



The Point Solar Farm

Glint and glare study

Final Report

DOCUMENT CONTROL

Report Title		The Point Solar Farm – Glint and glare study			
Client Contract No.			ITP Project Number	23053	
File Path		https://itprenewables.sharepoint.com/sites/Projects/External/23053 - The Point SF Glare Study/Project/4 Work/4 Reports/23053 - The Point SF Glare Study Final.docx			
Client		Far North Solar Farm	Client Contact	John Andrews	
Rev	Date	Status	Author/s	Reviewed By	Approved
1	4/07/2023	Draft	Drew Thompson	N Logan	N Logan
1	17/07/2023	Final	Drew Thompson	N Logan	N Logan

A person or organisation choosing to use documents prepared by ITP Renewables accepts the following:

- (a) Conclusions and figures presented in draft documents are subject to change. ITP Renewables accepts no responsibility for use outside of the original report.
- (b) The document is only to be used for purposes explicitly agreed to by ITP Renewables.
- (c) All responsibility and risks associated with the use of this report lie with the person or organisation who chooses to use it.

Unless otherwise specified, all intellectual property in this report remains the exclusive property of ITP Renewables and may be used only to evaluate and implement the findings and recommendations in this report. Intellectual property includes but is not limited to designs, drawings, layouts, charts, data, formulas, technical information, recommendations, and other written content.

ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au

Project No.23053 – The Point Solar Farm July 2023

ABOUT ITP RENEWABLES

ITP Renewables (ITP) is a global leader in renewable energy engineering, strategy, construction, and energy sector analytics. Our technical and policy expertise spans the breadth of renewable energy, energy storage, energy efficiency and smart integration technologies. Our range of services cover the entire spectrum of the energy sector value chain, from technology assessment and market forecasting right through to project operations, maintenance, and quality assurance.

We were established in 2003 and operate out of offices in Canberra (Head Office), Sydney, North Coast NSW, Adelaide and Auckland, New Zealand. We are part of the international ITP Energised Group, one of the world's largest, most experienced, and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

Our regular clients include governments, energy utilities, financial institutions, international development donor agencies, project developers and investors, the R&D community, and private firms.

ABOUT THIS REPORT

This report assesses the glint and glare impact of the proposed The Point Solar Farm near Lake Benmore, New Zealand. It was commissioned by Far North Solar Farm Limited.

ABBREVIATIONS

AC	Alternating current
CASA	Civil Aviation Safety Authority
DC	Direct current
FAA	Federal Aviation Administration (United States)
FNSF	Far North Solar Farm Limited
ha	Hectare
ITP	ITP Renewables
MW	Megawatt, unit of power (1 million Watts)
MWp	Megawatt-peak, unit of power at standard test conditions; used to indicate PV system capacity
OP	Observation point
PV	Photovoltaic
SGHAT	Solar Glare Hazard Analysis Tool

TABLES

Table 1: Site Information.....	10
Table 2: Solar farm information.....	11
Table 3: SGHAT specification inputs	12
Table 4: Glare potential at each receptor, year 1 of operation	17
Table 5: Total glare impact for year 1 without the vegetation screen, and years 1 and 5 with the vegetation screen	18

FIGURES

Figure 1: Angles of incidence and increased levels of reflected light	6
Figure 2: Classification of glare based on severity of ocular effects	7
Figure 3: Typical percentage of sunlight reflected from different surfaces.....	8
Figure 4: Typical sunlight reflection off the surface of a solar module.....	8
Figure 5: Sun position relative to PV modules on a horizontal single-axis tracking system.....	9
Figure 6: The Point Solar Farm indicative PV layout.....	10
Figure 7: Potential visual receptors within 2 km of the site	14
Figure 8: Site boundary and vegetation screen	16

TABLE OF CONTENTS

1	INTRODUCTION	6
1.1	Overview.....	6
1.2	Glint and Glare	6
1.3	Glare from Solar PV	7
2	PROJECT DESCRIPTION	10
2.1	Site Overview.....	10
2.2	Solar Farm Details.....	11
3	ANALYSIS.....	12
3.1	Overview.....	12
3.2	Potential Receptors.....	13
3.3	Assumptions.....	14
3.3.1	Atmospheric conditions	15
3.3.2	Obstructions.....	15
3.4	Results	16
3.4.1	Year 1 results	16
3.4.2	Year 5 results	18
4	SUMMARY	19
5	REFERENCES	20
	APPENDIX A. YEAR 1 FORGESOLAR GLARE ANALYSIS.....	21
	APPENDIX B. YEAR 5 FORGESOLAR GLARE ANALYSIS.....	22

1 INTRODUCTION

1.1 Overview

Far North Solar Farm Limited (FNSF) has requested a glint and glare assessment for a proposed solar photovoltaic (PV) installation near Lake Benmore, New Zealand. This assessment will be submitted as part of the consent process for the project. It includes:

- Identification of potential receptors of glint and glare from the proposed solar farm
- Assessment of the glint and glare hazard using the Solar Glare Hazard Analysis Tool (SGHAT) GlareGauge analysis

1.2 Glint and Glare

The United States Federal Aviation Administration (FAA) defines glint and glare as follows:¹

- **Glint** is a momentary flash of bright light
- **Glare** is a continuous source of excessive brightness relative to ambient lighting.

Glint and glare can occur when light reflected off a surface (reflector) is viewed by a person (receptor). Glint typically occurs when either the receptor or the reflector is moving, while glare typically occurs when the reflector and receptor are completely, or nearly, stationary. For a transparent material (e.g., glass, water) the quantity of light reflected depends on the surface itself (i.e., material and texture), and the angle at which the light intercepts it (angle of incidence). A higher angle of incidence will result in a higher proportion of light being reflected, as shown in Figure 1.

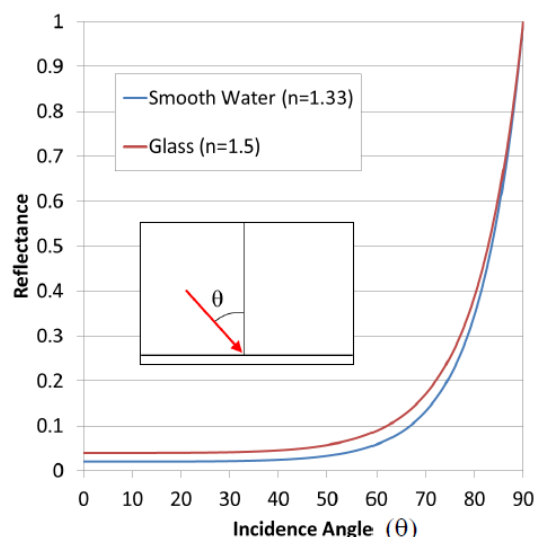


Figure 1: Angles of incidence and increased levels of reflected light

¹ Federal Aviation Administration [FAA], 2018

Potential visual impacts from glint and glare include distraction and temporary afterimage; at its worst, it can cause retinal burn. The ocular hazard caused by glint or glare is a function of:

1. The intensity of the glare upon the eye (retinal irradiance)
2. The subtended angle of the glare source (i.e., the extent to which the glare occupies the receptor's field of vision; dependent on size and distance of the reflector).

The severity of the ocular hazard can be divided into three levels, as shown in Figure 2:

- **Green glare**, which has low potential to cause temporary afterimage
- **Yellow glare**, which has potential to cause temporary afterimage
- **Red glare**, which can cause retinal burn and is not expected for PV.

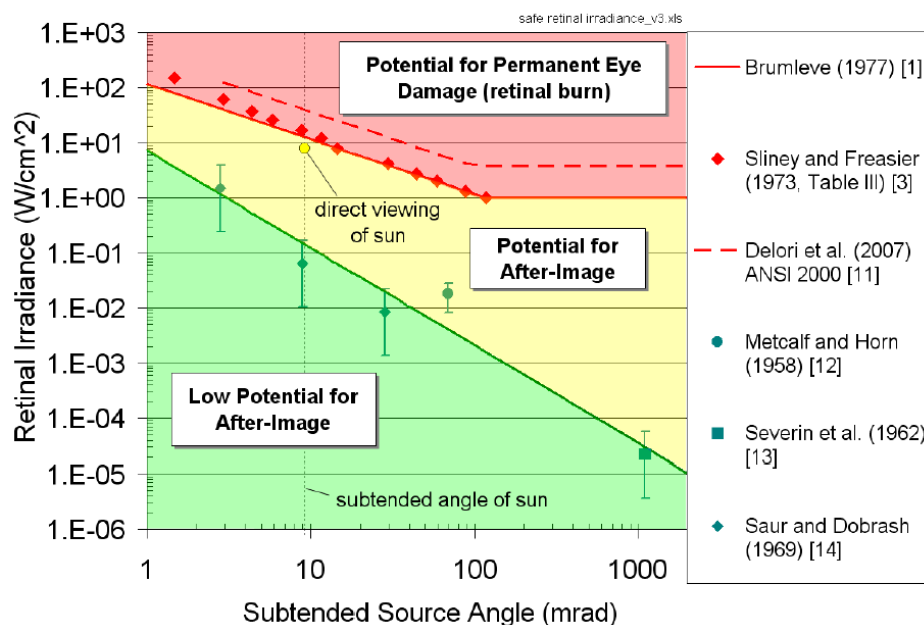


Figure 2: Classification of glare based on severity of ocular effects

1.3 Glare from Solar PV

Solar photovoltaic (PV) cells are designed to absorb as much light as possible to maximise efficiency (generally around 98% of the light received). To limit reflection, solar cells are constructed from dark, light-absorbing material and are treated with an anti-reflective coating. PV modules generate less glare than many other surfaces, as shown in Figure 3.

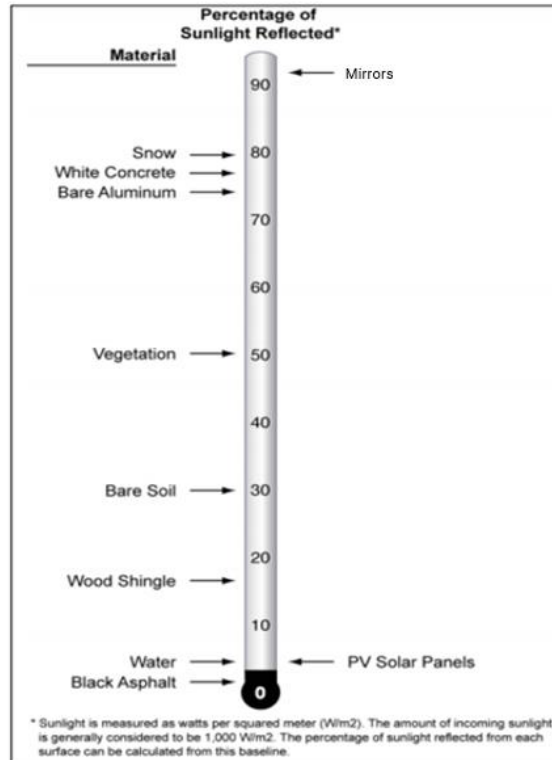


Figure 3: Typical percentage of sunlight reflected from different surfaces (Source: Adapted from Journal of Airport Management, 2014)

The small percentage of light reflected from PV modules varies depending on the angle of incidence. Figure 4 shows an example of this with a solar module. A larger angle of incidence will result in a higher percentage of reflected light.

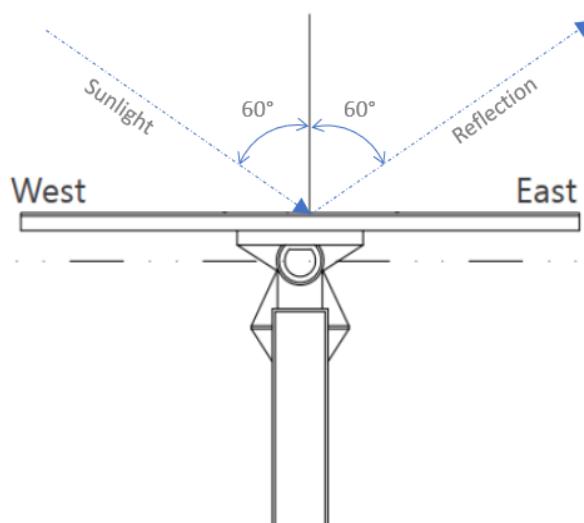


Figure 4: Typical sunlight reflection off the surface of a solar module

The two most common PV mounting structures are fixed tilt and single axis tracking. Fixed tilt arrays are stationary, while single axis tracking arrays rotate the receiving surface of the modules from east to west throughout the day as the sun moves across the sky.

In a fixed tilt PV array, since the sun is moving but the modules are stationary, the angle of incidence varies as the sun moves across the sky. It is smallest around noon when the sun is overhead and largest in the early morning and late afternoon when the sun is near the horizon. There is therefore a higher potential for glare at these times.

The angle of incidence for a single axis tracking system varies less as the reflective surface of the modules rotates on a horizontal axis to follow the sun. Single axis tracking arrays therefore generate less glare than fixed tilt arrays. The tracking varies throughout the year to match seasonal changes in the sun's path (see Figure 5).

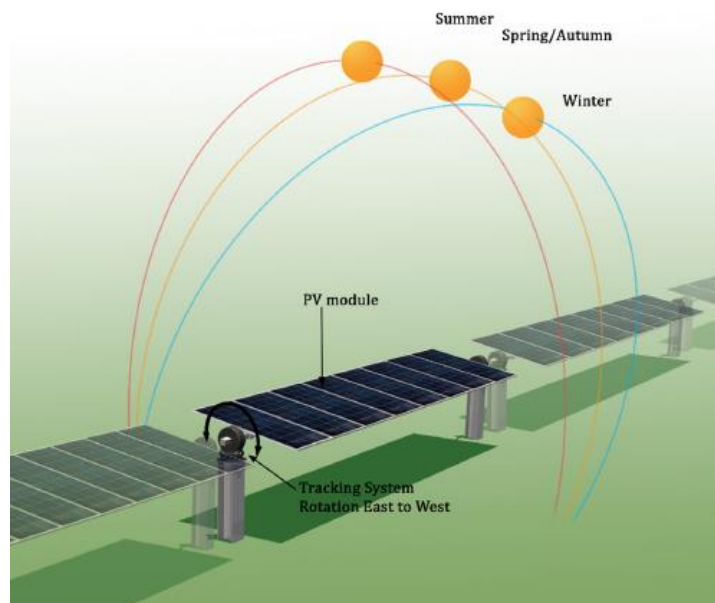


Figure 5: Sun position relative to PV modules on a horizontal single-axis tracking system

2.2 Solar Farm Details

Table 2 summarises the details of the proposed solar farm.

Table 2: Solar farm information

Parameter	Description
Solar farm name	The Point Solar Farm
Capacity	420 MWp
Mounting system	Single-axis tracking

FNSF is proposing to construct a solar farm with a DC capacity of 420MWp on a 973 ha site. There will be approximately 740,000 solar modules installed in 28,000 single-axis tracking tables (each table approximately 30 m long) running north-east to south-west. There is approximately 6 m spacing between each row and the maximum height of each table is approximately 2.2 m. The mounting system is constructed on piles that are driven into the ground.

The solar farm will include 41 **medium voltage (MV)** power stations. Each power station incorporates high/medium voltage switchgear, transformers, and inverters. The power stations are ground mounted.

3 ANALYSIS

3.1 Overview

The Solar Glare Hazard Analysis Tool (SGHAT) was developed by Sandia National Laboratories to evaluate glare resulting from solar farms at different viewpoints, based on the location, orientation, and specifications of the PV modules. This tool was required by the United States FAA for glare hazard analysis near airports until 2021 and is also recognised by the Australian Government Civil Aviation Safety Authority (CASA).

The GlareGauge software uses SGHAT to provide an indication of the type of glare expected at each potential receptor. It runs with a simulation timestep of one minute. Glint lasting for less than one minute is unlikely to occur from the sun on PV modules due to their slow movement.

Table 3 details the parameters used in the SGHAT model. GlareGauge default settings were adopted for the analysis time interval, direct normal irradiance, observer eye characteristics and slope error. The height of the observation points for road and rail users was assumed to be 1.5 m for a car driver. The height for a person standing was assumed to be 1.65 m.

The array was modelled as five different objects to improve the accuracy of the results.

Table 3: SGHAT specification inputs

Parameters	Input
Time zone	UTC+12:00
Module surface material	Smooth glass with ARC (anti-reflective coating)
Module tracking	Single Axis Tracking with backtracking
Maximum tilt angle	$\pm 60^\circ$
Module axis orientation	0°
Height of modules above ground	1.64 m (height from the ground to the table centre)
Flight path threshold height	15 m
Flight path glide length	2 km
Flight path glide slope	3°
Flight path vertical view restriction	30°
Flight path azimuthal view restriction	50°

3.2 Potential Receptors

This assessment considers potential visual receptors (e.g., residences and road users) within 2 km of the site. There is no formal guidance on the maximum distance for glint and glare assessments; however, the significance of a reflection decreases with distance for two main reasons:

1. The solar farm appears smaller (smaller subtended angle), and glare has less impact
2. Visual obstructions (e.g., terrain, vegetation) may block the view of the solar farm

Glint and glare impacts beyond 2 km are highly unlikely. This choice of distance is conservative and is based on existing studies and assessment experience.

Five observation points, eleven road routes, and two flight paths were identified as potential visual receptors, as shown in Figure 7. One of the road routes, Mcaughtries Road, was divided into four different road routes for compatibility with the modelling tool. The flight paths are outside the 2 km assessment boundary but were included at the request of the client. Full details of all receptors are included in Appendix A.

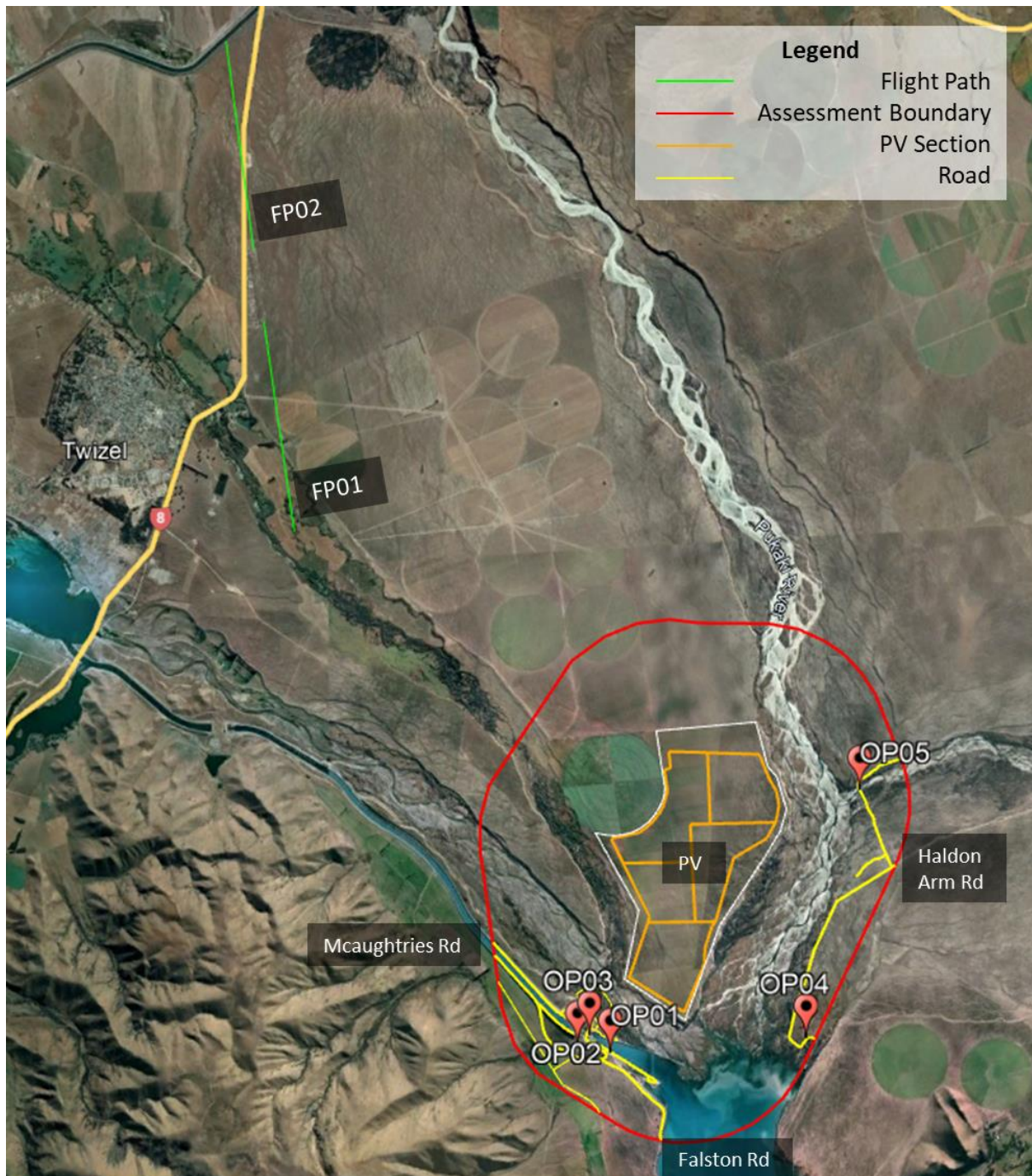


Figure 7: Potential visual receptors within 2 km of the site

3.3 Assumptions

The visual impact of solar farms depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed screening measures to reduce visibility of the site. Minor screening, such as roadside vegetation, was not assessed in detail. The GlareGauge analysis results are therefore considered conservative as the model assumes there is no screening from existing vegetation.

3.3.1 Atmospheric conditions

Atmospheric conditions, such as cloud cover, influence light reflection and the resulting impact on visual receptors. GlareGauge does not model varying atmospheric conditions. Instead, it assumes clear sky conditions, with a peak direct normal irradiance of 1,000 W/m² which varies throughout the day.

3.3.2 Obstructions

The client has advised ITP that 49 ha of vegetation will be planted along the site's south, east and west boundaries. The vegetation will have a clearance from the edges of the solar farm itself. The site boundary, vegetation screen and clearance (mitigation strip) are illustrated in Figure 8. We have included this in the analysis as it is expected to mitigate some of the impacts of glare for observers. Two scenarios were investigated for the vegetation screen:

1. First year of operation. ITP has assumed an obstruction height of 3 m.
2. Fifth year of operation. ITP has assumed an obstruction height of 5 m.

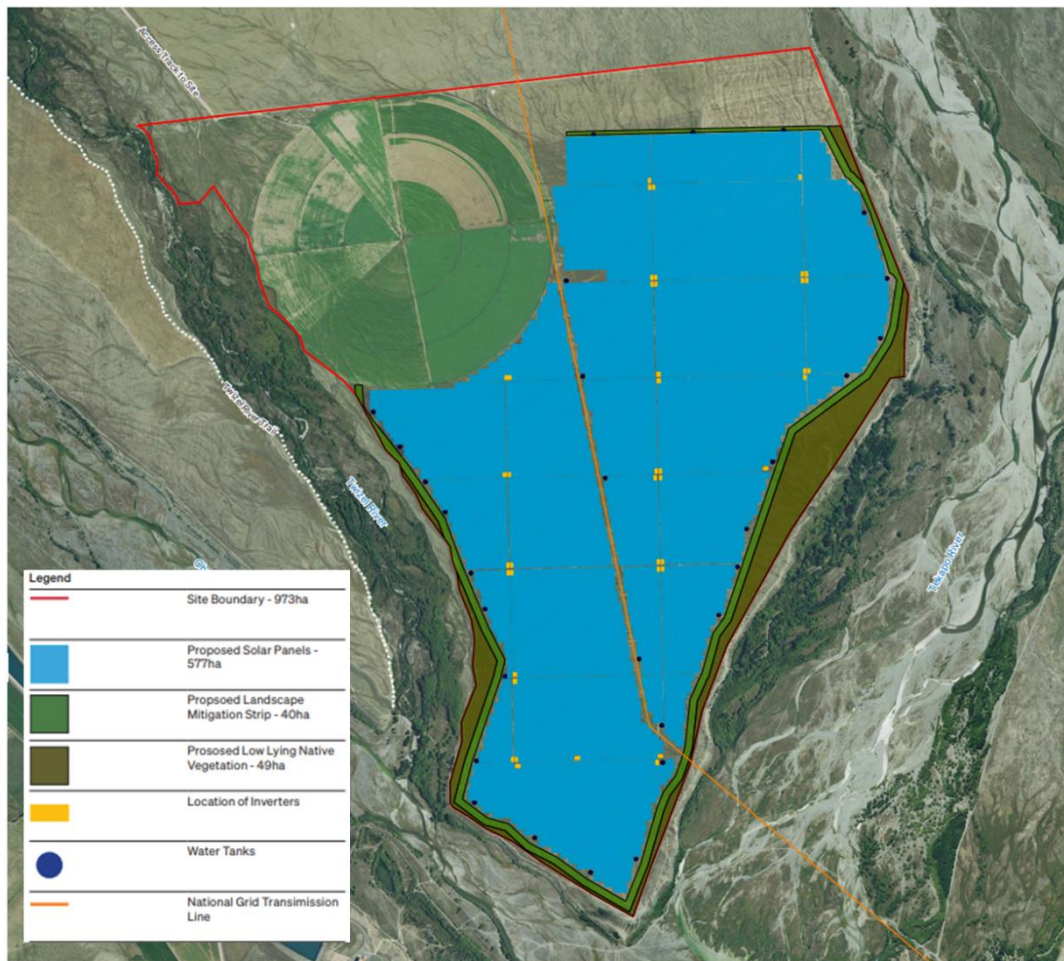


Figure 8: Site boundary and vegetation screen

3.4 Results

3.4.1 Year 1 results

The results of the GlareGauge analysis for year 1 (attached in Appendix A) are summarised in Table 4. The analysis identified a total 15,303 minutes (255 hours) of green glare and 500 minutes (8 hours) of yellow glare spread across multiple road routes and observation points. Neither flight path received any glare.

The glare received each day varied across year 1. For observation points where some glare occurred, the impact is described qualitatively. The maximum glare impact at any receptor was 4 minutes of yellow glare in a single day. The time of day at which glare was observed varied between receptors and across the year. In general, most glare occurred in the early mornings or late evenings when the arrays are backtracking.

Table 4: Glare potential at each receptor, year 1 of operation

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
FP 1	Extending from southern end	0	0	None
FP 2	Extending from northern end	0	0	None
OP 1	Lake Benmore Camping Ground / -44.3443, 170.1866	680	0	Up to 11 minutes of green glare between 8:00 am and 9:00 am from mid-May to early August.
OP 2	Ohau C Substation / -44.3433, 170.1803	1,081	0	Up to 11 minutes of green glare between 7:00 am and 9:00 am from mid-April to late August.
OP 3	Ohau C Power Station / -44.3419, 170.1826	1,139	0	Up to 11 minutes of green glare between 7:00 am and 9:00 am from mid-April to late August.
OP 4	Haldon Arm Campground / -44.3423, 170.2244	1,517	0	Up to 16 minutes of green glare between 4:00 pm and 6:30 pm from early April to early September.
OP 5	Tekapo River Iron Bridge / -44.3081, 170.2437	80	0	Up to 2 minutes of green glare between 6:30 pm and 8:30 pm from mid-October to late February.
Route 1	Falston Rd	0	0	None
Route 2	Mcaughtries Road around Ohau C Substation, and running through Benmore Camping Ground.	1,224	0	Up to 11 minutes of green glare between 6:00 am and 9:00 am from mid-March to late September.
Route 3	Mcaughtries Road across Ohau C Dam and along the river.	1,582	0	Up to 15 minutes of green glare between 6:00 am and 9:00 am from mid-March to late September.
Route 4	Mcaughtries Road running past Ohau C Power Station.	1,441	0	Up to 14 minutes of green glare between 6:00 am and 9:00 am from mid-March to late September.
Route 5	Mcaughtries Road off Falston Road	0	0	None
Route 6	Haldon Arm Road	1,607	300	Up to 4 minutes of yellow glare between 4:00 pm to 6:30 pm from early April to early September.

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
Route 7	Off Haldon Arm Road and running past Tekapo River Iron Bridge.	1,444	125	Up to 3 minutes of yellow glare between 4:30 pm and 8:00 pm from late March to late May, mid July to mid-September and early November.
Route 8	Short detour off Route 7	1,229	75	Up to 2 minutes of yellow glare between 4:30 pm to 6:30 pm from early April to early September.
Route 9	Off Mcaughtries Road and towards Glencairn Station	948	0	Up to 11 minutes of green glare between 7:30 am to 9:00 am from late April to mid-August.
Route 10	Looped road off Mcaughtries, to the North of Ohau C Power Station	1,331	0	Up to 11 minutes of green glare between 6:00 am to 9:00 am from mid-March to late September.
Route 11	Off Mcaughtries Road and away from Glencairn Station	0	0	None
Total		15,303	500	

3.4.2 Year 5 results

The GlareGauge analysis of year 5 (attached in Appendix B) identified 14,516 minutes (242 hours) of green glare and 374 (6 hours) of yellow glare. This shows a 5% reduction in green glare, and a 25% reduction in yellow glare when compared to the first year of operation. Table 5 presents a comparison of the glare analysis in the first and fifth years of operation, including glare in the absence of a vegetation screen for reference.

Table 5: Total glare impact for year 1 without the vegetation screen, and years 1 and 5 with the vegetation screen

Year	Green glare (min/year)	Yellow glare (min/year)
1 (no vegetation screen)	15,563	4,694
1	15,303	500
5	14,516	374

4 SUMMARY

The results of the GlareGauge analysis indicated that three road routes received yellow glare, which has the potential to cause afterimage to observers. None of these road routes received more than 4 minutes of yellow glare in any single day. Both flight paths received zero glare.

The proposed vegetation screen provides effective mitigation in year 1. The year 5 results indicate glare will be reduced further as vegetation matures.

In general, most of the glare occurred during early mornings and late evenings when backtracking is active. Existing vegetation is expected to reduce the visual impact of the project for some receptors. As the impacted receptors are rural roads and campsites, the glare impact is low and does not require further mitigation.

5 REFERENCES

Federal Aviation Administration (FAA), 2018. Solar Guide: Technical Guidance for Evaluating Selected Solar Technologies on Airports. Retrieved from the FAA website:

<https://www.faa.gov/airports/environmental/>

Thompson, R., Ave, I., Anne, D., Jan, M., David, S. and Robert, C., 2013. Interim policy, FAA review of solar energy system projects on federally obligated airports.

Barrett, S., Devita, P., Ho, C. and Miller, B., 2014. Energy technologies' compatibility with airports and airspace: Guidance for aviation and energy planners. *Journal of Airport Management*, 8(4), pp.318-326.

