Solar Photovoltaic Glint & Glare Study Aviation Specific (Casement Aerodrome)

For roof mounted PV panels at a proposed residential development at Cooldown Commons Phase 3, Fortunestown, Citywest, Dublin 24

April 2021

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Executive Summary

This report assesses the potential for ocular impact of glare emanating from sunlight reflections from proposed rooftop solar PV panels and its potential to cause an impact to users of the nearby Casement Aerodrome or the helipad at Tallaght Hospital. Receptors considered for assessment include the final approaches to Runways 05, 11, 23 & 29, the Air Traffic Control Tower (ATCT) at Casement Aerodrome as well as several potential approaches to the helipad at Tallaght Hospital.

Using sun-path algorithms for every minute of the year, it was calculated if and when glare may theoretically occur at a particular receptor. If reflection was found geometrically possible at a particular location, further desk analysis was then carried out to ascertain if a view of the proposal (and thus potential for glare) would indeed be possible in reality.

The level of potential glare from solar PV panels is similar to that of water and much less than that of materials such as concrete and vegetation. Many common elements of the Irish landscape offer similar, if not higher levels of glare than that caused by solar PV systems such as shed roofs, poly tunnels and still lakes.

This is an aviation specific glint and glare report focusing only on the nearby Casement Aerodrome and the helipad at Tallaght Hospital. It does not consider ground based receptors such as nearby roads, railway lines, residences or other aerodromes. However, due to the small scale of residential rooftop solar PV panels, it would not be deemed necessary to assess these receptors.

For the purpose of aviation analysis the US Federal Aviation Administration (FAA) recommend the use of the Solar Glare Hazard Plot (Figure 9) to measure the ocular impact of a solar array. Receptors with theoretical potential for glare can fall into one of three different areas: Green - “Low potential for after-image”, Yellow - “Potential for after-image” and Red - “Potential for Permanent Eye Damage (retinal burn)”.

Figure 1 below gives a brief overview of the results of this glint and glare report. From this it can be seen that of the 9 solar arrays assessed;

- None of the arrays have the potential to be a source of glare for the Air Traffic Control Tower at Casement Aerodrome

- Westerly approaches to Tallaght Hospital Helipad have no potential glare sources from these arrays.

Based on the “worst case” scenario analysis carried out, there is the potential for small amounts of “green” glare from certain rooftop arrays but durations and magnitudes would be considered **negligible** to **very low**.

In addition, from analysis of historical sunshine data near the proposed site, the number of days glare could potentially be experienced at each receptor could realistically be reduced by 70%, based on the actual hours of sunshine that would be expected to be experienced within the study area, and still offer an overstated prediction of glare.

It will be shown from the report and analyses herein that nuisance or hazardous glare **can not** be expected for users of the nearby Casement Aerodrome and Tallaght Hospital Helipad.

FIGURE 1 RESULTS AT A GLANCE (GREEN LINE INDICATES POTENTIAL FOR GREEN GLARE RESULT, BLACK INDICATES NO POTENTIAL FOR GLARE RESULT)

NAME	ARRAYS ASSESSED	ARRAYS WITH POTENTIAL FOR GLARE	ARRAYS WITH NO POTENTIAL FOR GLARE
Casement Air Traffic Control Tower	9	0	9
Tallaght Helipad Approach E	9	5	4
Tallaght Helipad Approach ENE	9	5	4
Tallaght Helipad Approach ESE	9	6	3
Tallaght Helipad Approach N	9	3	6
Tallaght Helipad Approach NNE	9	5	4
Tallaght Helipad Approach NNW	9	0	9
Casement Runway 5	9	6	4
Casement Runway 11	9	4	5
Casement Runway 23	9	0	9
Casement Runway 29	9	4	5
Tallaght Helipad Approach S	9	3	6
Tallaght Helipad Approach SSE	9	6	3
Tallaght Helipad Approach SSW	9	0	9
Tallaght Helipad Approach W	9	0	9
Tallaght Helipad Approach WNW	9	0	9
Tallaght Helipad Approach WSW	9	0	9

TABLE 1 SUMMARY OF GLARE POTENTIAL AT RECEPTORS

Introduction

Innovision has been appointed by Cairn Homes to carry out an aviation specific glint and glare study for roof mounted solar PV panels at a proposed residential development at Cooldown Commons & Fortunestown, Citywest, Dublin 24. The subject site is located approximately 1.7km south east of Casement Aerodrome (Figure 2). The proposed development consists of various different building types including duplexes and apartments. It is proposed to mount solar PV panels to a small portion of the roof of each residence.

Innovision is a leading visualisation, mapping & geographical information systems (GIS) analysis company. Our innovative team has over ten years' experience in the photomontage and 3D visualisation industry, working on a wide range of proposed commercial developments including numerous wind and solar farms, both in Ireland and abroad. Innovision is also a certified Forge Solar 'Glare Expert'. This is currently the only glint and glare assessor qualification available internationally.

