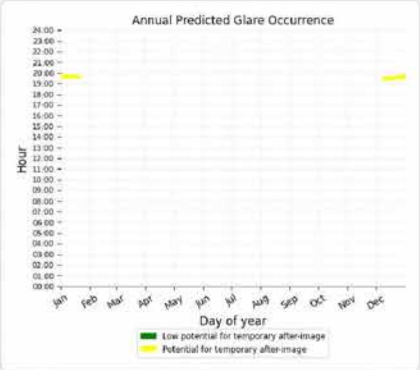


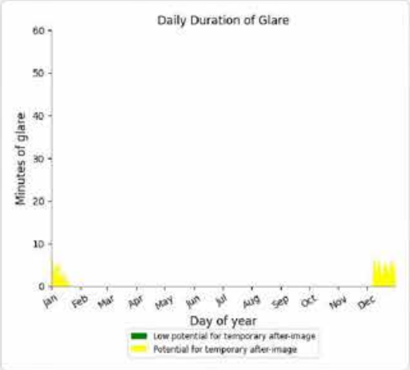


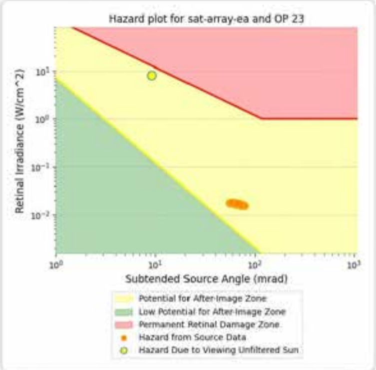
SAT Array East: OP 23

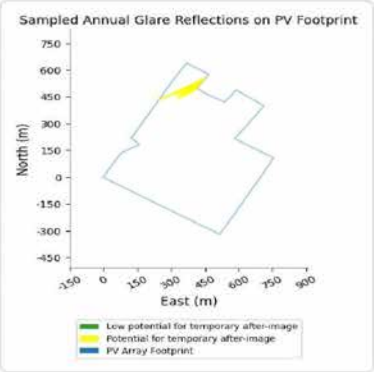
PV array is expected to produce the following glare for this receptor:

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









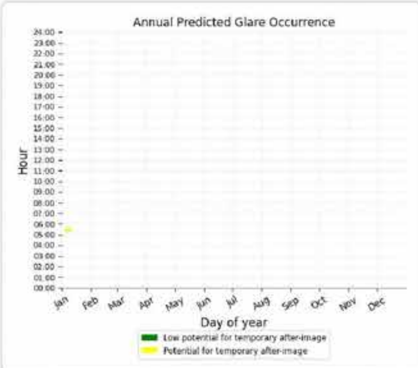
SAT Array East: OP 24

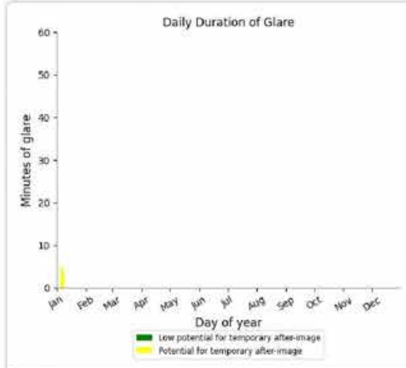
No glare found

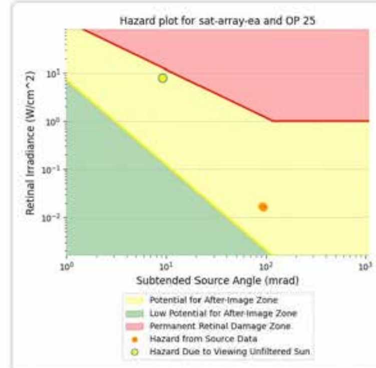
SAT Array East: OP 25

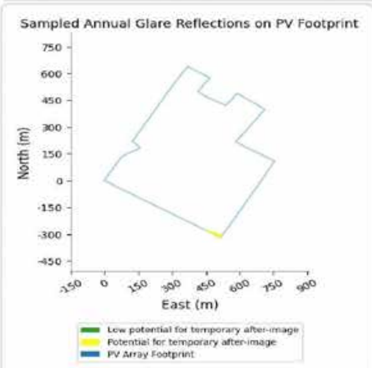
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 26

No glare found

SAT Array West potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	80
OP: OP 4	0	375
OP: OP 5	0	1212
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	1669
OP: OP 9	0	1512

OP: OP 10	0	3660
OP: OP 11	0	0
OP: OP 12	0	1034
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0

SAT Array West: OP 1

No glare found

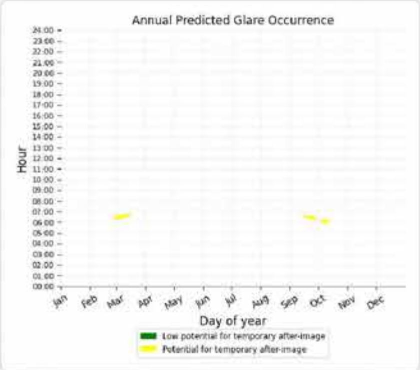
SAT Array West: OP 2

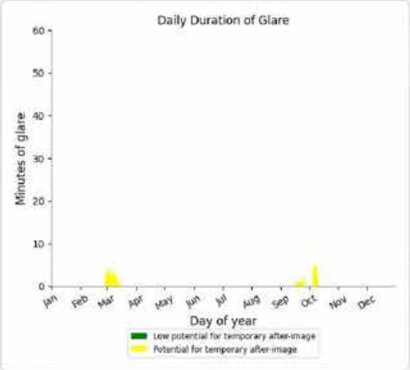
No glare found

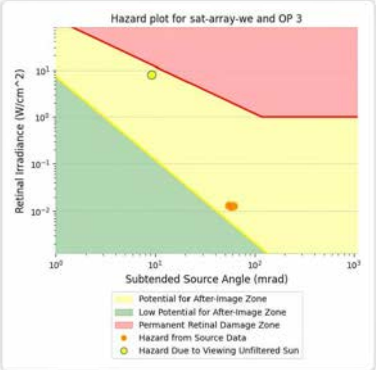
SAT Array West: OP 3

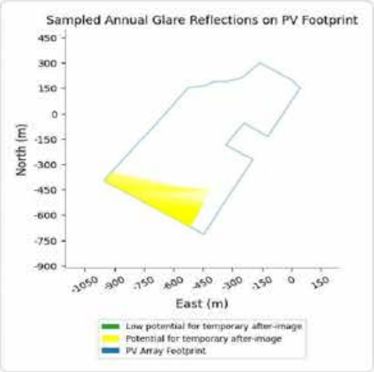
PV array is expected to produce the following glare for this receptor:

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





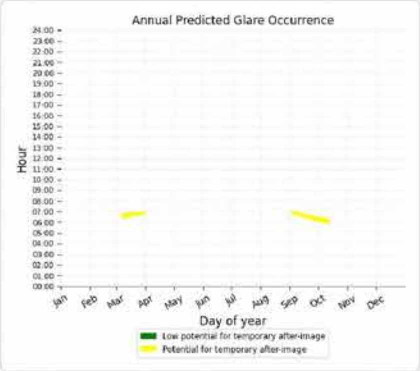


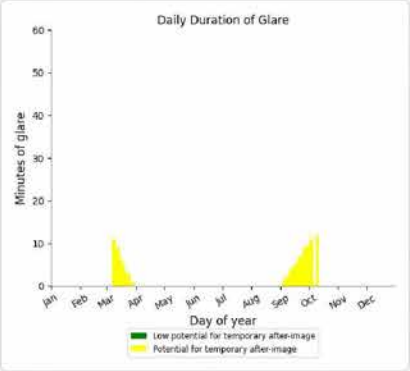


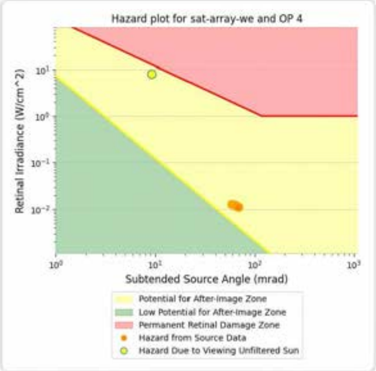
SAT Array West: OP 4

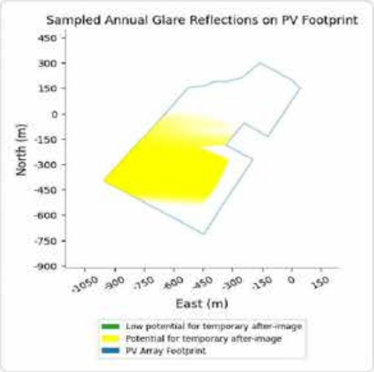
PV array is expected to produce the following glare for this receptor:

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





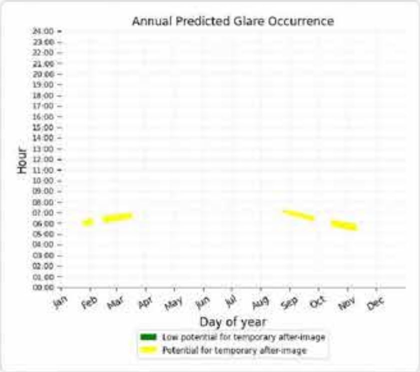


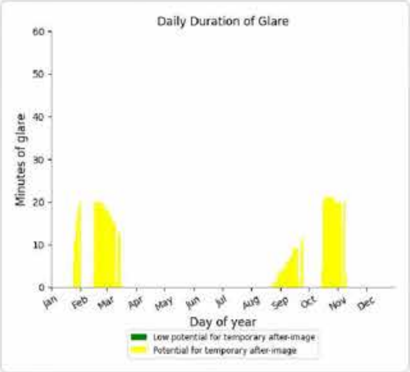


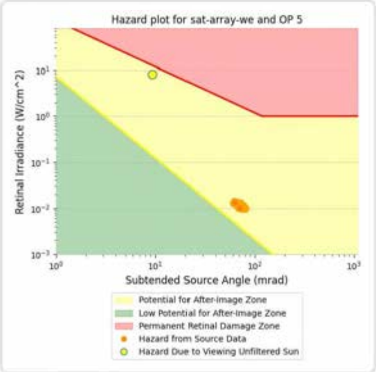
SAT Array West: OP 5

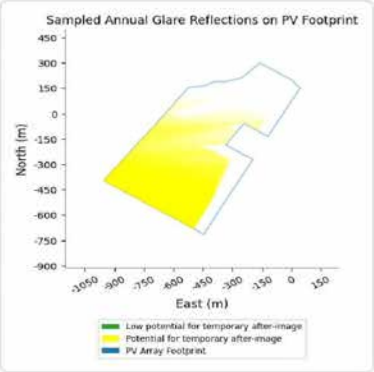
PV array is expected to produce the following glare for this receptor:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,212 minutes of "yellow" glare with potential to cause temporary after-image.









SAT Array West: OP 6

No glare found

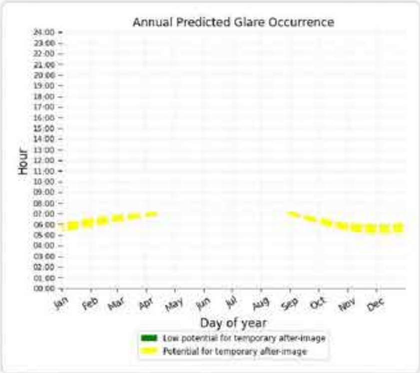
SAT Array West: OP 7

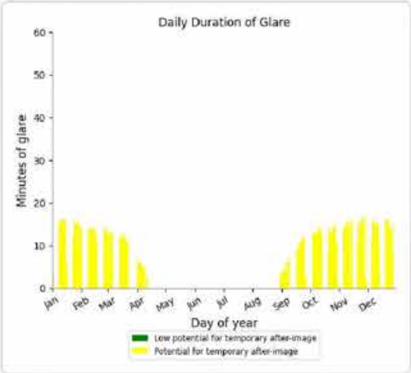
No glare found

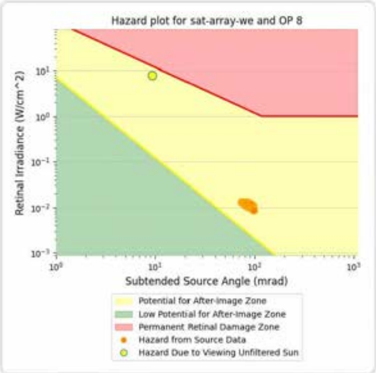
SAT Array West: OP 8

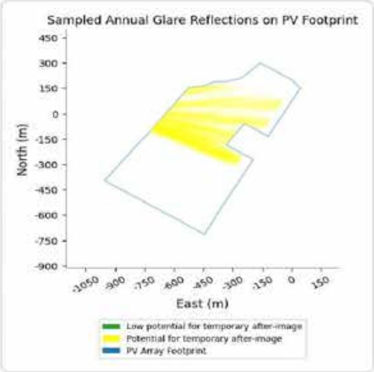
PV array is expected to produce the following glare for this receptor:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,669 minutes of "yellow" glare with potential to cause temporary after-image.





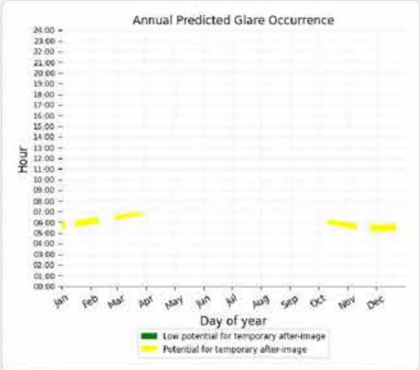


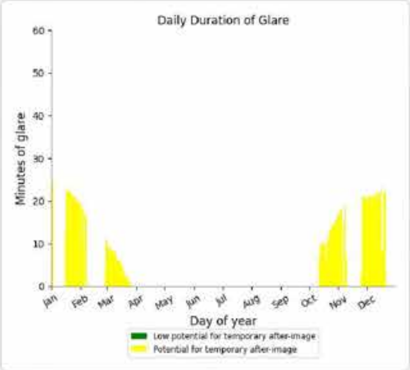


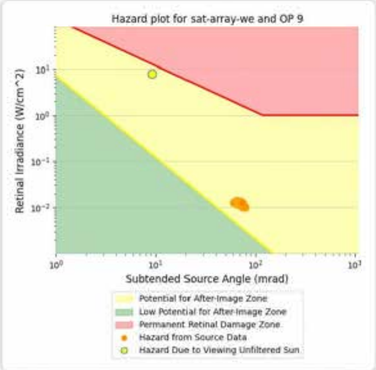
SAT Array West: OP 9

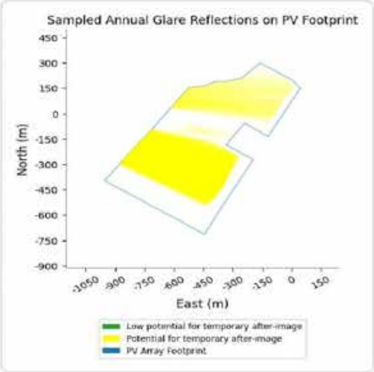
PV array is expected to produce the following glare for this receptor:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,512 minutes of "yellow" glare with potential to cause temporary after-image.





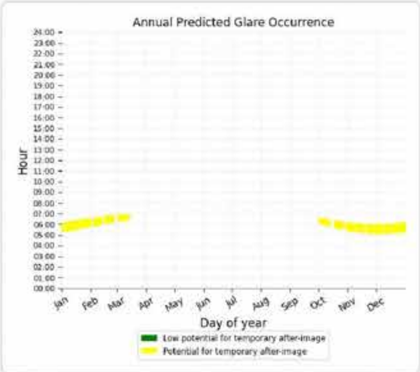


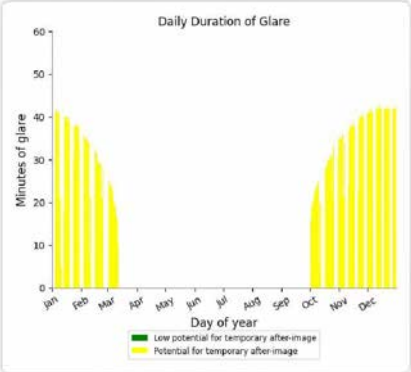


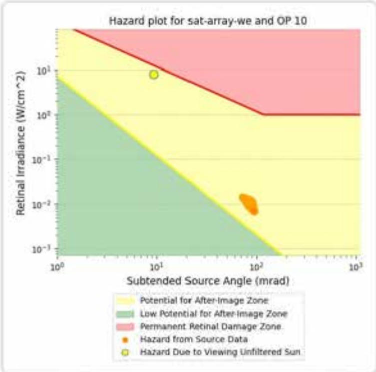
SAT Array West: OP 10

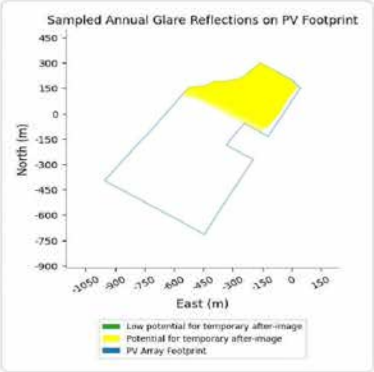
PV array is expected to produce the following glare for this receptor:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 3,660 minutes of "yellow" glare with potential to cause temporary after-image.









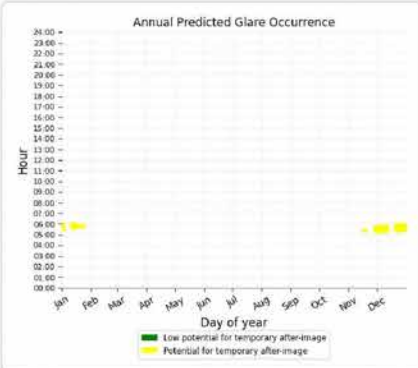
SAT Array West: OP 11

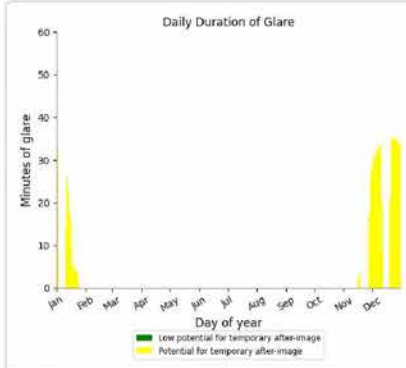
No glare found

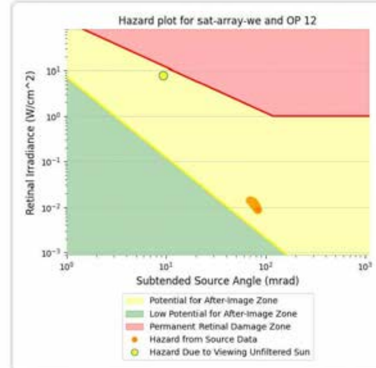
SAT Array West: OP 12

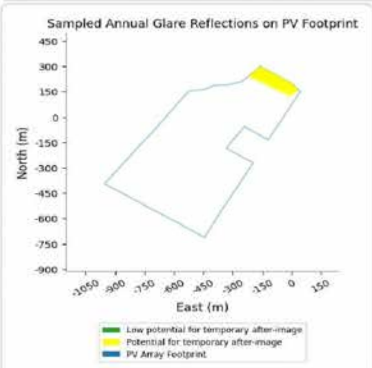
PV array is expected to produce the following glare for this receptor:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,034 minutes of "yellow" glare with potential to cause temporary after-image.