APPENDIX A. YEAR 1 FORGESOLAR GLARE ANALYSIS

FORGESOLAR GLARE ANALYSIS

Project: **23053 - The Point SF**

Proposed 400 MW solar farm near ... NZ

Site configuration: **The Point 2 - Yr 1**

Client: Far North Solar Farm

Created 13 Jul, 2023

Updated 13 Jul, 2023

Time-step 1 minute

Timezone offset UTC12

Minimum sun altitude 0.0 deg

DNI peaks at 1,000.0 W/m²

Category 100 MW to 1 GW

Site ID 95284.16310

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

PV analysis methodology V2

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

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV1	SA tracking	SA tracking	11,931	198.8	246	4.1	210,100,000.0
PV2	SA tracking	SA tracking	1,026	17.1	50	0.8	219,700,000.0
PV3	SA tracking	SA tracking	204	3.4	0	0.0	218,400,000.0
PV4	SA tracking	SA tracking	0	0.0	0	0.0	218,800,000.0
PV5	SA tracking	SA tracking	2,304	38.4	204	3.4	216,300,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 10 Unnamed Rd 3	1,331	22.2	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 2 Mcaughtries Rd 1	1,224	20.4	0	0.0
Route 3 Mcaughtries Rd 2	1,582	26.4	0	0.0
Route 4 Mcaughtries Rd 3	1,441	24.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	1,689	28.1	300	5.0
Route 7 Tekapo River Rd	1,488	24.8	125	2.1
Route 8 Unnamed Rd 1	1,265	21.1	75	1.2
Route 9 Unnamed Rd 2	948	15.8	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	680	11.3	0	0.0
OP 2	1,081	18.0	0	0.0
OP 3	1,139	19.0	0	0.0
OP 4	1,517	25.3	0	0.0
OP 5	80	1.3	0	0.0

Component Data

PV Arrays

Name: PV1
Axis tracking: Single-axis rotation
Backtracking: Shade
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.38
Rated power: 84000.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.338794	170.200905	380.00	1.64	381.64
2	-44.334044	170.190305	378.83	1.64	380.47
3	-44.326437	170.193897	380.00	1.64	381.64
4	-44.326327	170.206920	379.00	1.64	380.64
5	-44.326884	170.206295	379.00	1.64	380.64
6	-44.329927	170.204918	380.00	1.64	381.64
7	-44.332140	170.204804	380.00	1.64	381.64
8	-44.338794	170.200905	380.00	1.64	381.64

Name: PV2
Axis tracking: Single-axis rotation
Backtracking: Shade
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.38
Rated power: 84000.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.326342	170.206924	379.00	1.64	380.64
2	-44.317531	170.210455	388.00	1.64	389.64
3	-44.314830	170.216876	383.00	1.64	384.64
4	-44.312621	170.218476	384.00	1.64	385.64
5	-44.312879	170.202096	401.53	1.64	403.17
6	-44.326343	170.203030	380.00	1.64	381.64
7	-44.326342	170.206924	379.00	1.64	380.64

Name: PV3

Axis tracking: Single-axis rotation

Backtracking: Shade

Tracking axis orientation: 0.0°

Max tracking angle: 60.0°

Resting angle: 0.0°

Ground Coverage Ratio: 0.38

Rated power: 84000.0 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.326343	170.203030	380.00	1.64	381.64
2	-44.326419	170.193906	380.00	1.64	381.64
3	-44.325651	170.194227	380.00	1.64	381.64
4	-44.318238	170.189135	401.00	1.64	402.64
5	-44.318129	170.202423	396.03	1.64	397.67
6	-44.326343	170.203030	380.00	1.64	381.64

Name: PV4

Axis tracking: Single-axis rotation

Backtracking: Shade

Tracking axis orientation: 0.0°

Max tracking angle: 60.0°

Resting angle: 0.0°

Ground Coverage Ratio: 0.38

Rated power: 84000.0 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.312822	170.205910	399.00	1.64	400.64
2	-44.302994	170.205393	405.00	1.64	406.64
3	-44.302853	170.197985	410.00	1.64	411.64
4	-44.305207	170.198273	408.94	1.64	410.58
5	-44.305316	170.197100	409.00	1.64	410.64
6	-44.308259	170.197690	407.00	1.64	408.64
7	-44.310480	170.196860	405.00	1.64	406.64
8	-44.311630	170.195876	405.00	1.64	406.64
9	-44.312932	170.194286	404.00	1.64	405.64
10	-44.314020	170.192271	404.00	1.64	405.64
11	-44.314866	170.186857	402.00	1.64	403.64
12	-44.318228	170.189143	401.00	1.64	402.64
13	-44.318123	170.202471	396.00	1.64	397.64
14	-44.312920	170.202069	401.21	1.64	402.85
15	-44.312822	170.205910	399.00	1.64	400.64

Name: PV5

Axis tracking: Single-axis rotation

Backtracking: Shade

Tracking axis orientation: 0.0°

Max tracking angle: 60.0°

Resting angle: 0.0°

Ground Coverage Ratio: 0.38

Rated power: 84000.0 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.312813	170.205942	399.00	1.64	400.64
2	-44.312622	170.218520	384.00	1.64	385.64
3	-44.312540	170.218587	384.00	1.64	385.64
4	-44.310253	170.219192	386.00	1.64	387.64
5	-44.308292	170.218628	390.22	1.64	391.86
6	-44.306576	170.217262	396.00	1.64	397.64
7	-44.303244	170.215371	401.00	1.64	402.64
8	-44.303023	170.205394	405.00	1.64	406.64
9	-44.312813	170.205942	399.00	1.64	400.64

Route Receptors

Name: Route 10 Unnamed Rd 3

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.341009	170.182909	375.87	1.50	377.37
2	-44.341623	170.184661	371.00	1.50	372.50
3	-44.342031	170.184894	372.09	1.50	373.59
4	-44.342742	170.187910	375.91	1.50	377.41
5	-44.342527	170.187911	375.00	1.50	376.50
6	-44.342388	170.187510	375.00	1.50	376.50
7	-44.341758	170.186216	372.95	1.50	374.45
8	-44.341048	170.185689	371.00	1.50	372.50
9	-44.340246	170.185495	371.00	1.50	372.50
10	-44.339739	170.185394	370.00	1.50	371.50
11	-44.339284	170.185559	370.00	1.50	371.50
12	-44.338028	170.186834	370.28	1.50	371.78
13	-44.337522	170.186742	370.00	1.50	371.50
14	-44.335902	170.185019	369.00	1.50	370.50
15	-44.335141	170.183604	369.00	1.50	370.50
16	-44.335152	170.183097	369.00	1.50	370.50
17	-44.335312	170.182282	369.00	1.50	370.50
18	-44.335574	170.181580	371.00	1.50	372.50
19	-44.335689	170.181472	371.36	1.50	372.86
20	-44.336167	170.180398	375.52	1.50	377.02
21	-44.336487	170.180171	377.69	1.50	379.19
22	-44.336705	170.180250	378.38	1.50	379.88
23	-44.337894	170.181300	378.00	1.50	379.50
24	-44.338406	170.181634	377.30	1.50	378.80
25	-44.339352	170.183253	373.37	1.50	374.87
26	-44.340005	170.184040	373.00	1.50	374.50
27	-44.340681	170.185189	371.00	1.50	372.50
28	-44.340625	170.184304	372.00	1.50	373.50
29	-44.341294	170.183773	372.00	1.50	373.50

Name: Route 11 Unnamed Rd 4

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.346965	170.175757	377.84	1.50	379.34
2	-44.348681	170.177288	376.00	1.50	377.50
3	-44.348798	170.177423	376.00	1.50	377.50
4	-44.350604	170.181749	378.00	1.50	379.50
5	-44.351000	170.182699	378.00	1.50	379.50
6	-44.351365	170.183192	378.00	1.50	379.50
7	-44.351982	170.183995	378.02	1.50	379.52
8	-44.352216	170.184252	378.82	1.50	380.32
9	-44.352474	170.184443	379.00	1.50	380.50
10	-44.352726	170.184565	379.00	1.50	380.50

Name: Route 1 Falston Rd
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.356478	170.196365	372.00	1.50	373.50
2	-44.356113	170.196363	372.00	1.50	373.50
3	-44.355946	170.196292	372.86	1.50	374.36
4	-44.355641	170.196253	373.00	1.50	374.50
5	-44.355226	170.196420	373.00	1.50	374.50
6	-44.352936	170.197035	374.00	1.50	375.50
7	-44.352569	170.197038	374.00	1.50	375.50
8	-44.352329	170.196883	375.00	1.50	376.50
9	-44.352026	170.196571	375.09	1.50	376.59
10	-44.349869	170.193119	379.00	1.50	380.50
11	-44.349430	170.192509	379.00	1.50	380.50
12	-44.348122	170.190958	380.00	1.50	381.50
13	-44.347247	170.189655	380.00	1.50	381.50
14	-44.346691	170.188596	380.04	1.50	381.54
15	-44.346337	170.187567	381.00	1.50	382.50
16	-44.346154	170.186964	382.00	1.50	383.50
17	-44.345382	170.184909	383.00	1.50	384.50

Name: Route 2 Mcaughtries Rd 1

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.330850	170.164343	401.00	1.50	402.50
2	-44.337237	170.172402	400.00	1.50	401.50
3	-44.338429	170.173061	400.00	1.50	401.50
4	-44.341409	170.173810	394.00	1.50	395.50
5	-44.342238	170.174323	394.00	1.50	395.50
6	-44.343151	170.175378	392.00	1.50	393.50
7	-44.344976	170.180214	388.00	1.50	389.50
8	-44.345682	170.182262	386.00	1.50	387.50
9	-44.345725	170.183257	385.00	1.50	386.50
10	-44.345131	170.185648	382.00	1.50	383.50
11	-44.344723	170.185945	380.43	1.50	381.93
12	-44.344387	170.185718	380.00	1.50	381.50
13	-44.343022	170.182867	379.00	1.50	380.50
14	-44.342838	170.183128	377.44	1.50	378.94
15	-44.342867	170.183421	376.93	1.50	378.43
16	-44.348179	170.195297	378.00	1.50	379.50
17	-44.348419	170.195395	377.46	1.50	378.96
18	-44.348530	170.195179	377.53	1.50	379.03
19	-44.348501	170.194728	378.00	1.50	379.50
20	-44.348808	170.194648	377.55	1.50	379.05
21	-44.348953	170.194701	377.00	1.50	378.50
22	-44.349038	170.194881	377.00	1.50	378.50
23	-44.349075	170.195040	377.00	1.50	378.50
24	-44.349075	170.195250	377.00	1.50	378.50
25	-44.348984	170.195460	377.00	1.50	378.50

Name: Route 3 Mcaughtries Rd 2

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.337668	170.172688	400.00	1.50	401.50
2	-44.337625	170.172819	400.00	1.50	401.50
3	-44.337650	170.172947	400.00	1.50	401.50
4	-44.339220	170.174996	400.00	1.50	401.50
5	-44.340310	170.176679	400.00	1.50	401.50
6	-44.341146	170.178223	400.00	1.50	401.50
7	-44.341685	170.179463	400.00	1.50	401.50
8	-44.341706	170.179831	400.00	1.50	401.50
9	-44.341408	170.180167	401.00	1.50	402.50
10	-44.340712	170.180598	401.00	1.50	402.50
11	-44.340507	170.180667	401.00	1.50	402.50
12	-44.340346	170.180607	401.00	1.50	402.50
13	-44.340254	170.180445	401.00	1.50	402.50
14	-44.339731	170.178677	400.00	1.50	401.50
15	-44.339266	170.177513	400.00	1.50	401.50
16	-44.338691	170.176359	400.00	1.50	401.50
17	-44.338260	170.175681	400.00	1.50	401.50
18	-44.336822	170.173778	401.00	1.50	402.50
19	-44.334880	170.171318	401.33	1.50	402.83
20	-44.329159	170.164063	404.00	1.50	405.50

Name: Route 4 Mcaughtries Rd 3

Path type: Two-way

Observer view angle: 50.0°

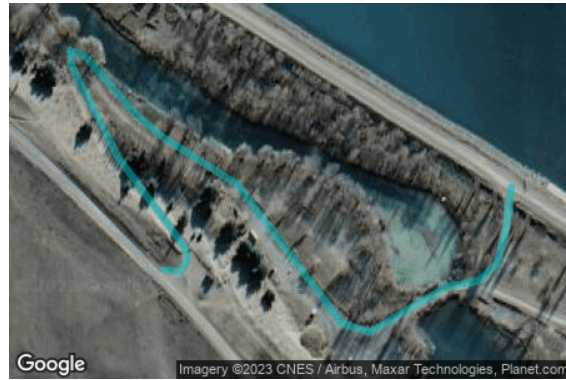


Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.343040	170.182830	379.28	1.50	380.78
2	-44.342695	170.182220	378.94	1.50	380.44
3	-44.342357	170.181917	377.94	1.50	379.44
4	-44.342095	170.181980	376.18	1.50	377.68
5	-44.341157	170.182641	375.58	1.50	377.08
6	-44.340859	170.183051	376.41	1.50	377.91
7	-44.340593	170.183188	377.13	1.50	378.63
8	-44.340395	170.183169	378.00	1.50	379.50
9	-44.340223	170.183096	378.18	1.50	379.68
10	-44.340068	170.182971	379.18	1.50	380.68
11	-44.339868	170.182664	380.28	1.50	381.78
12	-44.339675	170.182221	382.80	1.50	384.30
13	-44.338662	170.179281	399.17	1.50	400.67
14	-44.338523	170.178835	400.00	1.50	401.50
15	-44.338490	170.178399	400.00	1.50	401.50
16	-44.338501	170.178043	400.00	1.50	401.50
17	-44.338562	170.177760	400.00	1.50	401.50
18	-44.338689	170.177467	400.00	1.50	401.50
19	-44.338792	170.177312	400.00	1.50	401.50
20	-44.338972	170.177108	400.00	1.50	401.50

Name: Route 5 Mcaughtries Rd 4

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.347609	170.193981	379.00	1.50	380.50
2	-44.347894	170.193930	379.00	1.50	380.50
3	-44.348077	170.193856	378.34	1.50	379.84
4	-44.348185	170.193698	378.09	1.50	379.59
5	-44.348221	170.193423	378.99	1.50	380.49
6	-44.348499	170.192765	379.00	1.50	380.50
7	-44.348443	170.192527	379.00	1.50	380.50
8	-44.347595	170.191629	379.00	1.50	380.50
9	-44.347304	170.190987	379.00	1.50	380.50
10	-44.347165	170.190755	379.00	1.50	380.50
11	-44.346813	170.190325	379.00	1.50	380.50
12	-44.346773	170.190192	379.00	1.50	380.50
13	-44.346868	170.190203	379.48	1.50	380.98
14	-44.347430	170.190605	380.00	1.50	381.50
15	-44.347977	170.191174	380.00	1.50	381.50
16	-44.348059	170.191200	380.00	1.50	381.50
17	-44.348127	170.191137	380.00	1.50	381.50
18	-44.348114	170.191001	380.00	1.50	381.50

Name: Route 6 Haldon Arm Rd

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.342555	170.226106	377.00	1.50	378.50
2	-44.342427	170.225980	377.00	1.50	378.50
3	-44.342270	170.225337	377.00	1.50	378.50
4	-44.342257	170.225207	377.00	1.50	378.50
5	-44.342284	170.224833	377.00	1.50	378.50
6	-44.342845	170.224144	377.00	1.50	378.50
7	-44.343147	170.223841	377.00	1.50	378.50
8	-44.343669	170.223419	376.00	1.50	377.50
9	-44.343636	170.223239	376.00	1.50	377.50
10	-44.343438	170.222768	376.00	1.50	377.50
11	-44.342423	170.221191	376.00	1.50	377.50
12	-44.342305	170.221141	376.00	1.50	377.50
13	-44.337375	170.222685	377.00	1.50	378.50
14	-44.336203	170.223318	378.00	1.50	379.50
15	-44.335765	170.223519	378.00	1.50	379.50
16	-44.335130	170.224042	378.00	1.50	379.50
17	-44.334233	170.224345	378.00	1.50	379.50
18	-44.333356	170.224723	379.00	1.50	380.50
19	-44.333144	170.224794	379.00	1.50	380.50
20	-44.332307	170.225165	379.00	1.50	380.50
21	-44.330476	170.225904	379.00	1.50	380.50
22	-44.330170	170.226031	379.00	1.50	380.50
23	-44.323574	170.230314	376.00	1.50	377.50
24	-44.323488	170.230452	376.00	1.50	377.50
25	-44.318520	170.241575	382.00	1.50	383.50

Name: Route 7 Tekapo River Rd

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.318803	170.240924	381.00	1.50	382.50
2	-44.316019	170.239207	382.52	1.50	384.02
3	-44.314430	170.238404	382.00	1.50	383.50
4	-44.312669	170.237443	381.00	1.50	382.50
5	-44.312574	170.237430	381.00	1.50	382.50
6	-44.312266	170.237538	381.00	1.50	382.50
7	-44.311995	170.237438	381.00	1.50	382.50
8	-44.311713	170.237186	380.00	1.50	381.50
9	-44.311266	170.236720	380.00	1.50	381.50
10	-44.311067	170.236605	380.00	1.50	381.50
11	-44.310877	170.236478	380.00	1.50	381.50
12	-44.310624	170.236233	380.00	1.50	381.50
13	-44.310277	170.236125	381.00	1.50	382.50
14	-44.310036	170.236044	381.00	1.50	382.50
15	-44.309598	170.235774	381.74	1.50	383.24
16	-44.309322	170.235601	382.00	1.50	383.50
17	-44.307983	170.234611	381.00	1.50	382.50
18	-44.307543	170.234355	381.00	1.50	382.50
19	-44.307015	170.234581	382.00	1.50	383.50
20	-44.306761	170.234842	382.83	1.50	384.33
21	-44.305950	170.236680	385.00	1.50	386.50
22	-44.305470	170.237365	386.00	1.50	387.50
23	-44.305233	170.237986	387.00	1.50	388.50
24	-44.304834	170.238462	388.00	1.50	389.50
25	-44.304735	170.238695	388.24	1.50	389.74
26	-44.304690	170.239100	389.00	1.50	390.50
27	-44.304077	170.241599	393.00	1.50	394.50
28	-44.303971	170.242436	394.00	1.50	395.50
29	-44.303910	170.242647	394.00	1.50	395.50

Name: Route 8 Unnamed Rd 1

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.320133	170.234052	378.00	1.50	379.50
2	-44.319520	170.234820	379.00	1.50	380.50
3	-44.318946	170.235404	380.00	1.50	381.50
4	-44.318424	170.236139	380.00	1.50	381.50
5	-44.318080	170.236944	380.00	1.50	381.50
6	-44.317777	170.237422	381.00	1.50	382.50
7	-44.317676	170.237760	381.00	1.50	382.50
8	-44.317637	170.238266	381.00	1.50	382.50
9	-44.317553	170.238660	381.00	1.50	382.50
10	-44.317414	170.239110	382.00	1.50	383.50
11	-44.316974	170.239757	382.00	1.50	383.50

Name: Route 9 Unnamed Rd 2

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.334627	170.165110	396.00	1.50	397.50
2	-44.346959	170.175782	377.71	1.50	379.21
3	-44.346777	170.175791	378.00	1.50	379.50
4	-44.346701	170.175833	378.00	1.50	379.50
5	-44.346563	170.176058	379.00	1.50	380.50
6	-44.344885	170.179803	388.00	1.50	389.50

Flight Path Receptors

Name: FP1
Description: None
Threshold height: 15 m
Direction: 171.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-44.243637	170.120187	462.00	15.00	477.00
Two-mile	-44.272693	170.125988	444.00	120.00	564.00

Name: FP2
Description: None
Threshold height: 15 m
Direction: 171.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-44.233812	170.118270	479.00	15.00	494.00
Two-mile	-44.205073	170.113111	520.00	120.00	640.00

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-44.344335	170.186620	379.89	1.65
OP 2	2	-44.343304	170.180295	391.00	1.65
OP 3	3	-44.341905	170.182614	373.00	1.65
OP 4	4	-44.342322	170.224376	377.00	1.65
OP 5	5	-44.308104	170.234694	381.00	1.65

Obstruction Components

Name: Obstruction 1

Top height: 3.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.303075	170.216119	400.00
2	-44.303075	170.216634	400.00
3	-44.307651	170.219209	389.46
4	-44.306407	170.217986	395.00
5	-44.303075	170.216119	400.00

Name: Obstruction 2

Top height: 3.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.322132	170.191311	390.24
2	-44.325586	170.193456	380.00
3	-44.334532	170.189658	377.00
4	-44.334255	170.189165	376.75
5	-44.330341	170.190238	378.00
6	-44.327333	170.191632	379.00
7	-44.324042	170.191426	382.00
8	-44.323182	170.190954	383.00
9	-44.322132	170.191311	390.24

Name: Obstruction 3

Top height: 3.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.318500	170.188506	400.00
2	-44.321355	170.190780	394.22
3	-44.320035	170.188892	399.00
4	-44.319114	170.188677	399.00
5	-44.318500	170.188506	400.00

Name: Obstruction 4

Top height: 3.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.334511	170.189616	377.00
2	-44.339914	170.200967	380.00
3	-44.337167	170.195710	380.00
4	-44.336906	170.194788	380.00
5	-44.335816	170.193221	380.00
6	-44.334511	170.189616	377.00

Name: Obstruction 5

Top height: 3.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.333345	170.204851	380.00
2	-44.339898	170.201032	380.00
3	-44.339668	170.200688	380.00
4	-44.337090	170.202448	380.00
5	-44.335647	170.203177	380.00
6	-44.334266	170.204057	380.00
7	-44.333345	170.204851	380.00

Name: Obstruction 6

Top height: 3.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.313225	170.220215	381.00
2	-44.313286	170.219765	381.77
3	-44.313179	170.218477	383.03
4	-44.312703	170.218949	383.63
5	-44.310338	170.219679	384.99
6	-44.308757	170.219700	386.00
7	-44.310031	170.220387	383.00
8	-44.313225	170.220215	381.00

Name: Obstruction 7

Top height: 3.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.313332	170.219765	381.32
2	-44.327318	170.207662	379.00
3	-44.332168	170.205452	380.00
4	-44.330081	170.205409	380.00
5	-44.327164	170.206890	379.00
6	-44.326443	170.207791	379.00
7	-44.317815	170.211182	386.02
8	-44.315113	170.217404	382.00
9	-44.313225	170.218499	383.00
10	-44.313332	170.219765	381.32

Glare Analysis Results

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

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV1	SA tracking	SA tracking	11,931	198.8	246	4.1	210,100,000.0
PV2	SA tracking	SA tracking	1,026	17.1	50	0.8	219,700,000.0
PV3	SA tracking	SA tracking	204	3.4	0	0.0	218,400,000.0
PV4	SA tracking	SA tracking	0	0.0	0	0.0	218,800,000.0
PV5	SA tracking	SA tracking	2,304	38.4	204	3.4	216,300,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 10 Unnamed Rd 3	1,331	22.2	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	1,224	20.4	0	0.0
Route 3 Mcaughtries Rd 2	1,582	26.4	0	0.0
Route 4 Mcaughtries Rd 3	1,441	24.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	1,689	28.1	300	5.0
Route 7 Tekapo River Rd	1,488	24.8	125	2.1
Route 8 Unnamed Rd 1	1,265	21.1	75	1.2
Route 9 Unnamed Rd 2	948	15.8	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	680	11.3	0	0.0
OP 2	1,081	18.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 3	1,139	19.0	0	0.0
OP 4	1,517	25.3	0	0.0
OP 5	80	1.3	0	0.0

PV: PV1 potential temporary after-image

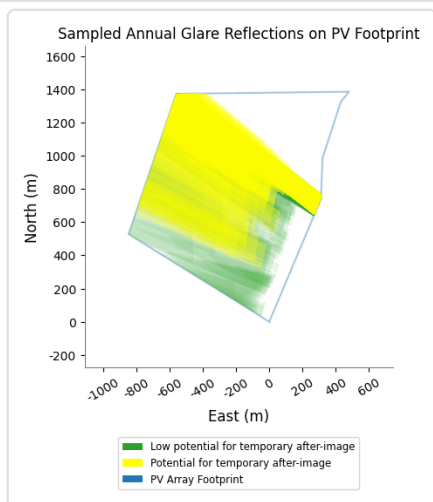
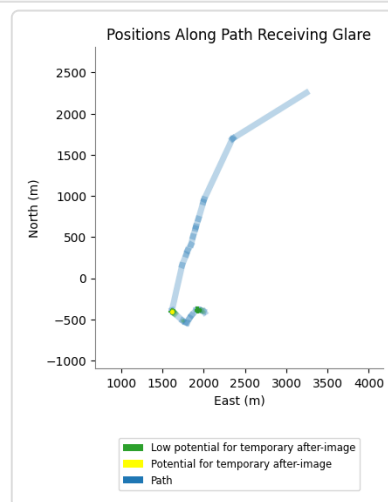
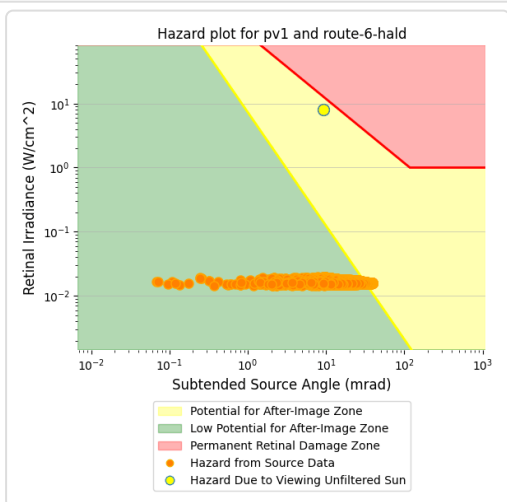
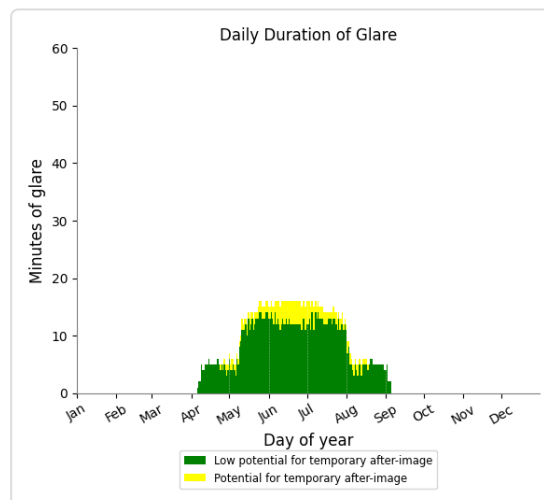
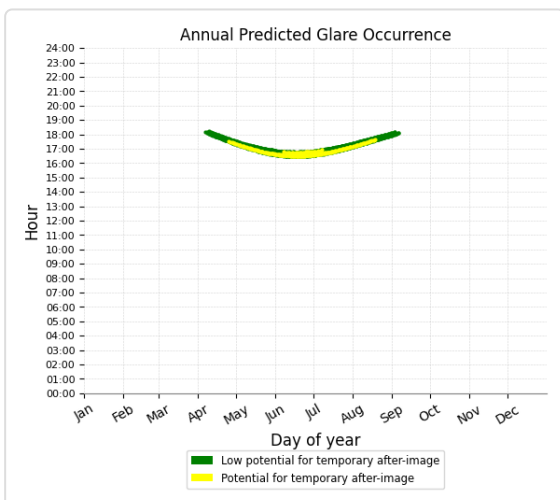
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 6 Haldon Arm Rd	1,350	22.5	246	4.1
Route 10 Unnamed Rd 3	1,331	22.2	0	0.0
Route 2 Mcaughtries Rd 1	1,224	20.4	0	0.0
Route 3 Mcaughtries Rd 2	1,336	22.3	0	0.0
Route 4 Mcaughtries Rd 3	1,325	22.1	0	0.0
Route 9 Unnamed Rd 2	948	15.8	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 7 Tekapo River Rd	0	0.0	0	0.0
Route 8 Unnamed Rd 1	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	680	11.3	0	0.0
OP 2	1,081	18.0	0	0.0
OP 3	1,139	19.0	0	0.0
OP 4	1,517	25.3	0	0.0
OP 5	0	0.0	0	0.0

PV1 and Route: Route 6 Haldon Arm Rd

Yellow glare: 246 min.

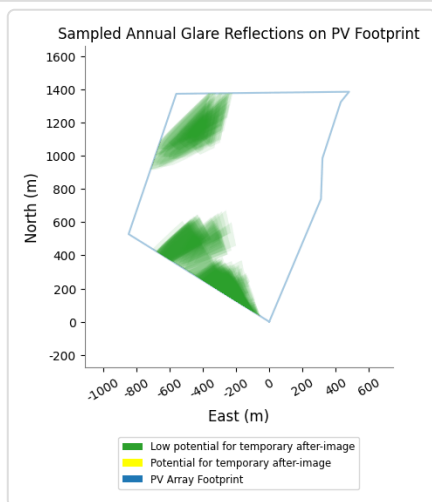
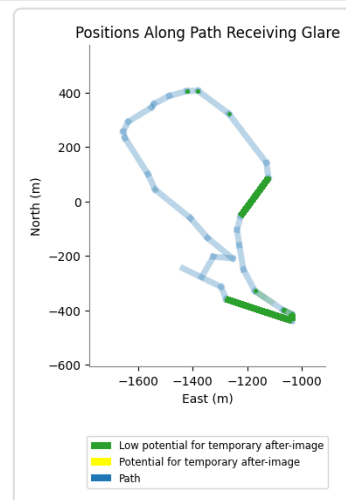
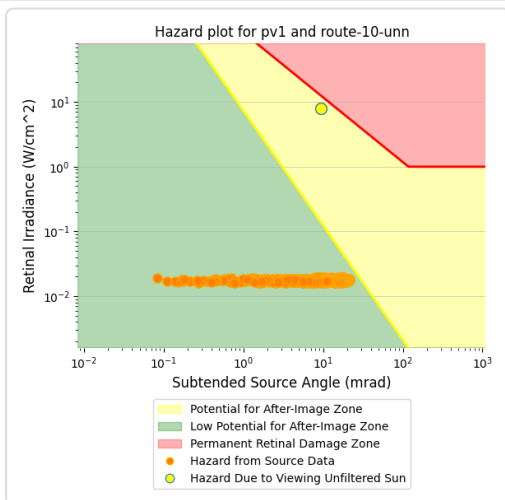
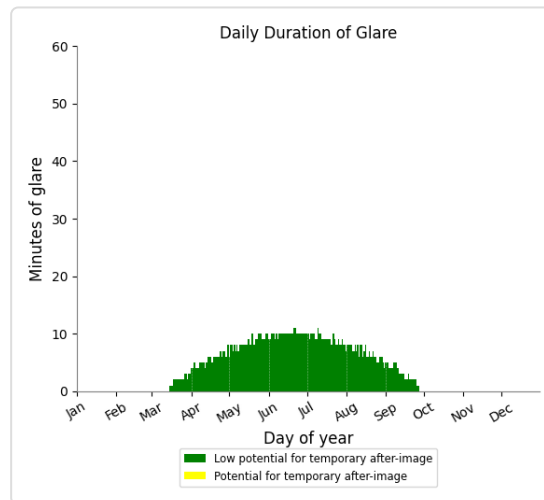
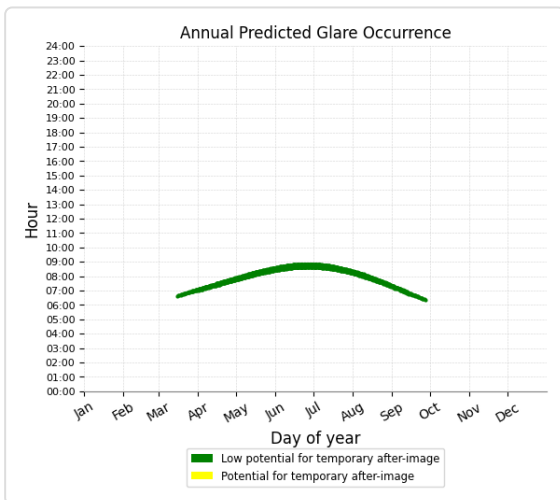
Green glare: 1,350 min.