Using desk-based analysis, this report has assessed the potential for glare on aircraft taking off and landing at Casement Aerodrome. Using sun-path algorithms for every minute of the year (assuming 100% sunshine for all daylight hours), it is determined if and when reflections may occur at these selected receptors. If reflection is found geometrically possible from a particular location, further analysis is then carried out. This further analysis determines the significance of the glare that could potentially be experienced and also if, in reality, these effects are likely to be experienced by an observer at that location. In certain cases, where glare is found to be significant and a likely source of hazard or nuisance, mitigation factors can then be discussed.

Note on Casement Runway Designations

In February 2019, Casement's runway designations were changed: its main runway (formerly 11/29, as in the SDCC Development Plan) was redesignated as **10/28**, and its subsidiary runway (formerly 05/23) was redesignated as **04/22**. This report refers to the **old** numbering as per the SDCC Development plan.

Proposed Solar PV Array Details

The majority of the proposed solar arrays will be mounted on the most southern aspect of each block of buildings. For the purpose of this report, there are six arrays situated on top of apartment / mixed-use blocks (Arrays 1 to 6) and a panel on each of 18 duplex units. These individual panels have been grouped into three "arrays" of six panels each, one array for each block. Please refer to Map 1 for a visual overview of these areas.

FIGURE 2: SITE LOCATION RELATIVE TO CASEMENT AERODROME

MAP 1: ARRAY OVERVIEW

Due to the nature of the site layout, panels will be facing at various different orientations depending on the orientation of the building. The pitch angle of the panels too will vary depending on building type. Both the pitch angle and the orientation angle of the panels will be fixed so the panels will not track the sun throughout the day/year.

Glint and Glare Overview

What are Glint and Glare?

Glint and glare are phenomenon caused by many reflective materials, whereby light from the sun is reflected off such materials with a potential to cause hazard, nuisance or unwanted visual impact. Glint and glare have been best defined by the United States Federal Aviation Administration (FAA) in their "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[1]:

Glint is a momentary flash of bright light.

Glare is a continuous source of bright light.

Glint and Glare are also commonly referred to as 'solar reflection'. To determine the impact that solar reflection could potentially have on members of the public, it is sometimes necessary to carry out a glint and glare assessment for proposed solar PV farms or roof mounted arrays.

When do Glint and Glare Occur?

The sun rises in the east and sets in the west and in the northern hemisphere, tracks a southerly arc across the sky (Figure 3). The elevation angle that the sun reaches varies depending on the time of year, with high angles in the summer months and much lower angles in winter.

Once the sun reaches a certain elevation in the sky, the incident angle of the sun will reflect off the solar panels at an opposing angle that will not impact on any ground-based receptors. As a result of this, for ground-based receptors, glint and glare from solar farms will generally only occur in the mornings and the evenings. At these times, the sun will also be shining from a similar direction as any potential glare. For aviation receptors however, glare can potentially occur at any time of day depending on the location of the aircraft.

[1] Federal Aviation Administration, November 2010: *Technical Guidance for Evaluating Selected Solar Technologies on Airports*