SAT Array West: OP 13

No glare found

SAT Array West: OP 14

No glare found

SAT Array West: OP 15

No glare found

SAT Array West: OP 16

No glare found

SAT Array West: OP 17

No glare found

SAT Array West: OP 18

No glare found

SAT Array West: OP 19

No glare found

SAT Array West: OP 20

No glare found

SAT Array West: OP 21

No glare found

SAT Array West: OP 22

No glare found

SAT Array West: OP 23

No glare found

SAT Array West: OP 24

No glare found

SAT Array West: OP 25

No glare found

SAT Array West: OP 26

No glare found

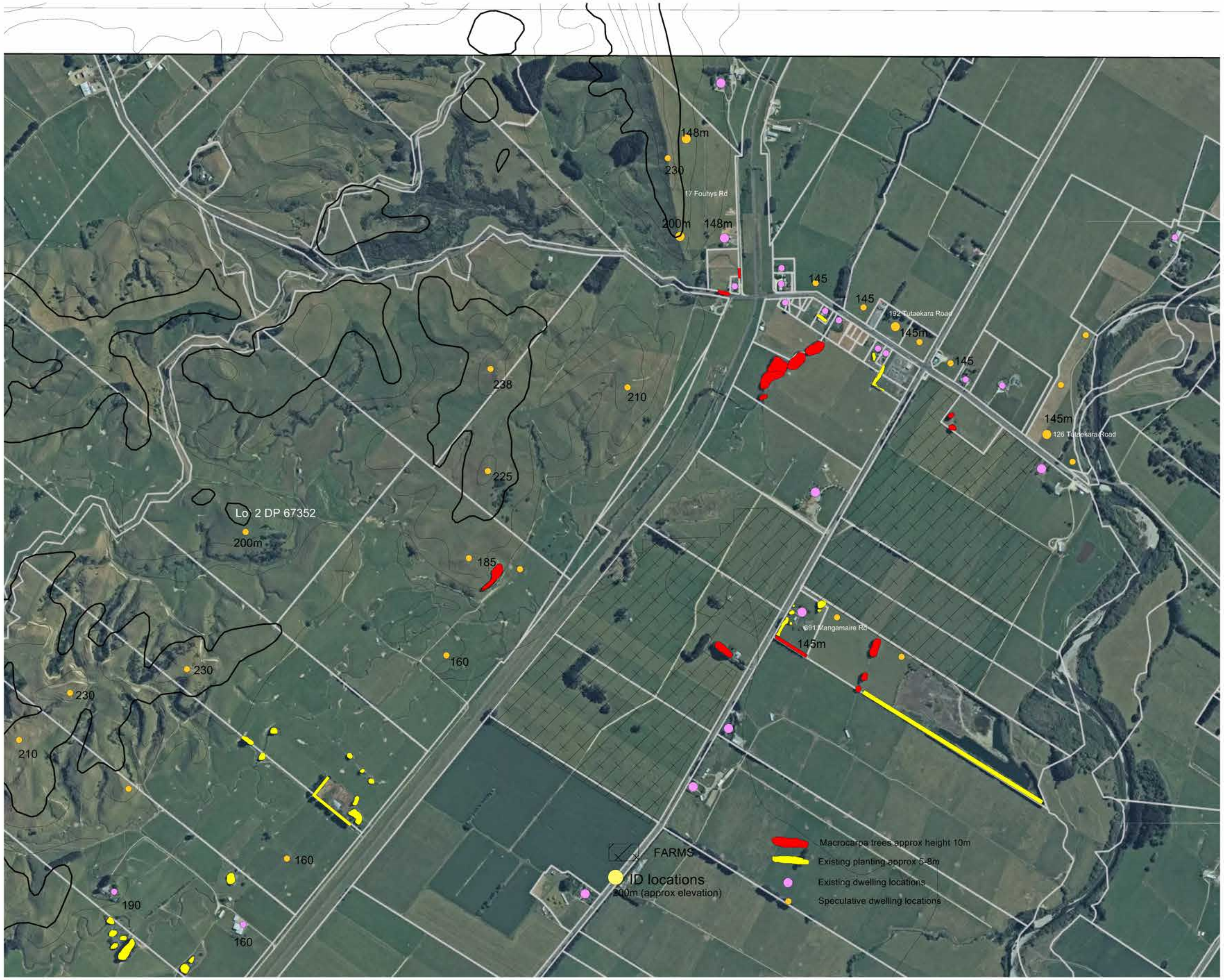
Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- 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.
- 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 siz Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ROUGH MILNE MITCHELL LANDSCAPE ARCHITECTS LIMITED

DO NOT SCALE, ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO COMMENCING ANY WORK

REV	DATE	NOTES
1	16/06/2023	RFI Glint and Glare
2	4/08/2023	ADDITIONAL GLINT AND GLARE



NORTH

RMM

ROUGH MILNE MITCHELL LANDSCAPE ARCHITECTS

CHRISTCHURCH	+64 3 366 3268
WĀNAKA	+64 3 974 7940
AUCKLAND	+64 21 244 8630
DUNEDIN	+64 27 498 8795
NELSON	+64 27 250 0500
rmmla.co.nz	info@rmmla.co.nz

RFI - GLINT AND GLARE
SOLAR FARM PAIHIATUA

Mangamaire Road, Mangamaire

JOB No.	22026
SCALE	1:10000
DATE	4/08/2023
DESIGNED	RL
DRAWN	RL
CHECKED	CHECKED BY
STATUS	DRAFT
DRAWING No.	REVISION
L 1.0 SERIES	2

1 of 1

ROUGH MILNE MITCHELL LANDSCAPE ARCHITECTS LIMITED

DO NOT SCALE, ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO COMMENCING ANY WORK

REV	DATE	NOTES
1	16/06/2023	RFI Glint and Glare
2	4/08/2023	ADDITIONAL GLINT AND GLARE

CYPRESS OR TOTARA HEDGE

WETLAND BUFFER PLANTING

NORTH

RMM

ROUGH MILNE MITCHELL LANDSCAPE ARCHITECTS

CHRISTCHURCH	+64 3 366 3268
WĀNAKA	+64 3 974 7940
AUCKLAND	+64 21 244 8630
DUNEDIN	+64 27 498 8795
NELSON	+64 27 250 0500
rmmla.co.nz	info@rmmla.co.nz

MITIGATION PLANTING
SOLAR FARM PAIHIATUA

Mangamaire Road, Mangamaire

JOB No.	22026
SCALE	1:10000
DATE	4/08/2023
DESIGNED	RL
DRAWN	RL
CHECKED	CHECKED BY
STATUS	DRAFT
DRAWING No.	REVISION
L 1.2	2
SERIES	

1 of 1

ForgeSolar

2945 - Tararua

Existing shelterbelts-mitigation - roads only - 2P

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97614.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

Summary of Results No glare predicted!

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
SAT Array East	SA tracking	SA tracking	0	0	-
SAT Array West	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40
8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.521784	175.749185	154.00	2.40	156.40

2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40
39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Route Receptor(s)

Name: Mangamaire Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.532089	175.741029	166.00	1.80	167.80
2	-40.530972	175.742230	164.00	1.80	165.80
3	-40.530083	175.743175	163.00	1.80	164.80
4	-40.529427	175.743797	162.00	1.80	163.80
5	-40.528477	175.744462	161.00	1.80	162.80
6	-40.527351	175.745272	160.00	1.80	161.80
7	-40.526634	175.745792	160.00	1.80	161.80
8	-40.525847	175.746393	160.00	1.80	161.80
9	-40.525068	175.746994	159.20	1.80	161.00
10	-40.524008	175.747799	159.00	1.80	160.80
11	-40.523143	175.748437	157.00	1.80	158.80
12	-40.522365	175.749027	155.00	1.80	156.80
13	-40.521305	175.749820	153.00	1.80	154.80
14	-40.520319	175.750565	151.00	1.80	152.80
15	-40.519425	175.751204	149.00	1.80	150.80
16	-40.518516	175.751912	147.00	1.80	148.80
17	-40.516640	175.753296	145.00	1.80	146.80
18	-40.515645	175.754031	144.00	1.80	145.80
19	-40.514813	175.754669	143.00	1.80	144.80
20	-40.514259	175.755055	142.00	1.80	143.80

Name: Tutaekara Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.522049	175.762475	147.00	1.80	148.80
2	-40.521413	175.761724	147.00	1.80	148.80
3	-40.520956	175.761166	147.00	1.80	148.80
4	-40.520597	175.760715	147.00	1.80	148.80
5	-40.520336	175.760243	147.00	1.80	148.80
6	-40.520141	175.759170	147.00	1.80	148.80
7	-40.519978	175.758377	147.40	1.80	149.20
8	-40.519668	175.757626	147.40	1.80	149.20
9	-40.519146	175.756767	147.00	1.80	148.80
10	-40.518477	175.755523	147.00	1.80	148.80
11	-40.518085	175.754922	146.00	1.80	147.80
12	-40.517645	175.754064	146.00	1.80	147.80
13	-40.517319	175.753463	145.80	1.80	147.60
14	-40.517090	175.752969	145.00	1.80	146.80

Obstruction Components

Name: Obstruction 1
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	0	0	-	-
SAT Array West	SA tracking	SA tracking	0	0	-	-

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

SAT Array West no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- 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.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Railway with existing and mitigation planting

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97615.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

Summary of Results No glare predicted!

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
SAT Array East	SA tracking	SA tracking	0	0	-
SAT Array West	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
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4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40
8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.521784	175.749185	154.00	2.40	156.40

2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40
39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Route Receptor(s)

Name: Railway
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.509494	175.747086	146.99	3.00	149.99
2	-40.510587	175.746700	149.54	3.00	152.54
3	-40.513409	175.746829	148.02	3.00	151.02
4	-40.515269	175.746872	149.00	3.00	152.00
5	-40.517161	175.745906	148.00	3.00	151.00
6	-40.519119	175.744705	148.00	3.00	151.00
7	-40.521207	175.742537	155.00	3.00	158.00
8	-40.524322	175.739319	159.26	3.00	162.26
9	-40.527845	175.735607	164.00	3.00	167.00
10	-40.531188	175.732066	170.00	3.00	173.00
11	-40.533015	175.730242	171.00	3.00	174.00
12	-40.535331	175.727732	174.92	3.00	177.92

Obstruction Components

Name: Obstruction 1
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	0	0	-	-
SAT Array West	SA tracking	SA tracking	0	0	-	-

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Railway	0	0

No glare found

SAT Array West no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Railway	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- 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.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Tararua Rev 5 - SAT - Exisiting Receptors - 2P

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97617.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

Summary of Results

Glare with low potential for temporary after-image predicted

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
SAT Array East	SA tracking	SA tracking	359	0	-
SAT Array West	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40
8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.521784	175.749185	154.00	2.40	156.40

2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40
39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Route Receptor(s)

Name: Mangamaire Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.532089	175.741029	166.00	1.30	167.30
2	-40.530972	175.742230	164.00	1.30	165.30
3	-40.530083	175.743175	163.00	1.30	164.30
4	-40.529427	175.743797	162.00	1.30	163.30
5	-40.528477	175.744462	161.00	1.30	162.30
6	-40.527351	175.745272	160.00	1.30	161.30
7	-40.526634	175.745792	160.00	1.30	161.30
8	-40.525847	175.746393	160.00	1.30	161.30
9	-40.525068	175.746994	159.20	1.30	160.50
10	-40.524008	175.747799	159.00	1.30	160.30
11	-40.523143	175.748437	157.00	1.30	158.30
12	-40.522365	175.749027	155.00	1.30	156.30
13	-40.521305	175.749820	153.00	1.30	154.30
14	-40.520319	175.750565	151.00	1.30	152.30
15	-40.519425	175.751204	149.00	1.30	150.30
16	-40.518516	175.751912	147.00	1.30	148.30
17	-40.516640	175.753296	145.00	1.30	146.30
18	-40.515645	175.754031	144.00	1.30	145.30
19	-40.514813	175.754669	143.00	1.30	144.30
20	-40.514259	175.755055	142.00	1.30	143.30

Name: Tutaekara Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.522049	175.762475	147.00	1.30	148.30
2	-40.521413	175.761724	147.00	1.30	148.30
3	-40.520956	175.761166	147.00	1.30	148.30
4	-40.520597	175.760715	147.00	1.30	148.30
5	-40.520336	175.760243	147.00	1.30	148.30
6	-40.520141	175.759170	147.00	1.30	148.30
7	-40.519978	175.758377	147.40	1.30	148.70
8	-40.519668	175.757626	147.40	1.30	148.70
9	-40.519146	175.756767	147.00	1.30	148.30
10	-40.518477	175.755523	147.00	1.30	148.30
11	-40.518085	175.754922	146.00	1.30	147.30
12	-40.517645	175.754064	146.00	1.30	147.30
13	-40.517319	175.753463	145.80	1.30	147.10
14	-40.517090	175.752969	145.00	1.30	146.30

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-40.509167	175.746093	156.60	1.70	158.30
OP 2	-40.513637	175.745921	152.00	1.70	153.70
OP 3	-40.515007	175.746114	151.00	1.70	152.70
OP 4	-40.514551	175.747723	146.70	1.70	148.40
OP 5	-40.514909	175.747723	147.00	1.70	148.70
OP 6	-40.515350	175.747895	147.00	1.70	148.70
OP 7	-40.515529	175.749268	145.00	1.70	146.70
OP 8	-40.515816	175.749825	145.00	1.70	146.70
OP 9	-40.516591	175.751343	145.00	1.70	146.70
OP 10	-40.516709	175.751558	145.00	1.70	146.70
OP 11	-40.517476	175.754245	145.90	1.70	147.60
OP 12	-40.517625	175.755716	145.60	1.70	147.30
OP 13	-40.519819	175.757191	148.00	1.70	149.70
OP 14	-40.520749	175.748919	152.00	1.70	153.70
OP 15	-40.523791	175.748425	158.00	1.70	159.70
OP 16	-40.527047	175.745839	160.00	1.70	161.70
OP 17	-40.528654	175.744734	161.00	1.70	162.70
OP 18	-40.531566	175.740810	166.00	1.70	167.70
OP 19	-40.532505	175.728347	170.00	1.70	171.70
OP 20	-40.531551	175.723669	181.00	1.70	182.70

Obstruction Components

Name: Obstruction 1
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	359	0	-	-
SAT Array West	SA tracking	SA tracking	0	0	-	-

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
sat-array-ea (green)	19	0	0	0	0	0	0	0	0	0	125	194
sat-array-ea (yellow)	0	0	0	0	0	0	0	0	0	0	0	0

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East low potential for temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	276	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	83	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0

OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

SAT Array East: OP 1

No glare found

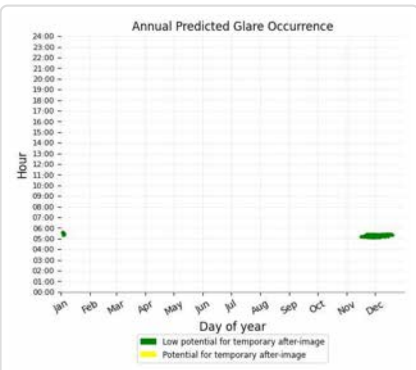
SAT Array East: OP 2

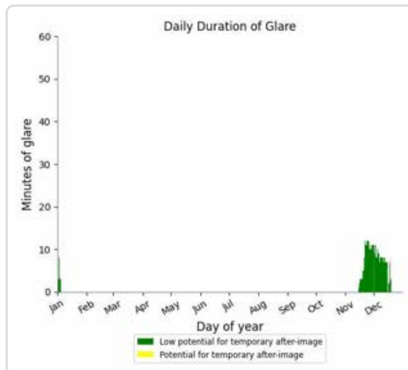
No glare found

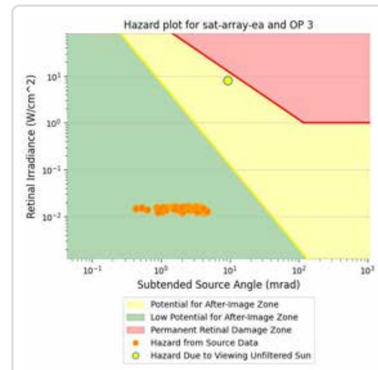
SAT Array East: OP 3

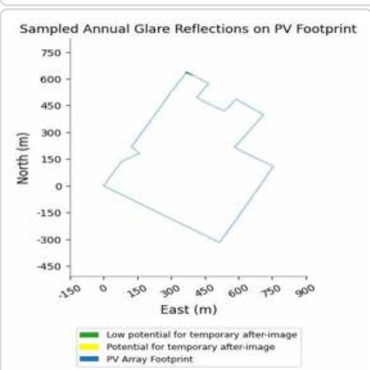
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 4

No glare found

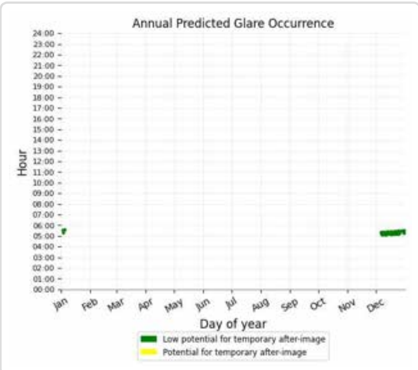
SAT Array East: OP 5

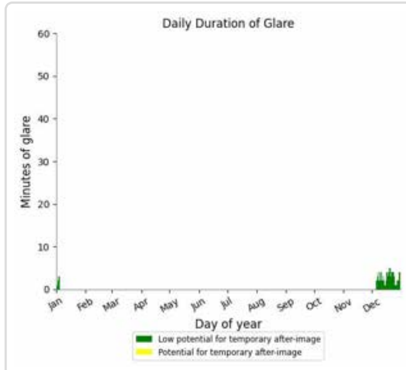
No glare found

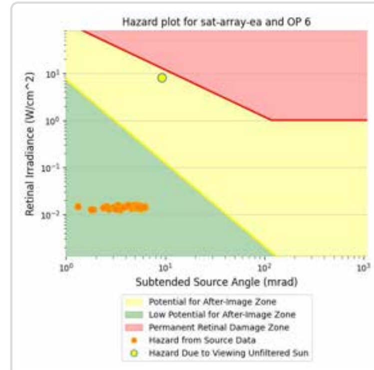
SAT Array East: OP 6

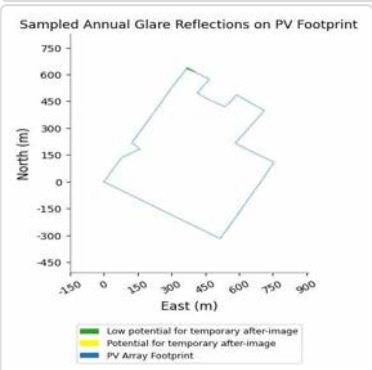
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 7

No glare found

SAT Array East: OP 8

No glare found

SAT Array East: OP 9

No glare found

SAT Array East: OP 10

No glare found

SAT Array East: OP 11

No glare found

SAT Array East: OP 12

No glare found

SAT Array East: OP 13

No glare found

SAT Array East: OP 14

No glare found

SAT Array East: OP 15

No glare found

SAT Array East: OP 16

No glare found

SAT Array East: OP 17

No glare found

SAT Array East: OP 18

No glare found

SAT Array East: OP 19

No glare found

SAT Array East: OP 20

No glare found

SAT Array East: Mangamaire Road

No glare found

SAT Array East: Tutaekara Road

No glare found

SAT Array West no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- 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.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Tararua Rev 5 - SAT - Potential Receptors - 2P

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97616.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

Summary of Results

Glare with potential for temporary after-image predicted

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
SAT Array East	SA tracking	SA tracking	3,278	514	-
SAT Array West	SA tracking	SA tracking	6,658	3,451	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40

8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.521784	175.749185	154.00	2.40	156.40
2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40

39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	-40.530849	175.730612	169.00	1.70	170.70
OP 2	-40.528772	175.724436	180.50	1.70	182.20
OP 3	-40.527277	175.720330	201.00	1.70	202.70
OP 4	-40.526006	175.722248	222.40	1.70	224.10
OP 5	-40.525407	175.726448	221.40	1.70	223.10
OP 6	-40.525060	175.735779	160.00	1.70	161.70
OP 7	-40.522646	175.738676	151.00	1.70	152.70
OP 8	-40.522760	175.736509	182.90	1.70	184.60
OP 9	-40.521635	175.728484	197.40	1.70	199.10
OP 10	-40.519922	175.737281	221.00	1.70	222.70
OP 11	-40.517645	175.742153	202.50	1.70	204.20
OP 12	-40.517025	175.737089	224.10	1.70	225.80
OP 13	-40.510847	175.744292	189.00	1.70	190.70
OP 14	-40.511092	175.743605	221.00	1.70	222.70
OP 15	-40.513572	175.744034	198.30	1.70	200.00
OP 16	-40.514844	175.748934	146.00	1.70	147.70
OP 17	-40.515545	175.750651	144.00	1.70	145.70
OP 18	-40.516018	175.751745	144.80	1.70	146.50
OP 19	-40.516418	175.752657	145.00	1.70	146.70
OP 20	-40.516989	175.753741	145.00	1.70	146.70
OP 21	-40.518938	175.757367	147.00	1.70	148.70
OP 22	-40.517650	175.757968	145.00	1.70	146.70
OP 23	-40.516182	175.758719	143.40	1.70	145.10
OP 24	-40.519819	175.758472	147.00	1.70	148.70
OP 25	-40.525033	175.752206	156.00	1.70	157.70
OP 26	-40.523826	175.749578	157.00	1.70	158.70