PV1 and Route: Route 10 Unnamed Rd 3

Yellow glare: none

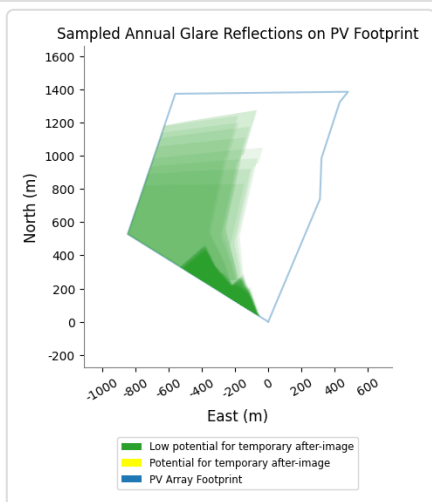
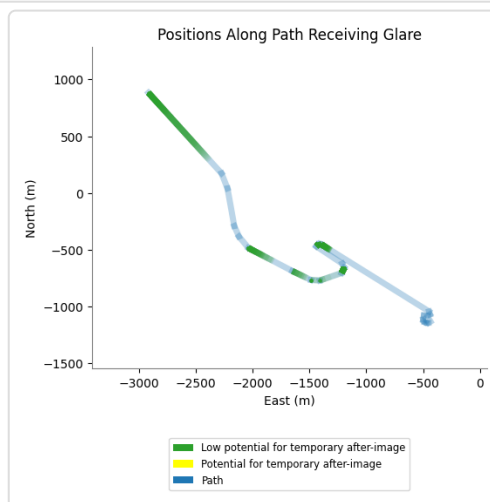
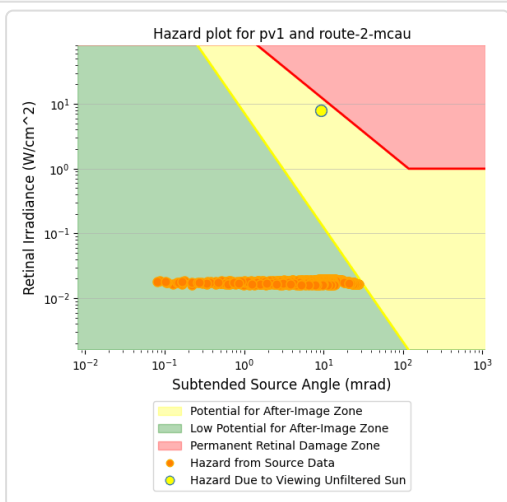
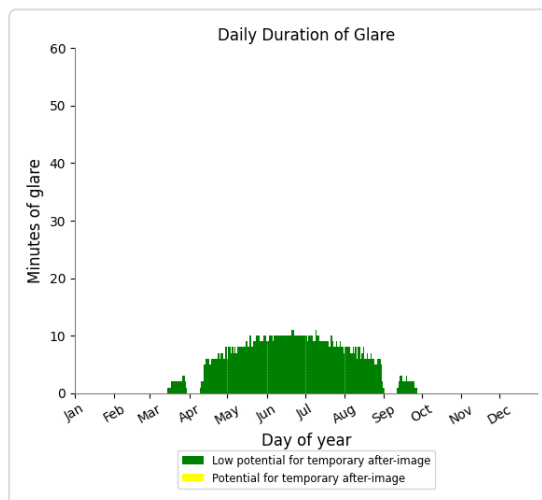
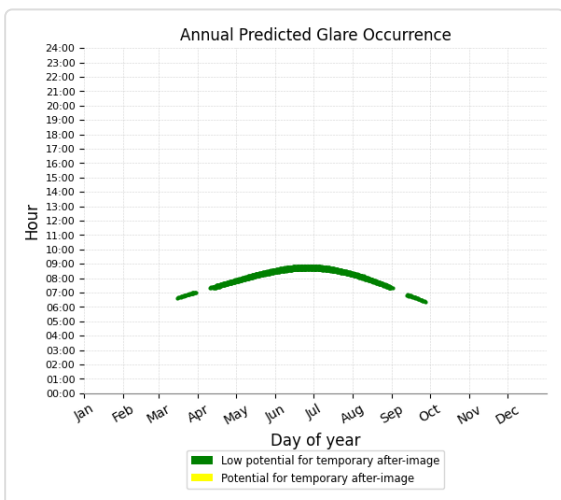
Green glare: 1,331 min.



PV1 and Route: Route 2 Mcaughtries Rd 1

Yellow glare: none

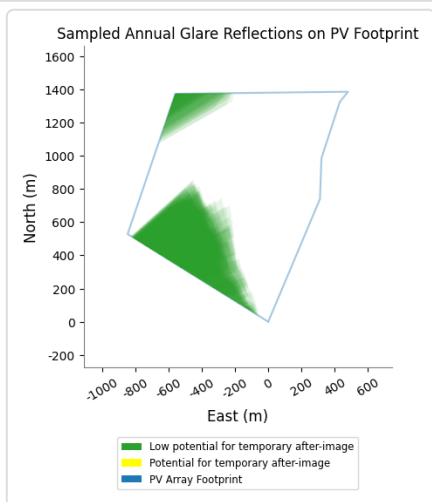
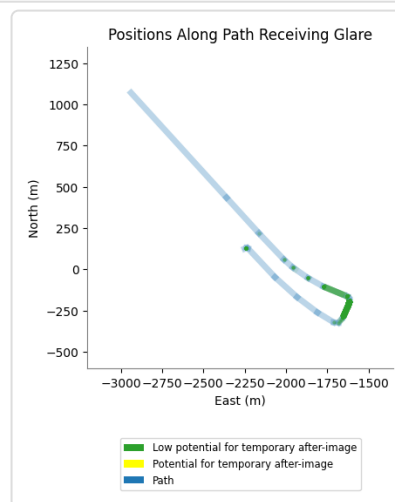
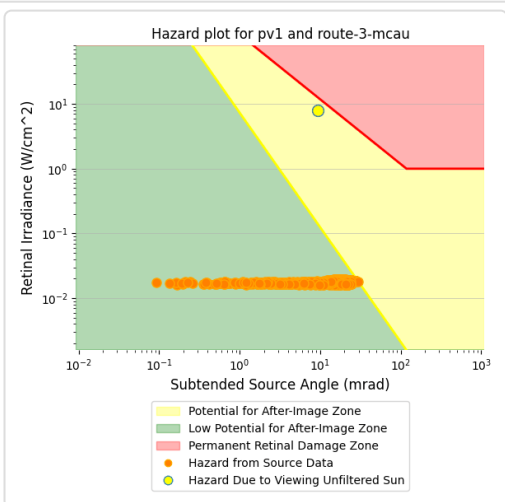
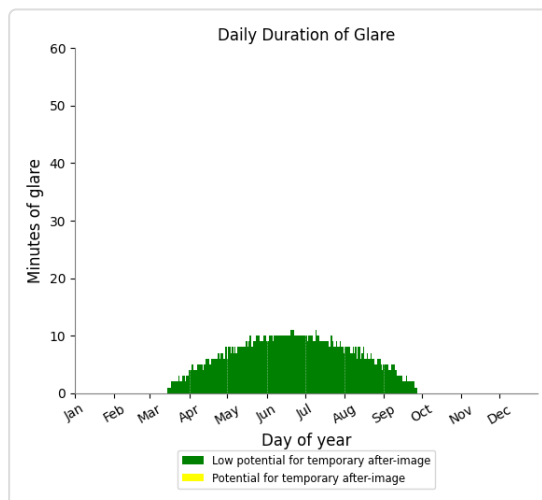
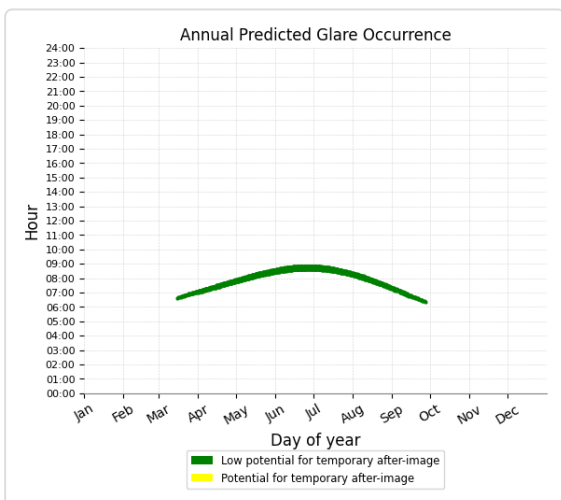
Green glare: 1,224 min.



PV1 and Route: Route 3 Mcaughtries Rd 2

Yellow glare: none

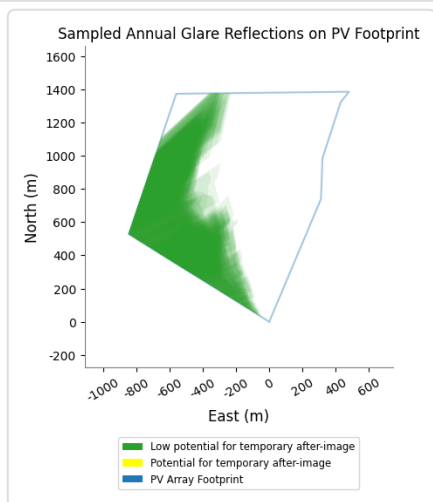
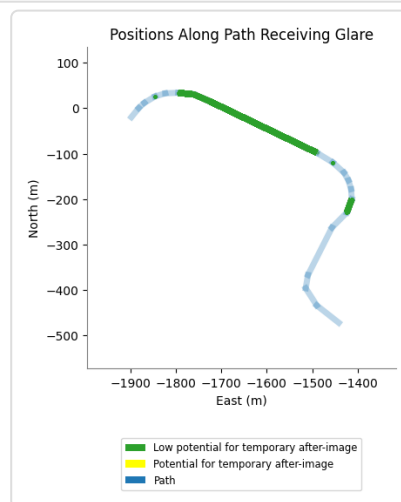
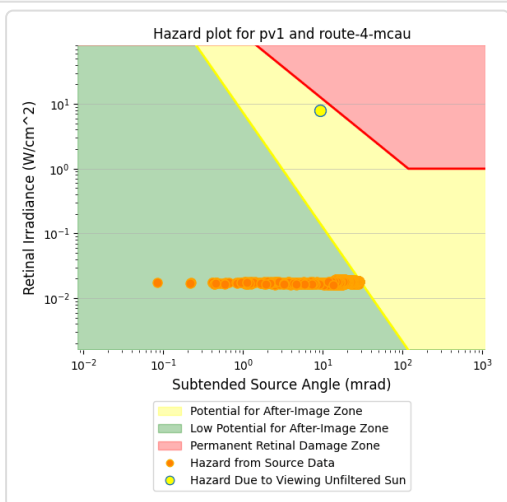
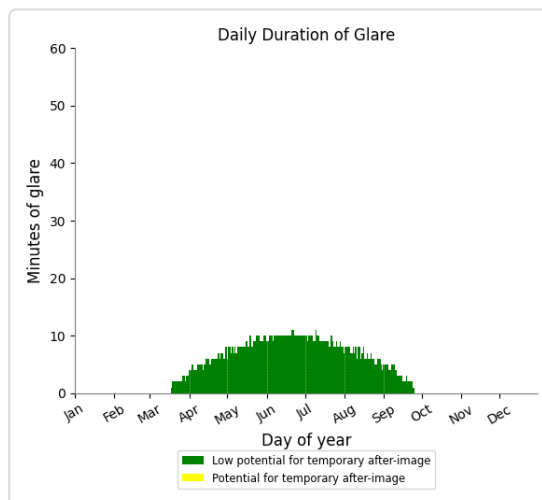
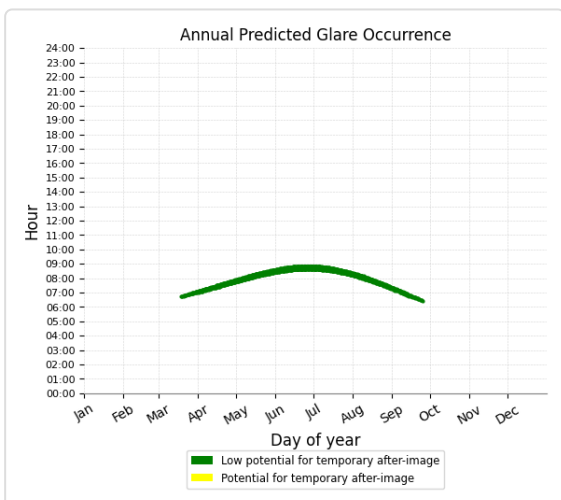
Green glare: 1,336 min.



PV1 and Route: Route 4 Mcaughtries Rd 3

Yellow glare: none

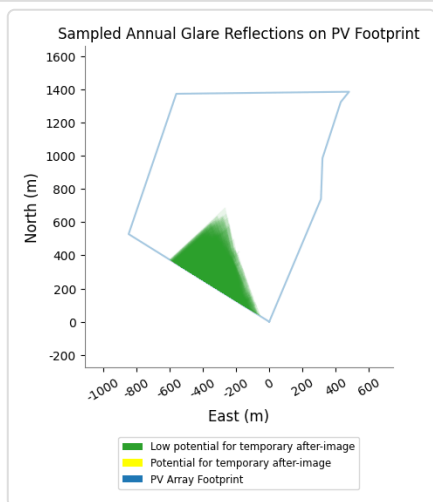
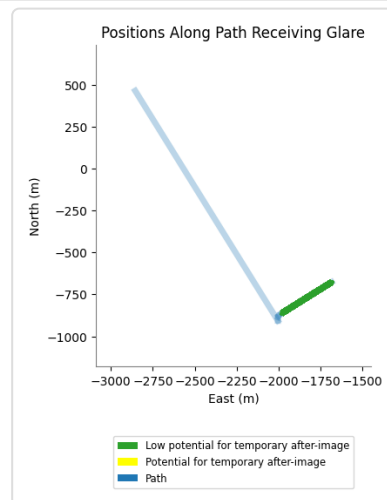
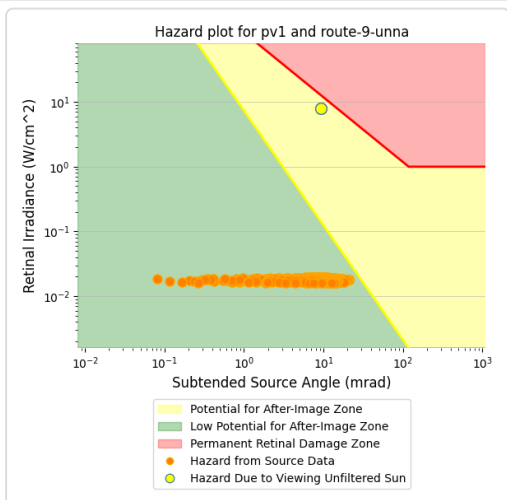
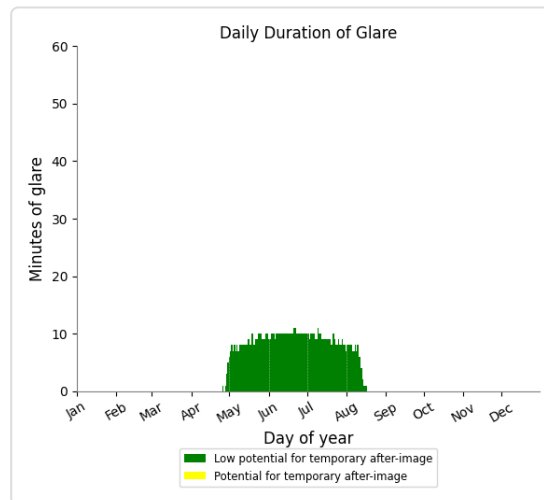
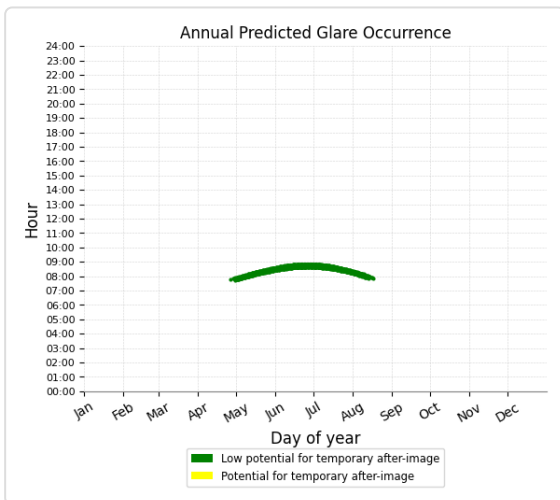
Green glare: 1,325 min.



PV1 and Route: Route 9 Unnamed Rd 2

Yellow glare: none

Green glare: 948 min.



PV1 and Route: Route 11 Unnamed Rd 4

No glare found

PV1 and Route: Route 1 Falston Rd

No glare found

PV1 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV1 and Route: Route 7 Tekapo River Rd

No glare found

PV1 and Route: Route 8 Unnamed Rd 1

No glare found

PV1 and FP: FP1

No glare found

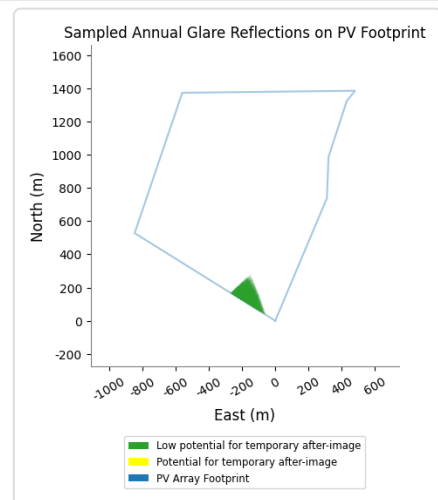
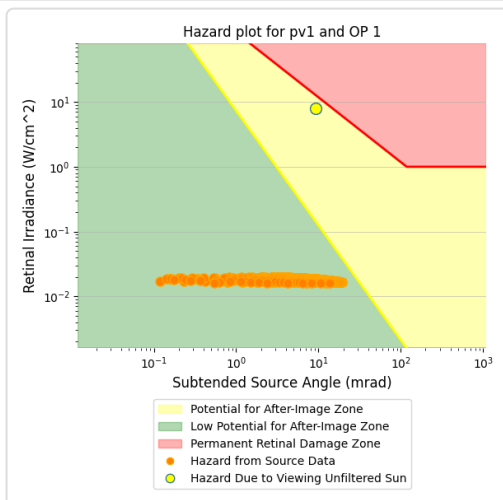
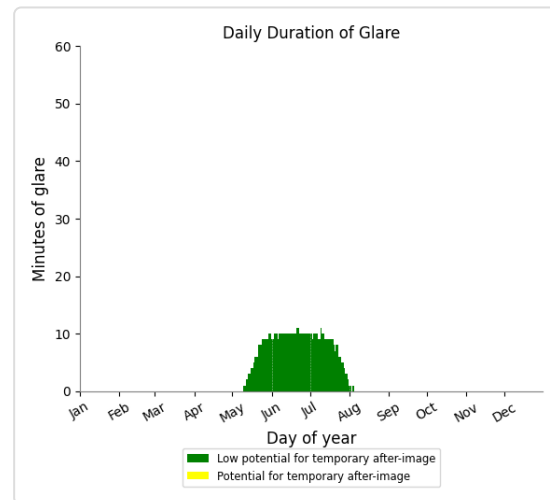
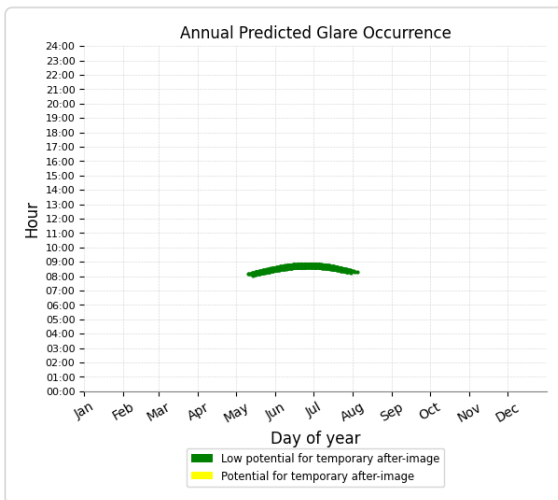
PV1 and FP: FP2

No glare found

PV1 and OP 1

Yellow glare: none

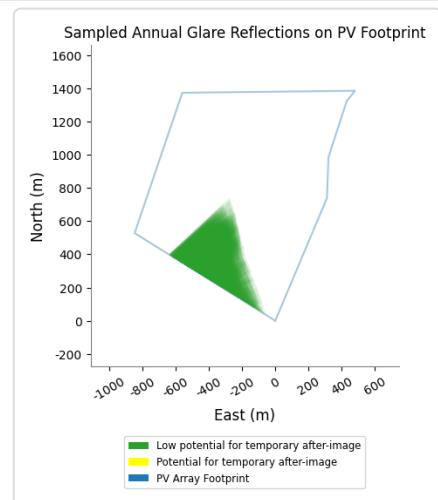
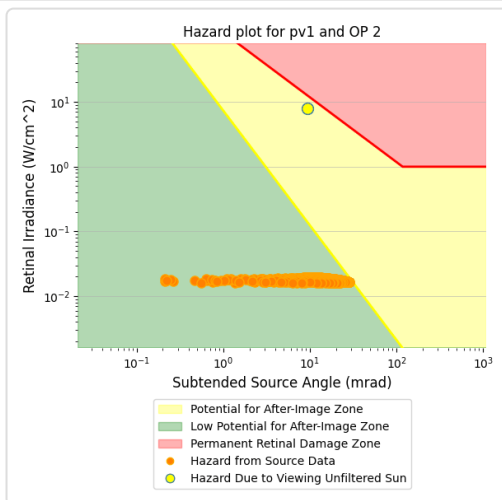
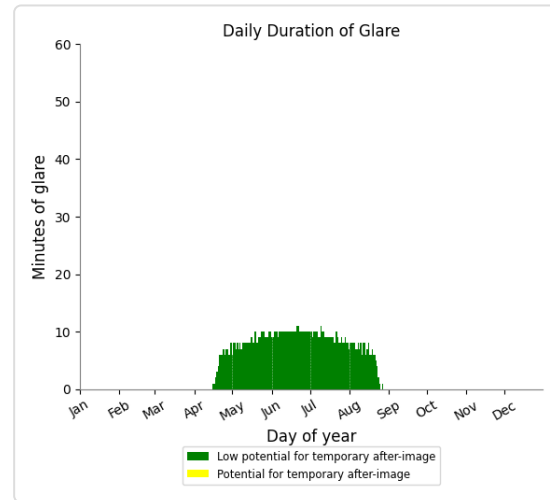
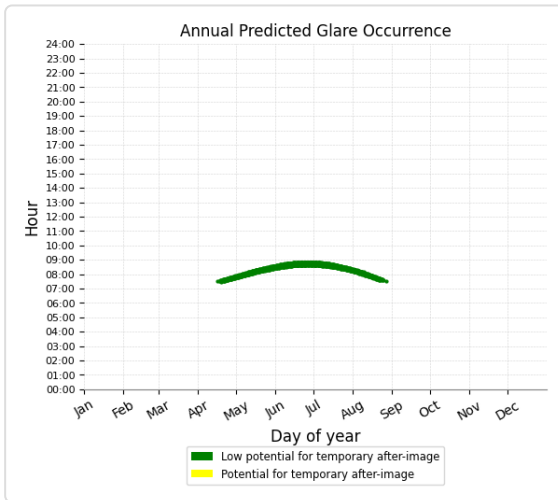
Green glare: 680 min.



PV1 and OP 2

Yellow glare: none

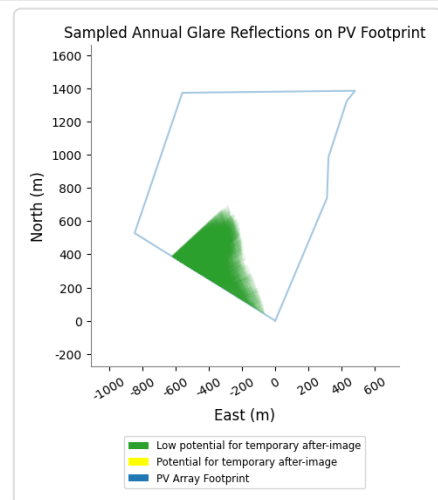
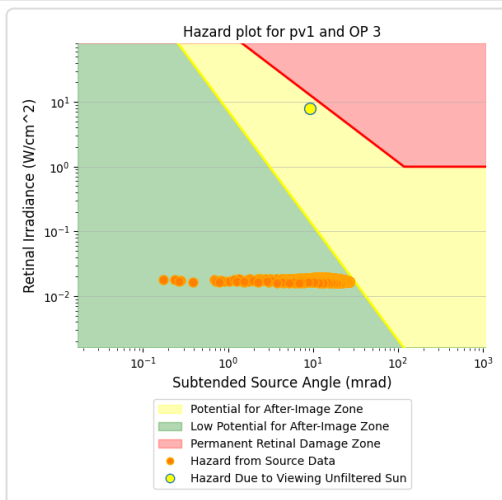
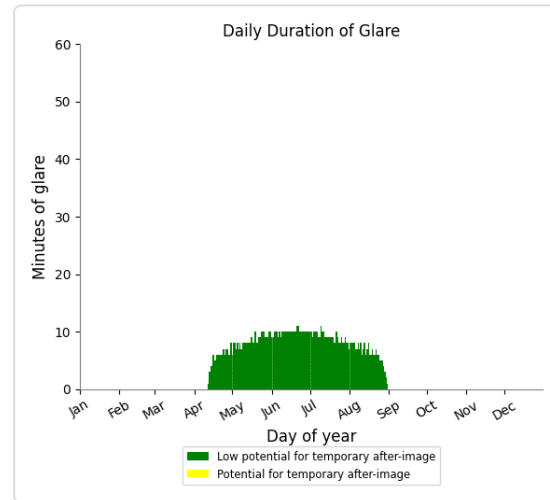
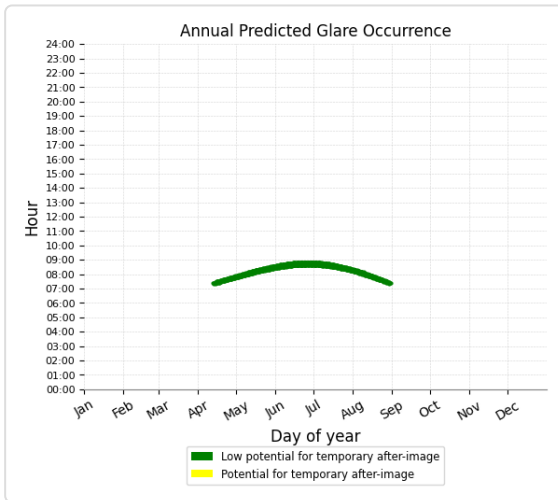
Green glare: 1,081 min.



PV1 and OP 3

Yellow glare: none

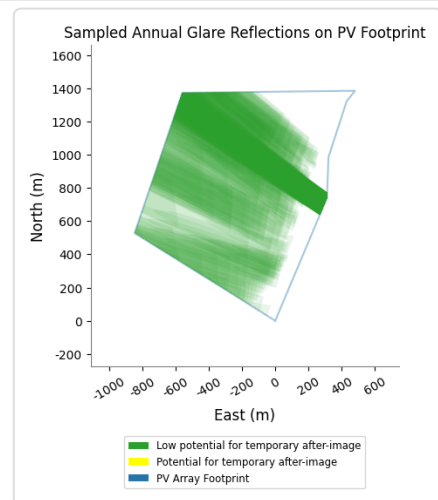
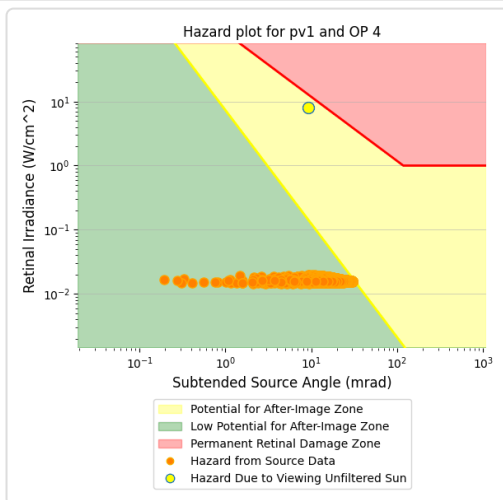
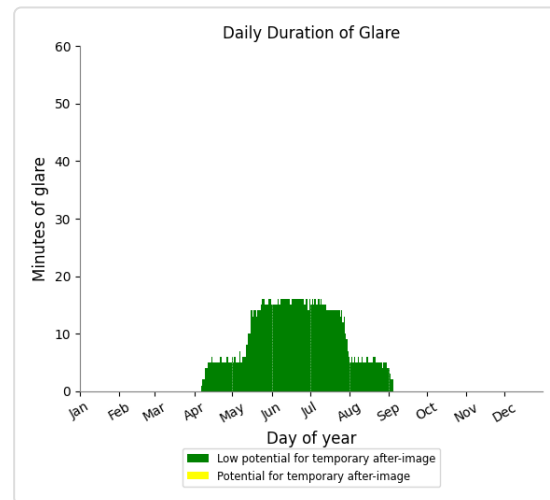
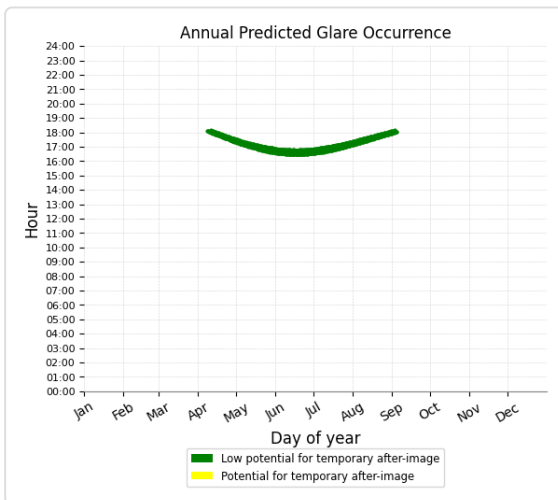
Green glare: 1,139 min.



PV1 and OP 4

Yellow glare: none

Green glare: 1,517 min.