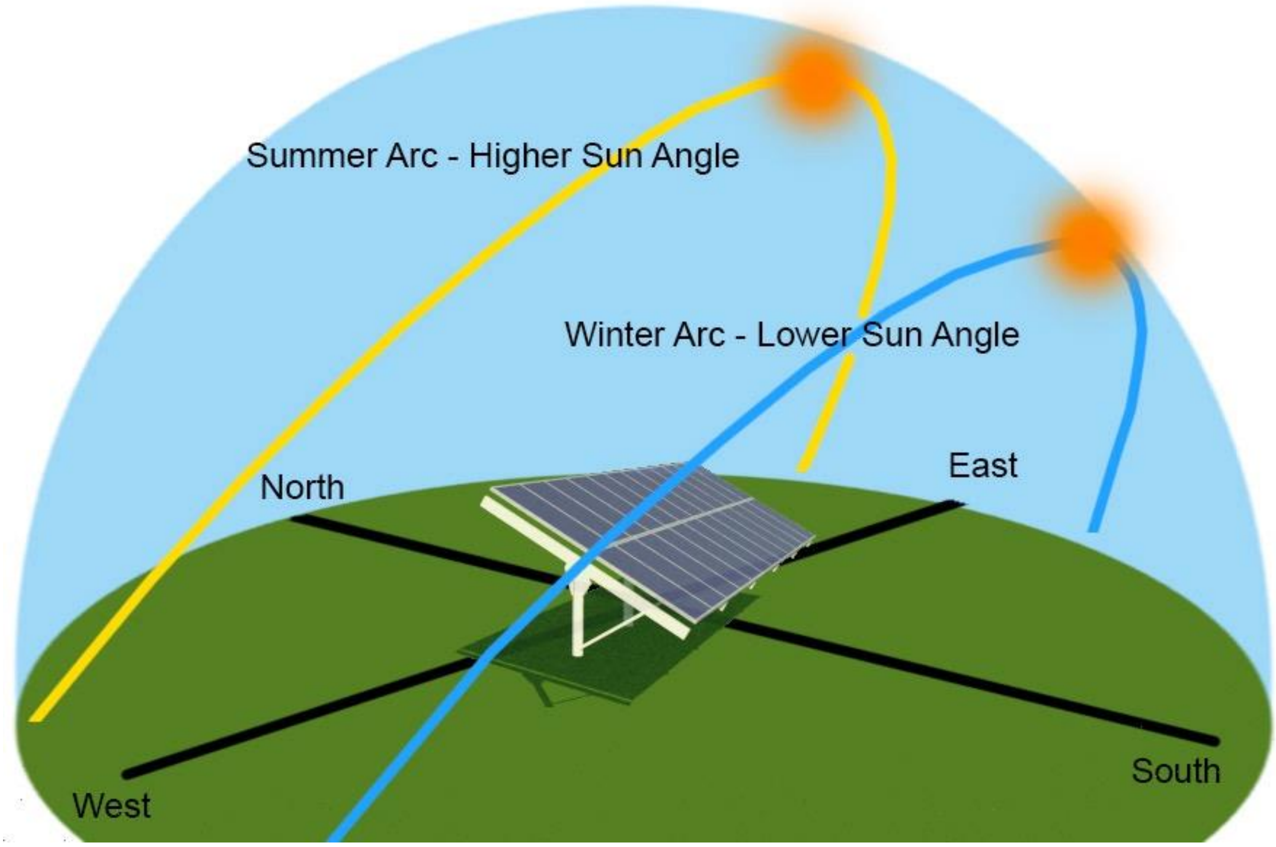


FIGURE 3: ARCS TRACKED BY SUN AT DIFFERENT TIMES OF YEAR

Meteorological & Atmospheric Conditions

It is also worth noting that glint and glare can only occur when there is direct sunlight reaching the solar panels. In overcast or rainy conditions, no glint or glare will occur. Met Éireann, Ireland's National Meteorological Service, suggests that due to Ireland's position off the northwest of Europe we are kept in humid, cloudy airflows for much of the time. *"Irish skies are completely covered by cloud for well over fifty percent of the time."*[2]

For this proposed development, historical sunshine duration data from 1981-2010, recorded at Casement Aerodrome has been analysed. Casement is the nearest Met Éireann weather station to the proposed development that records sunshine data. From looking at Figure 4 & Figure 5 below it can be seen that for this particular site, the number of days glare could potentially be experienced at each receptor could realistically be reduced by 70% and still offer an overstated prediciton of glare.

[2] Met Éireann "Sunshine and Solar Radiation" www.met.ie.

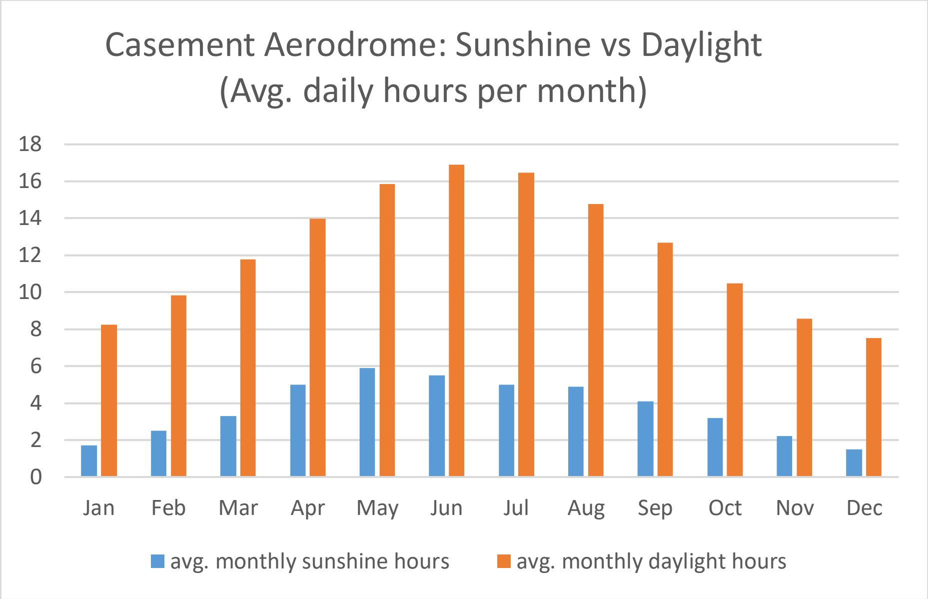


FIGURE 4: CASEMENT AERODROME: SUNSHINE VS DAYLIGHT (AVG. DAILY HOURS PER MONTH)