Obstruction Components

Name: Obstruction 1
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 4.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 4.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

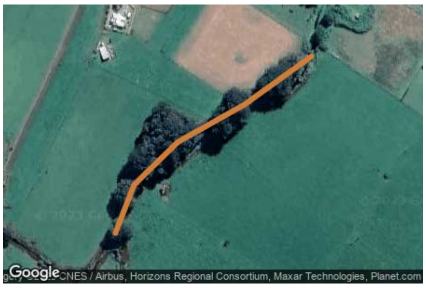
Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m



Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	3,278	514	-	-
SAT Array West	SA tracking	SA tracking	6,658	3,451	-	-

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
sat-array-ea (green)	130	143	338	231	3	0	0	100	313	388	134	299
sat-array-ea (yellow)	41	26	0	0	0	0	0	0	0	11	87	78
sat-array-we (green)	357	395	407	91	0	0	0	18	209	488	346	430
sat-array-we (yellow)	483	310	0	0	0	0	0	0	3	199	509	261

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	99	0
OP: OP 4	202	0
OP: OP 5	264	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	198	0
OP: OP 9	83	0
OP: OP 10	811	131
OP: OP 11	595	226
OP: OP 12	624	156
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	165	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	45	0
OP: OP 23	158	0
OP: OP 24	0	0
OP: OP 25	19	0

OP: OP 26	15	1

SAT Array East: OP 1

No glare found

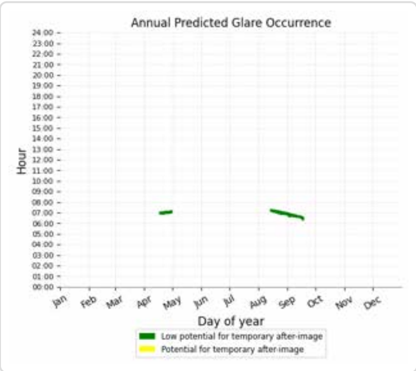
SAT Array East: OP 2

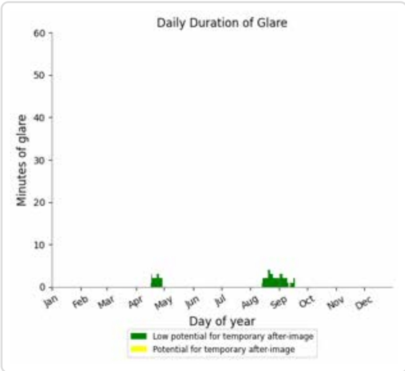
No glare found

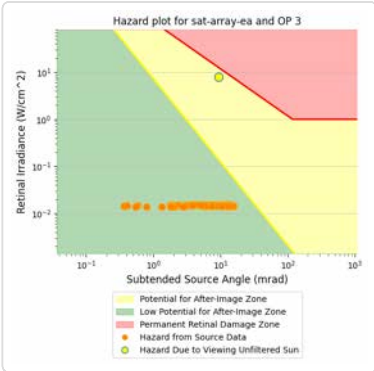
SAT Array East: OP 3

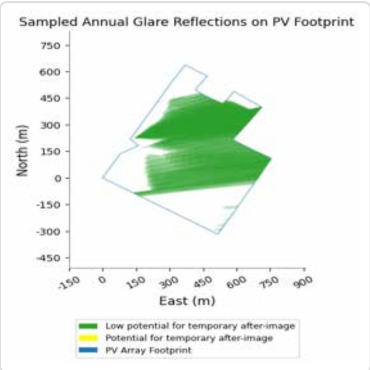
PV array is expected to produce the following glare for this receptor:

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





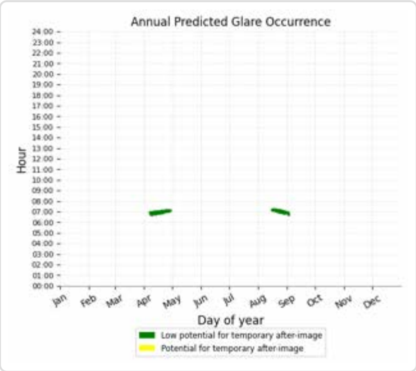


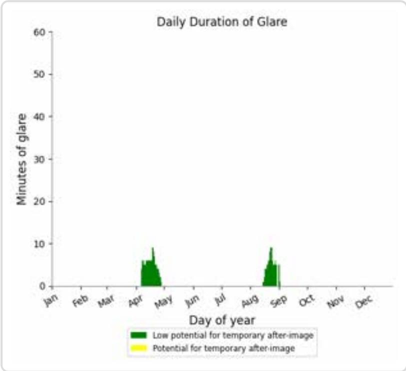


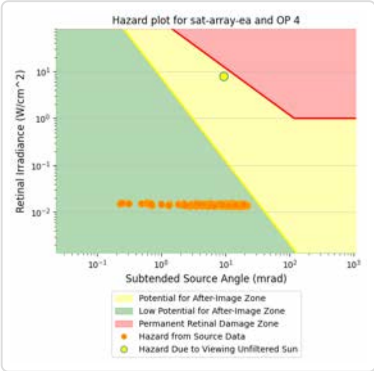
SAT Array East: OP 4

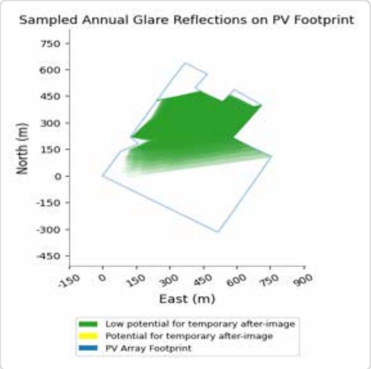
PV array is expected to produce the following glare for this receptor:

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





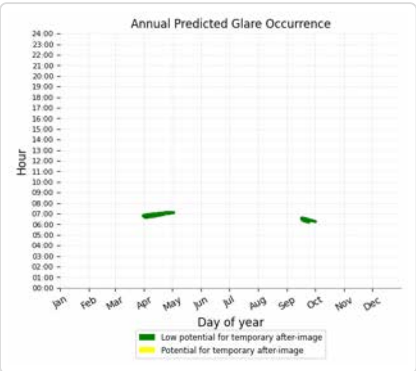


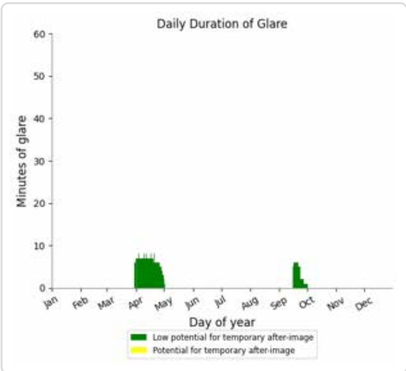


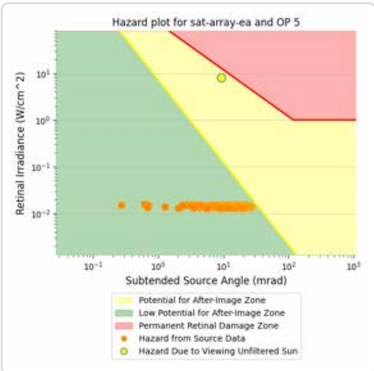
SAT Array East: OP 5

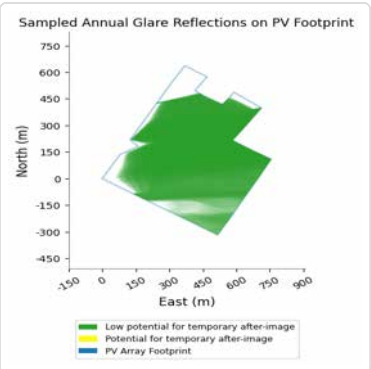
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 6

No glare found

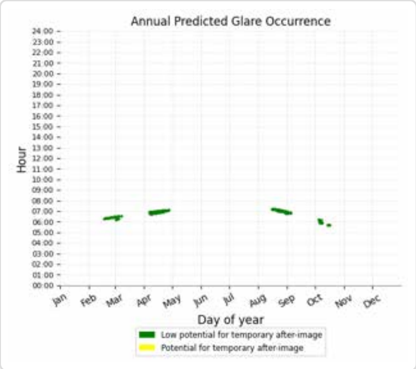
SAT Array East: OP 7

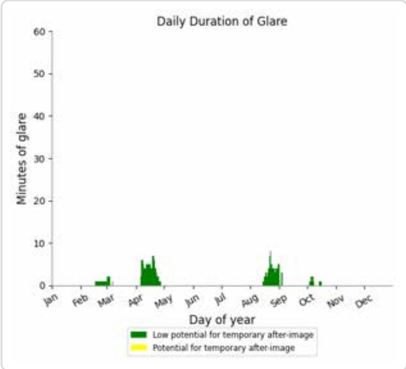
No glare found

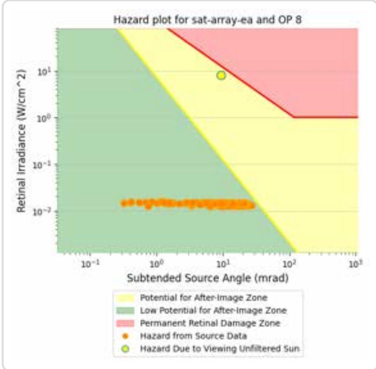
SAT Array East: OP 8

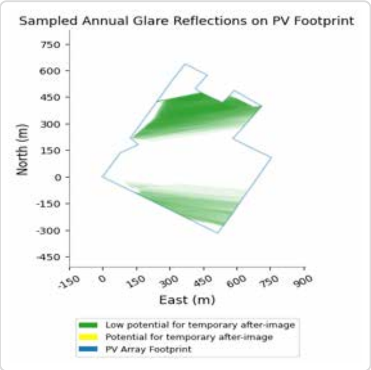
PV array is expected to produce the following glare for this receptor:

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





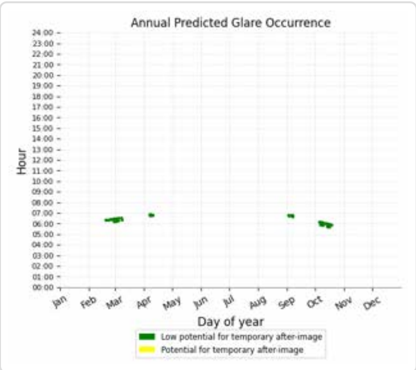


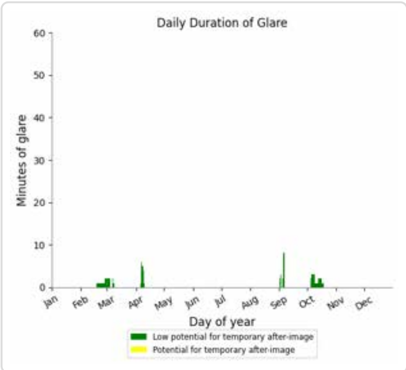


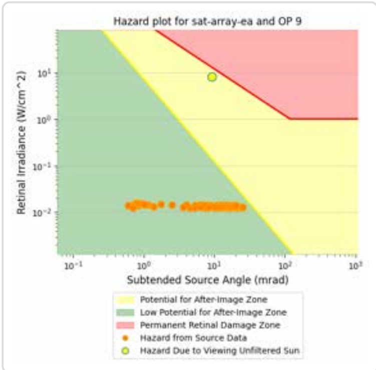
SAT Array East: OP 9

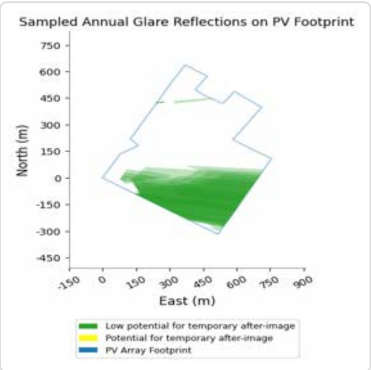
PV array is expected to produce the following glare for this receptor:

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





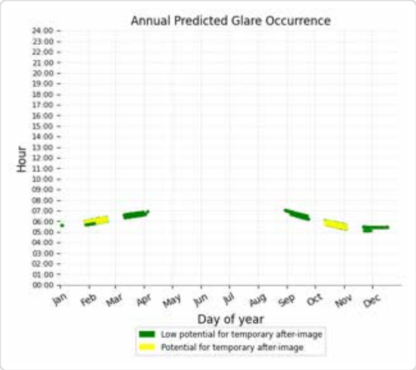


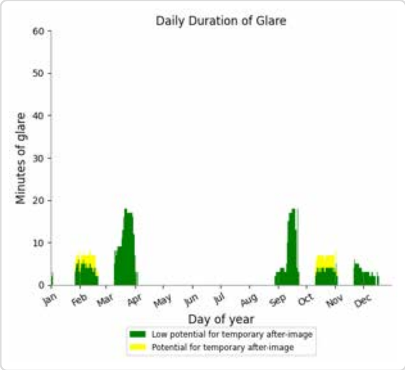


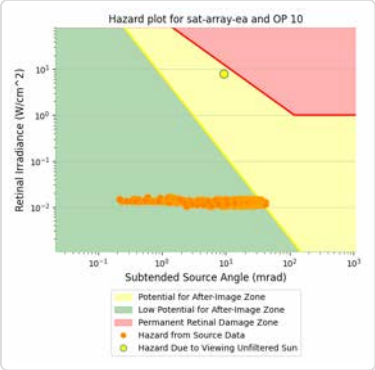
SAT Array East: OP 10

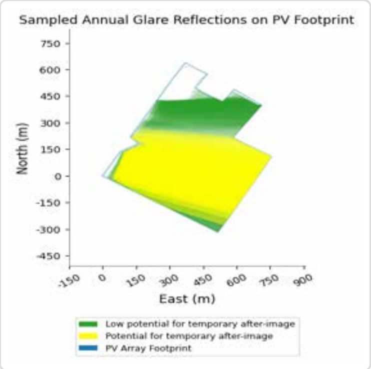
PV array is expected to produce the following glare for this receptor:

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





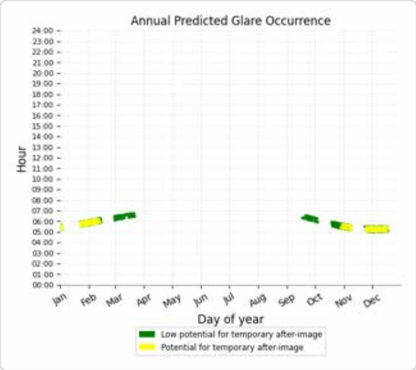


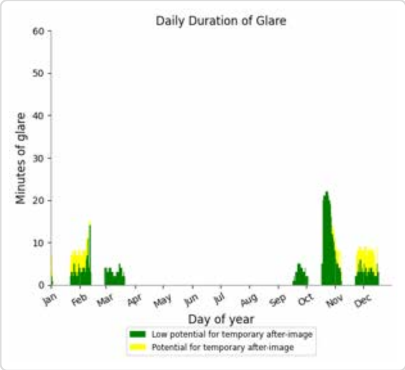


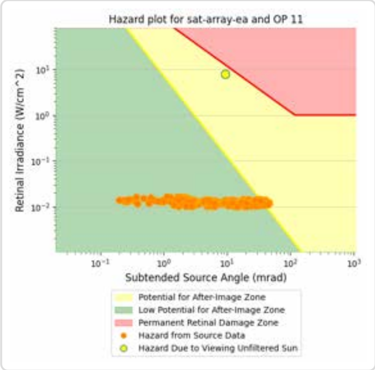
SAT Array East: OP 11

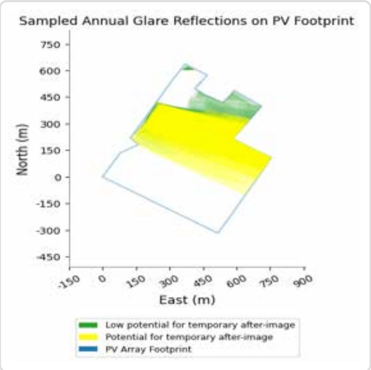
PV array is expected to produce the following glare for this receptor:

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





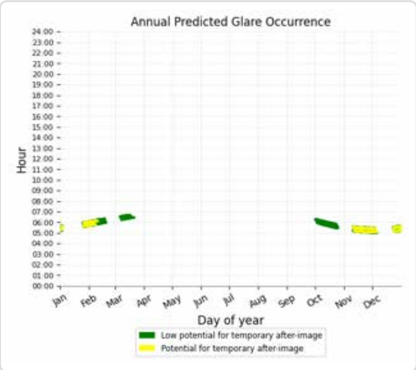


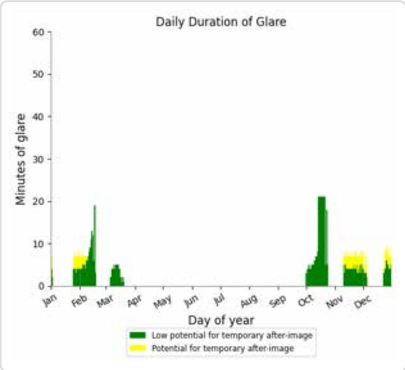


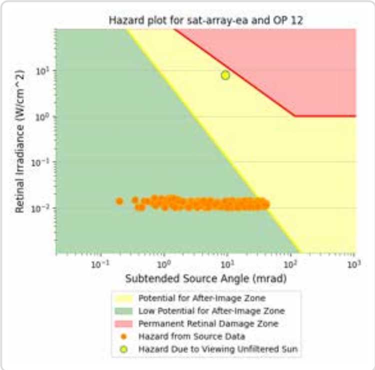
SAT Array East: OP 12

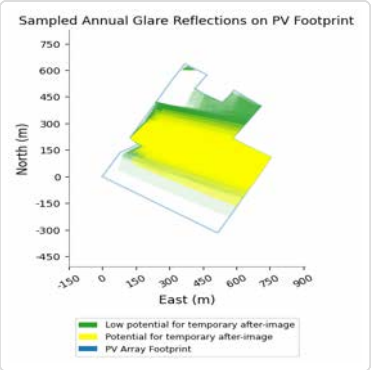
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 13

No glare found

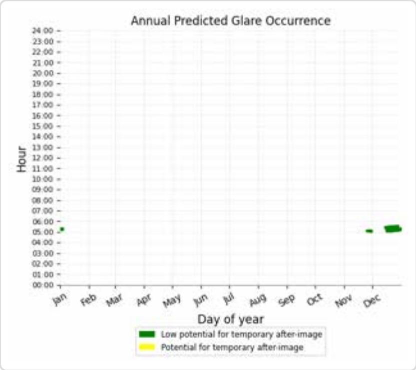
SAT Array East: OP 14

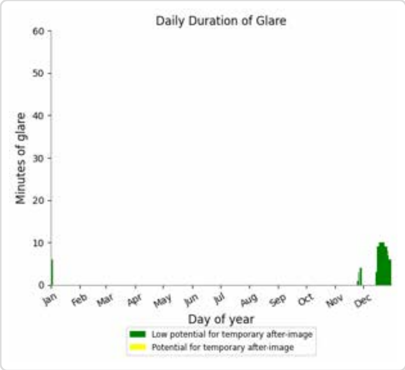
No glare found

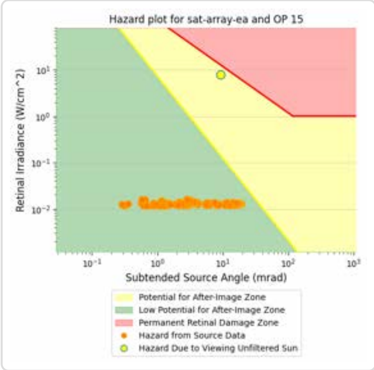
SAT Array East: OP 15

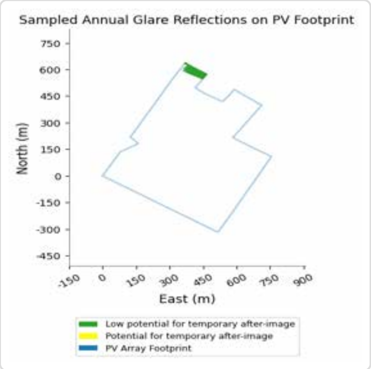
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 16