PV1 and OP 5

No glare found

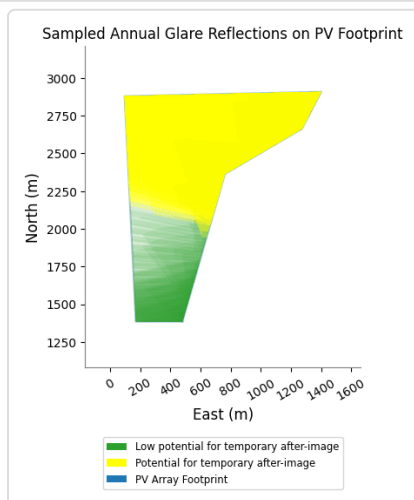
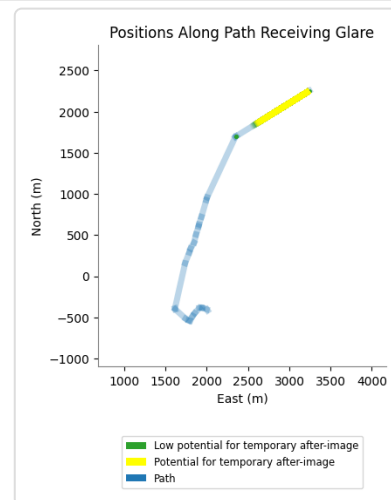
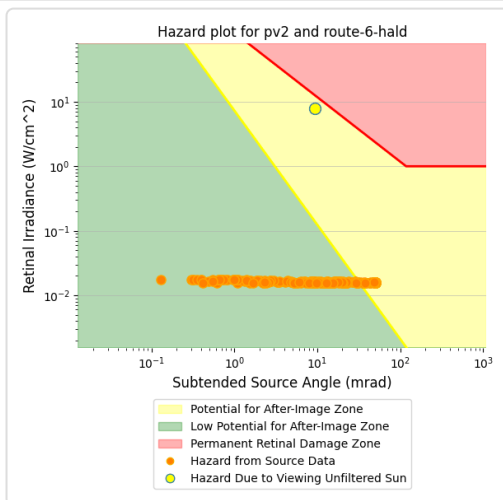
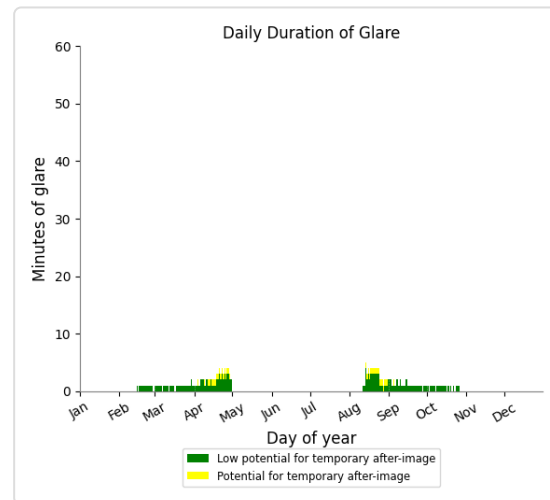
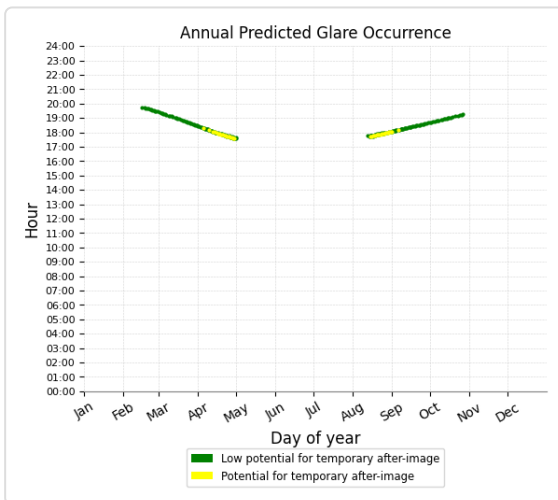
PV: PV2 potential temporary after-image*Receptor results ordered by category of glare*

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 6 Haldon Arm Rd	189	3.1	38	0.6
Route 7 Tekapo River Rd	319	5.3	4	0.1
Route 8 Unnamed Rd 1	280	4.7	8	0.1
Route 3 Mcaughtries Rd 2	93	1.6	0	0.0
Route 4 Mcaughtries Rd 3	65	1.1	0	0.0
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 5	80	1.3	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0

PV2 and Route: Route 6 Haldon Arm Rd

Yellow glare: 38 min.

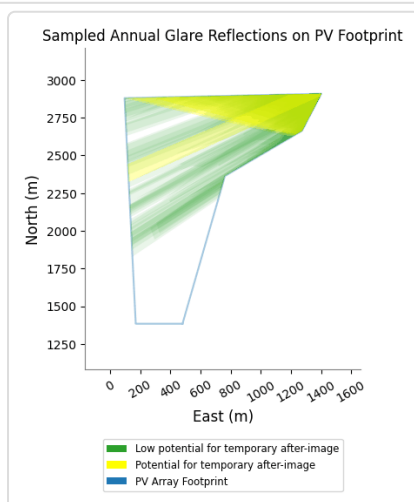
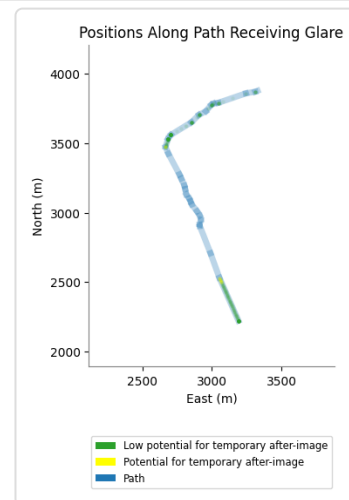
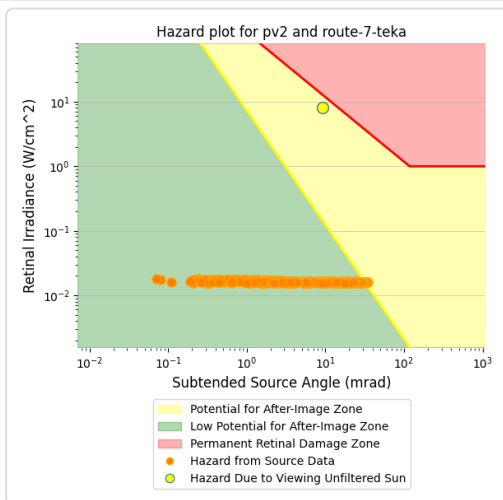
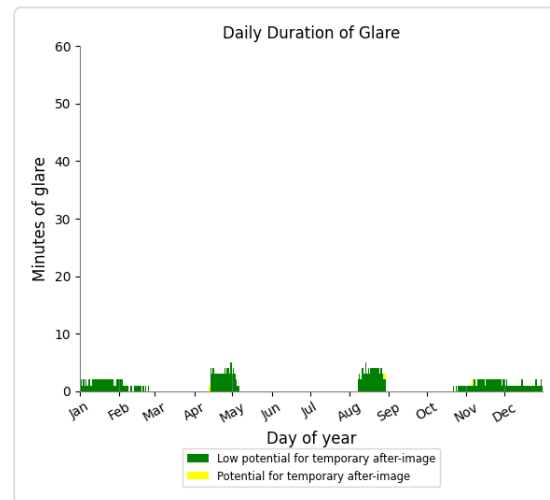
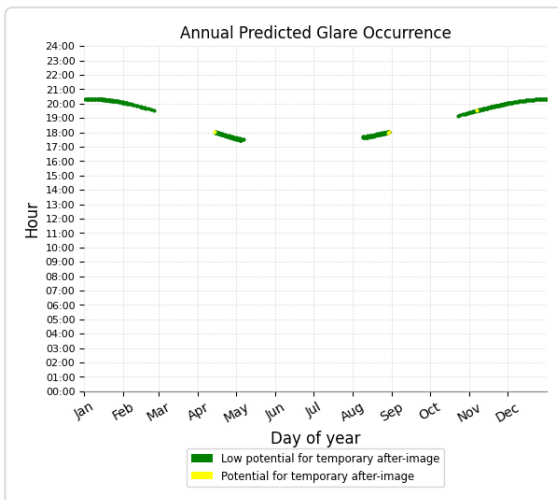
Green glare: 189 min.



PV2 and Route: Route 7 Tekapo River Rd

Yellow glare: 4 min.

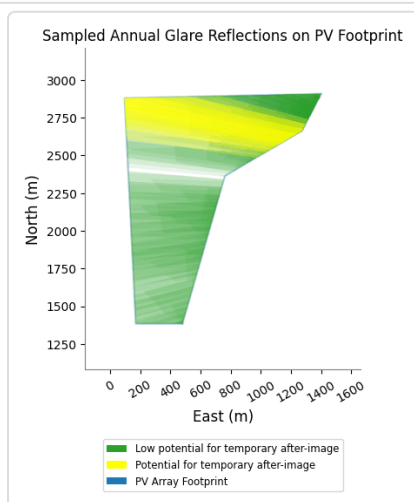
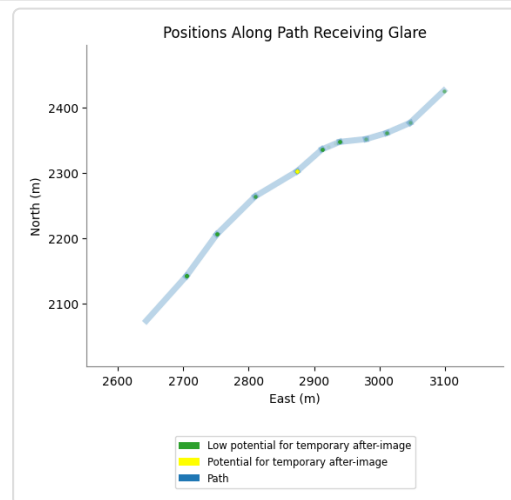
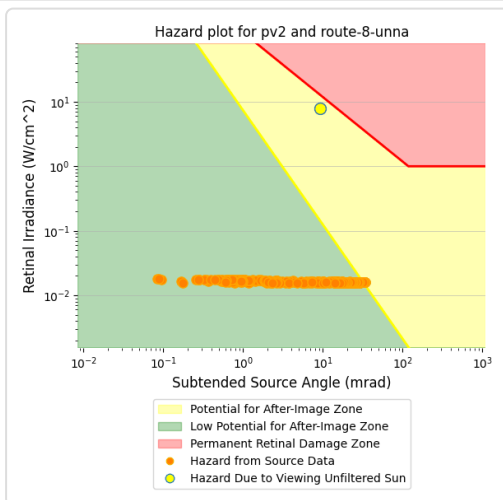
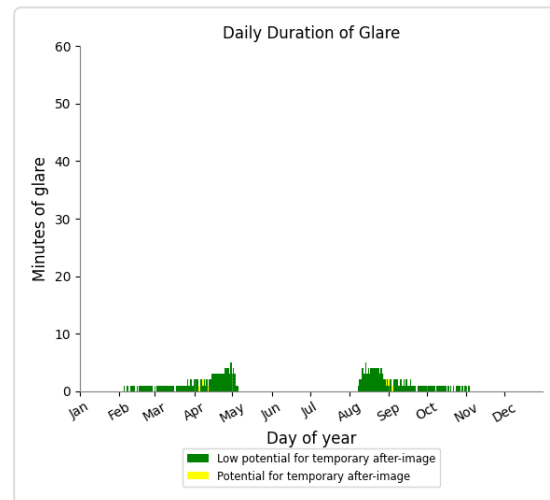
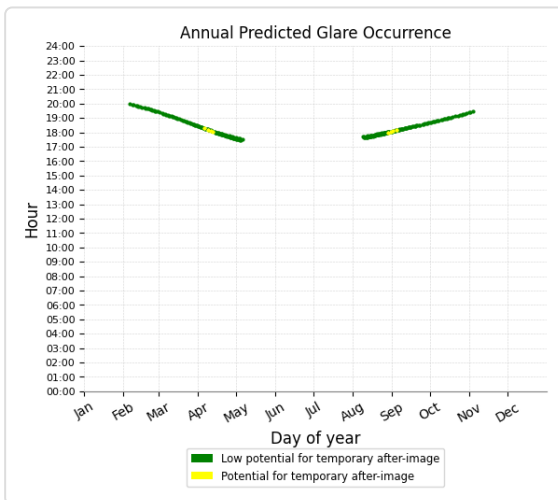
Green glare: 319 min.



PV2 and Route: Route 8 Unnamed Rd 1

Yellow glare: 8 min.

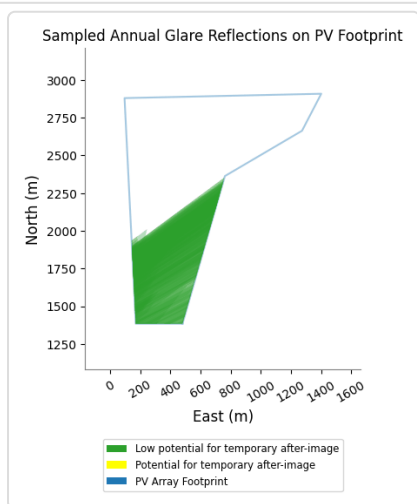
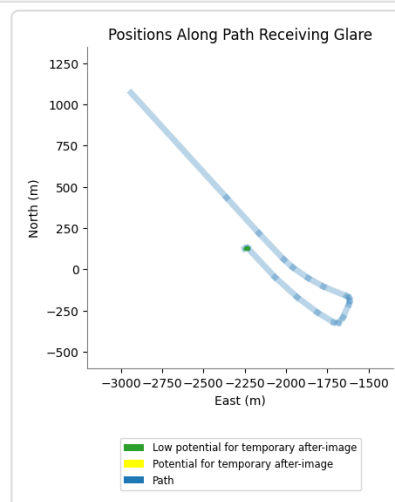
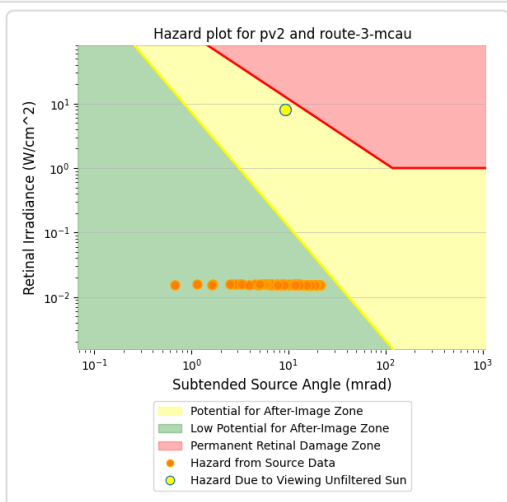
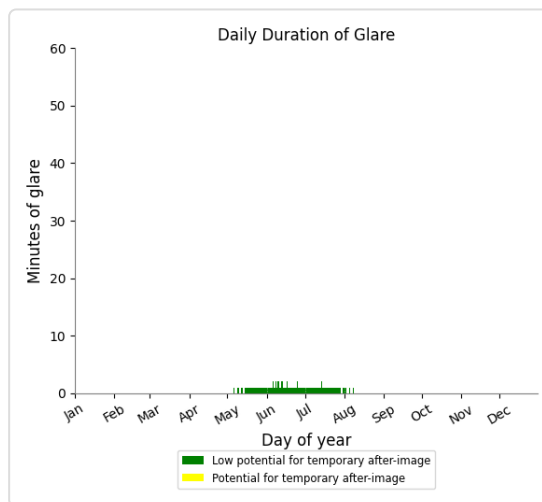
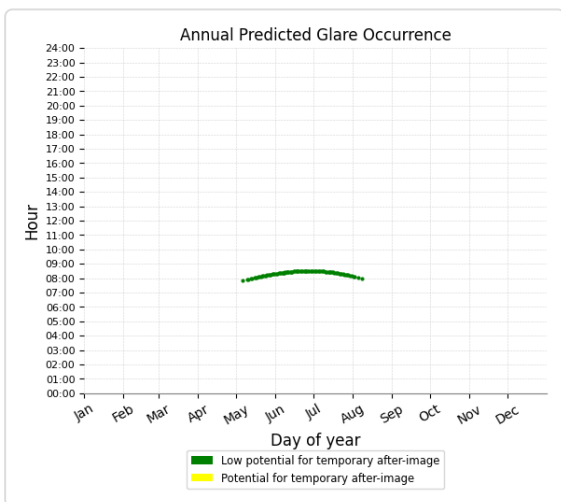
Green glare: 280 min.



PV2 and Route: Route 3 Mcaughtries Rd 2

Yellow glare: none

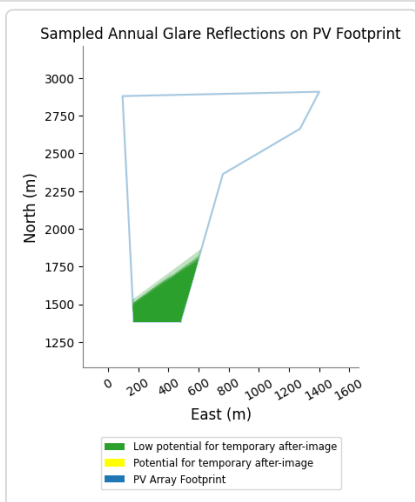
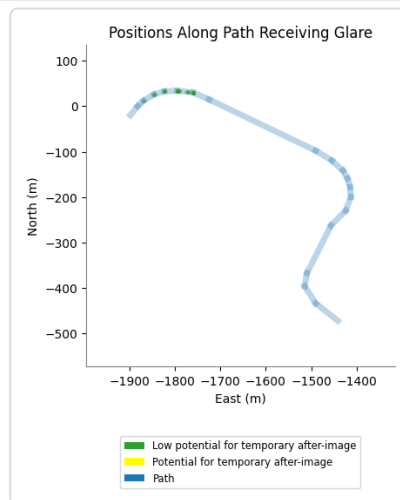
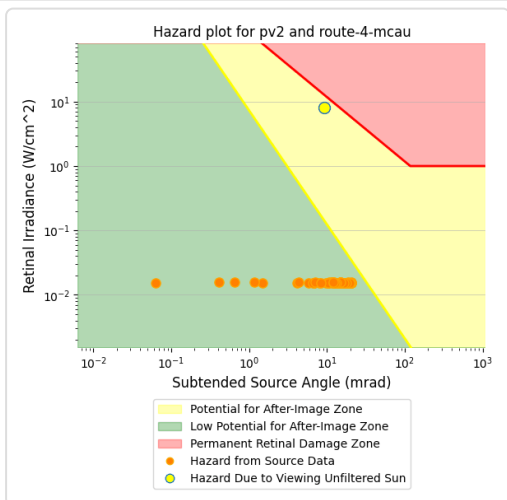
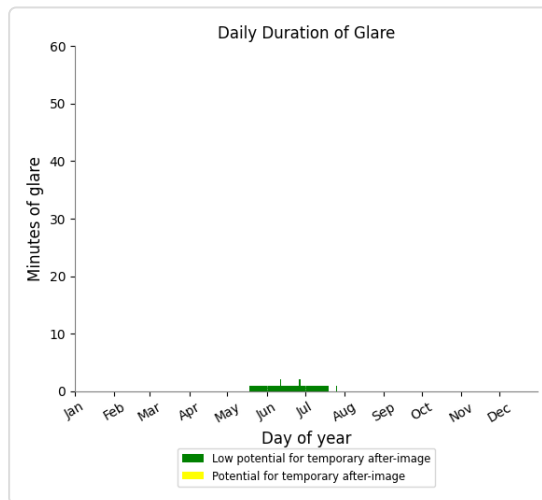
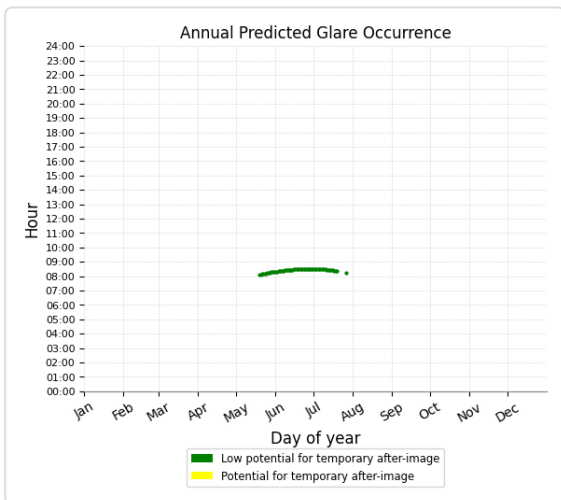
Green glare: 93 min.



PV2 and Route: Route 4 Mcaughtries Rd 3

Yellow glare: none

Green glare: 65 min.



PV2 and Route: Route 10 Unnamed Rd 3

No glare found

PV2 and Route: Route 11 Unnamed Rd 4

No glare found

PV2 and Route: Route 1 Falston Rd

No glare found

PV2 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV2 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV2 and Route: Route 9 Unnamed Rd 2

No glare found

PV2 and FP: FP1

No glare found

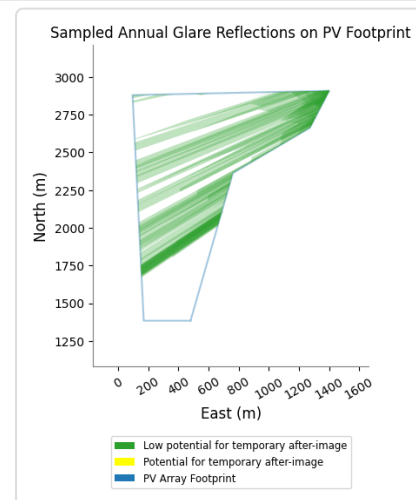
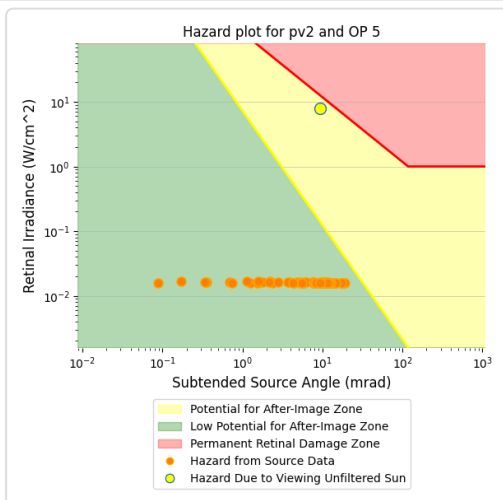
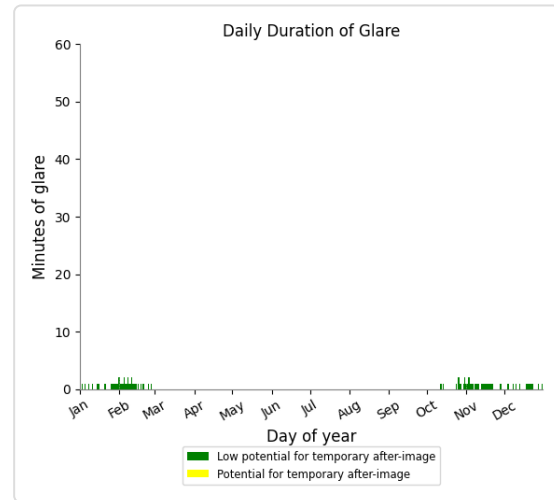
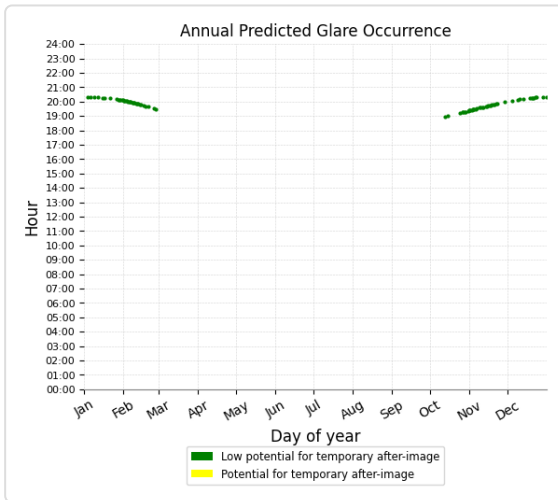
PV2 and FP: FP2

No glare found

PV2 and OP 5

Yellow glare: none

Green glare: 80 min.



PV2 and OP 1

No glare found

PV2 and OP 2

No glare found

PV2 and OP 3

No glare found

PV2 and OP 4

No glare found

PV: PV3 low potential for temporary after-image

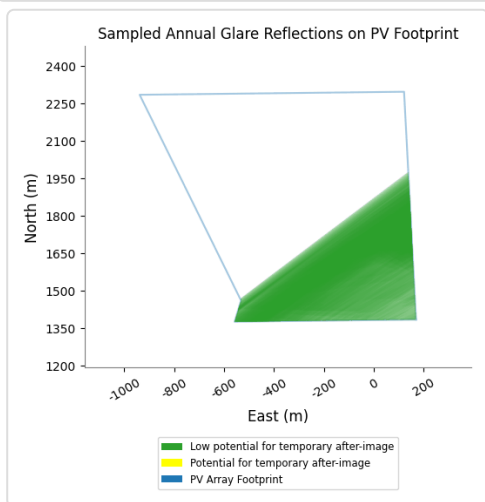
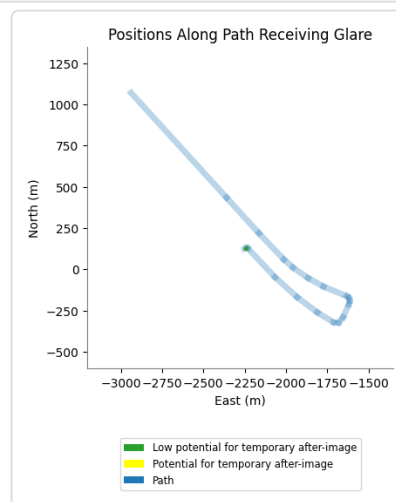
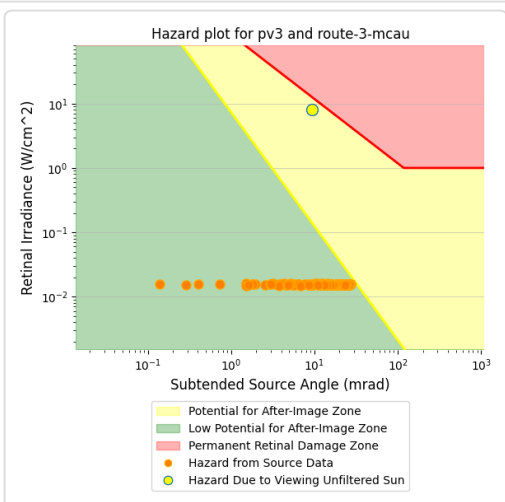
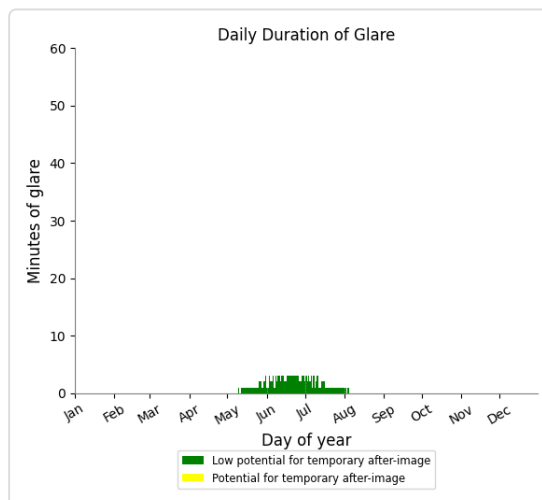
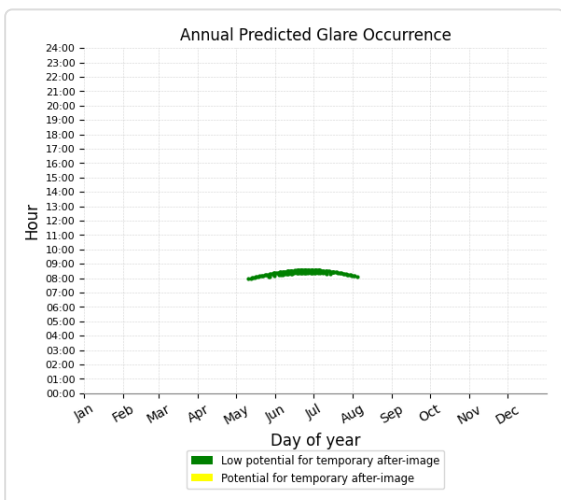
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 3 Mcaughtries Rd 2	153	2.5	0	0.0
Route 4 Mcaughtries Rd 3	51	0.8	0	0.0
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	0	0.0	0	0.0
Route 7 Tekapo River Rd	0	0.0	0	0.0
Route 8 Unnamed Rd 1	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

PV3 and Route: Route 3 Mcaughtries Rd 2

Yellow glare: none

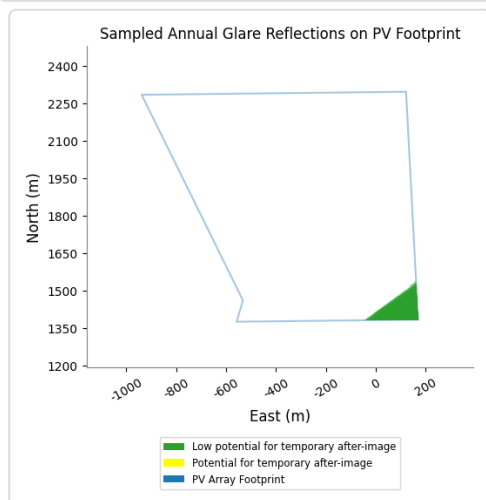
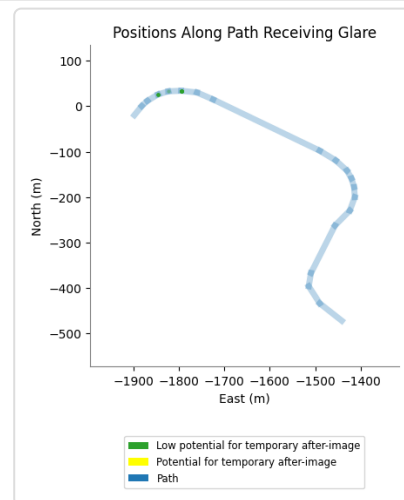
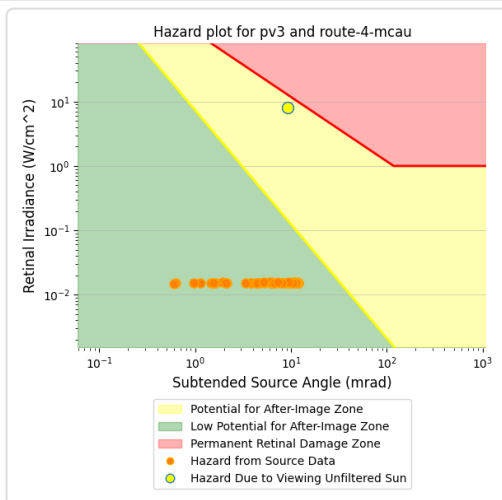
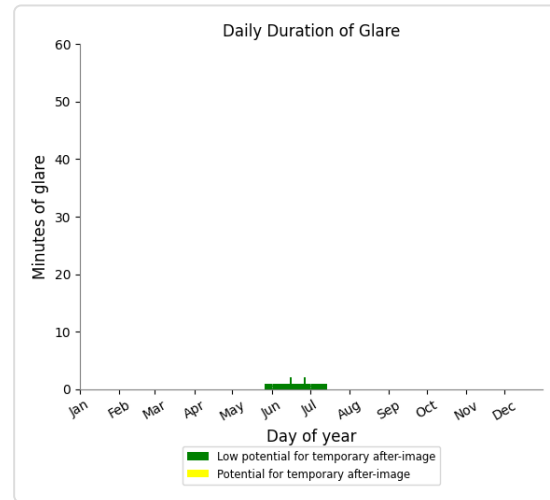
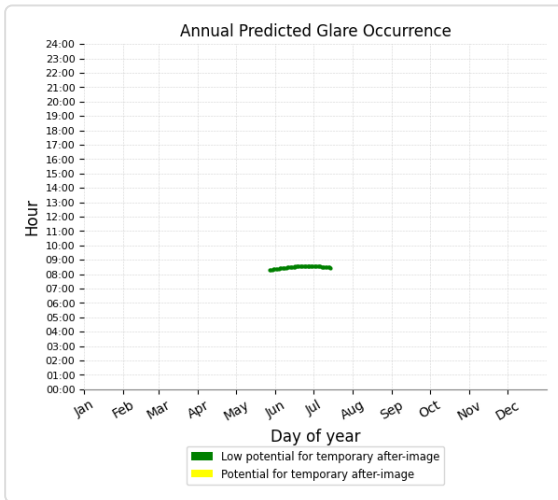
Green glare: 153 min.



PV3 and Route: Route 4 Mcaughtries Rd 3

Yellow glare: none

Green glare: 51 min.