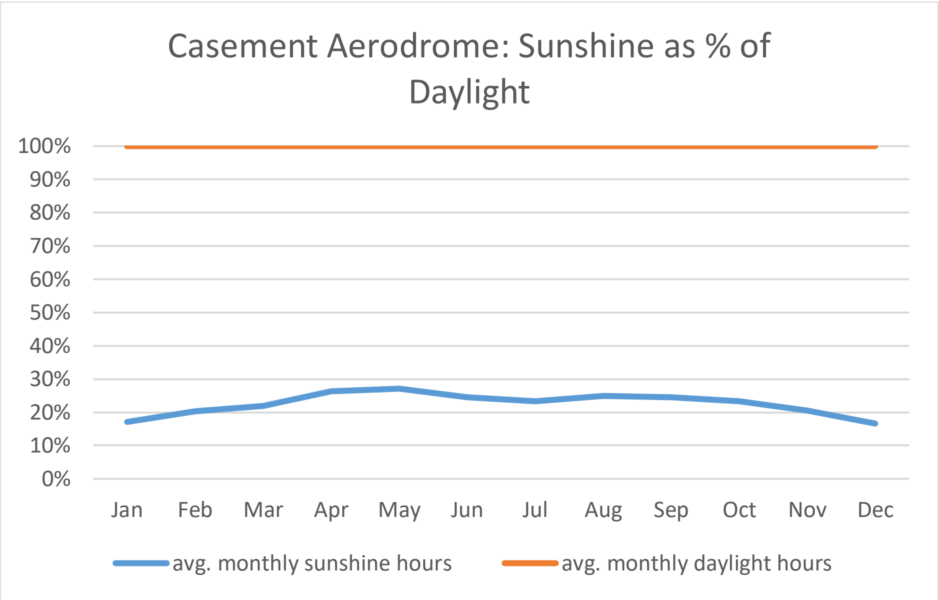


FIGURE 5: CASEMENT AERODROME: SUNSHINE AS A PERCENTAGE OF DAYLIGHT

Solar Reflectance from PV Panels

Surface Reflectance

All surface types have different reflectivity characteristics. This results in varying degrees of sunlight reflection. Solar panels, by their nature, are designed to absorb as much sunlight as possible, thus converting the sun's energy to electricity. As a result, the amount of light reflected off these installations is far less than one might expect. The figure below (Figure 6) is taken from the FAA 2010 Solar Guidance and illustrates that the reflectance of solar PV panels is of a similar nature to water. Typical values for the reflectance levels of solar PV panels are far less than that of materials such as snow, concrete and even vegetation. It should be noted however, that at certain times of the day, generally early morning and late evening, with the sun low in the sky, the amount of light reflected off solar panels can increase, causing a potential for glare in certain directions.

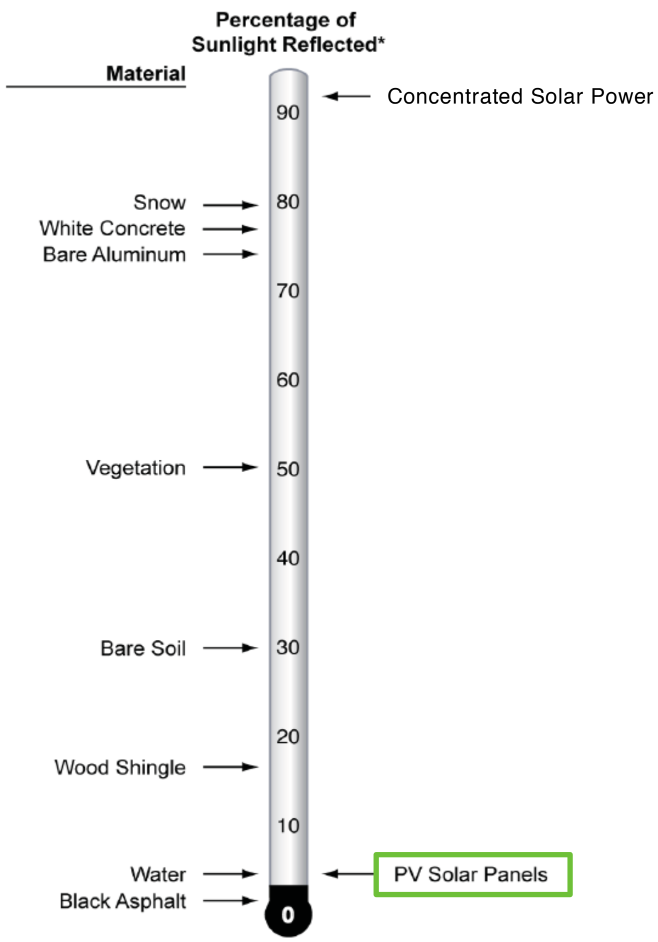


FIGURE 6: REFLECTIVITY PRODUCED BY DIFFERENT SURFACES (SOURCE: FAA)