No glare found

SAT Array East: OP 17

No glare found

SAT Array East: OP 18

No glare found

SAT Array East: OP 19

No glare found

SAT Array East: OP 20

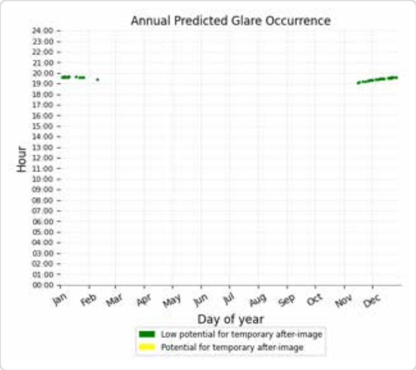
No glare found

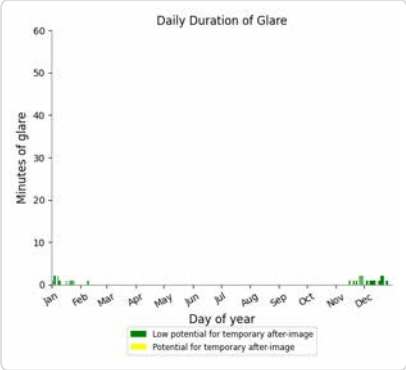
SAT Array East: OP 21

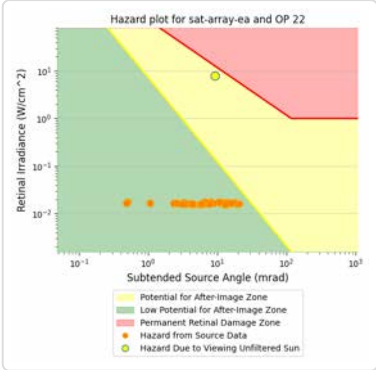
No glare found

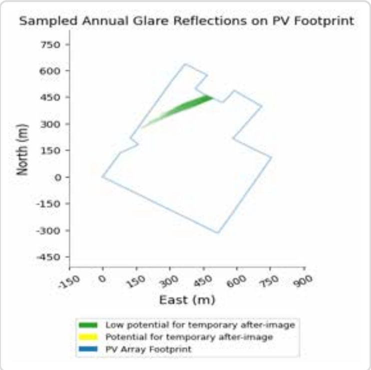
SAT Array East: OP 22

PV array is expected to produce the following glare for this receptor:
- 45 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



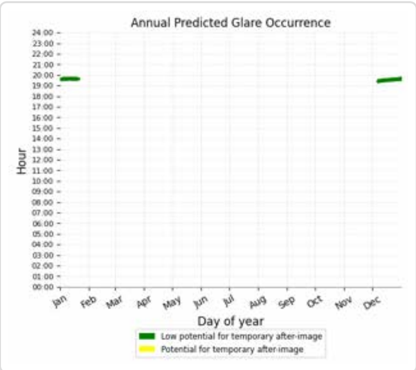


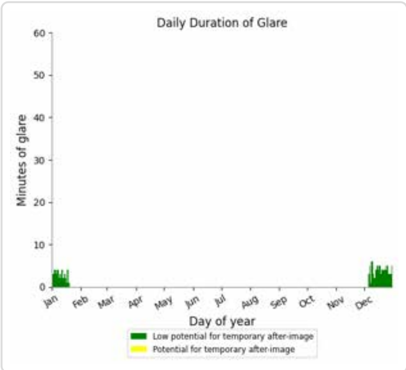


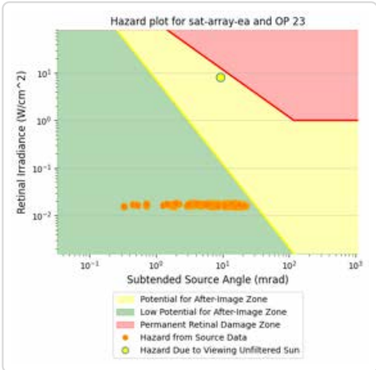


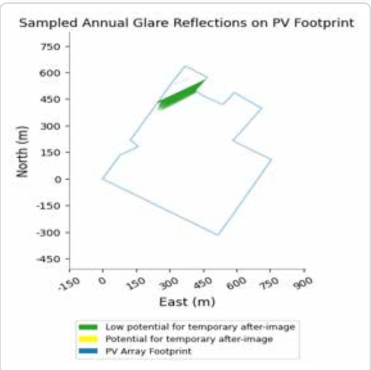
SAT Array East: OP 23

PV array is expected to produce the following glare for this receptor:
- 158 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.









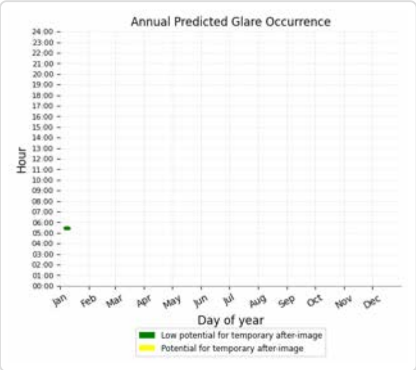
SAT Array East: OP 24

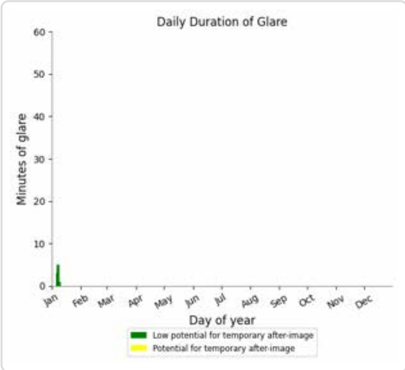
No glare found

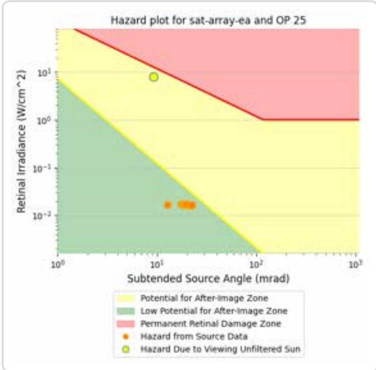
SAT Array East: OP 25

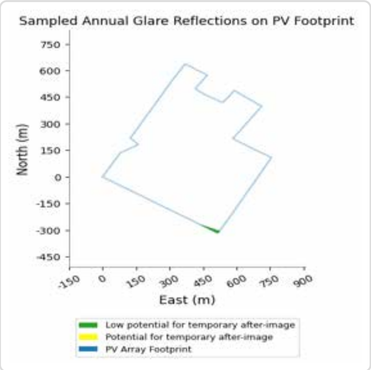
PV array is expected to produce the following glare for this receptor:

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





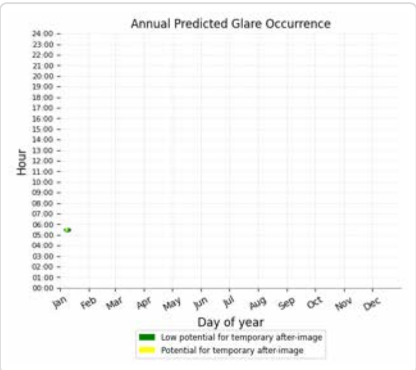


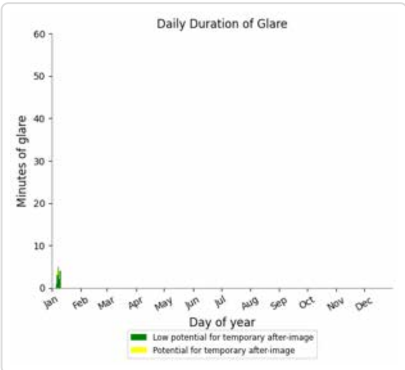


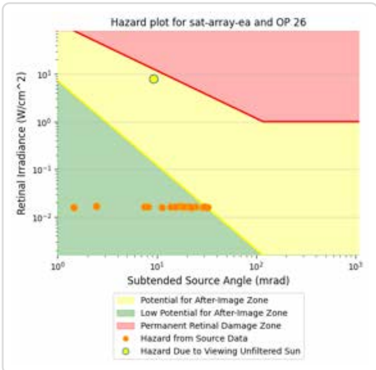
SAT Array East: OP 26

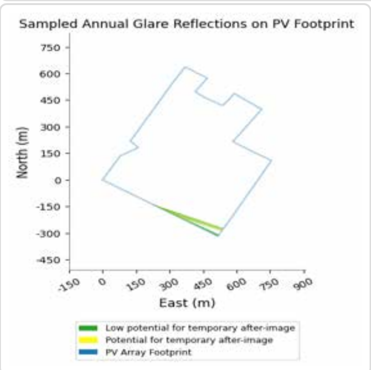
PV array is expected to produce the following glare for this receptor:

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









SAT Array West potential temporary after-image

Component	Green glare (min)	Yellow glare (min)

OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	651	28
OP: OP 5	881	527
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	1534	0
OP: OP 9	908	1105
OP: OP 10	1655	1791
OP: OP 11	0	0
OP: OP 12	1029	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0

SAT Array West: OP 1

No glare found

SAT Array West: OP 2

No glare found

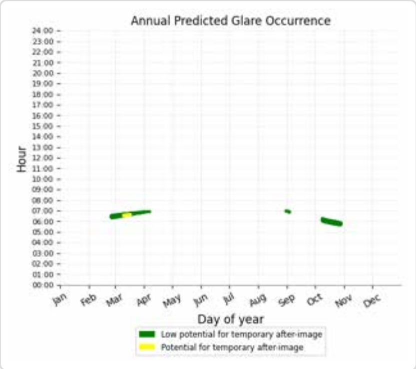
SAT Array West: OP 3

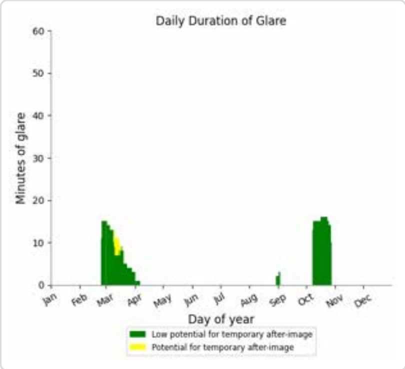
No glare found

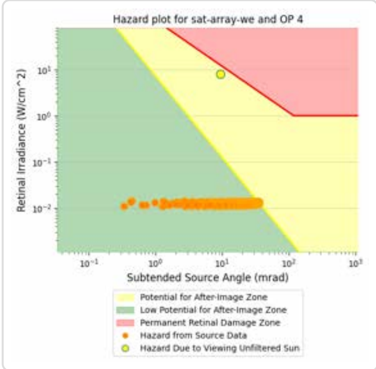
SAT Array West: OP 4

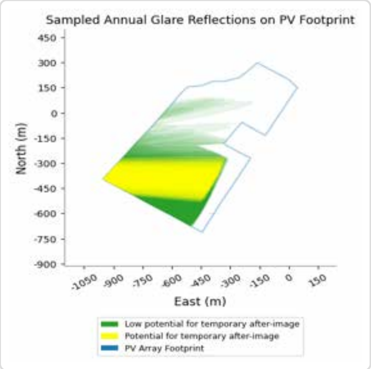
PV array is expected to produce the following glare for this receptor:

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





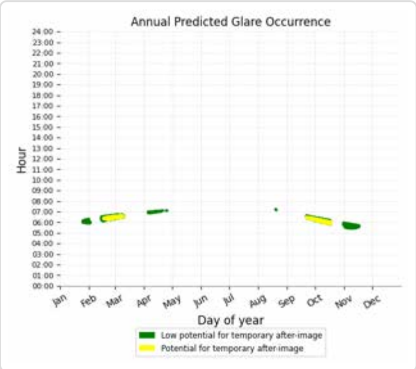


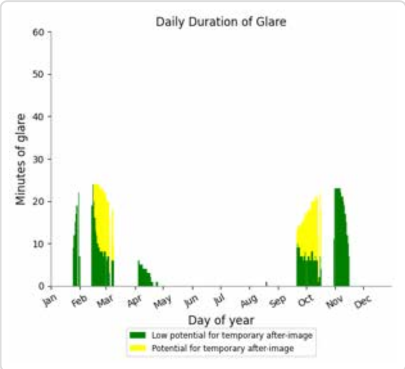


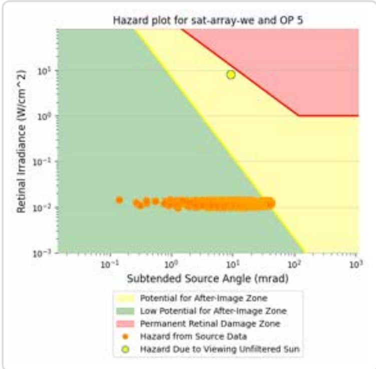
SAT Array West: OP 5

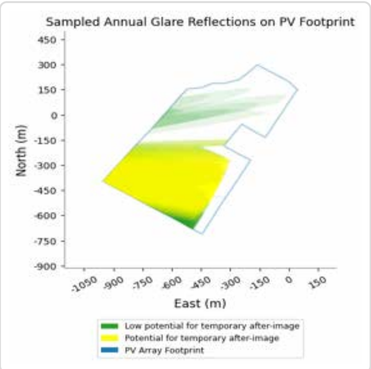
PV array is expected to produce the following glare for this receptor:

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









SAT Array West: OP 6

No glare found

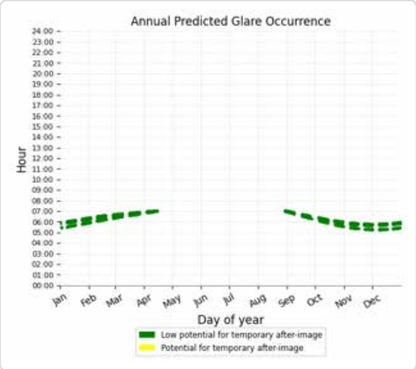
SAT Array West: OP 7

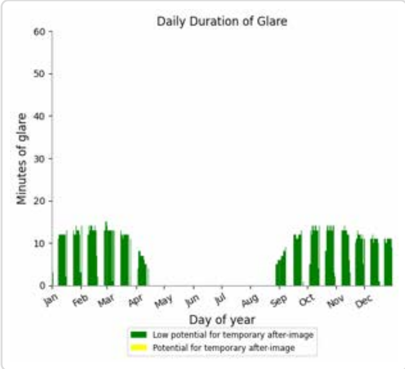
No glare found

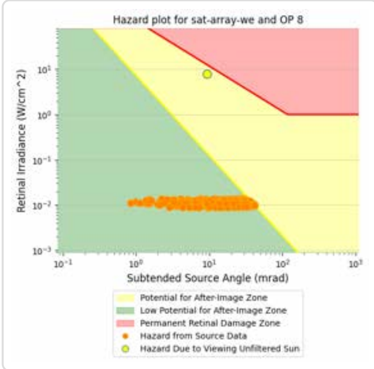
SAT Array West: OP 8

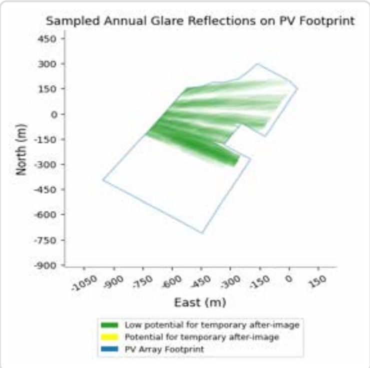
PV array is expected to produce the following glare for this receptor:

- 1,534 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.





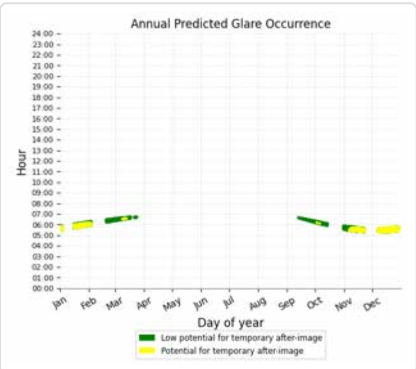


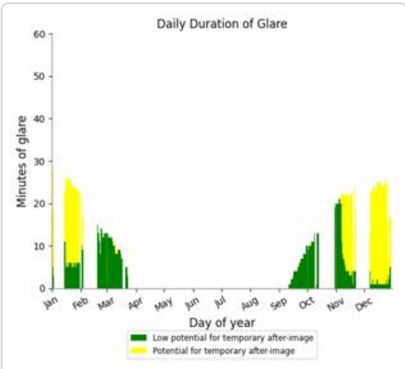


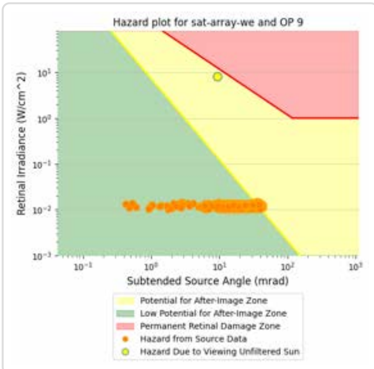
SAT Array West: OP 9

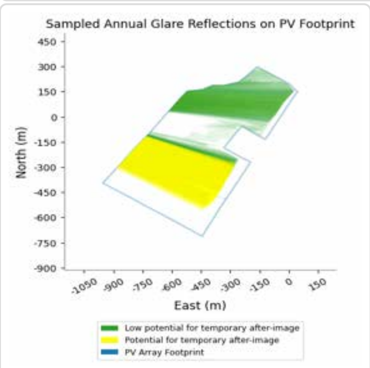
PV array is expected to produce the following glare for this receptor:

- 908 minutes of "green" glare with low potential to cause temporary after-image.
- 1,105 minutes of "yellow" glare with potential to cause temporary after-image.





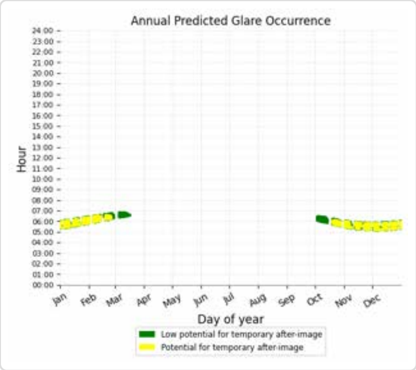


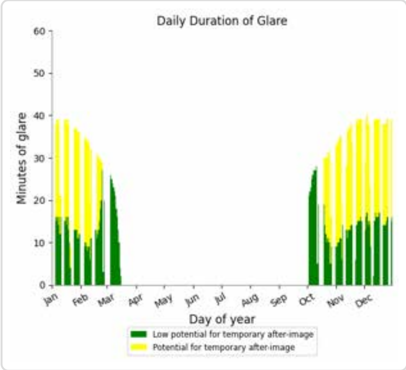


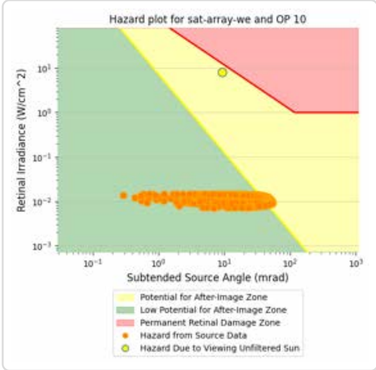
SAT Array West: OP 10

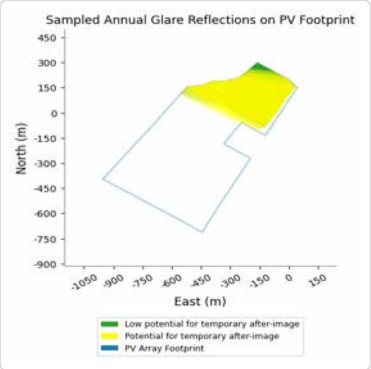
PV array is expected to produce the following glare for this receptor:

- 1,655 minutes of "green" glare with low potential to cause temporary after-image.
- 1,791 minutes of "yellow" glare with potential to cause temporary after-image.