PV3 and Route: Route 10 Unnamed Rd 3

No glare found

PV3 and Route: Route 11 Unnamed Rd 4

No glare found

PV3 and Route: Route 1 Falston Rd

No glare found

PV3 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV3 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV3 and Route: Route 6 Haldon Arm Rd

No glare found

PV3 and Route: Route 7 Tekapo River Rd

No glare found

PV3 and Route: Route 8 Unnamed Rd 1

No glare found

PV3 and Route: Route 9 Unnamed Rd 2

No glare found

PV3 and FP: FP1

No glare found

PV3 and FP: FP2

No glare found

PV3 and OP 1

No glare found

PV3 and OP 2

No glare found

PV3 and OP 3

No glare found

PV3 and OP 4

No glare found

PV3 and OP 5

No glare found

PV: PV4 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 3 Mcaughtries Rd 2	0	0.0	0	0.0
Route 4 Mcaughtries Rd 3	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	0	0.0	0	0.0
Route 7 Tekapo River Rd	0	0.0	0	0.0
Route 8 Unnamed Rd 1	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

PV4 and Route: Route 10 Unnamed Rd 3

No glare found

PV4 and Route: Route 11 Unnamed Rd 4

No glare found

PV4 and Route: Route 1 Falston Rd

No glare found

PV4 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV4 and Route: Route 3 Mcaughtries Rd 2

No glare found

PV4 and Route: Route 4 Mcaughtries Rd 3

No glare found

PV4 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV4 and Route: Route 6 Haldon Arm Rd

No glare found

PV4 and Route: Route 7 Tekapo River Rd

No glare found

PV4 and Route: Route 8 Unnamed Rd 1

No glare found

PV4 and Route: Route 9 Unnamed Rd 2

No glare found

PV4 and FP: FP1

No glare found

PV4 and FP: FP2

No glare found

PV4 and OP 1

No glare found

PV4 and OP 2

No glare found

PV4 and OP 3

No glare found

PV4 and OP 4

No glare found

PV4 and OP 5

No glare found

PV: PV5 potential temporary after-image

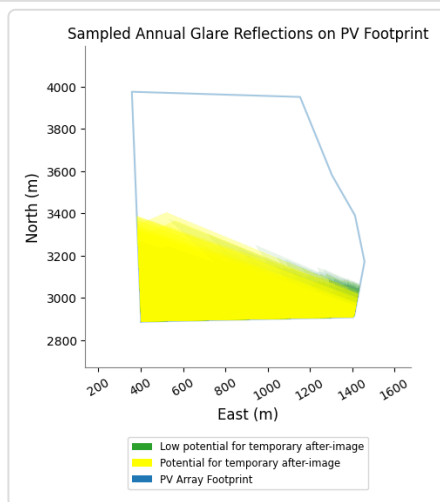
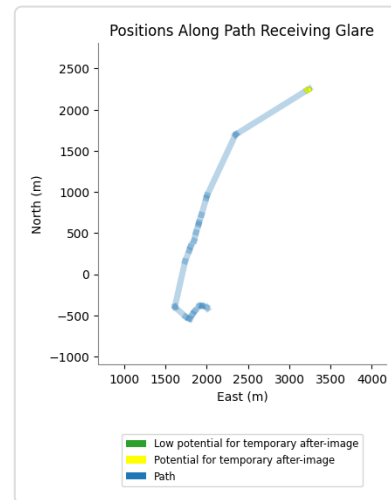
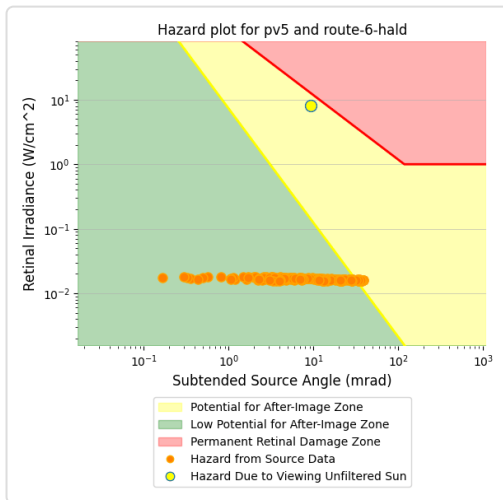
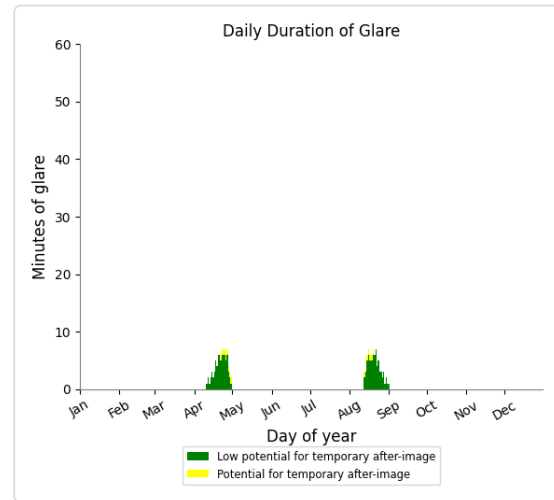
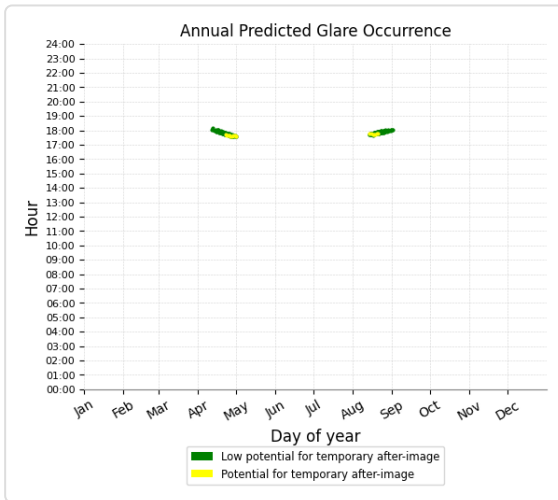
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 6 Haldon Arm Rd	150	2.5	16	0.3
Route 7 Tekapo River Rd	1,169	19.5	121	2.0
Route 8 Unnamed Rd 1	985	16.4	67	1.1
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 3 Mcaughtries Rd 2	0	0.0	0	0.0
Route 4 Mcaughtries Rd 3	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

PV5 and Route: Route 6 Haldon Arm Rd

Yellow glare: 16 min.

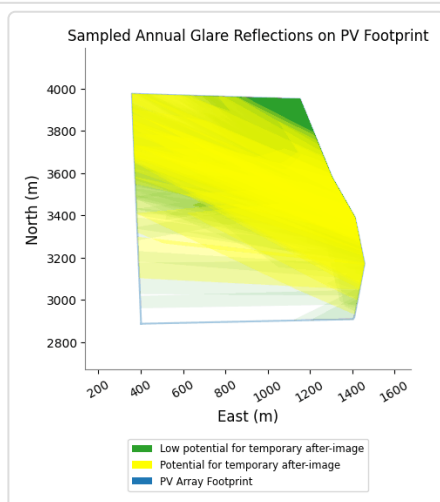
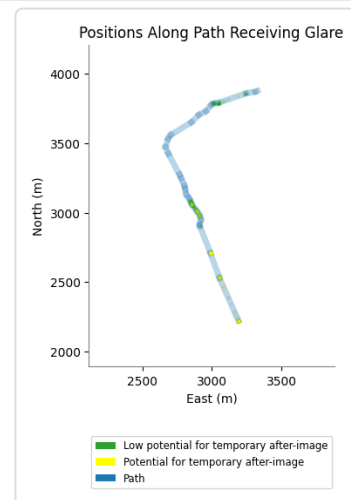
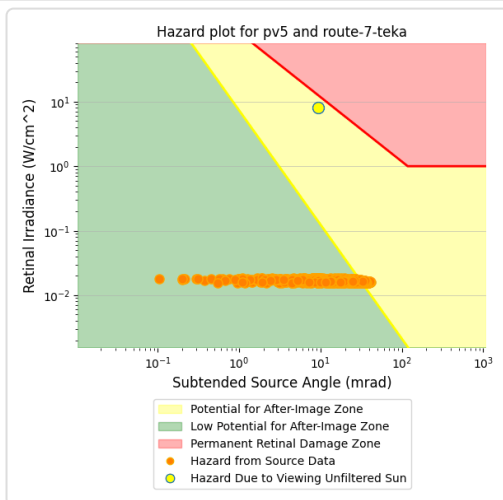
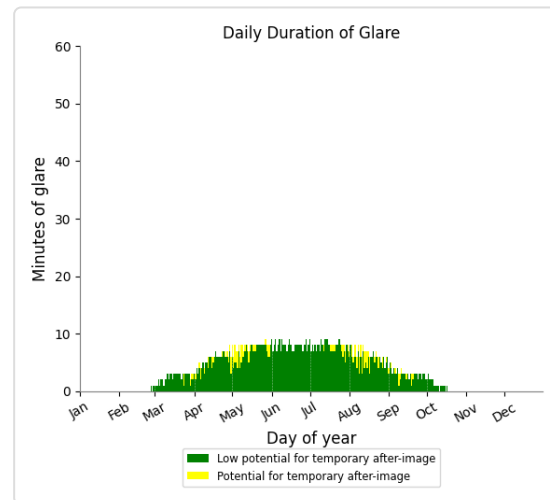
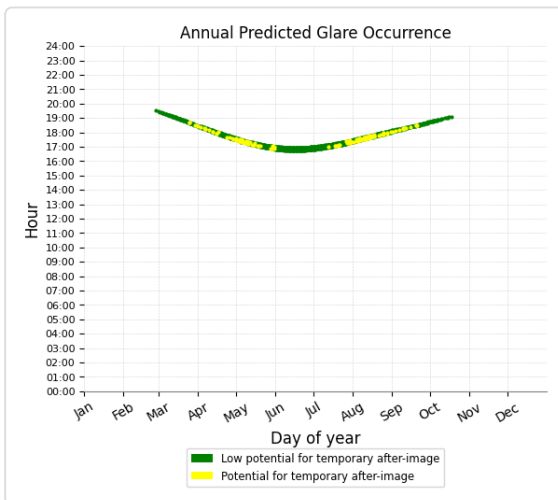
Green glare: 150 min.



PV5 and Route: Route 7 Tekapo River Rd

Yellow glare: 121 min.

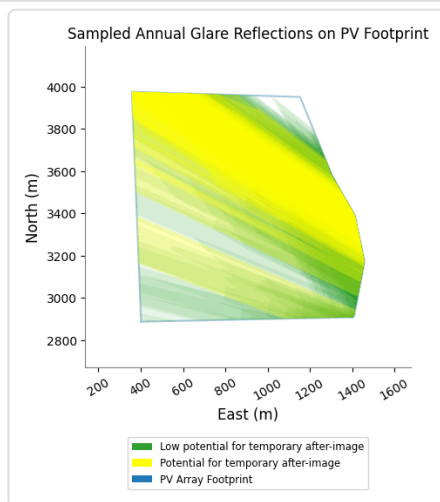
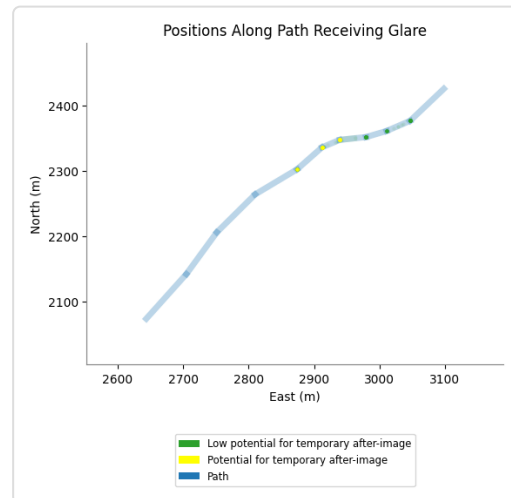
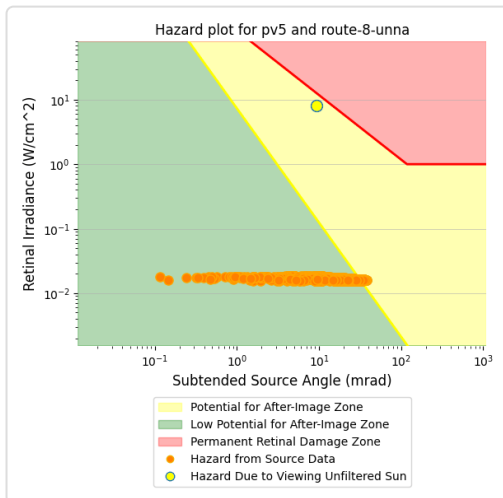
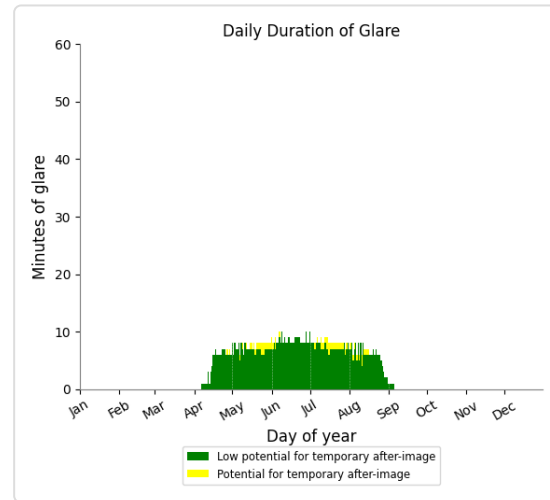
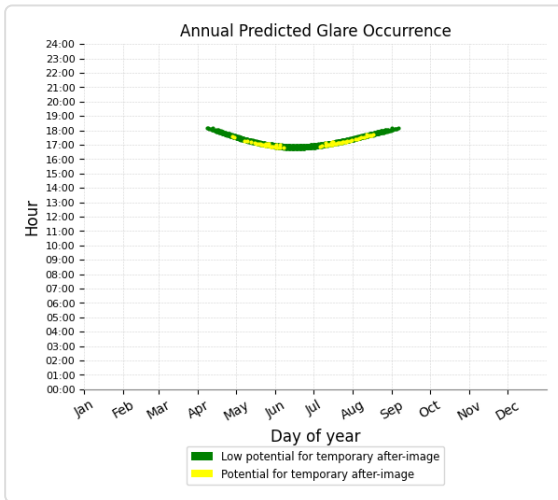
Green glare: 1,169 min.



PV5 and Route: Route 8 Unnamed Rd 1

Yellow glare: 67 min.

Green glare: 985 min.



PV5 and Route: Route 10 Unnamed Rd 3

No glare found

PV5 and Route: Route 11 Unnamed Rd 4

No glare found

PV5 and Route: Route 1 Falston Rd

No glare found

PV5 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV5 and Route: Route 3 Mcaughtries Rd 2

No glare found

PV5 and Route: Route 4 Mcaughtries Rd 3

No glare found

PV5 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV5 and Route: Route 9 Unnamed Rd 2

No glare found

PV5 and FP: FP1

No glare found

PV5 and FP: FP2

No glare found

PV5 and OP 1

No glare found

PV5 and OP 2

No glare found

PV5 and OP 3

No glare found

PV5 and OP 4

No glare found

PV5 and OP 5

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

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

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

© Sims Industries d/b/a ForgeSolar, All Rights Reserved.

APPENDIX B. YEAR 5 FORGESOLAR GLARE ANALYSIS

FORGESOLAR GLARE ANALYSIS

Project: **23053 - The Point SF**

Proposed 400 MW solar farm near ... NZ

Site configuration: **The Point 2 - Yr 5**

Client: Far North Solar Farm

Created 29 Jun, 2023

Updated 13 Jul, 2023

Time-step 1 minute

Timezone offset UTC12

Minimum sun altitude 0.0 deg

DNI peaks at 1,000.0 W/m²

Category 100 MW to 1 GW

Site ID 95116.16310

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

PV analysis methodology V2

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

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV1	SA tracking	SA tracking	11,798	196.6	166	2.8	210,100,000.0
PV2	SA tracking	SA tracking	413	6.9	26	0.4	219,700,000.0
PV3	SA tracking	SA tracking	140	2.3	0	0.0	218,400,000.0
PV4	SA tracking	SA tracking	0	0.0	0	0.0	218,800,000.0
PV5	SA tracking	SA tracking	2,212	36.9	182	3.0	216,300,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 10 Unnamed Rd 3	1,331	22.2	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 2 Mcaughtries Rd 1	1,215	20.2	0	0.0
Route 3 Mcaughtries Rd 2	1,502	25.0	0	0.0
Route 4 Mcaughtries Rd 3	1,424	23.7	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	1,555	25.9	202	3.4
Route 7 Tekapo River Rd	1,267	21.1	105	1.8
Route 8 Unnamed Rd 1	1,049	17.5	67	1.1
Route 9 Unnamed Rd 2	924	15.4	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	622	10.4	0	0.0
OP 2	1,064	17.7	0	0.0
OP 3	1,123	18.7	0	0.0
OP 4	1,472	24.5	0	0.0
OP 5	15	0.2	0	0.0

Component Data

PV Arrays

Name: PV1
Axis tracking: Single-axis rotation
Backtracking: Shade
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.38
Rated power: 84000.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.338794	170.200905	380.00	1.64	381.64
2	-44.334044	170.190305	378.83	1.64	380.47
3	-44.326437	170.193897	380.00	1.64	381.64
4	-44.326327	170.206920	379.00	1.64	380.64
5	-44.326884	170.206295	379.00	1.64	380.64
6	-44.329927	170.204918	380.00	1.64	381.64
7	-44.332140	170.204804	380.00	1.64	381.64
8	-44.338794	170.200905	380.00	1.64	381.64

Name: PV2
Axis tracking: Single-axis rotation
Backtracking: Shade
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.38
Rated power: 84000.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.326342	170.206924	379.00	1.64	380.64
2	-44.317531	170.210455	388.00	1.64	389.64
3	-44.314830	170.216876	383.00	1.64	384.64
4	-44.312621	170.218476	384.00	1.64	385.64
5	-44.312879	170.202096	401.53	1.64	403.17
6	-44.326343	170.203030	380.00	1.64	381.64
7	-44.326342	170.206924	379.00	1.64	380.64

Name: PV3

Axis tracking: Single-axis rotation

Backtracking: Shade

Tracking axis orientation: 0.0°

Max tracking angle: 60.0°

Resting angle: 0.0°

Ground Coverage Ratio: 0.38

Rated power: 84000.0 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.326343	170.203030	380.00	1.64	381.64
2	-44.326419	170.193906	380.00	1.64	381.64
3	-44.325651	170.194227	380.00	1.64	381.64
4	-44.318238	170.189135	401.00	1.64	402.64
5	-44.318129	170.202423	396.03	1.64	397.67
6	-44.326343	170.203030	380.00	1.64	381.64

Name: PV4

Axis tracking: Single-axis rotation

Backtracking: Shade

Tracking axis orientation: 0.0°

Max tracking angle: 60.0°

Resting angle: 0.0°

Ground Coverage Ratio: 0.38

Rated power: 84000.0 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.312822	170.205910	399.00	1.64	400.64
2	-44.302994	170.205393	405.00	1.64	406.64
3	-44.302853	170.197985	410.00	1.64	411.64
4	-44.305207	170.198273	408.94	1.64	410.58
5	-44.305316	170.197100	409.00	1.64	410.64
6	-44.308259	170.197690	407.00	1.64	408.64
7	-44.310480	170.196860	405.00	1.64	406.64
8	-44.311630	170.195876	405.00	1.64	406.64
9	-44.312932	170.194286	404.00	1.64	405.64
10	-44.314020	170.192271	404.00	1.64	405.64
11	-44.314866	170.186857	402.00	1.64	403.64
12	-44.318228	170.189143	401.00	1.64	402.64
13	-44.318123	170.202471	396.00	1.64	397.64
14	-44.312920	170.202069	401.21	1.64	402.85
15	-44.312822	170.205910	399.00	1.64	400.64

Name: PV5

Axis tracking: Single-axis rotation

Backtracking: Shade

Tracking axis orientation: 0.0°

Max tracking angle: 60.0°

Resting angle: 0.0°

Ground Coverage Ratio: 0.38

Rated power: 84000.0 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.312813	170.205942	399.00	1.64	400.64
2	-44.312622	170.218520	384.00	1.64	385.64
3	-44.312540	170.218587	384.00	1.64	385.64
4	-44.310253	170.219192	386.00	1.64	387.64
5	-44.308292	170.218628	390.22	1.64	391.86
6	-44.306576	170.217262	396.00	1.64	397.64
7	-44.303244	170.215371	401.00	1.64	402.64
8	-44.303023	170.205394	405.00	1.64	406.64
9	-44.312813	170.205942	399.00	1.64	400.64

Route Receptors

Name: Route 10 Unnamed Rd 3

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.341009	170.182909	375.87	1.50	377.37
2	-44.341623	170.184661	371.00	1.50	372.50
3	-44.342031	170.184894	372.09	1.50	373.59
4	-44.342742	170.187910	375.91	1.50	377.41
5	-44.342527	170.187911	375.00	1.50	376.50
6	-44.342388	170.187510	375.00	1.50	376.50
7	-44.341758	170.186216	372.95	1.50	374.45
8	-44.341048	170.185689	371.00	1.50	372.50
9	-44.340246	170.185495	371.00	1.50	372.50
10	-44.339739	170.185394	370.00	1.50	371.50
11	-44.339284	170.185559	370.00	1.50	371.50
12	-44.338028	170.186834	370.28	1.50	371.78
13	-44.337522	170.186742	370.00	1.50	371.50
14	-44.335902	170.185019	369.00	1.50	370.50
15	-44.335141	170.183604	369.00	1.50	370.50
16	-44.335152	170.183097	369.00	1.50	370.50
17	-44.335312	170.182282	369.00	1.50	370.50
18	-44.335574	170.181580	371.00	1.50	372.50
19	-44.335689	170.181472	371.36	1.50	372.86
20	-44.336167	170.180398	375.52	1.50	377.02
21	-44.336487	170.180171	377.69	1.50	379.19
22	-44.336705	170.180250	378.38	1.50	379.88
23	-44.337894	170.181300	378.00	1.50	379.50
24	-44.338406	170.181634	377.30	1.50	378.80
25	-44.339352	170.183253	373.37	1.50	374.87
26	-44.340005	170.184040	373.00	1.50	374.50
27	-44.340681	170.185189	371.00	1.50	372.50
28	-44.340625	170.184304	372.00	1.50	373.50
29	-44.341294	170.183773	372.00	1.50	373.50

Name: Route 11 Unnamed Rd 4

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.346965	170.175757	377.84	1.50	379.34
2	-44.348681	170.177288	376.00	1.50	377.50
3	-44.348798	170.177423	376.00	1.50	377.50
4	-44.350604	170.181749	378.00	1.50	379.50
5	-44.351000	170.182699	378.00	1.50	379.50
6	-44.351365	170.183192	378.00	1.50	379.50
7	-44.351982	170.183995	378.02	1.50	379.52
8	-44.352216	170.184252	378.82	1.50	380.32
9	-44.352474	170.184443	379.00	1.50	380.50
10	-44.352726	170.184565	379.00	1.50	380.50

Name: Route 1 Falston Rd
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.356478	170.196365	372.00	1.50	373.50
2	-44.356113	170.196363	372.00	1.50	373.50
3	-44.355946	170.196292	372.86	1.50	374.36
4	-44.355641	170.196253	373.00	1.50	374.50
5	-44.355226	170.196420	373.00	1.50	374.50
6	-44.352936	170.197035	374.00	1.50	375.50
7	-44.352569	170.197038	374.00	1.50	375.50
8	-44.352329	170.196883	375.00	1.50	376.50
9	-44.352026	170.196571	375.09	1.50	376.59
10	-44.349869	170.193119	379.00	1.50	380.50
11	-44.349430	170.192509	379.00	1.50	380.50
12	-44.348122	170.190958	380.00	1.50	381.50
13	-44.347247	170.189655	380.00	1.50	381.50
14	-44.346691	170.188596	380.04	1.50	381.54
15	-44.346337	170.187567	381.00	1.50	382.50
16	-44.346154	170.186964	382.00	1.50	383.50
17	-44.345382	170.184909	383.00	1.50	384.50

Name: Route 2 Mcaughtries Rd 1

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.330850	170.164343	401.00	1.50	402.50
2	-44.337237	170.172402	400.00	1.50	401.50
3	-44.338429	170.173061	400.00	1.50	401.50
4	-44.341409	170.173810	394.00	1.50	395.50
5	-44.342238	170.174323	394.00	1.50	395.50
6	-44.343151	170.175378	392.00	1.50	393.50
7	-44.344976	170.180214	388.00	1.50	389.50
8	-44.345682	170.182262	386.00	1.50	387.50
9	-44.345725	170.183257	385.00	1.50	386.50
10	-44.345131	170.185648	382.00	1.50	383.50
11	-44.344723	170.185945	380.43	1.50	381.93
12	-44.344387	170.185718	380.00	1.50	381.50
13	-44.343022	170.182867	379.00	1.50	380.50
14	-44.342838	170.183128	377.44	1.50	378.94
15	-44.342867	170.183421	376.93	1.50	378.43
16	-44.348179	170.195297	378.00	1.50	379.50
17	-44.348419	170.195395	377.46	1.50	378.96
18	-44.348530	170.195179	377.53	1.50	379.03
19	-44.348501	170.194728	378.00	1.50	379.50
20	-44.348808	170.194648	377.55	1.50	379.05
21	-44.348953	170.194701	377.00	1.50	378.50
22	-44.349038	170.194881	377.00	1.50	378.50
23	-44.349075	170.195040	377.00	1.50	378.50
24	-44.349075	170.195250	377.00	1.50	378.50
25	-44.348984	170.195460	377.00	1.50	378.50

Name: Route 3 Mcaughtries Rd 2

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.337668	170.172688	400.00	1.50	401.50
2	-44.337625	170.172819	400.00	1.50	401.50
3	-44.337650	170.172947	400.00	1.50	401.50
4	-44.339220	170.174996	400.00	1.50	401.50
5	-44.340310	170.176679	400.00	1.50	401.50
6	-44.341146	170.178223	400.00	1.50	401.50
7	-44.341685	170.179463	400.00	1.50	401.50
8	-44.341706	170.179831	400.00	1.50	401.50
9	-44.341408	170.180167	401.00	1.50	402.50
10	-44.340712	170.180598	401.00	1.50	402.50
11	-44.340507	170.180667	401.00	1.50	402.50
12	-44.340346	170.180607	401.00	1.50	402.50
13	-44.340254	170.180445	401.00	1.50	402.50
14	-44.339731	170.178677	400.00	1.50	401.50
15	-44.339266	170.177513	400.00	1.50	401.50
16	-44.338691	170.176359	400.00	1.50	401.50
17	-44.338260	170.175681	400.00	1.50	401.50
18	-44.336822	170.173778	401.00	1.50	402.50
19	-44.334880	170.171318	401.33	1.50	402.83
20	-44.329159	170.164063	404.00	1.50	405.50

Name: Route 4 Mcaughtries Rd 3

Path type: Two-way

Observer view angle: 50.0°

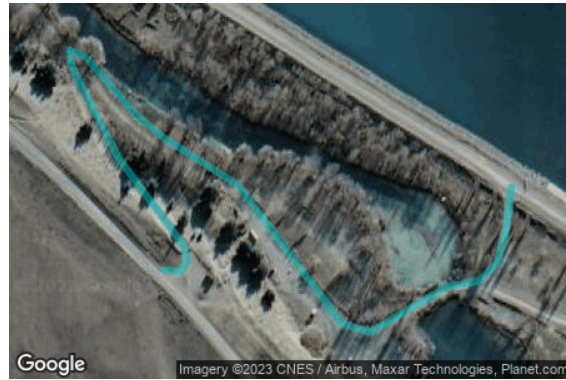


Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.343040	170.182830	379.28	1.50	380.78
2	-44.342695	170.182220	378.94	1.50	380.44
3	-44.342357	170.181917	377.94	1.50	379.44
4	-44.342095	170.181980	376.18	1.50	377.68
5	-44.341157	170.182641	375.58	1.50	377.08
6	-44.340859	170.183051	376.41	1.50	377.91
7	-44.340593	170.183188	377.13	1.50	378.63
8	-44.340395	170.183169	378.00	1.50	379.50
9	-44.340223	170.183096	378.18	1.50	379.68
10	-44.340068	170.182971	379.18	1.50	380.68
11	-44.339868	170.182664	380.28	1.50	381.78
12	-44.339675	170.182221	382.80	1.50	384.30
13	-44.338662	170.179281	399.17	1.50	400.67
14	-44.338523	170.178835	400.00	1.50	401.50
15	-44.338490	170.178399	400.00	1.50	401.50
16	-44.338501	170.178043	400.00	1.50	401.50
17	-44.338562	170.177760	400.00	1.50	401.50
18	-44.338689	170.177467	400.00	1.50	401.50
19	-44.338792	170.177312	400.00	1.50	401.50
20	-44.338972	170.177108	400.00	1.50	401.50

Name: Route 5 Mcaughtries Rd 4

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.347609	170.193981	379.00	1.50	380.50
2	-44.347894	170.193930	379.00	1.50	380.50
3	-44.348077	170.193856	378.34	1.50	379.84
4	-44.348185	170.193698	378.09	1.50	379.59
5	-44.348221	170.193423	378.99	1.50	380.49
6	-44.348499	170.192765	379.00	1.50	380.50
7	-44.348443	170.192527	379.00	1.50	380.50
8	-44.347595	170.191629	379.00	1.50	380.50
9	-44.347304	170.190987	379.00	1.50	380.50
10	-44.347165	170.190755	379.00	1.50	380.50
11	-44.346813	170.190325	379.00	1.50	380.50
12	-44.346773	170.190192	379.00	1.50	380.50
13	-44.346868	170.190203	379.48	1.50	380.98
14	-44.347430	170.190605	380.00	1.50	381.50
15	-44.347977	170.191174	380.00	1.50	381.50
16	-44.348059	170.191200	380.00	1.50	381.50
17	-44.348127	170.191137	380.00	1.50	381.50
18	-44.348114	170.191001	380.00	1.50	381.50

Name: Route 6 Haldon Arm Rd

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.342555	170.226106	377.00	1.50	378.50
2	-44.342427	170.225980	377.00	1.50	378.50
3	-44.342270	170.225337	377.00	1.50	378.50
4	-44.342257	170.225207	377.00	1.50	378.50
5	-44.342284	170.224833	377.00	1.50	378.50
6	-44.342845	170.224144	377.00	1.50	378.50
7	-44.343147	170.223841	377.00	1.50	378.50
8	-44.343669	170.223419	376.00	1.50	377.50
9	-44.343636	170.223239	376.00	1.50	377.50
10	-44.343438	170.222768	376.00	1.50	377.50
11	-44.342423	170.221191	376.00	1.50	377.50
12	-44.342305	170.221141	376.00	1.50	377.50
13	-44.337375	170.222685	377.00	1.50	378.50
14	-44.336203	170.223318	378.00	1.50	379.50
15	-44.335765	170.223519	378.00	1.50	379.50
16	-44.335130	170.224042	378.00	1.50	379.50
17	-44.334233	170.224345	378.00	1.50	379.50
18	-44.333356	170.224723	379.00	1.50	380.50
19	-44.333144	170.224794	379.00	1.50	380.50
20	-44.332307	170.225165	379.00	1.50	380.50
21	-44.330476	170.225904	379.00	1.50	380.50
22	-44.330170	170.226031	379.00	1.50	380.50
23	-44.323574	170.230314	376.00	1.50	377.50
24	-44.323488	170.230452	376.00	1.50	377.50
25	-44.318520	170.241575	382.00	1.50	383.50