Types of Reflection

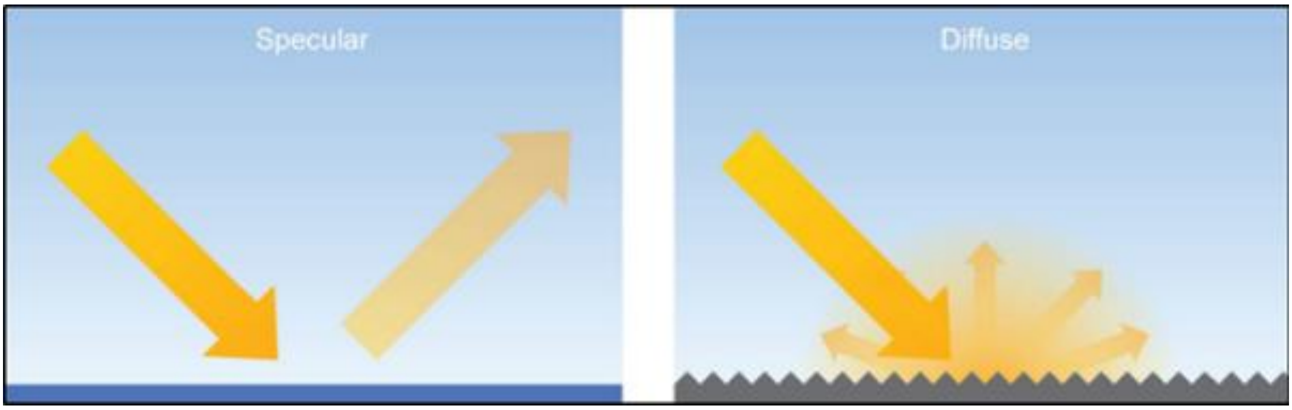


FIGURE 7: DIFFERENT TYPES OF REFLECTION (SOURCE: FAA)

There are two types of reflection which can occur on a surface; specular and diffuse. Specular reflection is a direct reflection which produces a more “focused” type of light. It occurs when light reflects off a smooth or polished surface like glass or still water. Diffuse reflection, on the other hand, produces a less “focused” type of light. Diffuse reflection occurs as a result of light reflecting off a rough surface such as vegetation, concrete or wavy water. Figure 7 helps to illustrate the difference between these two types of reflection. The main type of reflectance from solar PV panels is specular due to the glass like texture of the outer layer of the panels. However, in reality, like all surfaces, there will be a combination of both specular and diffuse reflection

As discussed earlier, the level of potential glare from solar PV panels is similar to that of water and much less than that of materials such as concrete and vegetation. Many common elements of the Irish landscape offer similar, if not higher levels of glare than that caused by solar PV systems such as shed roofs, still lakes and even the strips of plastic sheeting used on farms to produce maize (Figure 8).

FIGURE 8: PLASTIC MAIZE WRAP IN A FIELD WITH POTENTIAL TO CAUSE SIMILAR LEVELS OF GLARE AS SOLAR PV FARMS

Relevant Guidance & Studies

Republic of Ireland

In the Republic of Ireland (ROI), there is currently no guidance, policy or recommendations in relation to the assessment of glint and glare effects on aviation, road & rail users or residential buildings. Future Analytics in conjunction with the Sustainable Energy Authority of Ireland (SEAI) have produced planning and development guidance recommendations for utility scale solar photovoltaic schemes in Ireland[3]. While this is not formal guidance, it does set out recommended elements of the assessment based on international practice.

United Kingdom

In the United Kingdom (UK), where the development of large scale solar PV is more mature, certain studies have been carried out which help to establish an accepted best practice and planning guidance recommends the assessment of glint and glare effects. However, there is still no specific guidance by way of a prescriptive methodology document. In the absence of formal policy, the Civil Aviation Authority (CAA) have provided interim guidance in relation to the development of solar PV systems on, and in the vicinity (<15km) of aerodromes. This guidance recommends that solar PV developers should *"provide safety assurance documentation regarding the full potential impact of the SPV installation on aviation interests."*[4] The Building Research Establishment (BRE) have also issued several relevant papers, however neither the BRE nor the CAA have produced a methodology for assessing the effects of glint and glare on aviation, road & rail users or residential buildings.