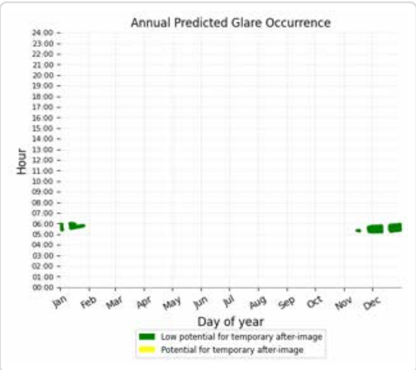
SAT Array West: OP 11

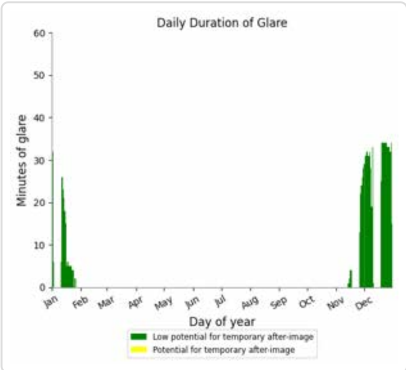
No glare found

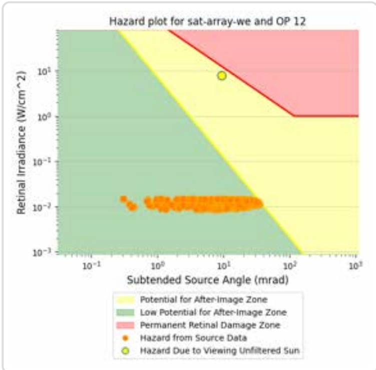
SAT Array West: OP 12

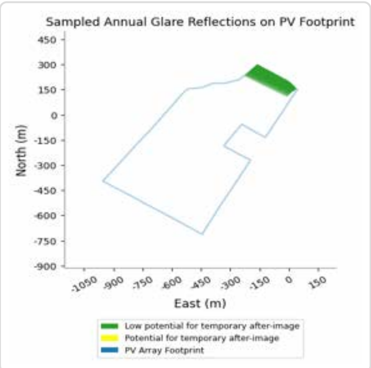
PV array is expected to produce the following glare for this receptor:

- 1,029 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.









SAT Array West: OP 13
No glare found

SAT Array West: OP 14
No glare found

SAT Array West: OP 15
No glare found

SAT Array West: OP 16
No glare found

SAT Array West: OP 17
No glare found

SAT Array West: OP 18
No glare found

SAT Array West: OP 19
No glare found

SAT Array West: OP 20
No glare found

SAT Array West: OP 21
No glare found

SAT Array West: OP 22
No glare found

SAT Array West: OP 23
No glare found

SAT Array West: OP 24
No glare found

SAT Array West: OP 25
No glare found

SAT Array West: OP 26
No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.

- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fo large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Existing shelterbelts only - roads only - 2P

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97613.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

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

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
SAT Array East	SA tracking	SA tracking	0	0	-
SAT Array West	SA tracking	SA tracking	26	9	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40
8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.521784	175.749185	154.00	2.40	156.40

2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40
39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Route Receptor(s)

Name: Mangamaire Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.532089	175.741029	166.00	1.80	167.80
2	-40.530972	175.742230	164.00	1.80	165.80
3	-40.530083	175.743175	163.00	1.80	164.80
4	-40.529427	175.743797	162.00	1.80	163.80
5	-40.528477	175.744462	161.00	1.80	162.80
6	-40.527351	175.745272	160.00	1.80	161.80
7	-40.526634	175.745792	160.00	1.80	161.80
8	-40.525847	175.746393	160.00	1.80	161.80
9	-40.525068	175.746994	159.20	1.80	161.00
10	-40.524008	175.747799	159.00	1.80	160.80
11	-40.523143	175.748437	157.00	1.80	158.80
12	-40.522365	175.749027	155.00	1.80	156.80
13	-40.521305	175.749820	153.00	1.80	154.80
14	-40.520319	175.750565	151.00	1.80	152.80
15	-40.519425	175.751204	149.00	1.80	150.80
16	-40.518516	175.751912	147.00	1.80	148.80
17	-40.516640	175.753296	145.00	1.80	146.80
18	-40.515645	175.754031	144.00	1.80	145.80
19	-40.514813	175.754669	143.00	1.80	144.80
20	-40.514259	175.755055	142.00	1.80	143.80

Name: Tutaekara Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.522049	175.762475	147.00	1.80	148.80
2	-40.521413	175.761724	147.00	1.80	148.80
3	-40.520956	175.761166	147.00	1.80	148.80
4	-40.520597	175.760715	147.00	1.80	148.80
5	-40.520336	175.760243	147.00	1.80	148.80
6	-40.520141	175.759170	147.00	1.80	148.80
7	-40.519978	175.758377	147.40	1.80	149.20
8	-40.519668	175.757626	147.40	1.80	149.20
9	-40.519146	175.756767	147.00	1.80	148.80
10	-40.518477	175.755523	147.00	1.80	148.80
11	-40.518085	175.754922	146.00	1.80	147.80
12	-40.517645	175.754064	146.00	1.80	147.80
13	-40.517319	175.753463	145.80	1.80	147.60
14	-40.517090	175.752969	145.00	1.80	146.80

Obstruction Components

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude	Longitude	Ground elevation
	deg	deg	m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	0	0	-	-
SAT Array West	SA tracking	SA tracking	26	9	-	-

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
sat-array-we (green)	3	0	0	0	0	0	0	0	0	0	0	23
sat-array-we (yellow)	1	0	0	0	0	0	0	0	0	0	0	8

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

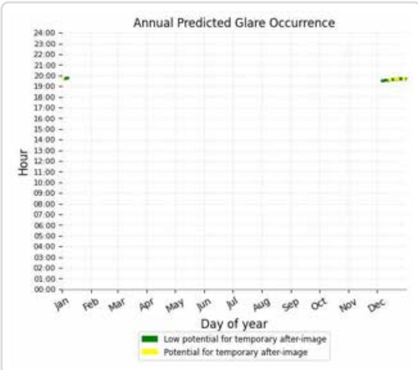
SAT Array West potential temporary after-image

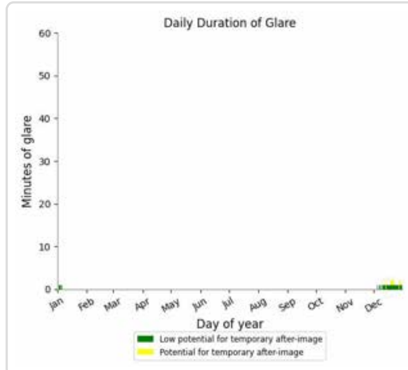
Component	Green glare (min)	Yellow glare (min)
Route: Mangamaire Road	26	9
Route: Tutaekara Road	0	0

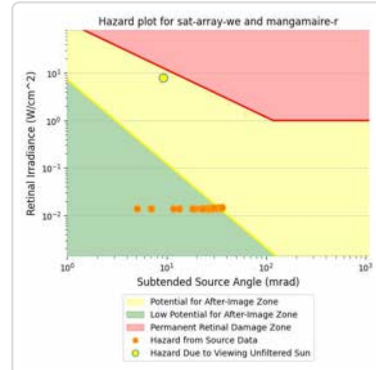
SAT Array West: Mangamaire Road

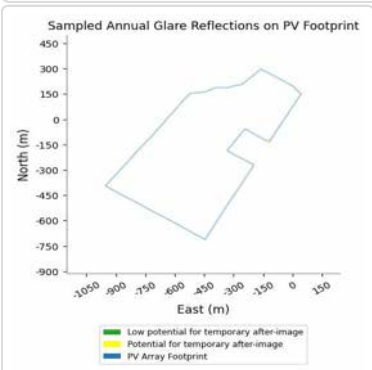
PV array is expected to produce the following glare for this receptor:

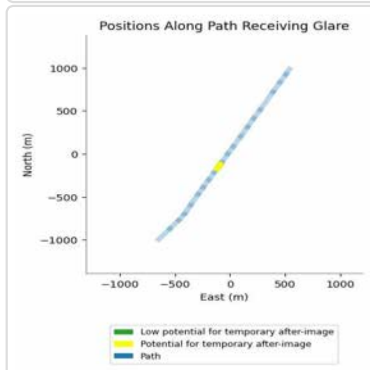
- 26 minutes of "green" glare with low potential to cause temporary after-image.
- 9 minutes of "yellow" glare with potential to cause temporary after-image.











SAT Array West: Tutaekara Road

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- 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.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Existing and 3m mitigation planting - Roads - 2P

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97632.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

Summary of Results No glare predicted!

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
SAT Array East	SA tracking	SA tracking	0	0	-
SAT Array West	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40

8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.521784	175.749185	154.00	2.40	156.40
2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40

39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Route Receptor(s)

Name: Mangamaire Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.532089	175.741029	166.00	1.80	167.80
2	-40.530972	175.742230	164.00	1.80	165.80
3	-40.530083	175.743175	163.00	1.80	164.80
4	-40.529427	175.743797	162.00	1.80	163.80
5	-40.528477	175.744462	161.00	1.80	162.80
6	-40.527351	175.745272	160.00	1.80	161.80
7	-40.526634	175.745792	160.00	1.80	161.80
8	-40.525847	175.746393	160.00	1.80	161.80
9	-40.525068	175.746994	159.20	1.80	161.00
10	-40.524008	175.747799	159.00	1.80	160.80
11	-40.523143	175.748437	157.00	1.80	158.80
12	-40.522365	175.749027	155.00	1.80	156.80
13	-40.521305	175.749820	153.00	1.80	154.80
14	-40.520319	175.750565	151.00	1.80	152.80
15	-40.519425	175.751204	149.00	1.80	150.80
16	-40.518516	175.751912	147.00	1.80	148.80
17	-40.516640	175.753296	145.00	1.80	146.80
18	-40.515645	175.754031	144.00	1.80	145.80
19	-40.514813	175.754669	143.00	1.80	144.80
20	-40.514259	175.755055	142.00	1.80	143.80

Name: Tutaekara Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.522049	175.762475	147.00	1.80	148.80
2	-40.521413	175.761724	147.00	1.80	148.80
3	-40.520956	175.761166	147.00	1.80	148.80
4	-40.520597	175.760715	147.00	1.80	148.80
5	-40.520336	175.760243	147.00	1.80	148.80
6	-40.520141	175.759170	147.00	1.80	148.80
7	-40.519978	175.758377	147.40	1.80	149.20
8	-40.519668	175.757626	147.40	1.80	149.20
9	-40.519146	175.756767	147.00	1.80	148.80
10	-40.518477	175.755523	147.00	1.80	148.80
11	-40.518085	175.754922	146.00	1.80	147.80
12	-40.517645	175.754064	146.00	1.80	147.80
13	-40.517319	175.753463	145.80	1.80	147.60
14	-40.517090	175.752969	145.00	1.80	146.80

Obstruction Components

Name: Obstruction 1
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

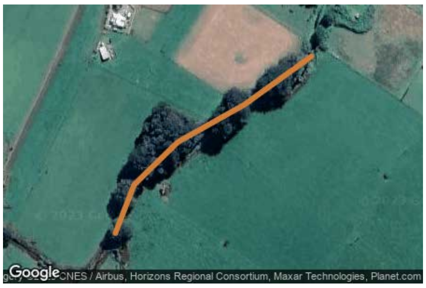
Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m



Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh	Data File
SAT Array East	SA tracking	SA tracking	0	0	-	-
SAT Array West	SA tracking	SA tracking	0	0	-	-

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

SAT Array West no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fc large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Railway with existing and 3m mitigation planting

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97631.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
SAT Array East	SA tracking	SA tracking	0	0	-
SAT Array West	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40

8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.521784	175.749185	154.00	2.40	156.40
2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40

39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Route Receptor(s)

Name: Railway
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.509494	175.747086	146.99	3.00	149.99
2	-40.510587	175.746700	149.54	3.00	152.54
3	-40.513409	175.746829	148.02	3.00	151.02
4	-40.515269	175.746872	149.00	3.00	152.00
5	-40.517161	175.745906	148.00	3.00	151.00
6	-40.519119	175.744705	148.00	3.00	151.00
7	-40.521207	175.742537	155.00	3.00	158.00
8	-40.524322	175.739319	159.26	3.00	162.26
9	-40.527845	175.735607	164.00	3.00	167.00
10	-40.531188	175.732066	170.00	3.00	173.00
11	-40.533015	175.730242	171.00	3.00	174.00
12	-40.535331	175.727732	174.92	3.00	177.92

Obstruction Components

Name: Obstruction 1
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

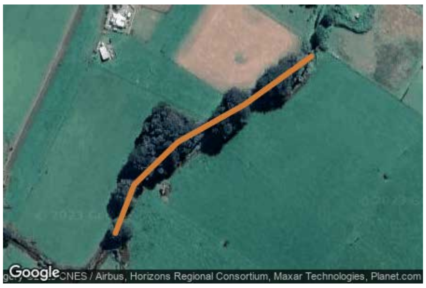
Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m



Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh	Data File
SAT Array East	SA tracking	SA tracking	0	0	-	-
SAT Array West	SA tracking	SA tracking	0	0	-	-

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Railway	0	0

No glare found

SAT Array West no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Railway	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fc large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Tararua Rev5 - SAT - Exisiting Recep - 2P 3mSB

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97635.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

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

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
SAT Array East	SA tracking	SA tracking	416	0	-
SAT Array West	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40

8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.521784	175.749185	154.00	2.40	156.40
2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40

39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Route Receptor(s)

Name: Mangamaire Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.532089	175.741029	166.00	1.30	167.30
2	-40.530972	175.742230	164.00	1.30	165.30
3	-40.530083	175.743175	163.00	1.30	164.30
4	-40.529427	175.743797	162.00	1.30	163.30
5	-40.528477	175.744462	161.00	1.30	162.30
6	-40.527351	175.745272	160.00	1.30	161.30
7	-40.526634	175.745792	160.00	1.30	161.30
8	-40.525847	175.746393	160.00	1.30	161.30
9	-40.525068	175.746994	159.20	1.30	160.50
10	-40.524008	175.747799	159.00	1.30	160.30
11	-40.523143	175.748437	157.00	1.30	158.30
12	-40.522365	175.749027	155.00	1.30	156.30
13	-40.521305	175.749820	153.00	1.30	154.30
14	-40.520319	175.750565	151.00	1.30	152.30
15	-40.519425	175.751204	149.00	1.30	150.30
16	-40.518516	175.751912	147.00	1.30	148.30
17	-40.516640	175.753296	145.00	1.30	146.30
18	-40.515645	175.754031	144.00	1.30	145.30
19	-40.514813	175.754669	143.00	1.30	144.30
20	-40.514259	175.755055	142.00	1.30	143.30

Name: Tutaekara Road
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-40.522049	175.762475	147.00	1.30	148.30
2	-40.521413	175.761724	147.00	1.30	148.30
3	-40.520956	175.761166	147.00	1.30	148.30
4	-40.520597	175.760715	147.00	1.30	148.30
5	-40.520336	175.760243	147.00	1.30	148.30
6	-40.520141	175.759170	147.00	1.30	148.30
7	-40.519978	175.758377	147.40	1.30	148.70
8	-40.519668	175.757626	147.40	1.30	148.70
9	-40.519146	175.756767	147.00	1.30	148.30
10	-40.518477	175.755523	147.00	1.30	148.30
11	-40.518085	175.754922	146.00	1.30	147.30
12	-40.517645	175.754064	146.00	1.30	147.30
13	-40.517319	175.753463	145.80	1.30	147.10
14	-40.517090	175.752969	145.00	1.30	146.30

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-40.509167	175.746093	156.60	1.70	158.30
OP 2	-40.513637	175.745921	152.00	1.70	153.70
OP 3	-40.515007	175.746114	151.00	1.70	152.70
OP 4	-40.514551	175.747723	146.70	1.70	148.40
OP 5	-40.514909	175.747723	147.00	1.70	148.70
OP 6	-40.515350	175.747895	147.00	1.70	148.70
OP 7	-40.515529	175.749268	145.00	1.70	146.70
OP 8	-40.515816	175.749825	145.00	1.70	146.70
OP 9	-40.516591	175.751343	145.00	1.70	146.70
OP 10	-40.516709	175.751558	145.00	1.70	146.70
OP 11	-40.517476	175.754245	145.90	1.70	147.60
OP 12	-40.517625	175.755716	145.60	1.70	147.30
OP 13	-40.519819	175.757191	148.00	1.70	149.70
OP 14	-40.520749	175.748919	152.00	1.70	153.70
OP 15	-40.523791	175.748425	158.00	1.70	159.70
OP 16	-40.527047	175.745839	160.00	1.70	161.70
OP 17	-40.528654	175.744734	161.00	1.70	162.70
OP 18	-40.531566	175.740810	166.00	1.70	167.70
OP 19	-40.532505	175.728347	170.00	1.70	171.70
OP 20	-40.531551	175.723669	181.00	1.70	182.70

Obstruction Components

Name: Obstruction 1
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

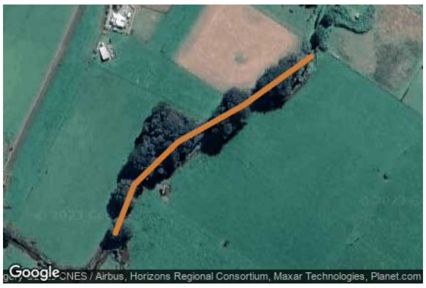
Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m



Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	416	0	-	-
SAT Array West	SA tracking	SA tracking	0	0	-	-

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
sat-array-ea (green)	40	0	0	0	0	0	0	0	0	0	133	213
sat-array-ea (yellow)	0	0	0	0	0	0	0	0	0	0	0	0

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East low potential for temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	311	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	86	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	19	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

SAT Array East: OP 1

No glare found

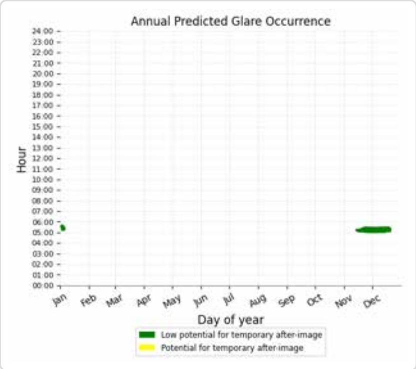
SAT Array East: OP 2

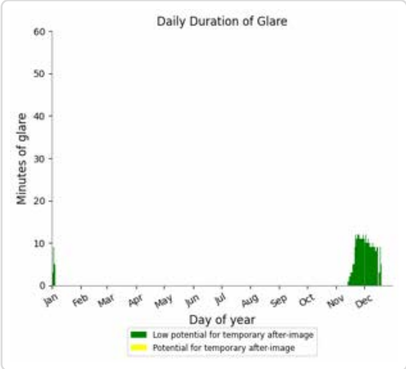
No glare found

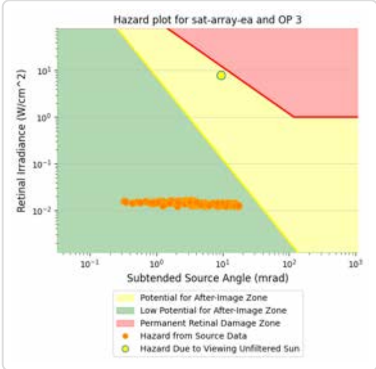
SAT Array East: OP 3

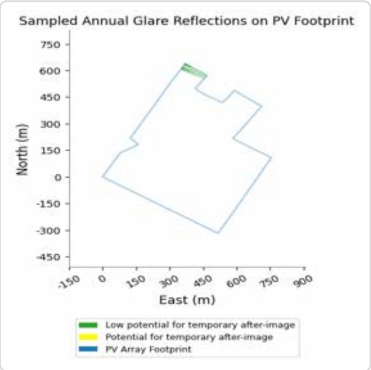
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 4