Name: Route 7 Tekapo River Rd

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.318803	170.240924	381.00	1.50	382.50
2	-44.316019	170.239207	382.52	1.50	384.02
3	-44.314430	170.238404	382.00	1.50	383.50
4	-44.312669	170.237443	381.00	1.50	382.50
5	-44.312574	170.237430	381.00	1.50	382.50
6	-44.312266	170.237538	381.00	1.50	382.50
7	-44.311995	170.237438	381.00	1.50	382.50
8	-44.311713	170.237186	380.00	1.50	381.50
9	-44.311266	170.236720	380.00	1.50	381.50
10	-44.311067	170.236605	380.00	1.50	381.50
11	-44.310877	170.236478	380.00	1.50	381.50
12	-44.310624	170.236233	380.00	1.50	381.50
13	-44.310277	170.236125	381.00	1.50	382.50
14	-44.310036	170.236044	381.00	1.50	382.50
15	-44.309598	170.235774	381.74	1.50	383.24
16	-44.309322	170.235601	382.00	1.50	383.50
17	-44.307983	170.234611	381.00	1.50	382.50
18	-44.307543	170.234355	381.00	1.50	382.50
19	-44.307015	170.234581	382.00	1.50	383.50
20	-44.306761	170.234842	382.83	1.50	384.33
21	-44.305950	170.236680	385.00	1.50	386.50
22	-44.305470	170.237365	386.00	1.50	387.50
23	-44.305233	170.237986	387.00	1.50	388.50
24	-44.304834	170.238462	388.00	1.50	389.50
25	-44.304735	170.238695	388.24	1.50	389.74
26	-44.304690	170.239100	389.00	1.50	390.50
27	-44.304077	170.241599	393.00	1.50	394.50
28	-44.303971	170.242436	394.00	1.50	395.50
29	-44.303910	170.242647	394.00	1.50	395.50

Name: Route 8 Unnamed Rd 1

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.320133	170.234052	378.00	1.50	379.50
2	-44.319520	170.234820	379.00	1.50	380.50
3	-44.318946	170.235404	380.00	1.50	381.50
4	-44.318424	170.236139	380.00	1.50	381.50
5	-44.318080	170.236944	380.00	1.50	381.50
6	-44.317777	170.237422	381.00	1.50	382.50
7	-44.317676	170.237760	381.00	1.50	382.50
8	-44.317637	170.238266	381.00	1.50	382.50
9	-44.317553	170.238660	381.00	1.50	382.50
10	-44.317414	170.239110	382.00	1.50	383.50
11	-44.316974	170.239757	382.00	1.50	383.50

Name: Route 9 Unnamed Rd 2

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-44.334627	170.165110	396.00	1.50	397.50
2	-44.346959	170.175782	377.71	1.50	379.21
3	-44.346777	170.175791	378.00	1.50	379.50
4	-44.346701	170.175833	378.00	1.50	379.50
5	-44.346563	170.176058	379.00	1.50	380.50
6	-44.344885	170.179803	388.00	1.50	389.50

Flight Path Receptors

Name: FP1
Description: None
Threshold height: 15 m
Direction: 171.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-44.243637	170.120187	462.00	15.00	477.00
Two-mile	-44.272693	170.125988	444.00	120.00	564.00

Name: FP2
Description: None
Threshold height: 15 m
Direction: 171.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-44.233812	170.118270	479.00	15.00	494.00
Two-mile	-44.205073	170.113111	520.00	120.00	640.00

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-44.344335	170.186620	379.89	1.65
OP 2	2	-44.343304	170.180295	391.00	1.65
OP 3	3	-44.341905	170.182614	373.00	1.65
OP 4	4	-44.342322	170.224376	377.00	1.65
OP 5	5	-44.308104	170.234694	381.00	1.65

Obstruction Components

Name: Obstruction 1

Top height: 5.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.303075	170.216119	400.00
2	-44.303075	170.216634	400.00
3	-44.307651	170.219209	389.46
4	-44.306407	170.217986	395.00
5	-44.303075	170.216119	400.00

Name: Obstruction 2

Top height: 5.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.322132	170.191311	390.24
2	-44.325586	170.193456	380.00
3	-44.334532	170.189658	377.00
4	-44.334255	170.189165	376.75
5	-44.330341	170.190238	378.00
6	-44.327333	170.191632	379.00
7	-44.324042	170.191426	382.00
8	-44.323182	170.190954	383.00
9	-44.322132	170.191311	390.24

Name: Obstruction 3

Top height: 5.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.318500	170.188506	400.00
2	-44.321355	170.190780	394.22
3	-44.320035	170.188892	399.00
4	-44.319114	170.188677	399.00
5	-44.318500	170.188506	400.00

Name: Obstruction 4

Top height: 5.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.334511	170.189616	377.00
2	-44.339914	170.200967	380.00
3	-44.337167	170.195710	380.00
4	-44.336906	170.194788	380.00
5	-44.335816	170.193221	380.00
6	-44.334511	170.189616	377.00

Name: Obstruction 5

Top height: 5.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.333345	170.204851	380.00
2	-44.339898	170.201032	380.00
3	-44.339668	170.200688	380.00
4	-44.337090	170.202448	380.00
5	-44.335647	170.203177	380.00
6	-44.334266	170.204057	380.00
7	-44.333345	170.204851	380.00

Name: Obstruction 6

Top height: 5.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.313225	170.220215	381.00
2	-44.313286	170.219765	381.77
3	-44.313179	170.218477	383.03
4	-44.312703	170.218949	383.63
5	-44.310338	170.219679	384.99
6	-44.308757	170.219700	386.00
7	-44.310031	170.220387	383.00
8	-44.313225	170.220215	381.00

Name: Obstruction 7

Top height: 5.0 m



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-44.313332	170.219765	381.32
2	-44.327318	170.207662	379.00
3	-44.332168	170.205452	380.00
4	-44.330081	170.205409	380.00
5	-44.327164	170.206890	379.00
6	-44.326443	170.207791	379.00
7	-44.317815	170.211182	386.02
8	-44.315113	170.217404	382.00
9	-44.313225	170.218499	383.00
10	-44.313332	170.219765	381.32

Glare Analysis Results

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

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV1	SA tracking	SA tracking	11,798	196.6	166	2.8	210,100,000.0
PV2	SA tracking	SA tracking	413	6.9	26	0.4	219,700,000.0
PV3	SA tracking	SA tracking	140	2.3	0	0.0	218,400,000.0
PV4	SA tracking	SA tracking	0	0.0	0	0.0	218,800,000.0
PV5	SA tracking	SA tracking	2,212	36.9	182	3.0	216,300,000.0

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 10 Unnamed Rd 3	1,331	22.2	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	1,215	20.2	0	0.0
Route 3 Mcaughtries Rd 2	1,502	25.0	0	0.0
Route 4 Mcaughtries Rd 3	1,424	23.7	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	1,555	25.9	202	3.4
Route 7 Tekapo River Rd	1,267	21.1	105	1.8
Route 8 Unnamed Rd 1	1,049	17.5	67	1.1
Route 9 Unnamed Rd 2	924	15.4	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	622	10.4	0	0.0
OP 2	1,064	17.7	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 3	1,123	18.7	0	0.0
OP 4	1,472	24.5	0	0.0
OP 5	15	0.2	0	0.0

PV: PV1 potential temporary after-image

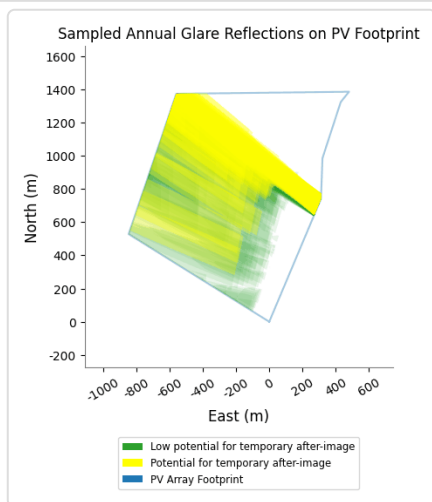
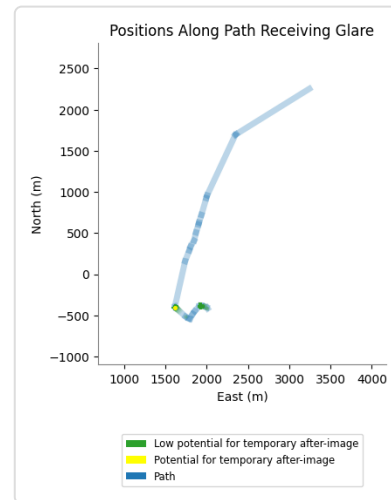
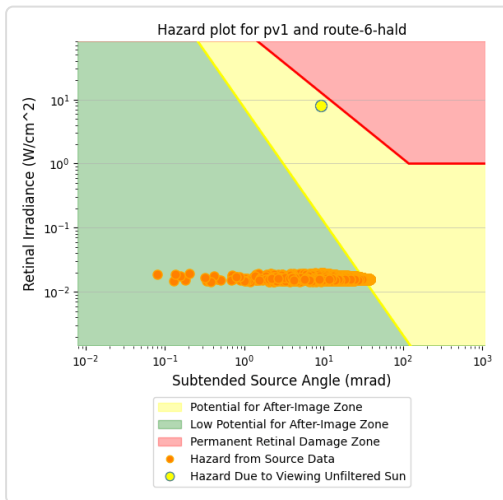
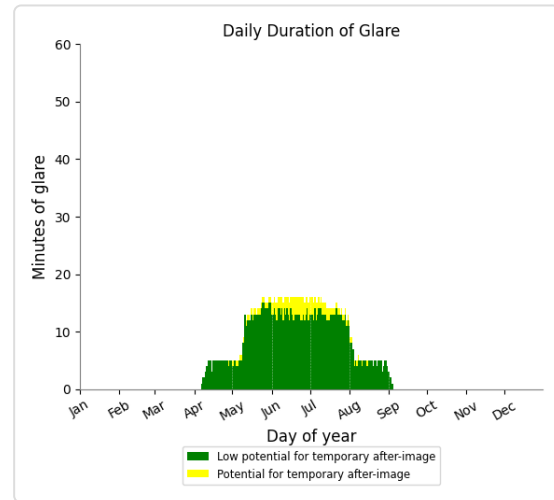
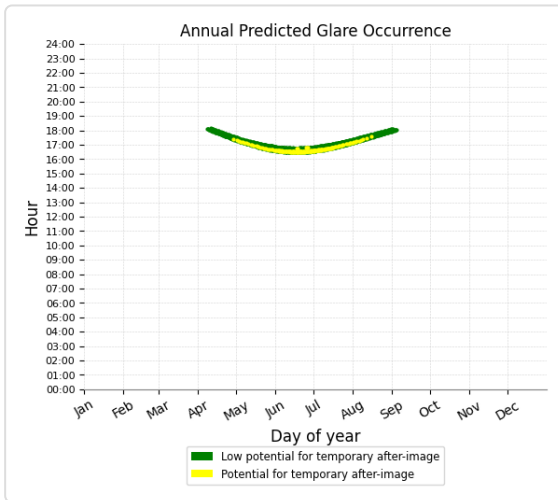
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 6 Haldon Arm Rd	1,390	23.2	166	2.8
Route 10 Unnamed Rd 3	1,331	22.2	0	0.0
Route 2 Mcaughtries Rd 1	1,215	20.2	0	0.0
Route 3 Mcaughtries Rd 2	1,335	22.2	0	0.0
Route 4 Mcaughtries Rd 3	1,322	22.0	0	0.0
Route 9 Unnamed Rd 2	924	15.4	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 7 Tekapo River Rd	0	0.0	0	0.0
Route 8 Unnamed Rd 1	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	622	10.4	0	0.0
OP 2	1,064	17.7	0	0.0
OP 3	1,123	18.7	0	0.0
OP 4	1,472	24.5	0	0.0
OP 5	0	0.0	0	0.0

PV1 and Route: Route 6 Haldon Arm Rd

Yellow glare: 166 min.

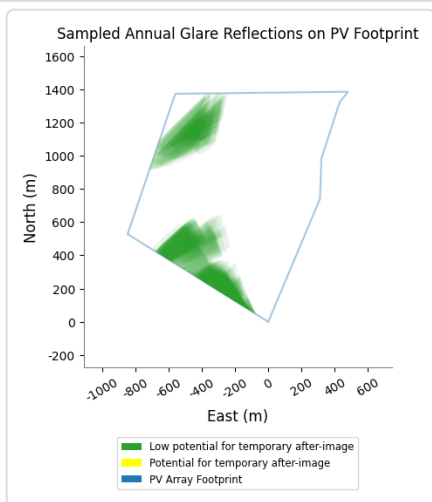
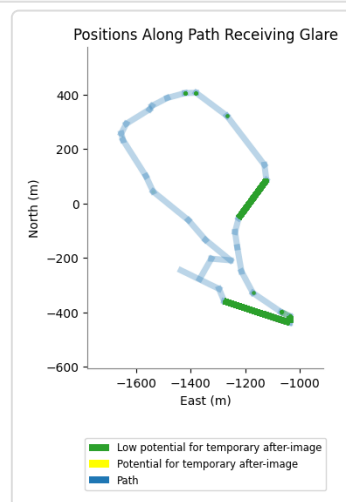
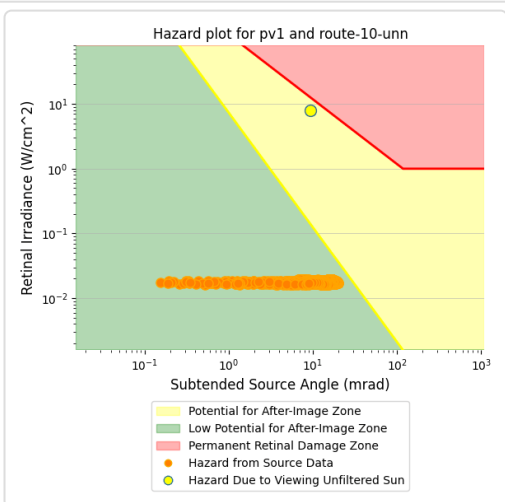
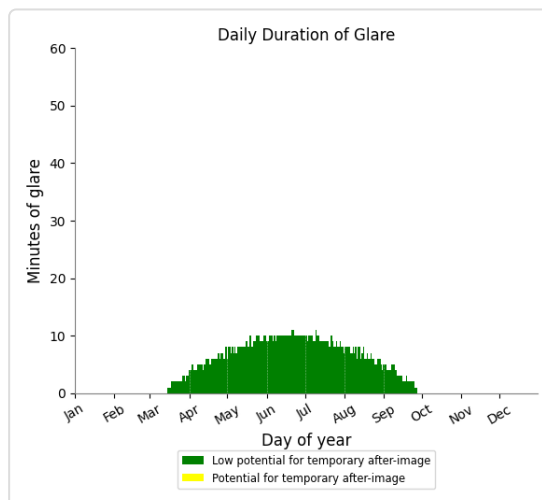
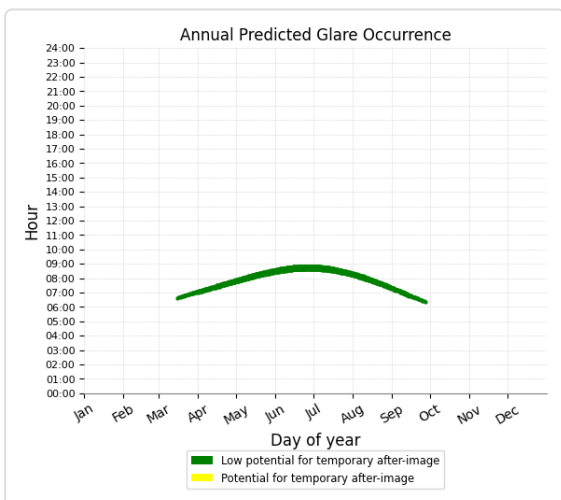
Green glare: 1,390 min.



PV1 and Route: Route 10 Unnamed Rd 3

Yellow glare: none

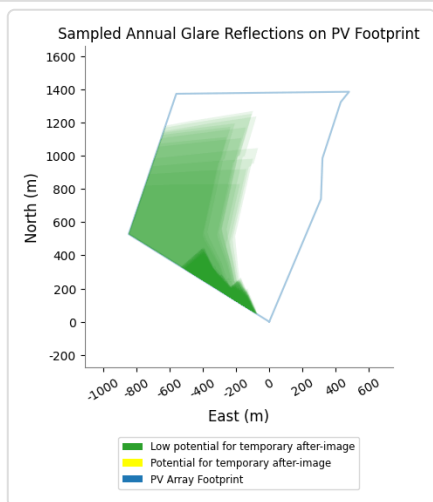
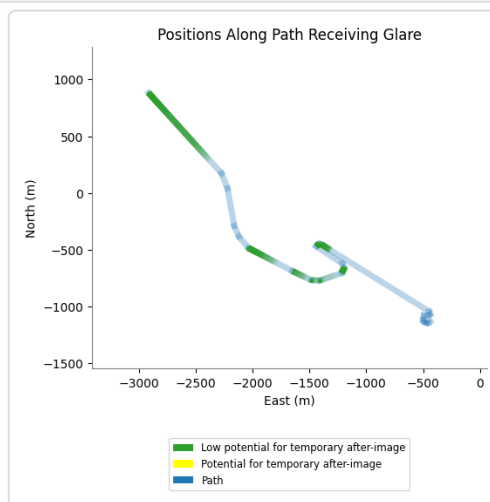
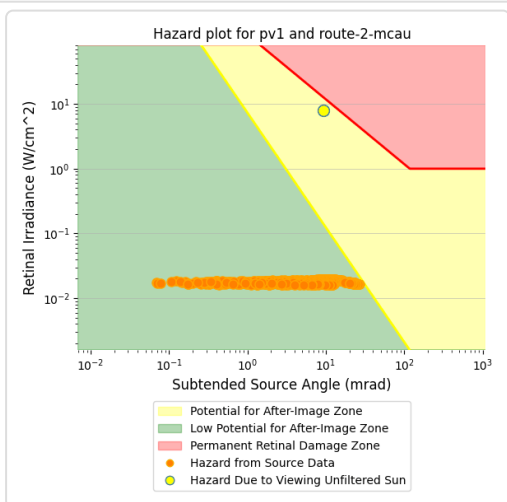
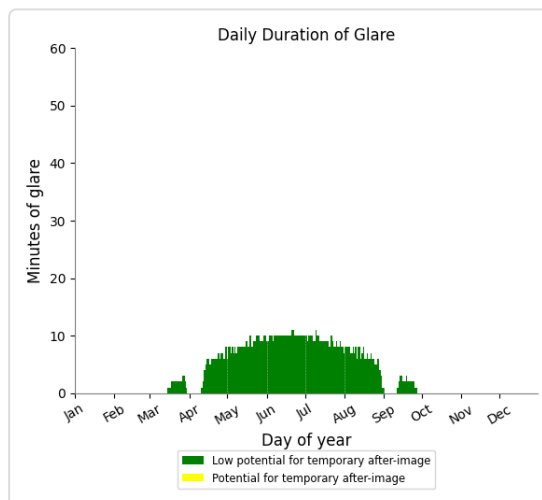
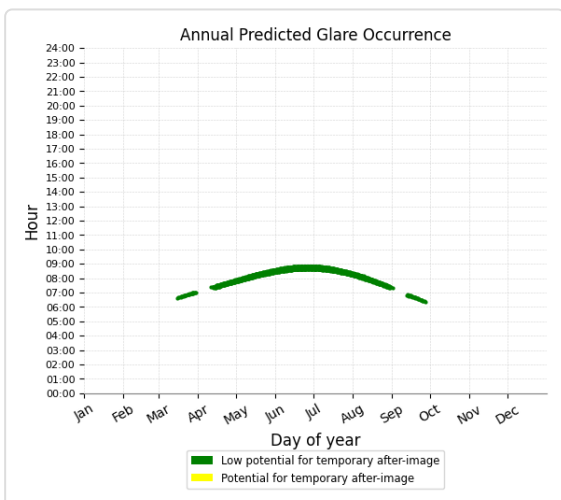
Green glare: 1,331 min.



PV1 and Route: Route 2 Mcaughtries Rd 1

Yellow glare: none

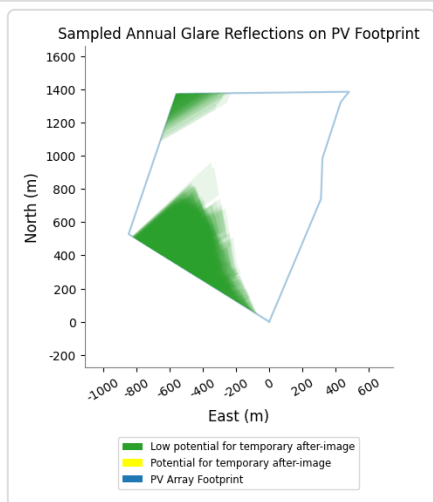
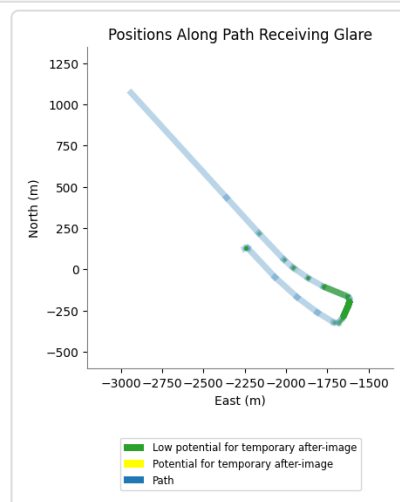
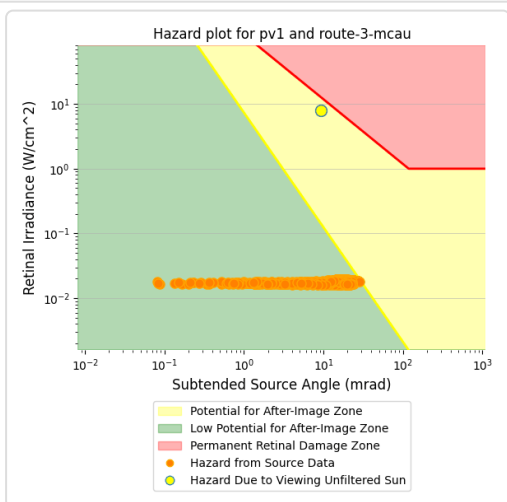
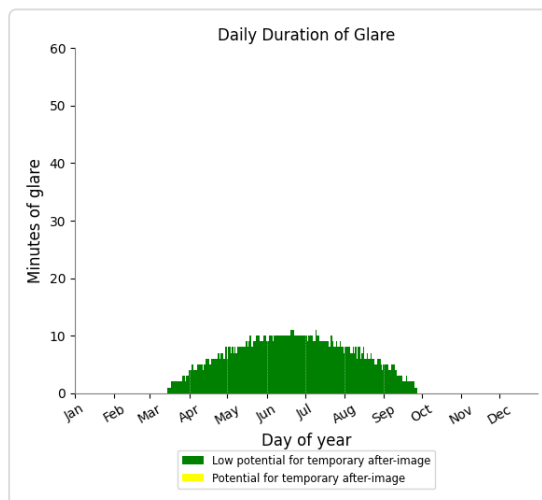
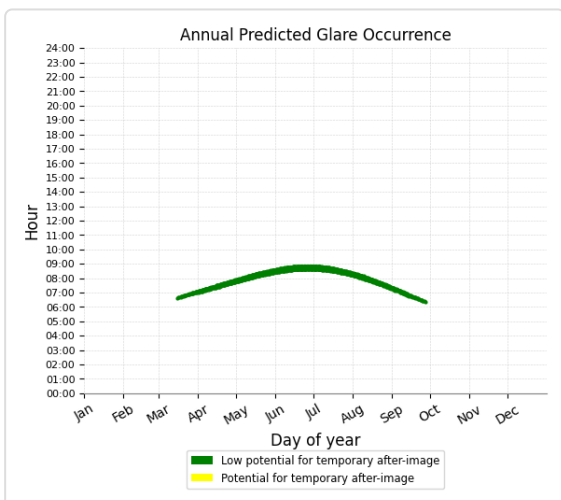
Green glare: 1,215 min.



PV1 and Route: Route 3 Mcaughtries Rd 2

Yellow glare: none

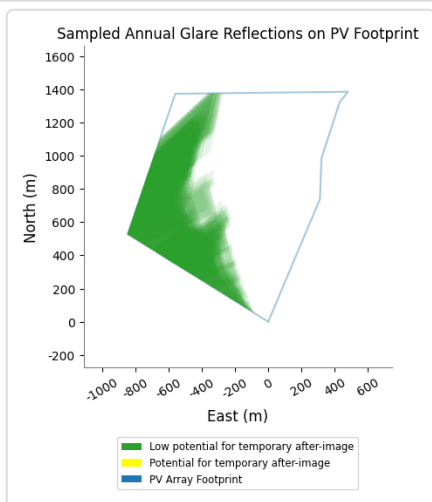
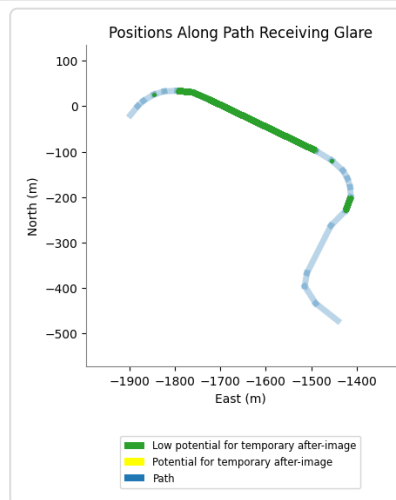
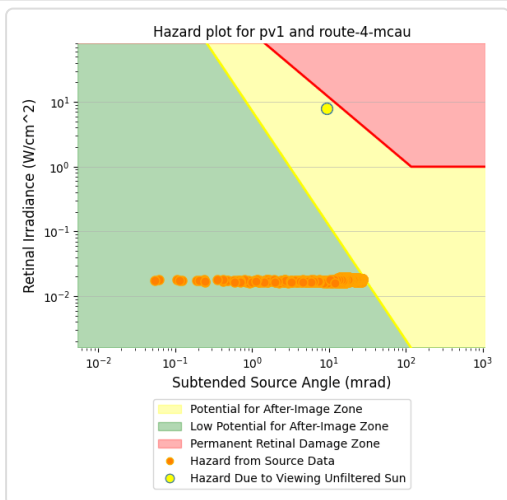
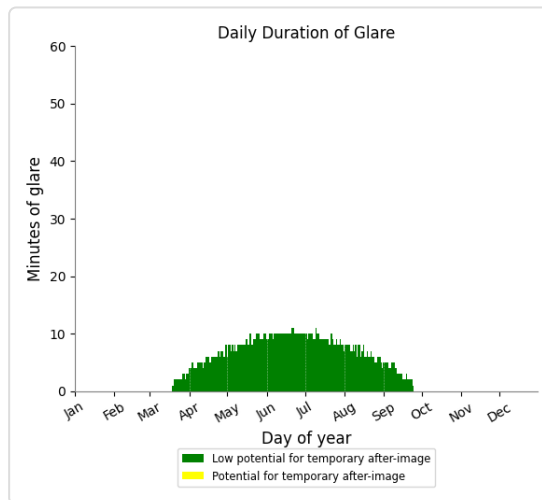
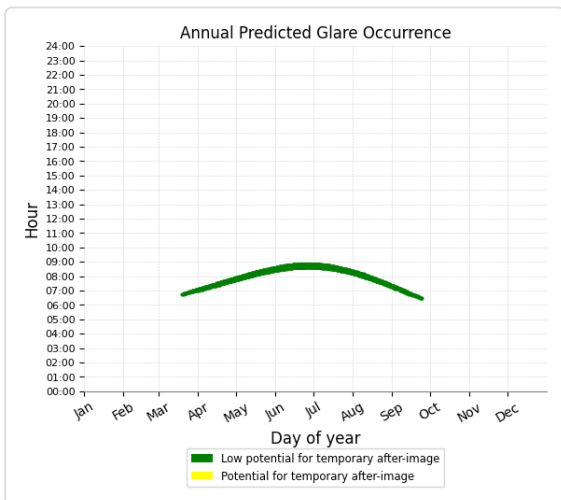
Green glare: 1,335 min.



PV1 and Route: Route 4 Mcaughtries Rd 3

Yellow glare: none

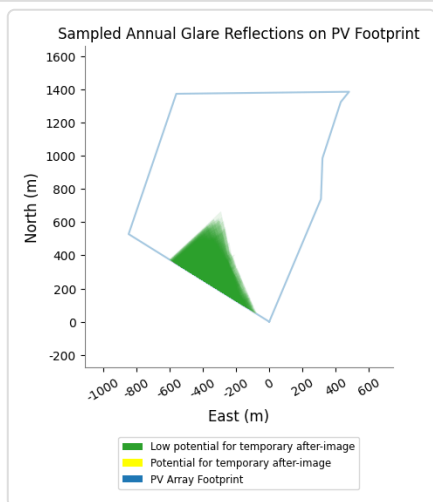
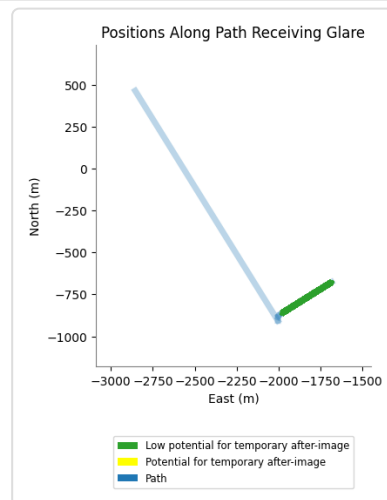
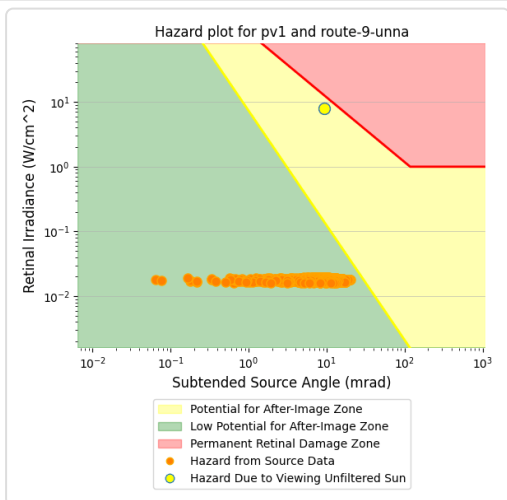
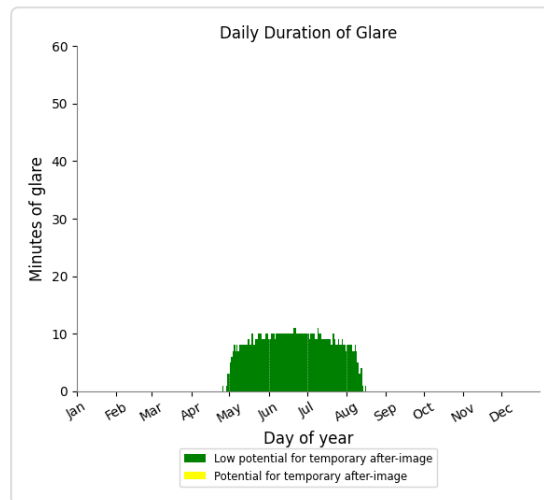
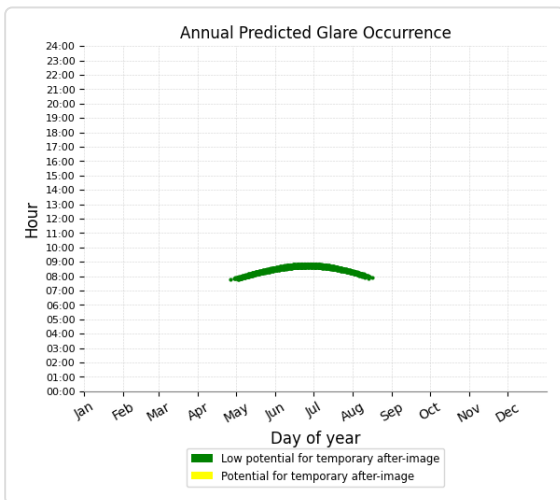
Green glare: 1,322 min.