Germany

In Germany, glare is considered an emission not unlike noise, odour or vibration. *"Licht-Leitlinie"*[5] or Light Guidelines produced by The Federal Ministry of the Environment defines acceptable levels of glare as being anything less than 30 minutes per day or 30 hours per year. The guidance also states that there is only additional impact to an observer as a result of glare from a solar array if the

[3] *Future Analytics. October 2016. Planning and Development Guidance Recommendations for Utility Scale Solar Photovoltaic Schemes in Ireland*

[4] Civil Aviation Authority. December 2010. *"Interim CAA Guidance - Solar Photovoltaic Systems".*

[5] Leitlinie des Ministeriums fur Umwelt. Gesundheit und Verbraucherschutz zur Messung und Beurteilung von Lichtimmissionen (Licht-Leitlinie). 2014 Available: http://www.mlul.brandenburg.de/media_fast/4055/licht_leitlinie.pdf

angle between the source of the glare and the sun is greater than ten degrees. These factors are taken into consideration at classification of impact stage in this report.

United States of America

The main form of guidance in assessing the likely effects of glint and glare (on aviation infrastructure) comes from the FAA in the United States. Their document, "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[6] is accepted internationally as the most detailed methodology for assessing the effects of glint and glare. This document is currently under review and an interim policy document[7] was produced in October 2013. The 2013 interim policy further addresses glint and glare issues and recommends the use of a particular analysis tool, the Solar Glare Hazard Analysis Tool (SGHAT), when carrying out glint & glare assessments of solar PV systems. This is a tool that was developed by the US Department of Energy research laboratories, Sandia National Laboratories, to assess the ocular impact of proposed solar energy systems.

Innovision has created a methodology for assessing glint and glare taking all of the above studies and guidelines into consideration. Although SGHAT is a tool which was created to assess the impact of solar PV systems on aviation infrastructure, Innovision has employed this tool and prescribed methodology to all receptor types including road & rail users, aviation & residential buildings. This is currently the **only FAA approved tool** for measuring the ocular impact of solar PV systems on receptors. Until formal guidance is provided in Ireland, Innovision will continue to follow international guidelines and best practice.

Methodology

Innovision's methodology can be broken down into seven key stages:

1. Study Area Selection
2. Receptor Identification
3. Geometric Analysis
4. Examination of Screening and Receptor Orientation
5. Determination of Impact
6. Mitigation

[6] Federal Aviation Administration. November 2010. "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"

[7] Federal Aviation Administration. October 2013. *"Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports."*

1. Study Area Selection

The first stage of any glint and glare assessment is to identify the study area. In the case of this development the runways and ATCT at Casement Aerodrome will be considered along with the helipad at Tallaght Hospital which would be regularly used by Coast Guard rescue helicopters. For ease of interpretation, the site has been broken up into two different areas and each solar array has been given a unique identification number. Please refer to Map 1 for a breakdown of these areas.

2. Receptor Identification

Once the study area has been defined, receptors can then be identified. For this site, the four runways and ATCT at Casement Aerodrome are being considered along with the helipad at Tallaght Hospital.

AIRPORTS & AIRSTRIPS

The two main receptors that need to be considered when assessing the glint and glare effects of solar PV farms on aerodromes are Air Traffic Control Towers (ATCT) and the final approach path to a runway. An ATCT is assessed much like any other receptor point using the correct altitude of the tower. For final runway approach paths, a line is extrapolated 2 miles back from the runway threshold (the point at which an aircraft enters the runway) at an angle of 3 degrees. This results in a continuous analysis of every point along the final approach to the runway. For utility scale solar PV systems any aerodromes within the vicinity of a proposed solar PV farm would be assessed. “Vicinity” in this case is within 15km as defined by the CAA interim guidance referred to earlier. It should also be noted that these calculations take the pilots field of view into consideration and thus limit the angle of view to 100 degrees in the horizontal and a downward viewing angle of 30 degrees.

HELIPADS

Although there are no specific guidelines to assess glint and glare impacts on helipads, Innovision has employed a similar system to that used for runway approach paths. This involves a line being extrapolated 2 miles back from the helipad centre. However, the angle of approach used is steeper than that of an airplane landing on a runway. Helicoptor pilots would approach the helipad at an angle close to 8 degrees. In addition, a helicopters approach direction is not bound by a physical runway direction and depending on a number of factors including wind direction, a pilot can approach from any direction. For this reason, we have analysed approaches from 12 different directions to account for the various different approaches that could be taken. It should also be noted that these calculations take the pilots field of view into consideration and thus limit the angle of view to 100 degrees in the horizontal and a downward viewing angle of 30 degrees.

4. Geometric Analysis

As discussed previously in this document, Innovision employs the use of the SGHAT in order to run the calculations for its glint and glare analysis. This is currently the only FAA approved tool for measuring the ocular impact of solar PV systems on receptors.

A number of parameters are considered in order to run these geometric analyses. These include, but are not limited to:

- The apparent position and height of the sun at a particular time of day and year (for every minute of the year).
- The position, height, orientation & pitch of the solar PV array.
- The position and height of the receptor.