No glare found

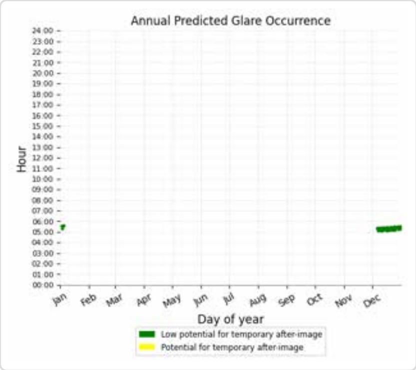
SAT Array East: OP 5

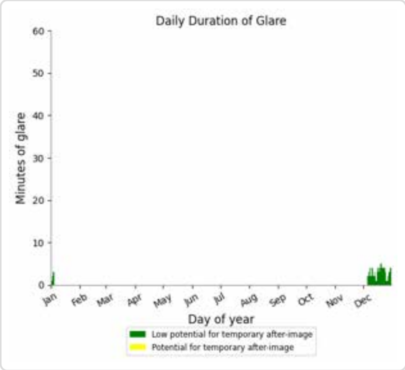
No glare found

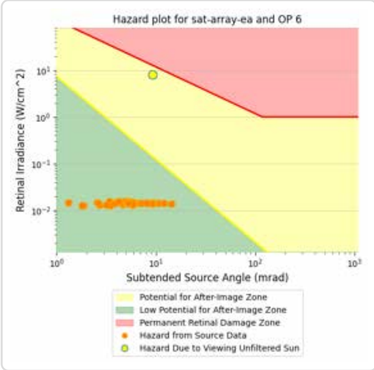
SAT Array East: OP 6

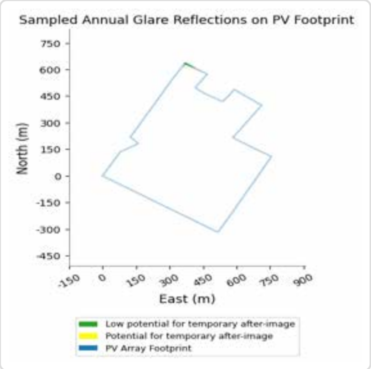
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 7

No glare found

SAT Array East: OP 8

No glare found

SAT Array East: OP 9

No glare found

SAT Array East: OP 10

No glare found

SAT Array East: OP 11

No glare found

SAT Array East: OP 12

No glare found

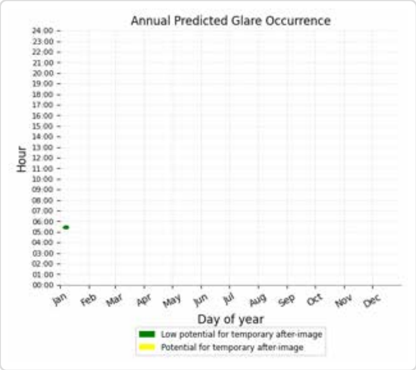
SAT Array East: OP 13

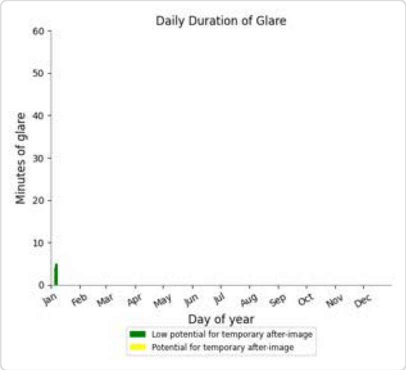
No glare found

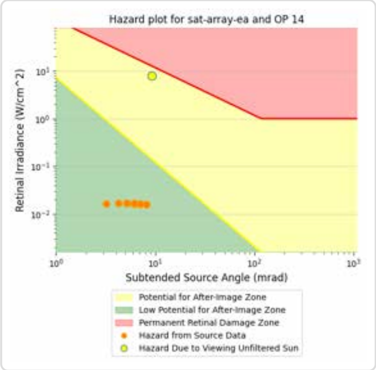
SAT Array East: OP 14

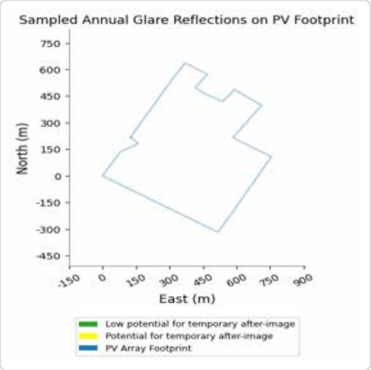
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 15

No glare found

SAT Array East: OP 16

No glare found

SAT Array East: OP 17

No glare found

SAT Array East: OP 18

No glare found

SAT Array East: OP 19

No glare found

SAT Array East: OP 20

No glare found

SAT Array East: Mangamaire Road

No glare found

SAT Array East: Tutaekara Road

No glare found

SAT Array West no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
Route: Mangamaire Road	0	0
Route: Tutaekara Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fo large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

2945 - Tararua

Tararua Rev5 - SAT - Potential Recep - 2P 3mSB

Client: Solar Bay

Created Aug 15, 2023
Updated Aug 15, 2023
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
Site ID 97637.12086

Project type Advanced
Project status: active
Category 10 MW to 100 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

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

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
SAT Array East	SA tracking	SA tracking	5,057	691	-
SAT Array West	SA tracking	SA tracking	6,677	3,600	-

Component Data

PV Array(s)

Total PV footprint area: 829,652 m^2

Name: SAT Array East
Footprint area: 375,139 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.523131	175.748672	157.00	2.40	159.40
2	-40.521914	175.749605	154.00	2.40	156.40
3	-40.521488	175.750568	153.00	2.40	155.40
4	-40.521159	175.750142	152.00	2.40	154.40
5	-40.520645	175.750533	151.00	2.40	153.40
6	-40.519854	175.751129	150.00	2.40	152.40
7	-40.519198	175.751628	148.00	2.40	150.40

8	-40.518333	175.752266	147.00	2.40	149.40
9	-40.517389	175.753038	146.00	2.40	148.40
10	-40.517662	175.753580	146.00	2.40	148.40
11	-40.517964	175.754197	146.00	2.40	148.40
12	-40.518659	175.753564	147.00	2.40	149.40
13	-40.518953	175.754079	147.00	2.40	149.40
14	-40.519357	175.755013	148.00	2.40	150.40
15	-40.519055	175.755345	147.00	2.40	149.40
16	-40.518745	175.755627	147.00	2.40	149.40
17	-40.519126	175.756308	147.00	2.40	149.40
18	-40.519540	175.757072	147.60	2.40	150.00
19	-40.520034	175.756627	148.00	2.40	150.40
20	-40.520658	175.756053	149.00	2.40	151.40
21	-40.521188	175.755549	150.00	2.40	152.40
22	-40.521624	175.756439	150.00	2.40	152.40
23	-40.522146	175.757587	150.00	2.40	152.40
24	-40.523155	175.756874	151.00	2.40	153.40
25	-40.524022	175.756225	152.60	2.40	155.00
26	-40.524986	175.755533	153.80	2.40	156.20
27	-40.525995	175.754760	154.10	2.40	156.50
28	-40.525482	175.753671	155.00	2.40	157.40
29	-40.524776	175.752164	155.90	2.40	158.30
30	-40.524160	175.750855	156.00	2.40	158.40
31	-40.523685	175.749841	157.00	2.40	159.40

Name: SAT Array West
Footprint area: 454,514 m^2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0 deg
Maximum tracking angle: 55.0 deg
Resting angle: 0.0 deg
Ground Coverage Ratio: 0.404

Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-40.521784	175.749185	154.00	2.40	156.40
2	-40.522361	175.748739	155.70	2.40	158.10
3	-40.523179	175.748136	157.20	2.40	159.60
4	-40.523727	175.747712	158.70	2.40	161.10
5	-40.524043	175.747488	159.00	2.40	161.40
6	-40.524343	175.747245	159.00	2.40	161.40
7	-40.524017	175.746564	160.00	2.40	162.40
8	-40.523723	175.745985	160.00	2.40	162.40
9	-40.523633	175.745840	160.00	2.40	162.40
10	-40.524241	175.745244	160.00	2.40	162.40
11	-40.524791	175.744735	161.00	2.40	163.40
12	-40.524985	175.745113	161.00	2.40	163.40
13	-40.525305	175.745778	160.00	2.40	162.40
14	-40.525560	175.746352	160.00	2.40	162.40
15	-40.525996	175.746038	160.00	2.40	162.40
16	-40.526791	175.745443	160.00	2.40	162.40
17	-40.527483	175.744912	161.00	2.40	163.40
18	-40.528100	175.744451	161.00	2.40	163.40
19	-40.529542	175.743423	163.00	2.40	165.40
20	-40.529164	175.742624	163.00	2.40	165.40
21	-40.528802	175.741902	163.00	2.40	165.40
22	-40.528441	175.741127	164.00	2.40	166.40
23	-40.527980	175.740135	163.00	2.40	165.40
24	-40.527487	175.739124	163.00	2.40	165.40
25	-40.527095	175.738265	162.00	2.40	164.40
26	-40.526687	175.737420	161.00	2.40	163.40
27	-40.525436	175.738721	160.00	2.40	162.40
28	-40.524746	175.739419	160.00	2.40	162.40
29	-40.524017	175.740223	160.00	2.40	162.40
30	-40.523405	175.740835	159.00	2.40	161.40
31	-40.522728	175.741511	157.00	2.40	159.40
32	-40.522125	175.742101	157.00	2.40	159.40
33	-40.521749	175.742519	157.00	2.40	159.40
34	-40.521668	175.743421	158.70	2.40	161.10
35	-40.521439	175.744054	157.00	2.40	159.40
36	-40.521439	175.744762	156.00	2.40	158.40
37	-40.521260	175.745631	155.00	2.40	157.40
38	-40.520942	175.746103	154.00	2.40	156.40

39	-40.520449	175.746763	152.40	2.40	154.80
40	-40.520864	175.747658	153.00	2.40	155.40
41	-40.521350	175.748667	153.60	2.40	156.00

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-40.530849	175.730612	169.00	1.70	170.70
OP 2	-40.528772	175.724436	180.50	1.70	182.20
OP 3	-40.527277	175.720330	201.00	1.70	202.70
OP 4	-40.526006	175.722248	222.40	1.70	224.10
OP 5	-40.525407	175.726448	221.40	1.70	223.10
OP 6	-40.525060	175.735779	160.00	1.70	161.70
OP 7	-40.522646	175.738676	151.00	1.70	152.70
OP 8	-40.522760	175.736509	182.90	1.70	184.60
OP 9	-40.521635	175.728484	197.40	1.70	199.10
OP 10	-40.519922	175.737281	221.00	1.70	222.70
OP 11	-40.517645	175.742153	202.50	1.70	204.20
OP 12	-40.517025	175.737089	224.10	1.70	225.80
OP 13	-40.510847	175.744292	189.00	1.70	190.70
OP 14	-40.511092	175.743605	221.00	1.70	222.70
OP 15	-40.513572	175.744034	198.30	1.70	200.00
OP 16	-40.514844	175.748934	146.00	1.70	147.70
OP 17	-40.515545	175.750651	144.00	1.70	145.70
OP 18	-40.516018	175.751745	144.80	1.70	146.50
OP 19	-40.516418	175.752657	145.00	1.70	146.70
OP 20	-40.516989	175.753741	145.00	1.70	146.70
OP 21	-40.518938	175.757367	147.00	1.70	148.70
OP 22	-40.517650	175.757968	145.00	1.70	146.70
OP 23	-40.516182	175.758719	143.40	1.70	145.10
OP 24	-40.519819	175.758472	147.00	1.70	148.70
OP 25	-40.525033	175.752206	156.00	1.70	157.70
OP 26	-40.523826	175.749578	157.00	1.70	158.70

Obstruction Components

Name: Obstruction 1
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517741	175.752624	146.00
2	-40.517398	175.752889	146.00
3	-40.517431	175.752962	146.00
4	-40.517359	175.753021	146.00
5	-40.517651	175.753616	146.00
6	-40.517946	175.754212	146.00

Name: Obstruction 10
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.517712	175.752594	146.00
2	-40.518510	175.751972	147.00
3	-40.519319	175.751371	149.00

Name: Obstruction 2
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.518719	175.755639	147.00
2	-40.519094	175.756328	147.00
3	-40.519519	175.757100	147.20

Name: Obstruction 3
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.519365	175.751373	149.00
2	-40.520279	175.750713	150.90
3	-40.521184	175.750042	152.00
4	-40.521461	175.750396	153.00
5	-40.521885	175.749479	154.00
6	-40.522501	175.749018	155.70
7	-40.523141	175.748573	157.00
8	-40.523892	175.750123	156.40
9	-40.525135	175.752762	155.00
10	-40.526053	175.754709	154.80

Name: Obstruction 4
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.520925	175.747897	153.00
2	-40.521139	175.748313	153.00
3	-40.521353	175.748729	153.00
4	-40.521757	175.749238	154.00
5	-40.522399	175.748749	156.00
6	-40.523047	175.748273	157.00
7	-40.523728	175.747762	158.70
8	-40.524389	175.747264	159.00
9	-40.524069	175.746591	160.00
10	-40.523688	175.745843	160.00

Name: Obstruction 5
Upper edge height: 3.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524781	175.744788	161.00
2	-40.525166	175.745600	160.00
3	-40.525552	175.746413	160.00
4	-40.527572	175.744919	161.00
5	-40.528562	175.744188	161.70
6	-40.529592	175.743414	163.00
7	-40.528854	175.741885	163.00
8	-40.528157	175.740378	163.90
9	-40.526722	175.737353	161.00

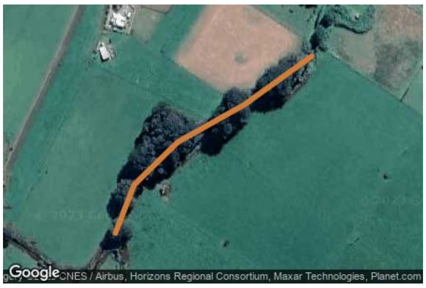
Name: Obstruction 6
Upper edge height: 8.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.529083	175.757262	155.00
2	-40.528696	175.756456	155.00
3	-40.528317	175.755683	156.00
4	-40.527947	175.754882	156.00
5	-40.527560	175.754081	156.00
6	-40.527187	175.753297	156.00
7	-40.526798	175.752491	156.00
8	-40.526405	175.751690	156.00
9	-40.526033	175.750895	157.00

Name: Obstruction 7
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.524484	175.747558	159.00
2	-40.524745	175.748079	159.00
3	-40.525006	175.748631	158.00

Name: Obstruction 8
Upper edge height: 10.0 m



Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.516380	175.749299	145.00
2	-40.516804	175.748526	146.00
3	-40.517130	175.747764	146.00
4	-40.517505	175.747260	146.00
5	-40.517929	175.747046	147.00

Name: Obstruction 9
Upper edge height: 10.0 m

Vertex	Latitude deg	Longitude deg	Ground elevation m
1	-40.522574	175.737690	165.20
2	-40.522937	175.737523	163.30
3	-40.523267	175.737083	164.10

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
SAT Array East	SA tracking	SA tracking	5,057	691	-	-
SAT Array West	SA tracking	SA tracking	6,677	3,600	-	-

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
sat-array-ea (green)	253	273	418	288	24	0	0	186	397	424	409	434
sat-array-ea (yellow)	46	43	19	0	0	0	0	0	0	16	109	90
sat-array-we (green)	351	364	403	91	0	0	0	18	205	502	325	428
sat-array-we (yellow)	493	335	3	0	0	0	0	0	4	208	522	262

PV & Receptor Analysis Results

Results for each PV array and receptor

SAT Array East potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	183	0
OP: OP 4	302	0
OP: OP 5	357	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	299	0
OP: OP 9	238	0
OP: OP 10	1071	208
OP: OP 11	1082	273
OP: OP 12	1100	209
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	166	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	62	0
OP: OP 23	163	0
OP: OP 24	0	0
OP: OP 25	19	0

OP: OP 26	15	1

SAT Array East: OP 1

No glare found

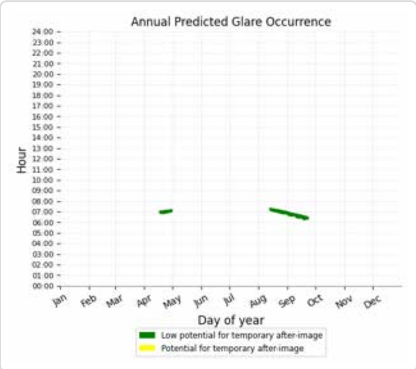
SAT Array East: OP 2

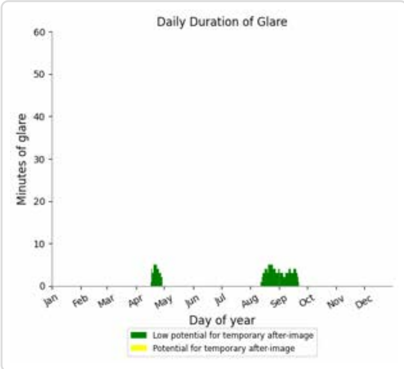
No glare found

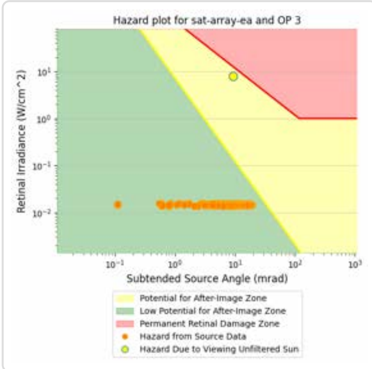
SAT Array East: OP 3

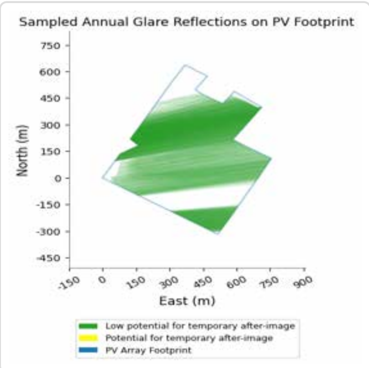
PV array is expected to produce the following glare for this receptor:

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





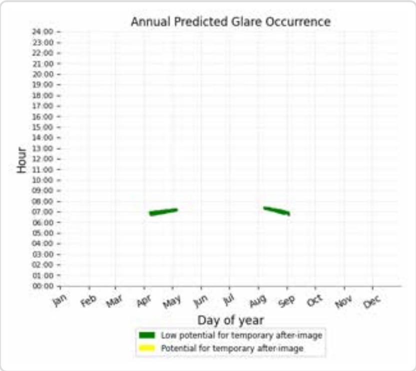


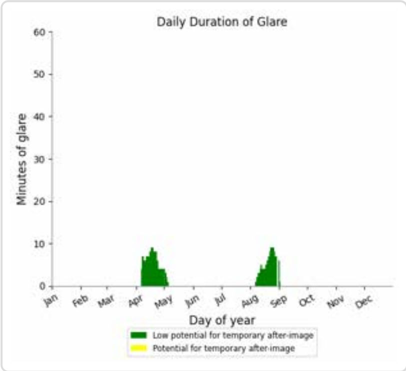


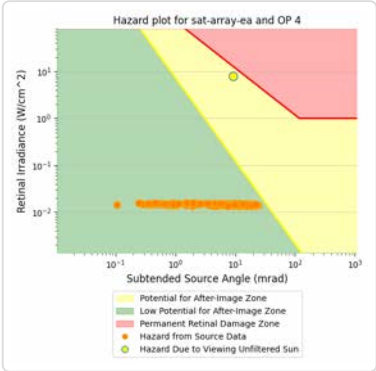
SAT Array East: OP 4

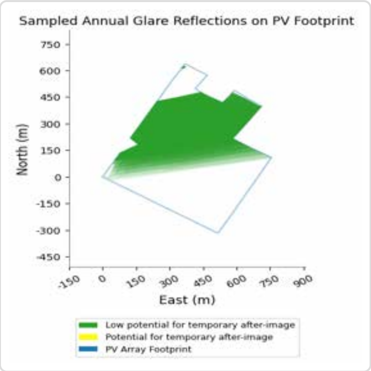
PV array is expected to produce the following glare for this receptor:

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





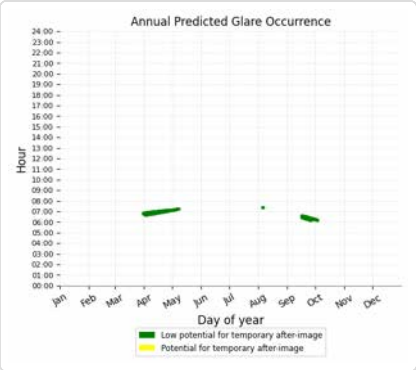


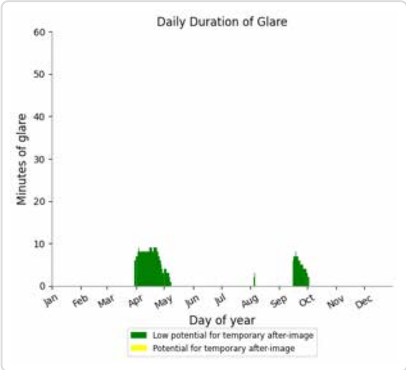


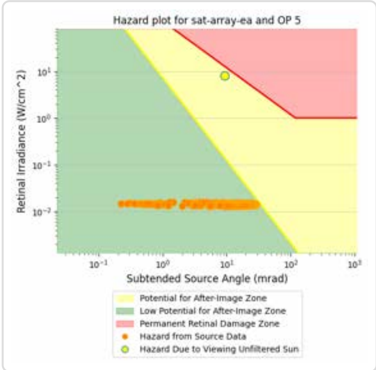
SAT Array East: OP 5

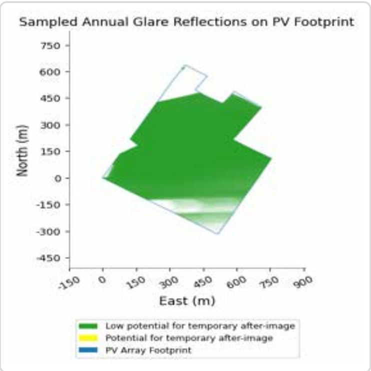
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 6

No glare found

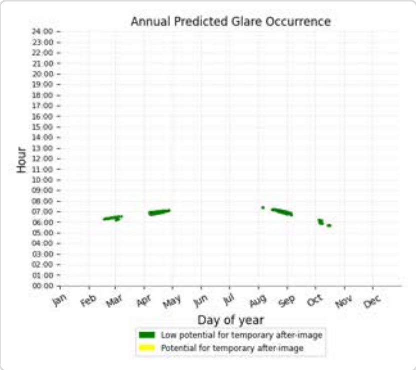
SAT Array East: OP 7

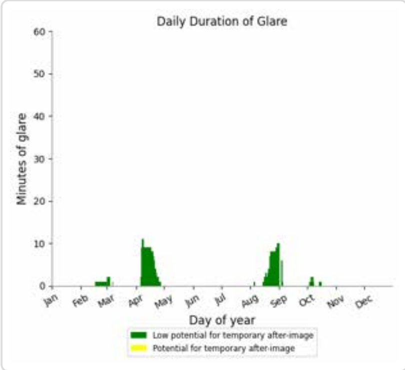
No glare found

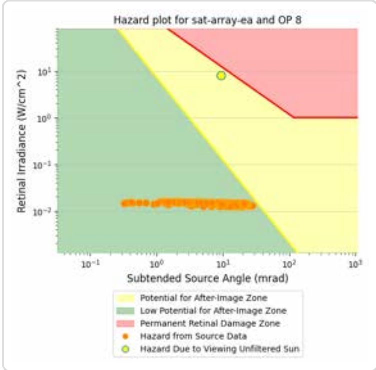
SAT Array East: OP 8

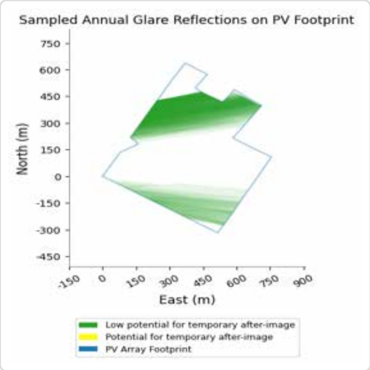
PV array is expected to produce the following glare for this receptor:

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





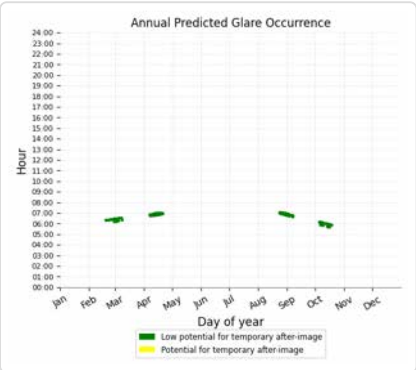


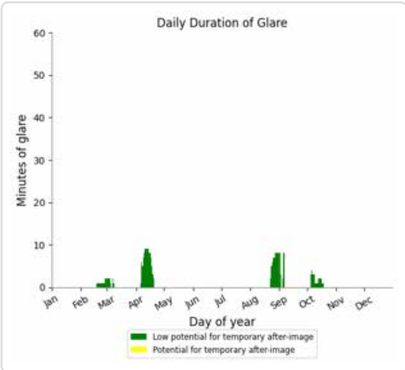


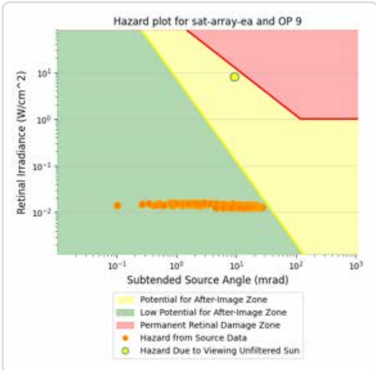
SAT Array East: OP 9

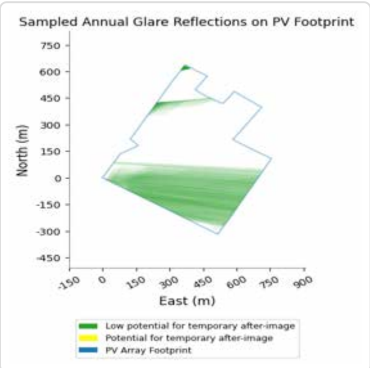
PV array is expected to produce the following glare for this receptor:

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





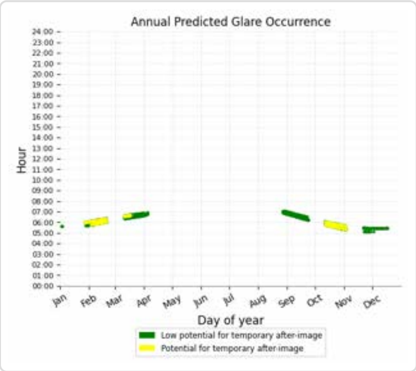


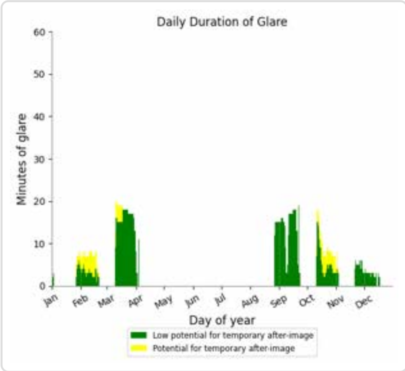


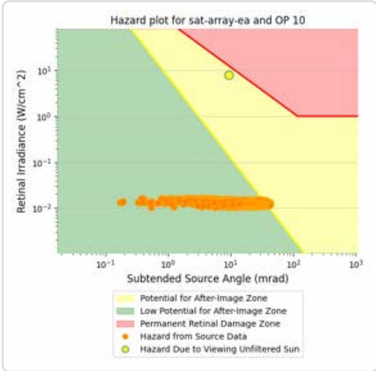
SAT Array East: OP 10

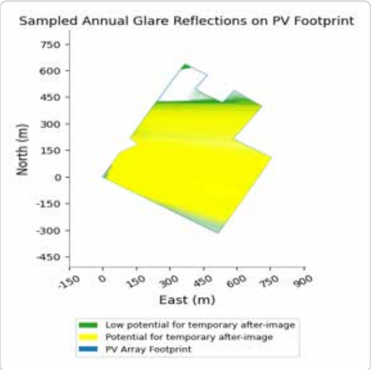
PV array is expected to produce the following glare for this receptor:

- 1,071 minutes of "green" glare with low potential to cause temporary after-image.
- 208 minutes of "yellow" glare with potential to cause temporary after-image.





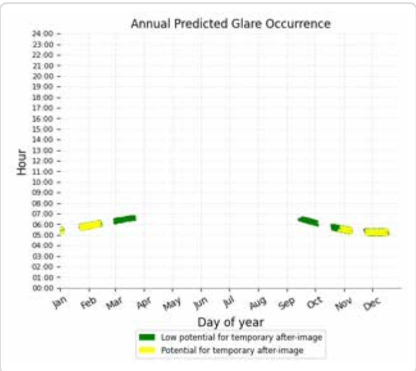


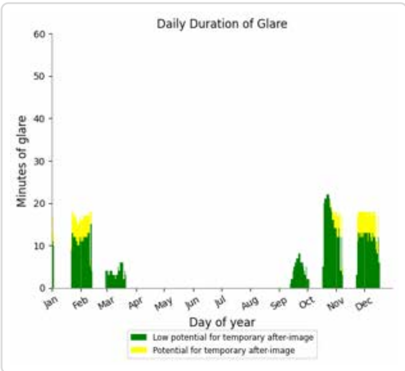


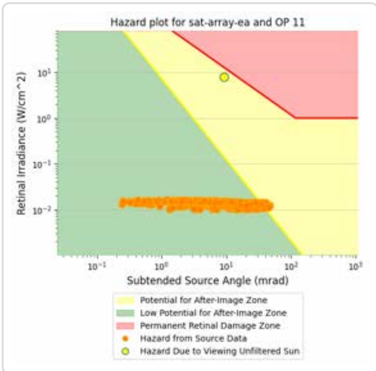
SAT Array East: OP 11

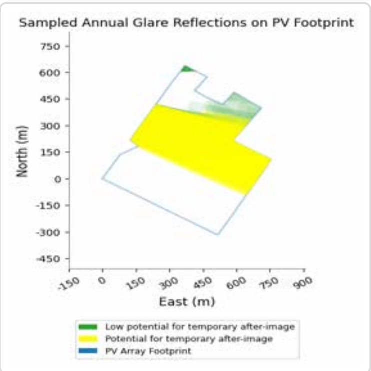
PV array is expected to produce the following glare for this receptor:

- 1,082 minutes of "green" glare with low potential to cause temporary after-image.
- 273 minutes of "yellow" glare with potential to cause temporary after-image.





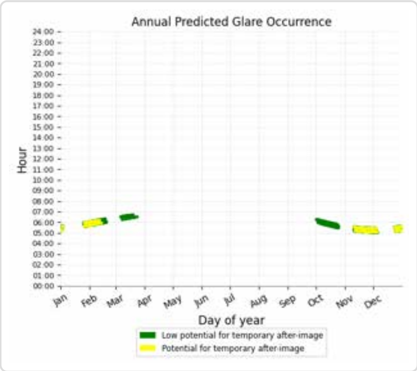


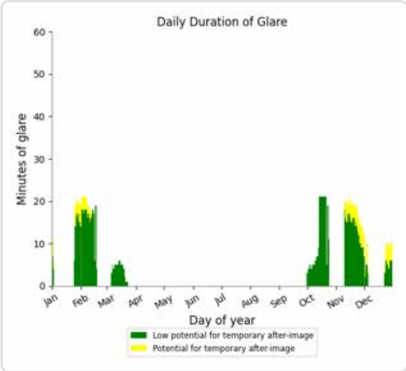


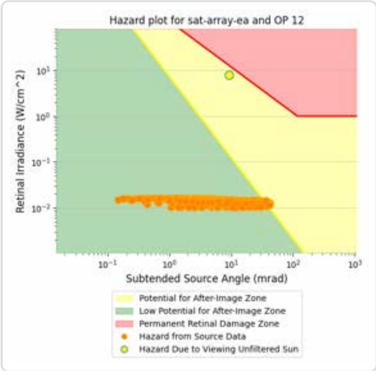
SAT Array East: OP 12

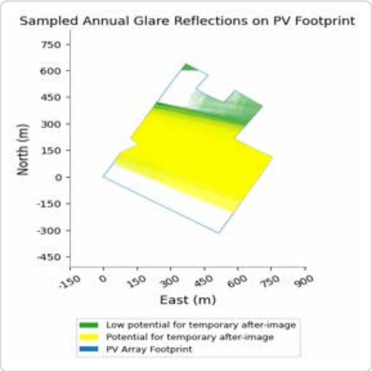
PV array is expected to produce the following glare for this receptor:

- 1,100 minutes of "green" glare with low potential to cause temporary after-image.
- 209 minutes of "yellow" glare with potential to cause temporary after-image.









SAT Array East: OP 13

No glare found

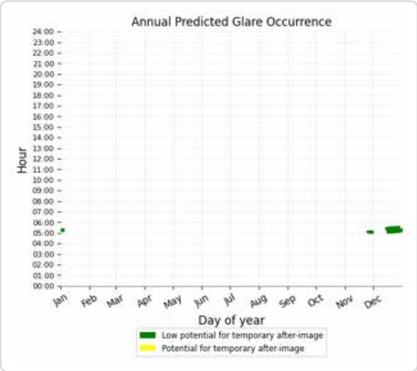
SAT Array East: OP 14

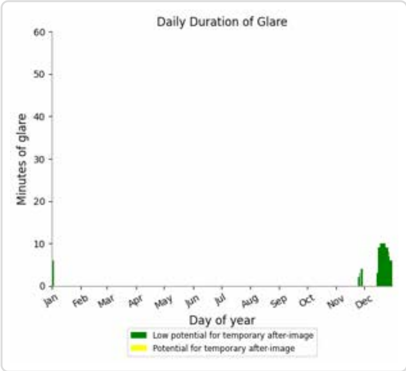
No glare found

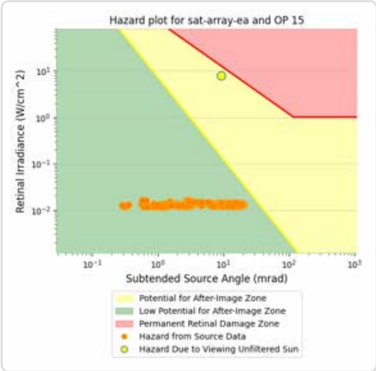
SAT Array East: OP 15

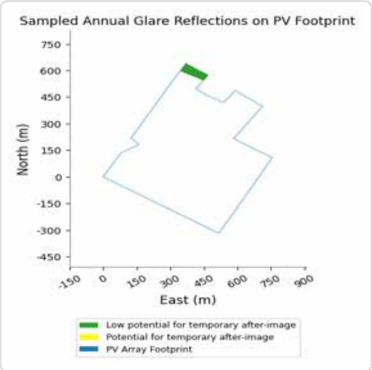
PV array is expected to produce the following glare for this receptor:

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









SAT Array East: OP 16

No glare found

SAT Array East: OP 17

No glare found

SAT Array East: OP 18

No glare found

SAT Array East: OP 19

No glare found

SAT Array East: OP 20

No glare found

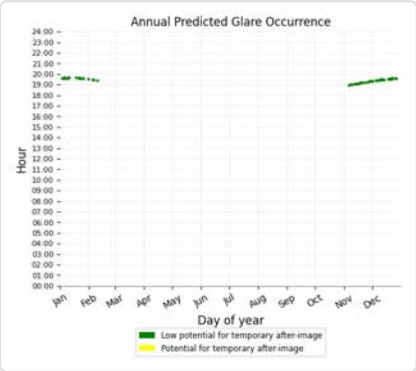
SAT Array East: OP 21

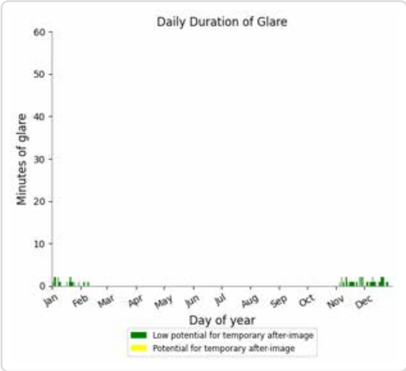
No glare found

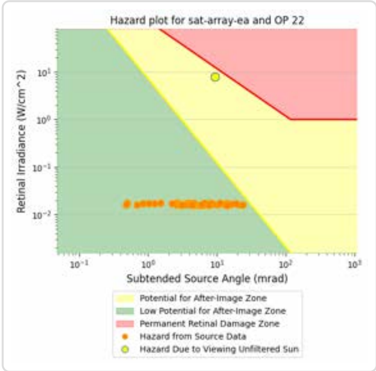
SAT Array East: OP 22

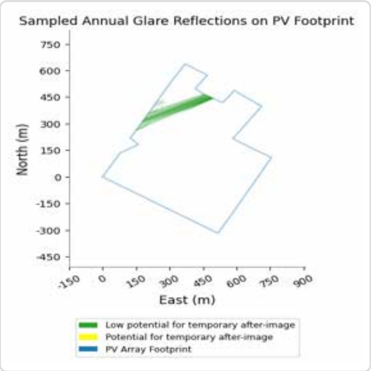
PV array is expected to produce the following glare for this receptor:

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





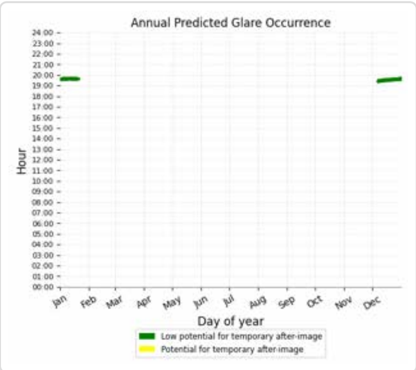


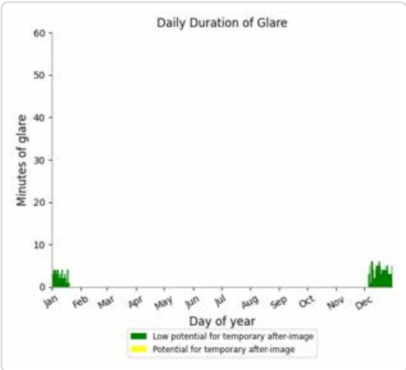


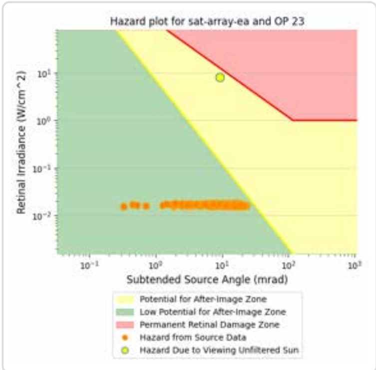
SAT Array East: OP 23

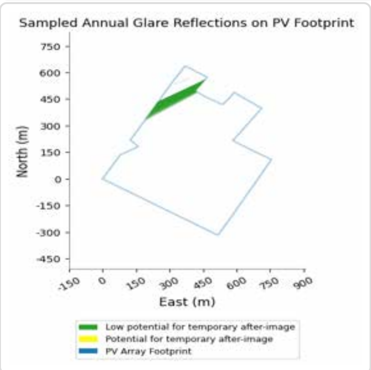
PV array is expected to produce the following glare for this receptor:

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









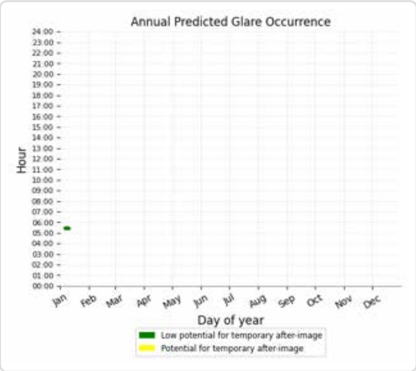
SAT Array East: OP 24

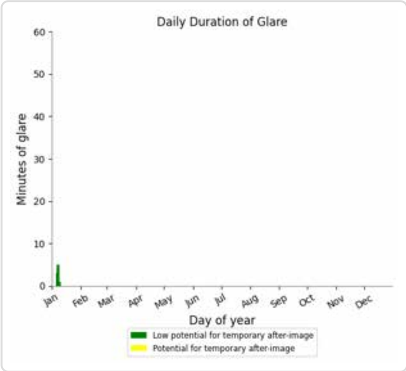
No glare found

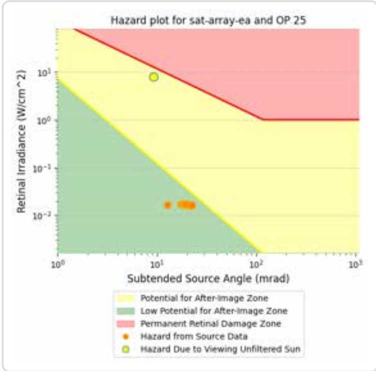
SAT Array East: OP 25

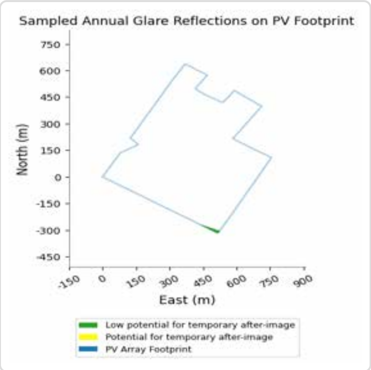
PV array is expected to produce the following glare for this receptor:

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





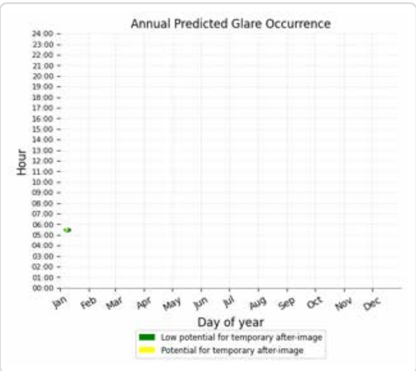


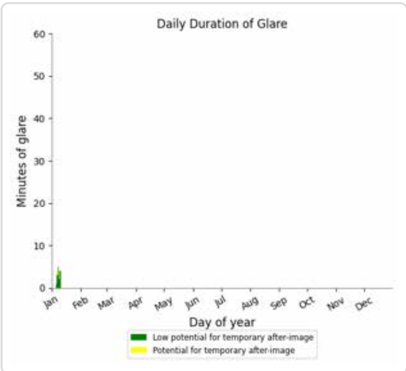


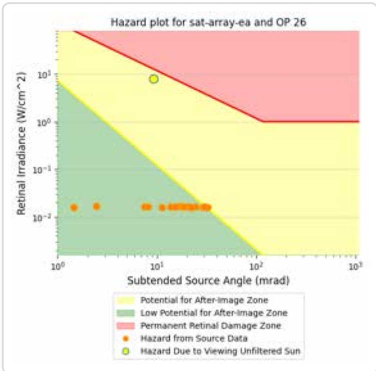
SAT Array East: OP 26

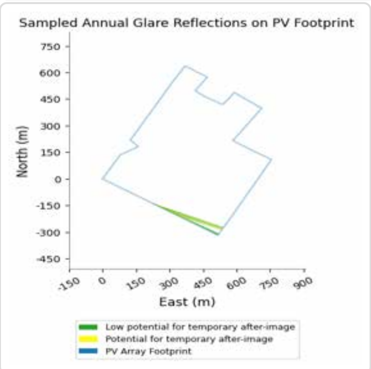
PV array is expected to produce the following glare for this receptor:

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









SAT Array West potential temporary after-image

Component	Green glare (min)	Yellow glare (min)

OP: OP 1	0	0
OP: OP 2	21	0
OP: OP 3	0	0
OP: OP 4	646	65
OP: OP 5	932	563
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	1556	0
OP: OP 9	863	1151
OP: OP 10	1630	1821
OP: OP 11	0	0
OP: OP 12	1029	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0

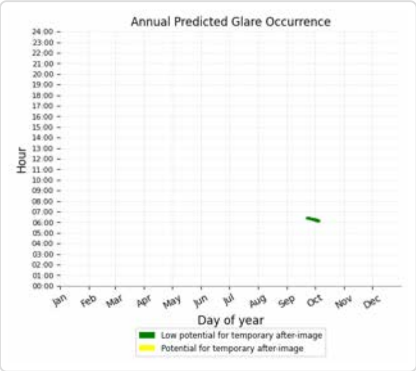
SAT Array West: OP 1

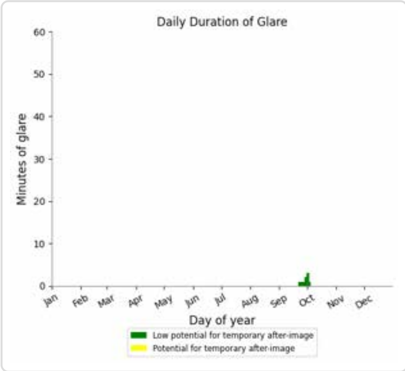
No glare found

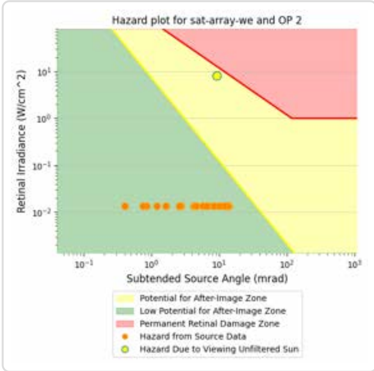
SAT Array West: OP 2

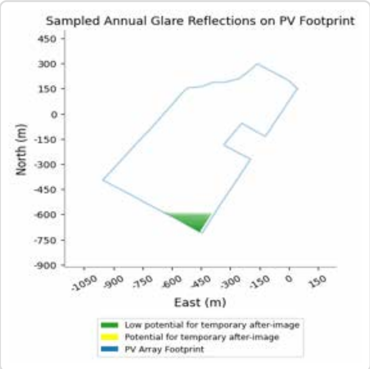
PV array is expected to produce the following glare for this receptor:

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









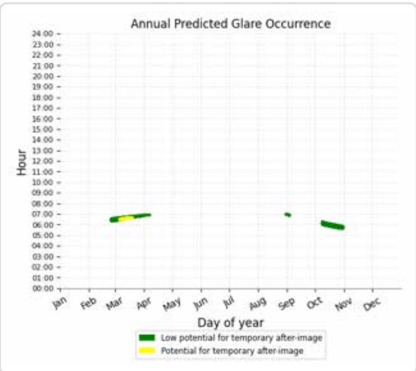
SAT Array West: OP 3

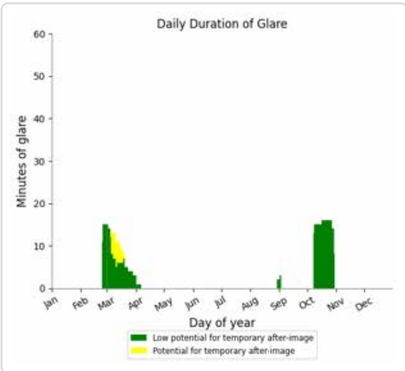
No glare found

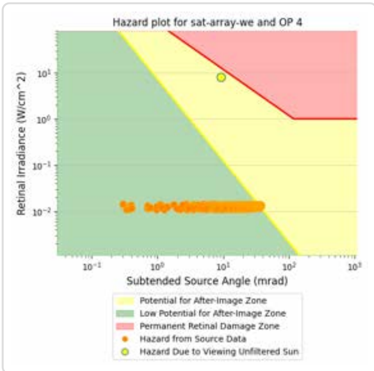
SAT Array West: OP 4

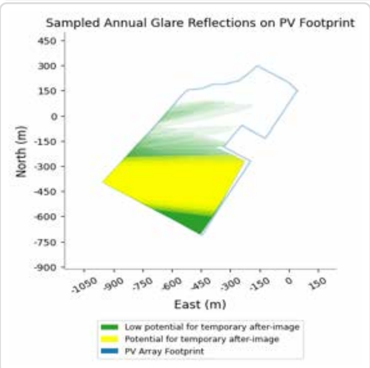
PV array is expected to produce the following glare for this receptor:

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





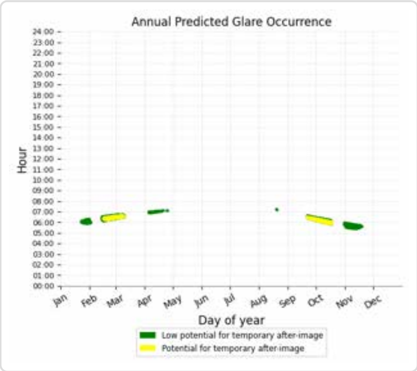


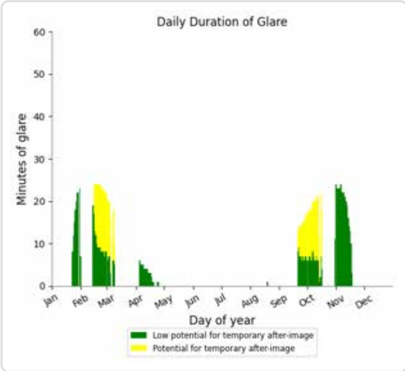


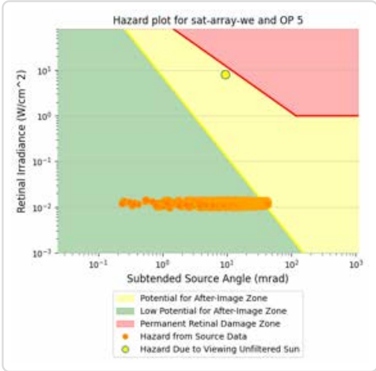
SAT Array West: OP 5

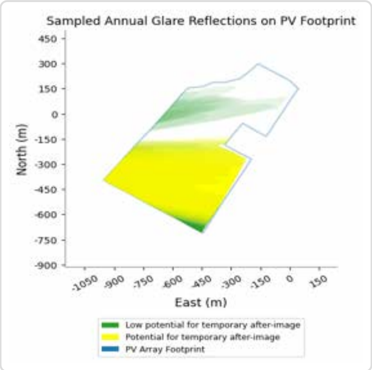
PV array is expected to produce the following glare for this receptor:

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









SAT Array West: OP 6

No glare found

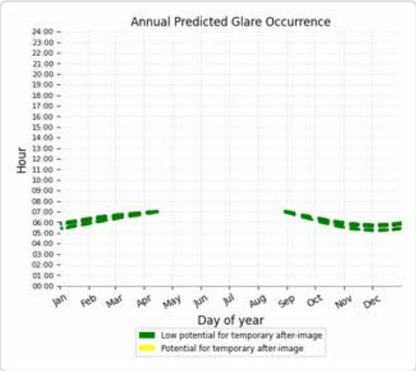
SAT Array West: OP 7

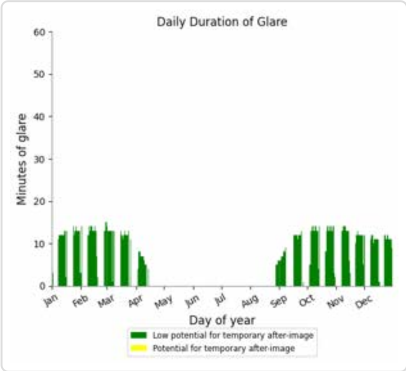
No glare found

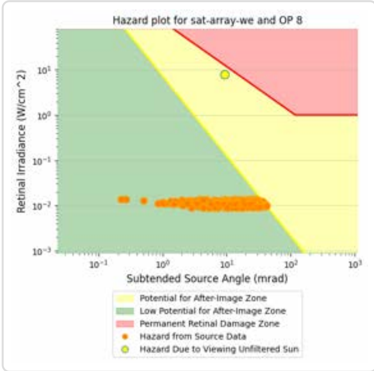
SAT Array West: OP 8

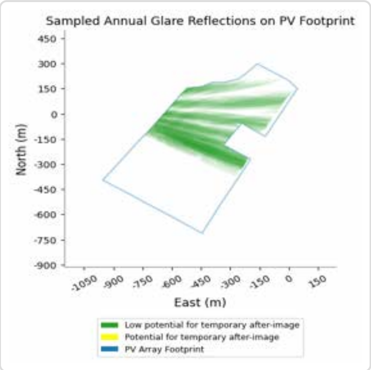
PV array is expected to produce the following glare for this receptor:

- 1,556 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.





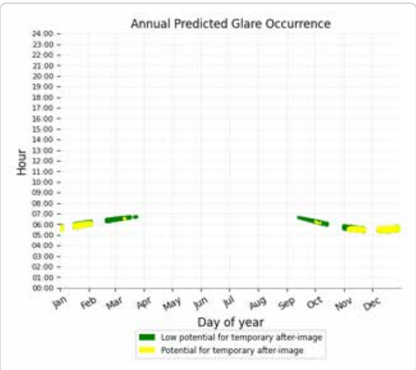


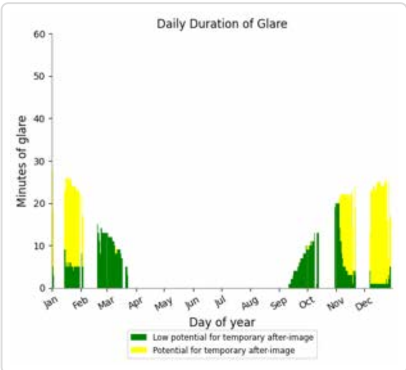


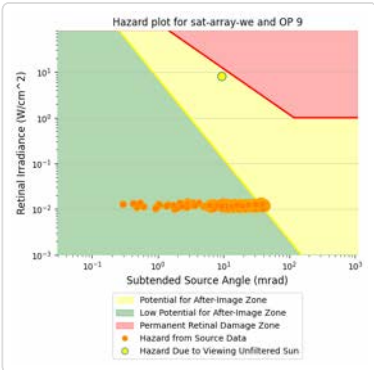
SAT Array West: OP 9

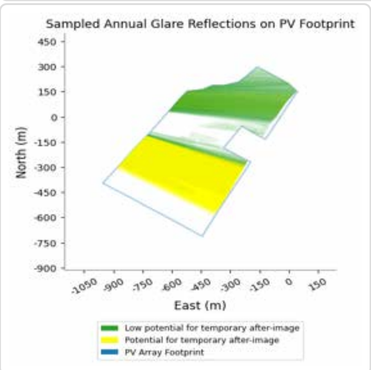
PV array is expected to produce the following glare for this receptor:

- 863 minutes of "green" glare with low potential to cause temporary after-image.
- 1,151 minutes of "yellow" glare with potential to cause temporary after-image.





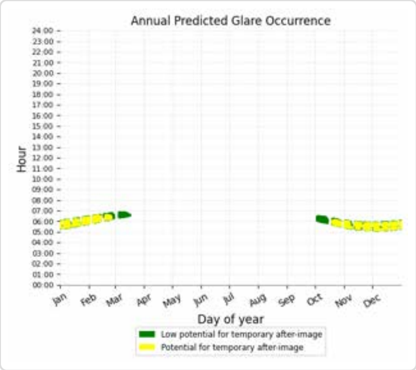


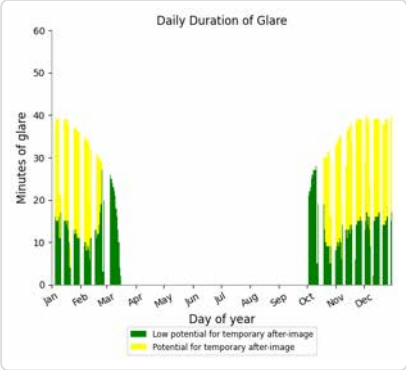


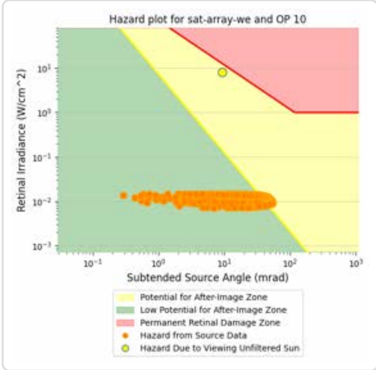
SAT Array West: OP 10

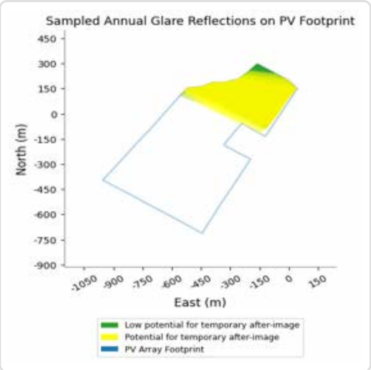
PV array is expected to produce the following glare for this receptor:

- 1,630 minutes of "green" glare with low potential to cause temporary after-image.
- 1,821 minutes of "yellow" glare with potential to cause temporary after-image.









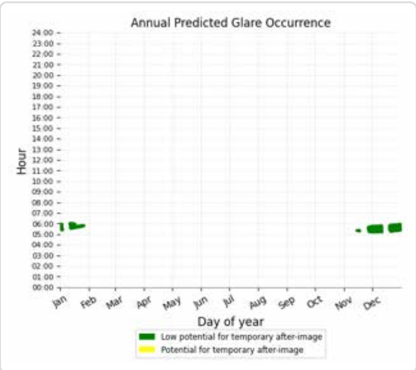
SAT Array West: OP 11

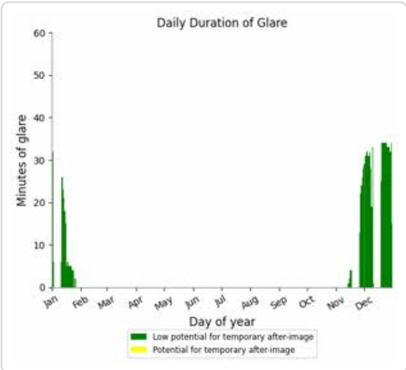
No glare found

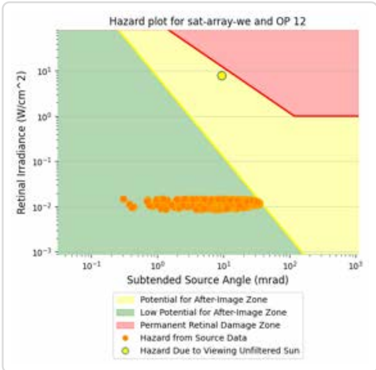
SAT Array West: OP 12

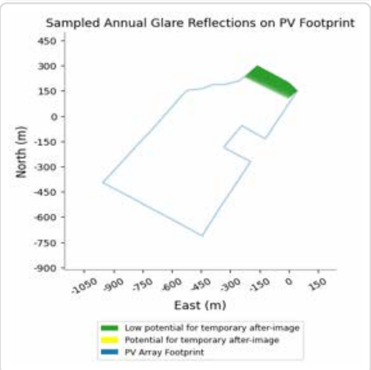
PV array is expected to produce the following glare for this receptor:

- 1,029 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.









SAT Array West: OP 13
No glare found

SAT Array West: OP 14
No glare found

SAT Array West: OP 15
No glare found

SAT Array West: OP 16
No glare found

SAT Array West: OP 17
No glare found

SAT Array West: OP 18
No glare found

SAT Array West: OP 19
No glare found

SAT Array West: OP 20
No glare found

SAT Array West: OP 21
No glare found

SAT Array West: OP 22
No glare found

SAT Array West: OP 23
No glare found

SAT Array West: OP 24
No glare found

SAT Array West: OP 25
No glare found

SAT Array West: OP 26
No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.

- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fc large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.