PV1 and Route: Route 9 Unnamed Rd 2

Yellow glare: none

Green glare: 924 min.



PV1 and Route: Route 11 Unnamed Rd 4

No glare found

PV1 and Route: Route 1 Falston Rd

No glare found

PV1 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV1 and Route: Route 7 Tekapo River Rd

No glare found

PV1 and Route: Route 8 Unnamed Rd 1

No glare found

PV1 and FP: FP1

No glare found

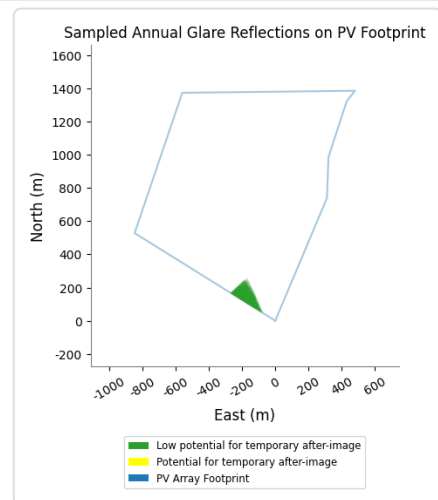
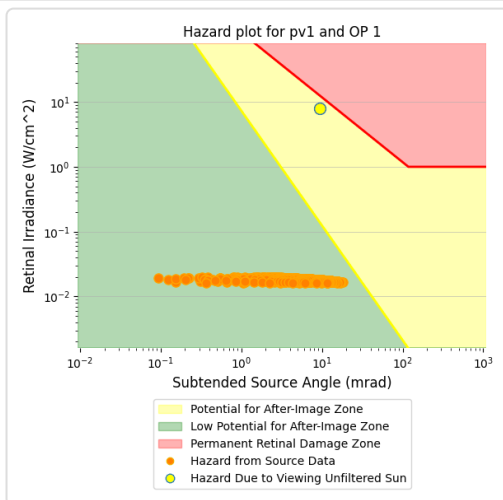
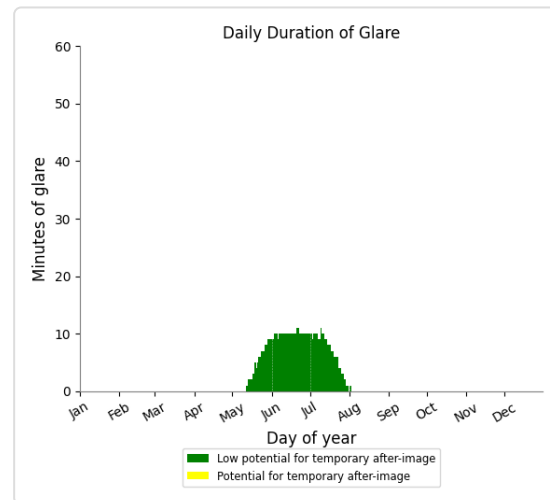
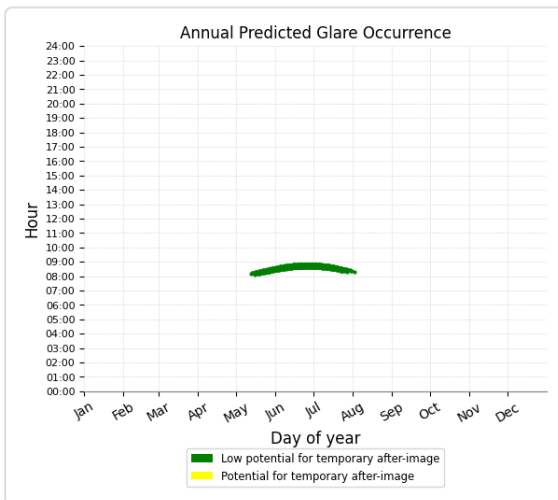
PV1 and FP: FP2

No glare found

PV1 and OP 1

Yellow glare: none

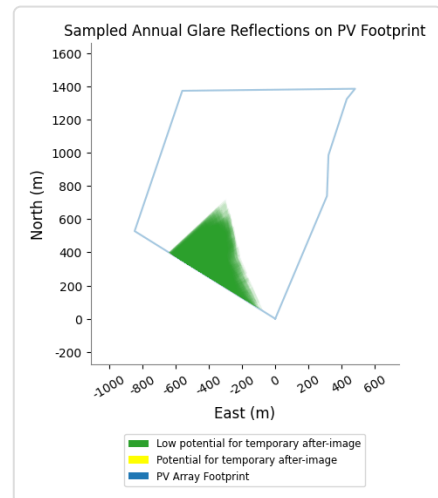
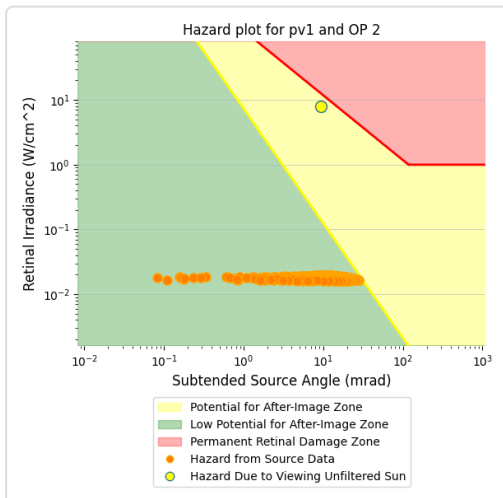
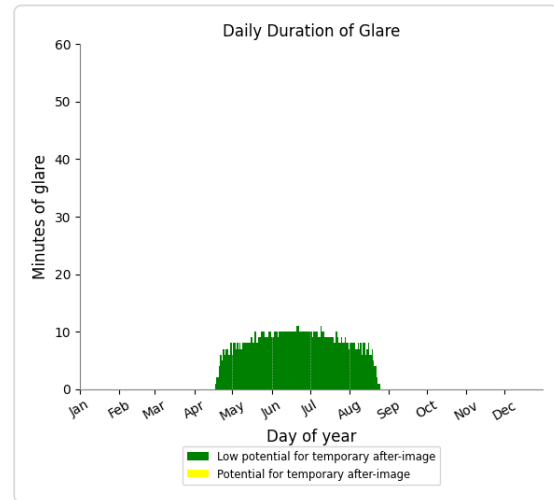
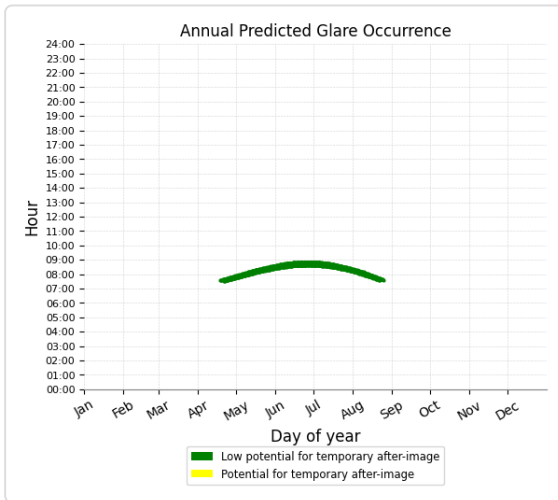
Green glare: 622 min.



PV1 and OP 2

Yellow glare: none

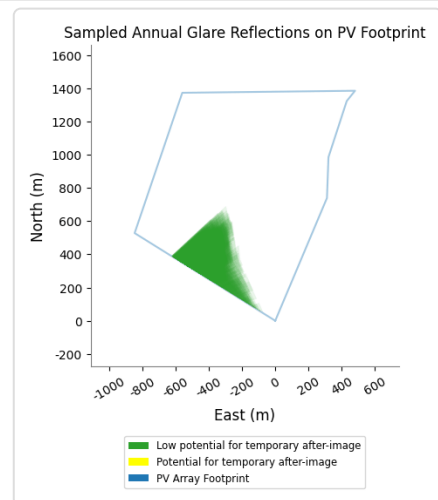
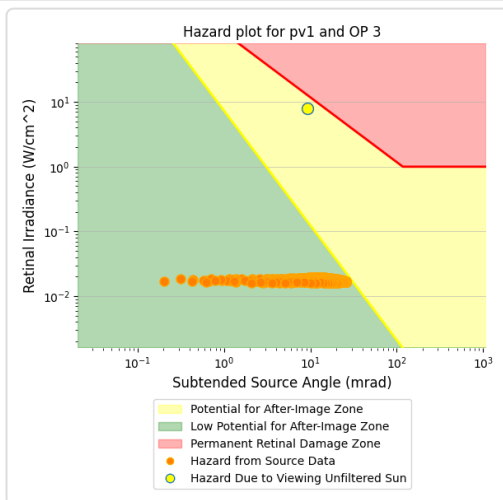
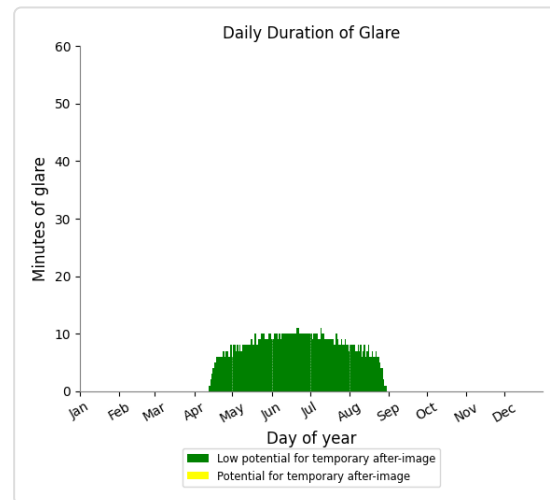
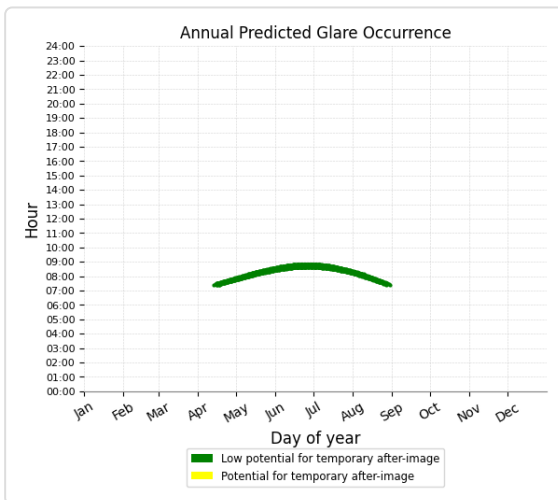
Green glare: 1,064 min.



PV1 and OP 3

Yellow glare: none

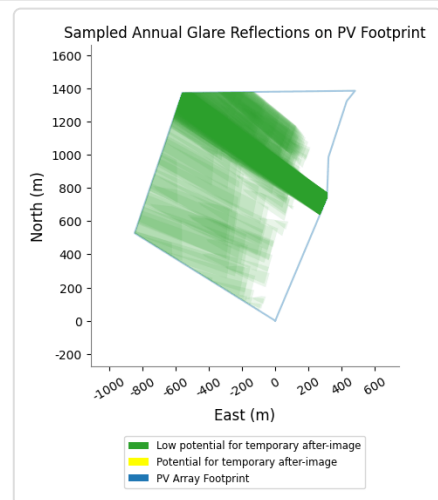
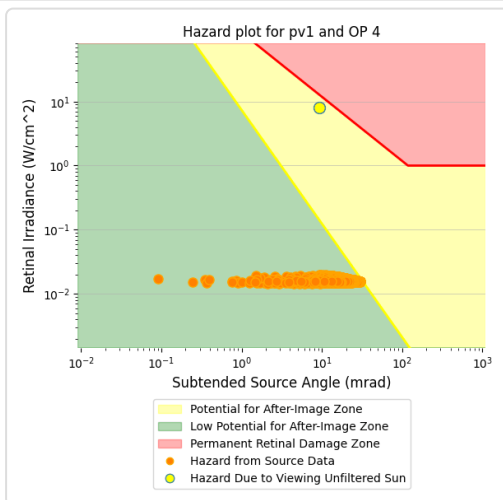
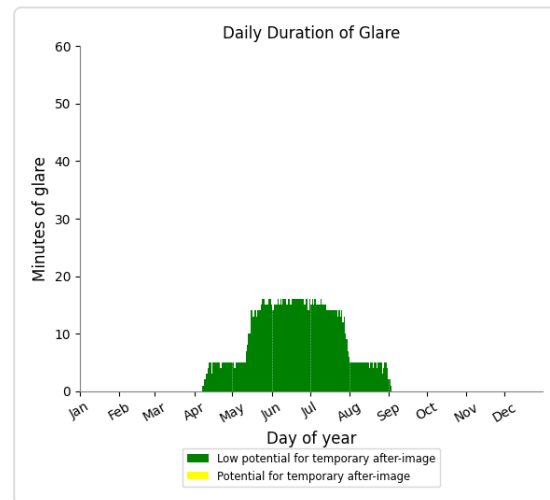
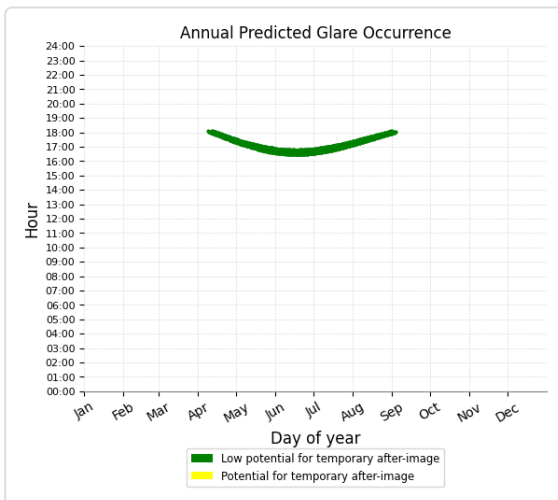
Green glare: 1,123 min.



PV1 and OP 4

Yellow glare: none

Green glare: 1,472 min.



PV1 and OP 5

No glare found

PV: PV2 potential temporary after-image

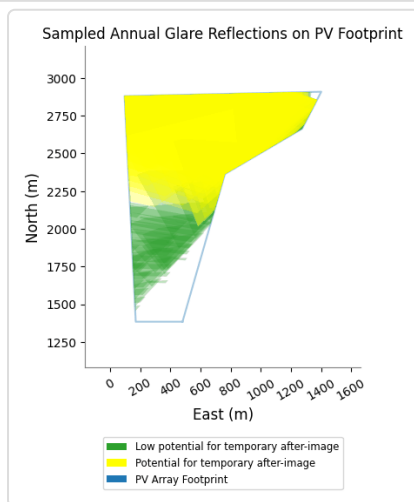
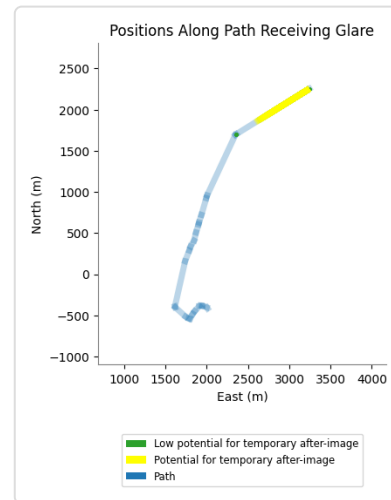
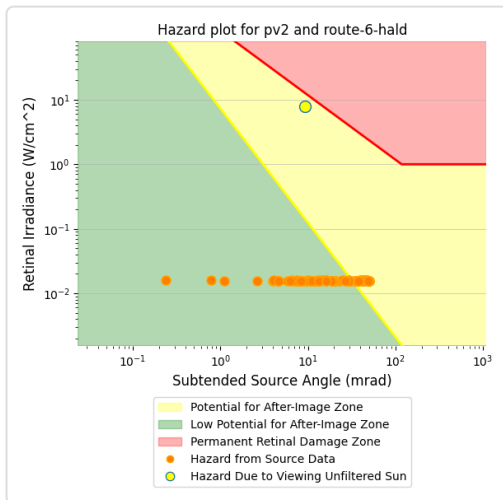
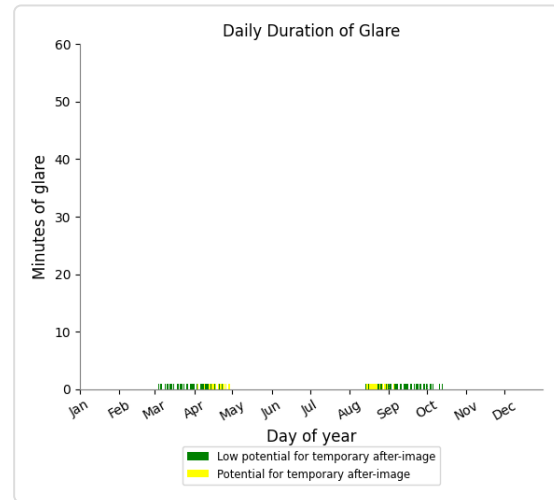
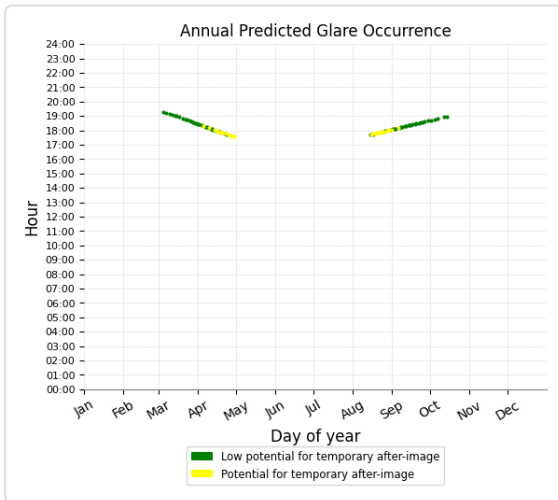
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 6 Haldon Arm Rd	57	0.9	25	0.4
Route 7 Tekapo River Rd	99	1.6	1	0.0
Route 3 Mcaughtries Rd 2	72	1.2	0	0.0
Route 4 Mcaughtries Rd 3	57	0.9	0	0.0
Route 8 Unnamed Rd 1	113	1.9	0	0.0
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 5	15	0.2	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0

PV2 and Route: Route 6 Haldon Arm Rd

Yellow glare: 25 min.

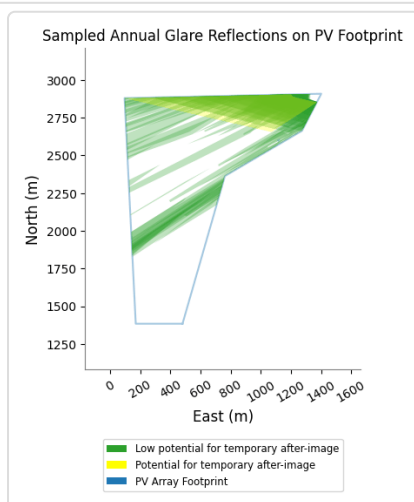
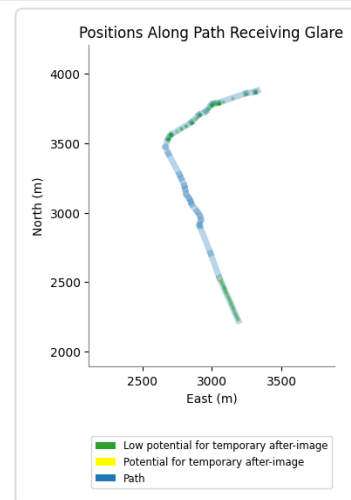
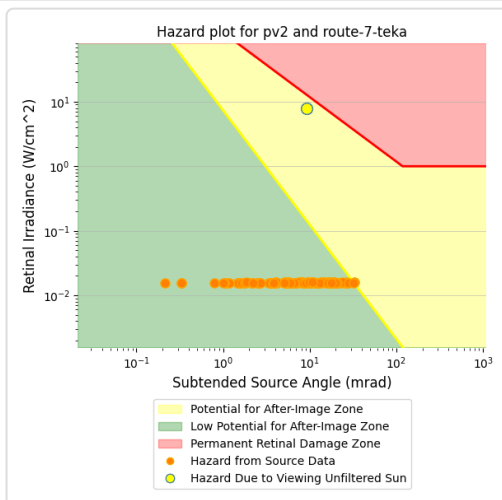
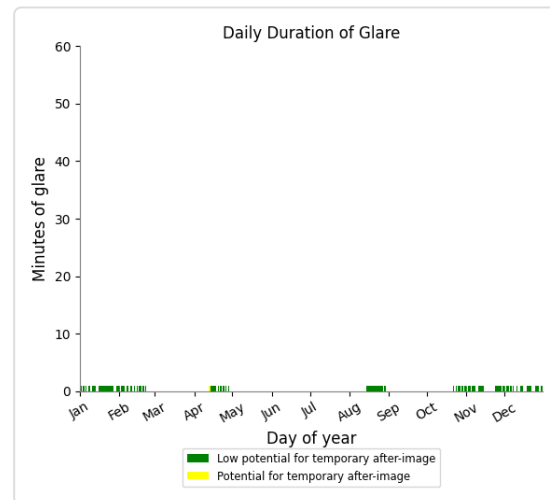
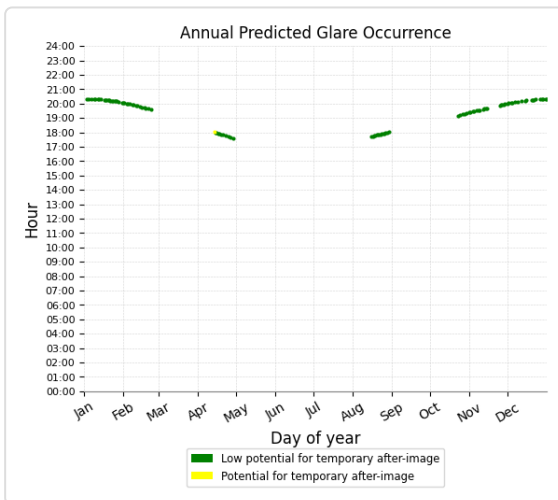
Green glare: 57 min.



PV2 and Route: Route 7 Tekapo River Rd

Yellow glare: 1 min.

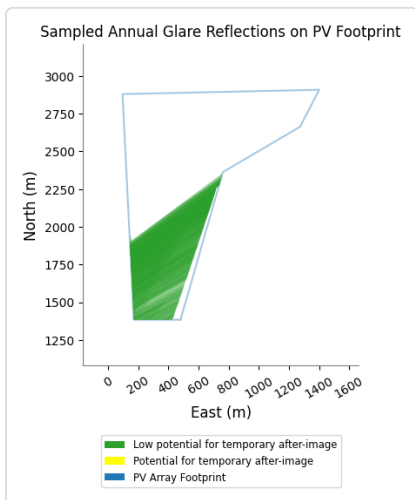
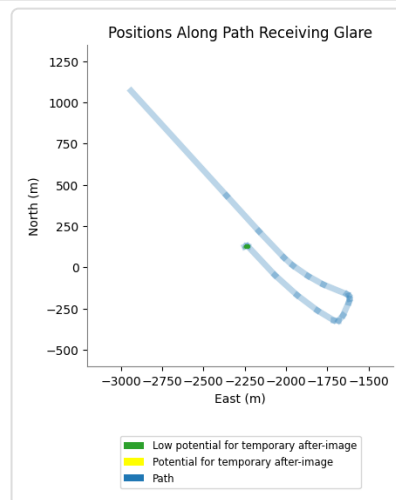
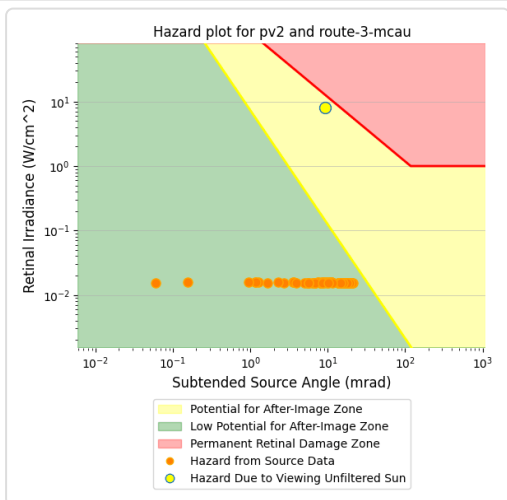
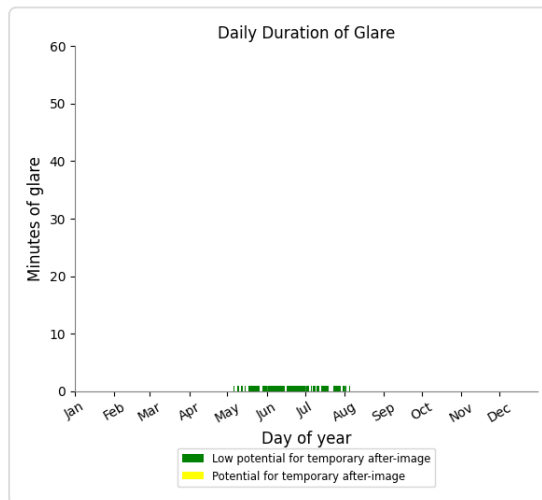
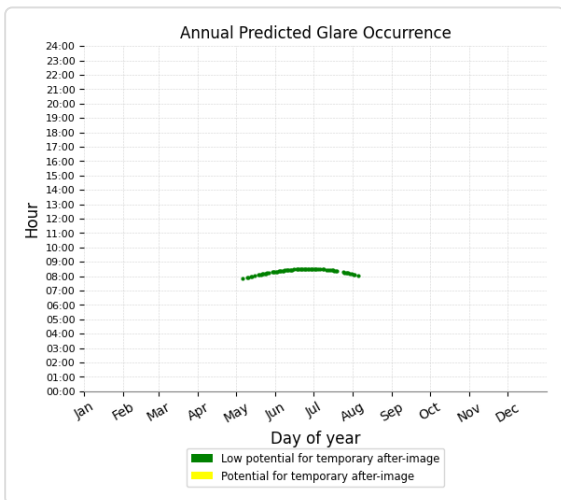
Green glare: 99 min.



PV2 and Route: Route 3 Mcaughtries Rd 2

Yellow glare: none

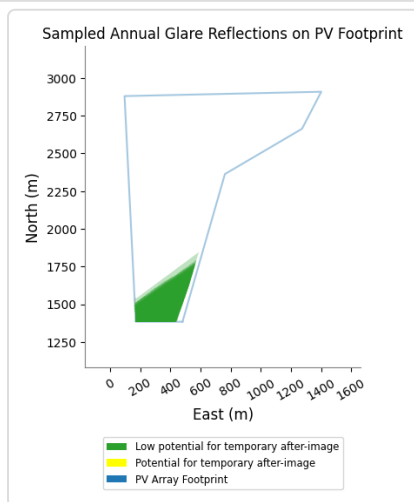
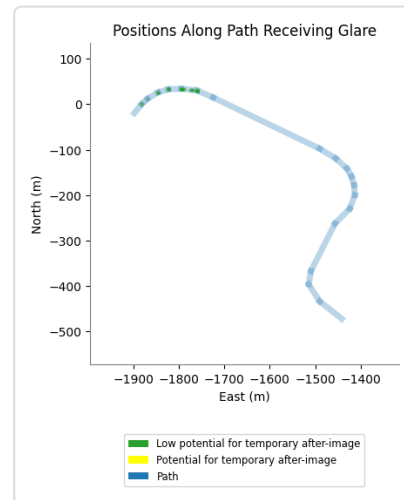
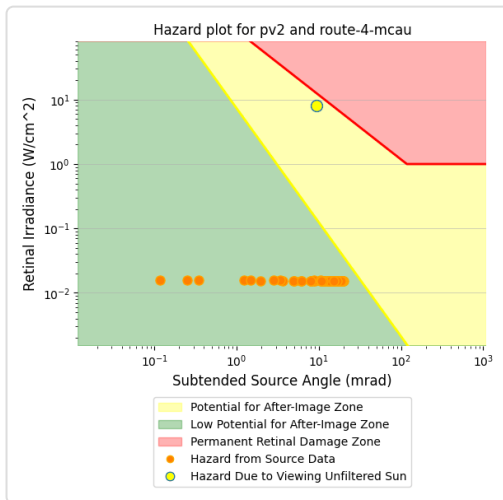
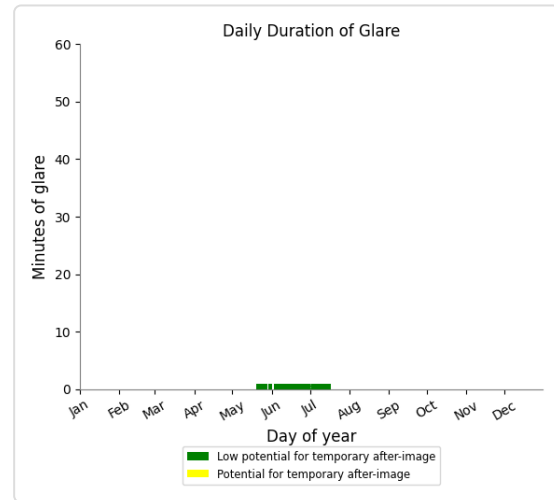
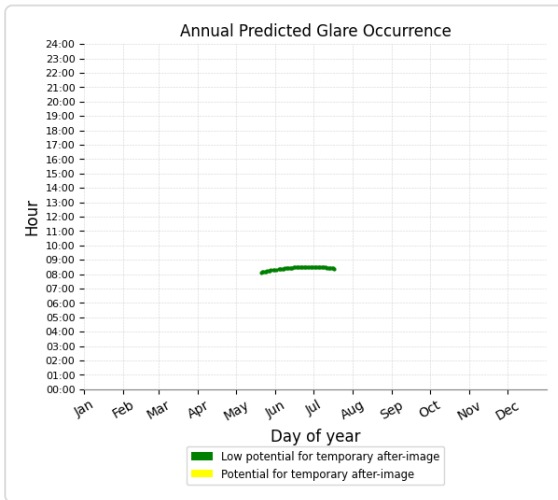
Green glare: 72 min.