The severity of the glare is influenced mainly by two factors:

- The distance of the observer from the glare spot, and
- The angle of the sunlight hitting the solar panels relevant to the observer

5. Examination of Screening and Receptor Orientation

The geometrical glare analysis does not consider screening from landform such as hills and mountains, or any vegetative or built environment elements of the landscape that may screen the development from view. For this reason, once the receptors that could potentially experience glare have been identified, their level of existing screening must be assessed. This is done through a combination of desk-based analysis of both Google StreetView and aerial photography and sometimes requires a site visit for further verification. Receptor orientation is also considered. Geometric analysis may suggest that a dwelling will experience glare, but the orientation of the dwelling also needs to be considered. If a dwelling is facing away from the solar array, any potential glare could have little or no impact. Similarly, a road may show up as having potential to experience glare, but unless the direction of travel is towards the source of glare, it is unlikely to cause significant impact.

6. Determination of Impact

Once all of the above steps are carried out, a determination of likely impacts can be made for each receptor. Results are collated into a comprehendable table with comments as to the likely glint and glare impact or otherwise, of the propsed solar PV panels on all assessed receptors. An initial determination is made using the table below, based purely on the theroetical amount of time a receptor may potentially experience glare.

Classification	Description
High	Potential for more than 45 mins of glare per day and/or more than 50 hours per year
Medium	Potential for no more than 45 mins of glare per day and/or no more than 50 hours per year
Low	Potential for 20 - 30 mins of glare per day and/or no more than 30 hours per year
Very Low	Potential for 10 - 20 mins of glare per day and/or no more than 20 hours per year
Negligible	Potential for less than 10 mins of glare per day and/or less than 10 hours per year
None	No geometric potential for glare / Any potential for glare fully screened by intervening landform, vegetation or the built environment

The above table is used as a guide only and final classification is based on a combination of additional factors including level of intervening screening (vegetative or otherwise), receptor orientation, position of sun in relation to source of glare, as well as professional judgement.

7. Mitigation

If it is determined that glare will be experienced at a particular receptor and there is no screening between the receptor and the solar array, mitigation may be recommended depending on the severity of the glare. Mitigating glare impact from a solar array can be achieved in a number of different ways. The most common method is to add vegetative screening to essentially form a visual barrier between the receptor and the development. This type of mitigation is often required for ecological and visual impact reasons also. Other forms of mitigation include changing the design of the solar array, such as a change in pitch and orientation of the panels.

Receptor Selection

As discussed, this report assesses the final approach at all runways and the ATCT at Casement Aerodrome and the helipad at Tallaght Hospital. These receptors have been analysed for glint and glare effects that may be experienced during take off and landing as a result of the propsed roof mounted solar PV arrays. The accompanying Maps 2 - 18 will help in identifying solar array locations and also give a graphical overview of any arrays that could potentially be a source of glare to aircraft at these receptors.

Results & Discussion

Tables 2 – 18 give an overview of the findings of this glint and glare report and can be used to assist in comprehension of the following discussion, along with the included maps (Maps 2 - 18). For more detailed information on the particulars of potential glare experienced at each receptor, please refer to the appendix of this report. The appendix contain graphs for each solar array showing the date and time of potential glare, the potential duration of the glare, the hazard plot indicating the magnitude of the potential glare and also where along the final approach the glare might potentially be experienced.

Please note, all references to time herein refer to Irish Standard Time (IST) which equates to UTC/GMT +1 hour. Between mid-March and early November Ireland uses Daylight Savings Time (DST) and as a result, 1 hour needs to be subtracted from any results occuring outside this time period.

Table 2: Glint and Glare Analysis Results for Approach to Casement Runway 29

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	rw29	FALSE	TRUE	18.3	25	1523	15:29:00	16:33:00	2021-01-11	2021-02-21	2021-10-20	2021-11-29
array_2	rw29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	rw29	FALSE	TRUE	18.2	25	1421	15:31:00	16:32:00	2021-01-09	2021-02-16	2021-10-24	2021-12-01
array_4	rw29	FALSE	TRUE	17.9	25	1468	15:33:00	16:34:00	2021-01-07	2021-02-16	2021-10-24	2021-12-03
array_5	rw29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	rw29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	rw29	FALSE	TRUE	11.3	21	623	16:00:00	16:48:00	2021-01-07	2021-02-02	2021-11-07	2021-12-04
array_8	rw29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	rw29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 3: Glint and Glare Analysis Results for Approach to Casement Runway 11