PV2 and Route: Route 4 Mcaughtries Rd 3

Yellow glare: none

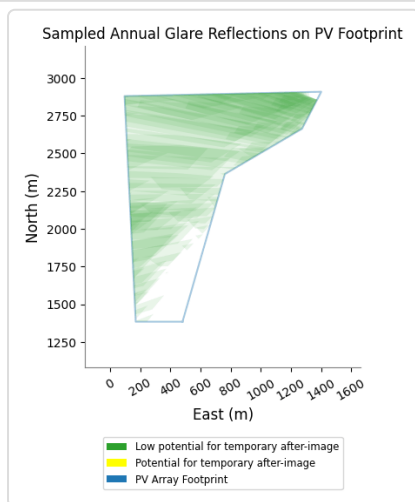
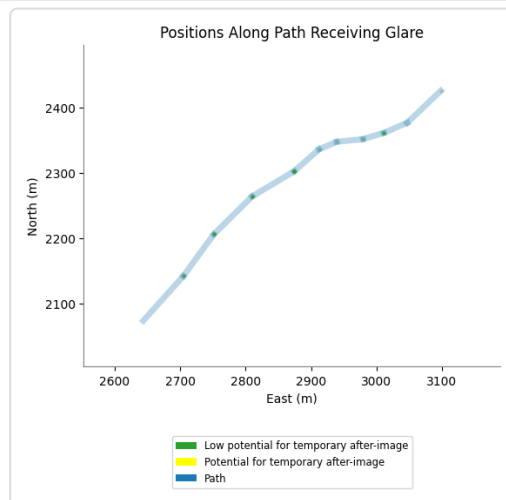
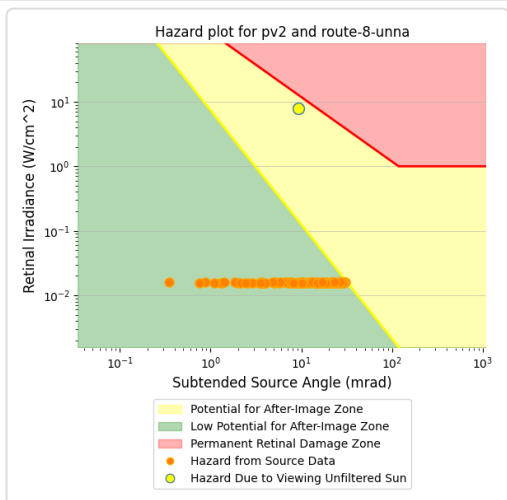
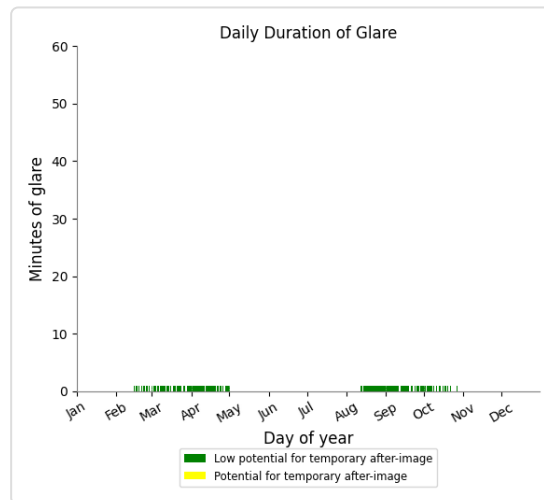
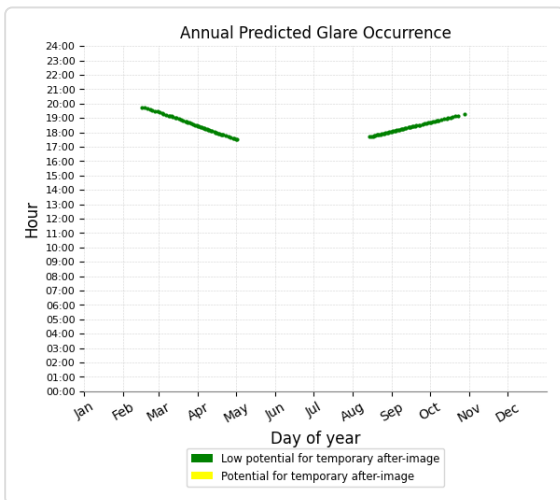
Green glare: 57 min.



PV2 and Route: Route 8 Unnamed Rd 1

Yellow glare: none

Green glare: 113 min.



PV2 and Route: Route 10 Unnamed Rd 3

No glare found

PV2 and Route: Route 11 Unnamed Rd 4

No glare found

PV2 and Route: Route 1 Falston Rd

No glare found

PV2 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV2 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV2 and Route: Route 9 Unnamed Rd 2

No glare found

PV2 and FP: FP1

No glare found

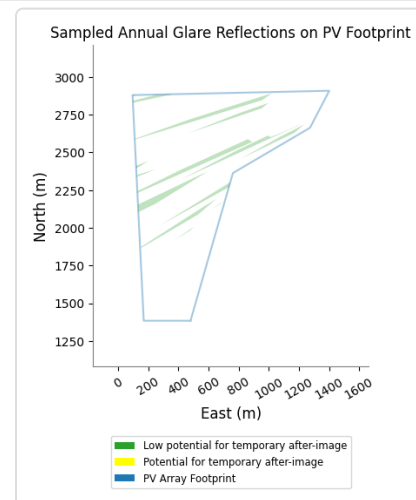
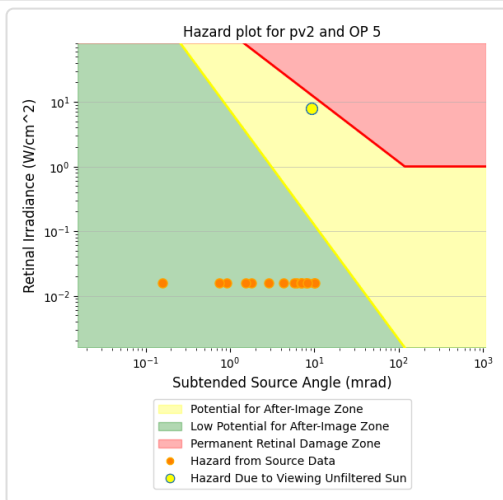
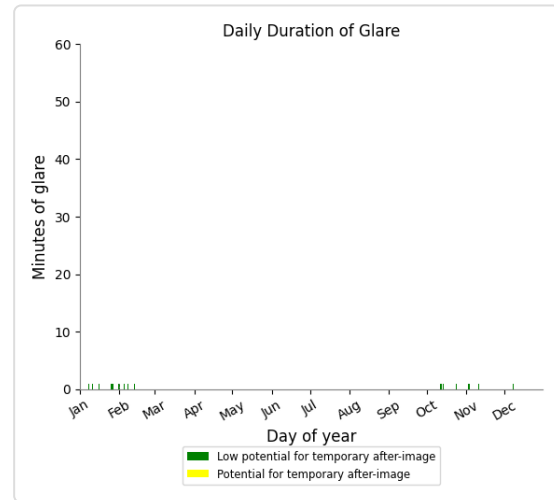
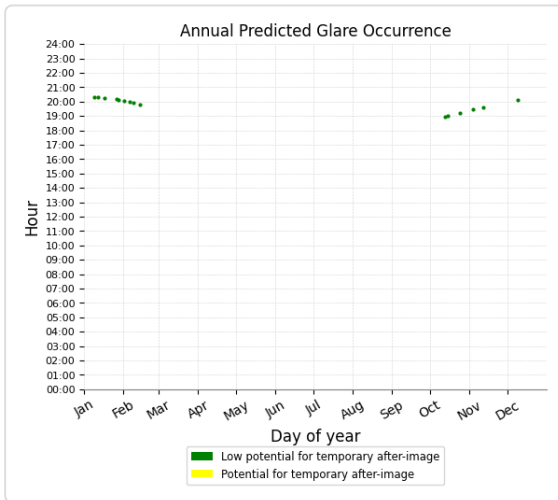
PV2 and FP: FP2

No glare found

PV2 and OP 5

Yellow glare: none

Green glare: 15 min.



PV2 and OP 1

No glare found

PV2 and OP 2

No glare found

PV2 and OP 3

No glare found

PV2 and OP 4

No glare found

PV: PV3 low potential for temporary after-image

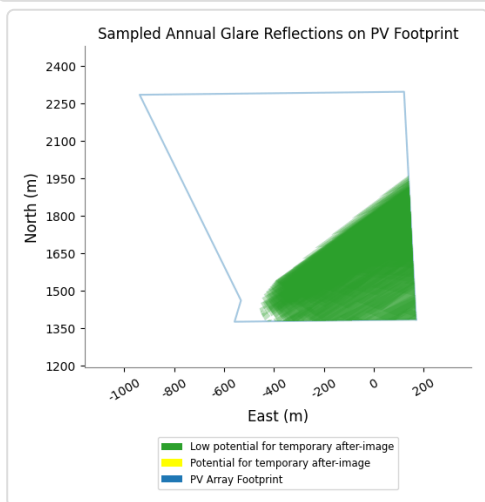
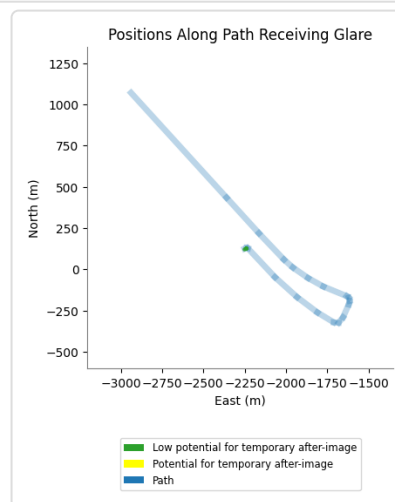
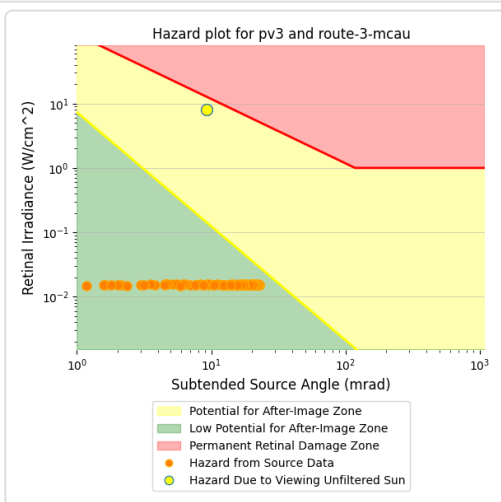
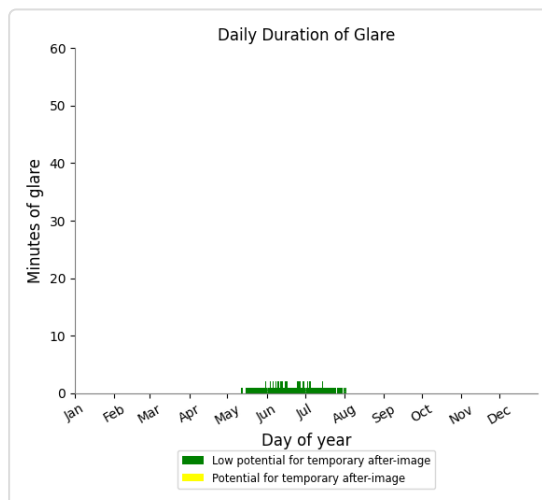
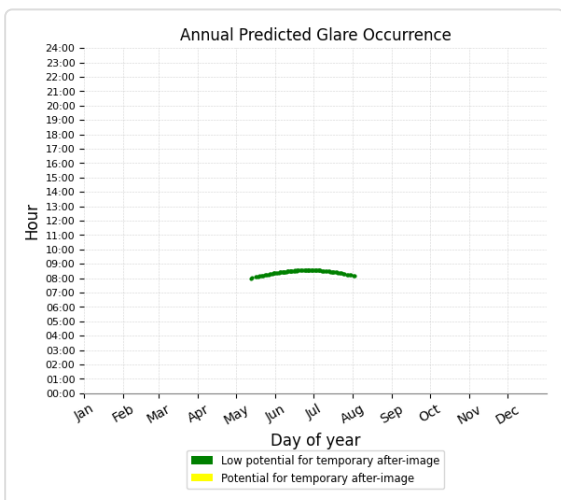
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 3 Mcaughtries Rd 2	95	1.6	0	0.0
Route 4 Mcaughtries Rd 3	45	0.8	0	0.0
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	0	0.0	0	0.0
Route 7 Tekapo River Rd	0	0.0	0	0.0
Route 8 Unnamed Rd 1	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

PV3 and Route: Route 3 Mcaughtries Rd 2

Yellow glare: none

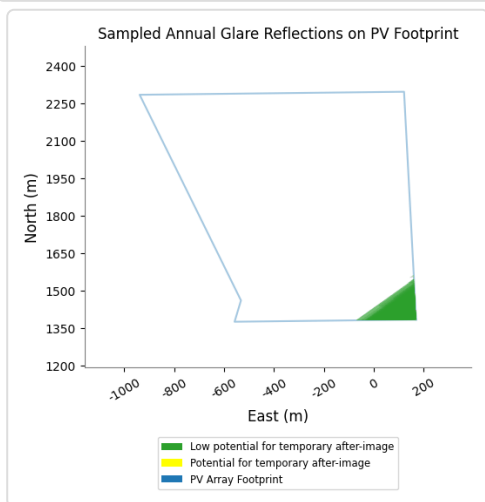
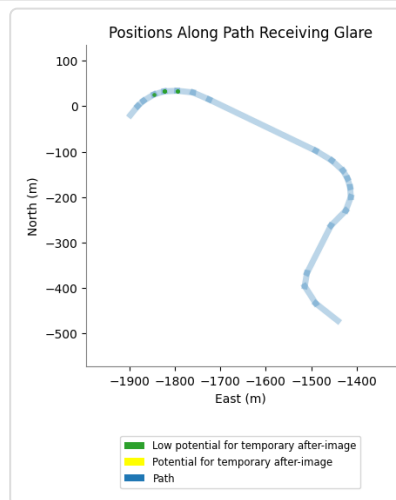
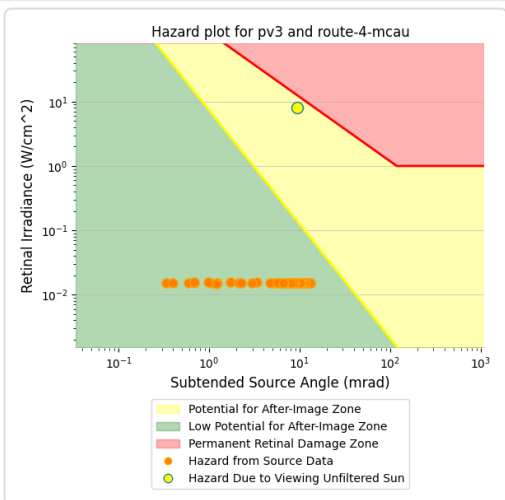
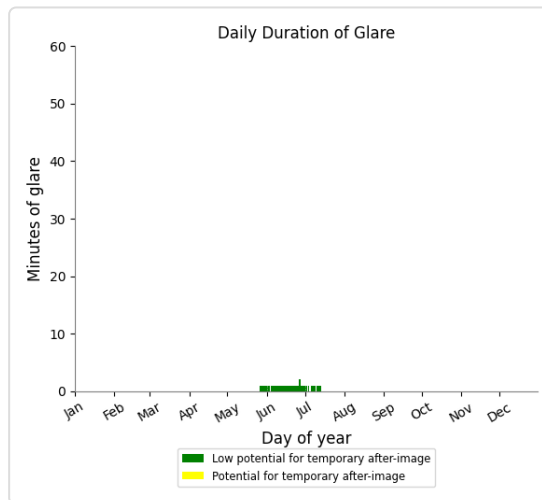
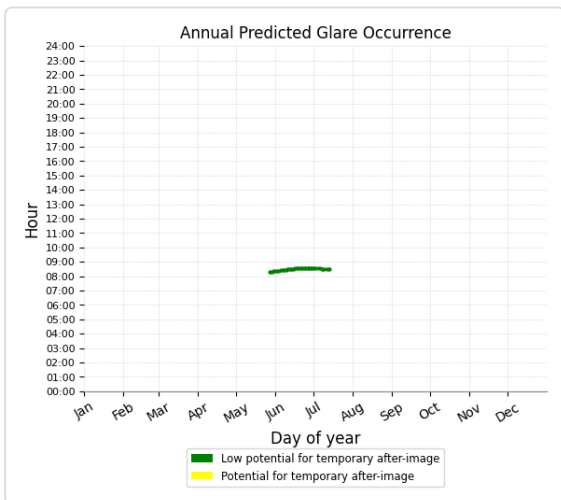
Green glare: 95 min.



PV3 and Route: Route 4 Mcaughtries Rd 3

Yellow glare: none

Green glare: 45 min.



PV3 and Route: Route 10 Unnamed Rd 3

No glare found

PV3 and Route: Route 11 Unnamed Rd 4

No glare found

PV3 and Route: Route 1 Falston Rd

No glare found

PV3 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV3 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV3 and Route: Route 6 Haldon Arm Rd

No glare found

PV3 and Route: Route 7 Tekapo River Rd

No glare found

PV3 and Route: Route 8 Unnamed Rd 1

No glare found

PV3 and Route: Route 9 Unnamed Rd 2

No glare found

PV3 and FP: FP1

No glare found

PV3 and FP: FP2

No glare found

PV3 and OP 1

No glare found

PV3 and OP 2

No glare found

PV3 and OP 3

No glare found

PV3 and OP 4

No glare found

PV3 and OP 5

No glare found

PV: PV4 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 3 Mcaughtries Rd 2	0	0.0	0	0.0
Route 4 Mcaughtries Rd 3	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 6 Haldon Arm Rd	0	0.0	0	0.0
Route 7 Tekapo River Rd	0	0.0	0	0.0
Route 8 Unnamed Rd 1	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

PV4 and Route: Route 10 Unnamed Rd 3

No glare found

PV4 and Route: Route 11 Unnamed Rd 4

No glare found

PV4 and Route: Route 1 Falston Rd

No glare found

PV4 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV4 and Route: Route 3 Mcaughtries Rd 2

No glare found

PV4 and Route: Route 4 Mcaughtries Rd 3

No glare found

PV4 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV4 and Route: Route 6 Haldon Arm Rd

No glare found

PV4 and Route: Route 7 Tekapo River Rd

No glare found

PV4 and Route: Route 8 Unnamed Rd 1

No glare found

PV4 and Route: Route 9 Unnamed Rd 2

No glare found

PV4 and FP: FP1

No glare found

PV4 and FP: FP2

No glare found

PV4 and OP 1

No glare found

PV4 and OP 2

No glare found

PV4 and OP 3

No glare found

PV4 and OP 4

No glare found

PV4 and OP 5

No glare found

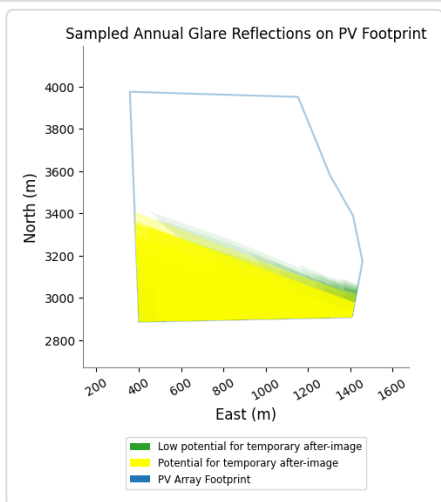
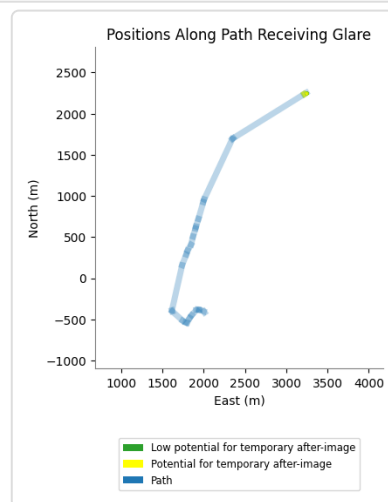
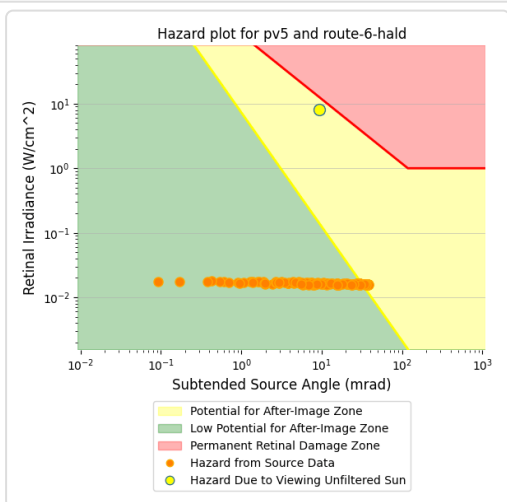
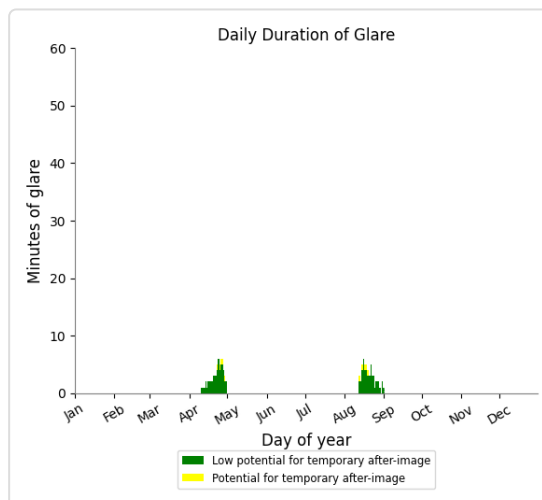
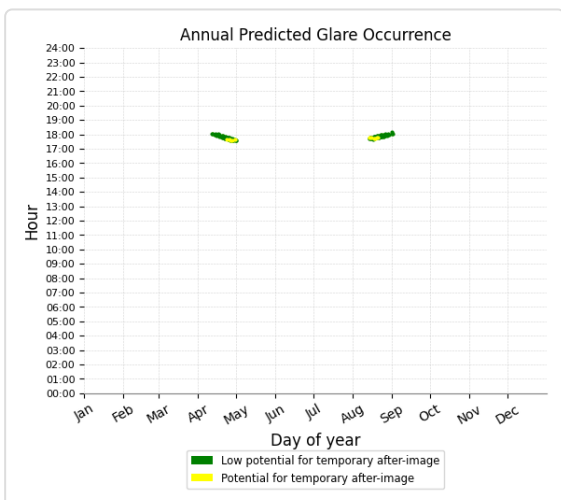
PV: PV5 potential temporary after-image*Receptor results ordered by category of glare*

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 6 Haldon Arm Rd	108	1.8	11	0.2
Route 7 Tekapo River Rd	1,168	19.5	104	1.7
Route 8 Unnamed Rd 1	936	15.6	67	1.1
Route 10 Unnamed Rd 3	0	0.0	0	0.0
Route 11 Unnamed Rd 4	0	0.0	0	0.0
Route 1 Falston Rd	0	0.0	0	0.0
Route 2 Mcaughtries Rd 1	0	0.0	0	0.0
Route 3 Mcaughtries Rd 2	0	0.0	0	0.0
Route 4 Mcaughtries Rd 3	0	0.0	0	0.0
Route 5 Mcaughtries Rd 4	0	0.0	0	0.0
Route 9 Unnamed Rd 2	0	0.0	0	0.0
FP1	0	0.0	0	0.0
FP2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0

PV5 and Route: Route 6 Haldon Arm Rd

Yellow glare: 11 min.

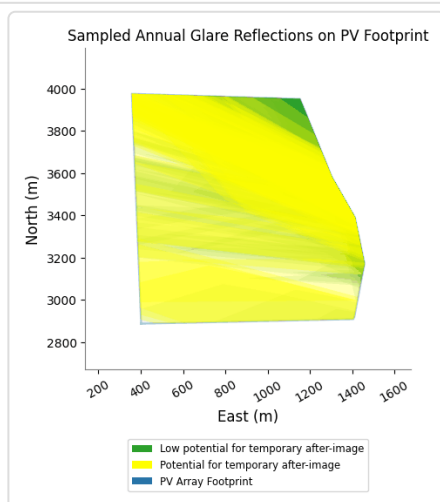
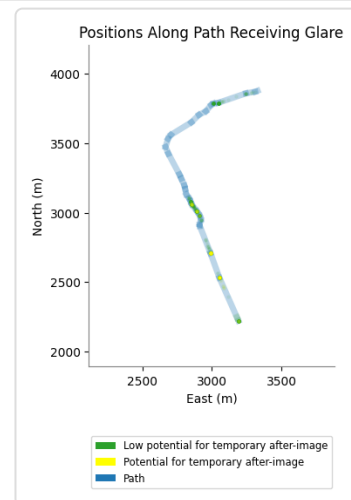
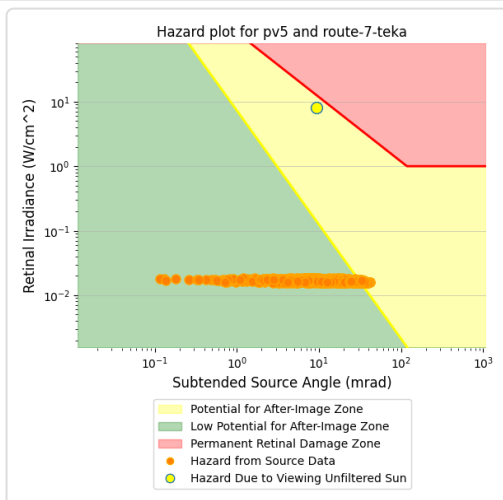
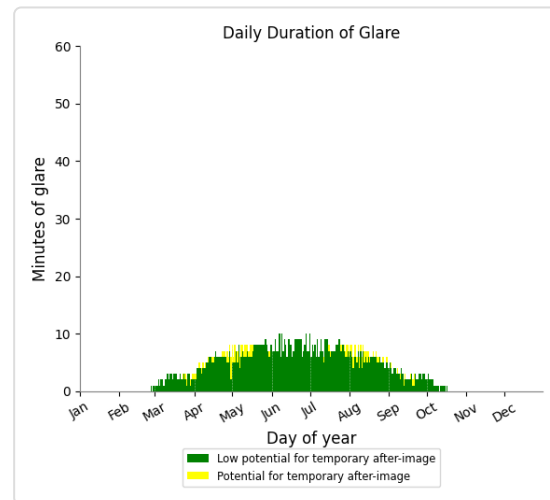
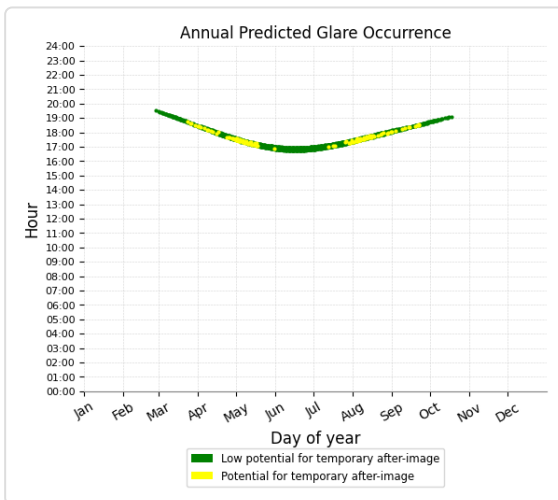
Green glare: 108 min.



PV5 and Route: Route 7 Tekapo River Rd

Yellow glare: 104 min.

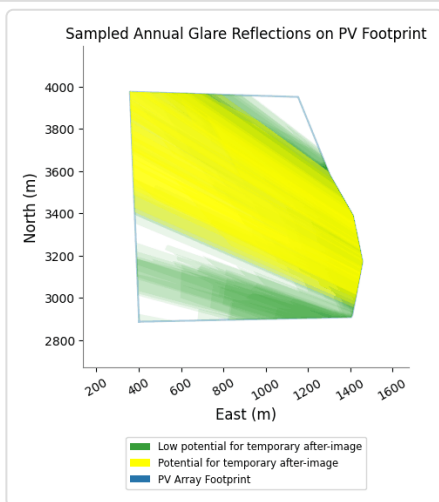
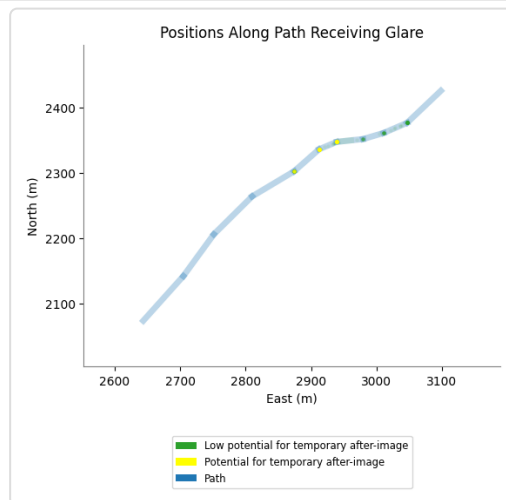
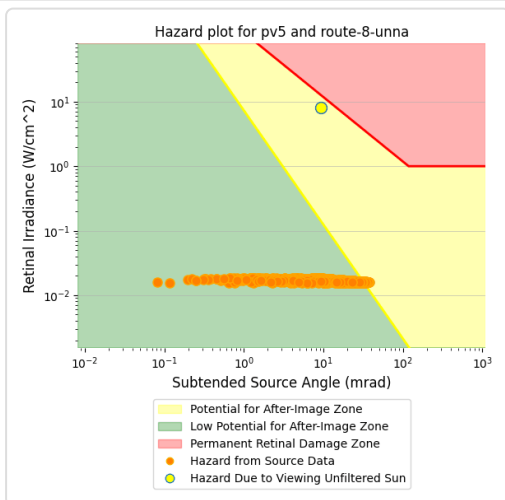
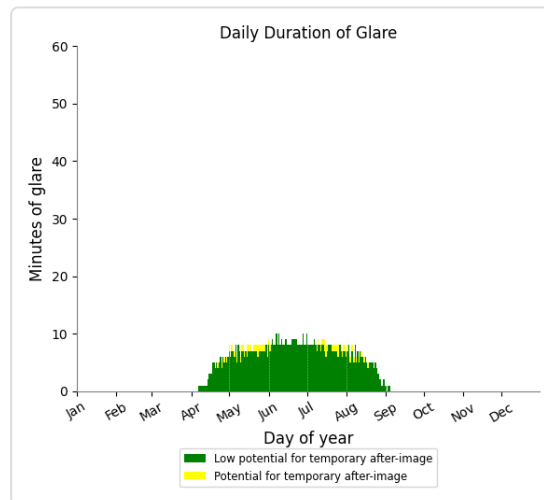
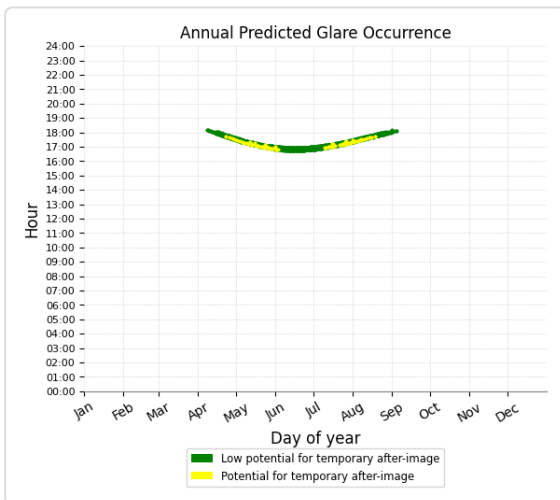
Green glare: 1,168 min.



PV5 and Route: Route 8 Unnamed Rd 1

Yellow glare: 67 min.

Green glare: 936 min.



PV5 and Route: Route 10 Unnamed Rd 3

No glare found

PV5 and Route: Route 11 Unnamed Rd 4

No glare found

PV5 and Route: Route 1 Falston Rd

No glare found

PV5 and Route: Route 2 Mcaughtries Rd 1

No glare found

PV5 and Route: Route 3 Mcaughtries Rd 2

No glare found

PV5 and Route: Route 4 Mcaughtries Rd 3

No glare found

PV5 and Route: Route 5 Mcaughtries Rd 4

No glare found

PV5 and Route: Route 9 Unnamed Rd 2

No glare found

PV5 and FP: FP1

No glare found

PV5 and FP: FP2

No glare found

PV5 and OP 1

No glare found

PV5 and OP 2

No glare found

PV5 and OP 3

No glare found

PV5 and OP 4

No glare found

PV5 and OP 5

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

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

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

© Sims Industries d/b/a ForgeSolar, All Rights Reserved.



ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au