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	rw11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	rw11	TRUE	FALSE	12.4	17	1193	08:14:00	09:10:00	2021-01-27	2021-03-15	2021-09-28	2021-11-14
array_3	rw11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	rw11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	rw11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	rw11	TRUE	FALSE	5.2	8	83	07:25:00	08:08:00	2021-02-08	2021-02-15	2021-10-26	2021-11-02
array_7	rw11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	rw11	TRUE	FALSE	11.1	17	1036	08:34:00	09:23:00	2021-02-02	2021-03-20	2021-09-23	2021-11-07
array_9	rw11	TRUE	FALSE	13.5	19	1184	08:34:00	09:24:00	2021-02-05	2021-03-20	2021-09-23	2021-11-05

Table 4: Glint and Glare Analysis Results for Approach to Casement Runway 23

Glare Result: None

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	rw23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5: Glint and Glare Analysis Results for Approach to Casement Runway 05

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	rw05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	rw05	TRUE	FALSE	17.6	20	1949	07:15:00	07:58:00	2021-04-27	2021-08-15	NA	NA
array_3	rw05	TRUE	FALSE	15.5	20	1643	05:35:00	06:29:00	2021-03-24	2021-05-15	2021-07-28	2021-09-18
array_4	rw05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	rw05	TRUE	FALSE	14.8	20	1154	05:28:00	06:12:00	2021-03-31	2021-05-08	2021-08-05	2021-09-12
array_6	rw05	TRUE	FALSE	17.7	21	2881	06:25:00	07:18:00	2021-04-01	2021-09-10	NA	NA
array_7	rw05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	rw05	TRUE	FALSE	18.1	20	1535	08:08:00	08:39:00	2021-05-10	2021-08-02	NA	NA
array_9	rw05	TRUE	FALSE	20.6	23	1796	08:04:00	08:39:00	2021-05-09	2021-08-03	NA	NA

Table 6: Glint and Glare Analysis Results for Tallaght Hospital Approach South

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	s	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	s	FALSE	TRUE	12.5	18	764	20:21:00	20:49:00	2021-05-22	2021-07-21	NA	NA
array_3	s	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	s	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	s	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	s	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	s	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	s	FALSE	TRUE	2.1	3	39	20:31:00	20:47:00	2021-05-29	2021-06-07	2021-07-05	2021-07-13
array_9	s	FALSE	TRUE	2.2	3	41	20:32:00	20:47:00	2021-05-30	2021-06-08	2021-07-05	2021-07-13

Table 7: Glint and Glare Analysis Results for Tallaght Hospital Approach E

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	e	FALSE	TRUE	18	22	1060	16:53:00	17:24:00	2021-03-29	2021-04-26	2021-08-16	2021-09-14
array_2	e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	e	FALSE	TRUE	15	22	674	17:35:00	18:13:00	2021-03-05	2021-03-27	2021-09-16	2021-10-07
array_4	e	FALSE	TRUE	18	22	1082	16:54:00	17:26:00	2021-03-27	2021-04-25	2021-08-18	2021-09-16
array_5	e	FALSE	TRUE	16	22	782	17:28:00	18:07:00	2021-03-07	2021-03-31	2021-09-12	2021-10-05
array_6	e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	e	FALSE	TRUE	19.3	25	1025	16:45:00	17:22:00	2021-03-25	2021-04-20	2021-08-23	2021-09-17
array_8	e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 8: Glint and Glare Analysis Results for Tallaght Hospital Approach N

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	n	FALSE	TRUE	25.3	29	2298	15:20:00	16:21:00	2021-01-01	2021-02-04	2021-11-06	2021-12-31
array_2	n	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	n	FALSE	TRUE	24.6	29	2163	15:24:00	16:22:00	2021-01-01	2021-02-02	2021-11-07	2021-12-31
array_4	n	FALSE	TRUE	25.1	29	2186	15:25:00	16:22:00	2021-01-01	2021-02-02	2021-11-08	2021-12-31
array_5	n	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	n	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	n	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	n	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	n	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 9: Glint and Glare Analysis Results for Tallaght Hospital Approach W

Glare Result: None

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	w	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 10: Glint and Glare Analysis Results for Tallaght Hospital Approach SSE

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	sse	FALSE	TRUE	19	24	1254	17:21:00	17:53:00	2021-05-20	2021-07-24	NA	NA
array_2	sse	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	sse	FALSE	TRUE	21.4	23	2870	18:07:00	18:48:00	2021-04-16	2021-08-27	NA	NA
array_4	sse	FALSE	TRUE	18.7	23	1293	17:23:00	17:54:00	2021-05-18	2021-07-25	NA	NA
array_5	sse	FALSE	TRUE	21.4	23	2678	17:59:00	18:39:00	2021-04-20	2021-08-22	NA	NA
array_6	sse	FALSE	TRUE	17.9	23	1935	18:56:00	19:41:00	2021-04-06	2021-05-29	2021-07-15	2021-09-06
array_7	sse	FALSE	TRUE	18.4	20	1291	16:57:00	17:26:00	2021-05-18	2021-07-26	NA	NA
array_8	sse	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	sse	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 11: Glint and Glare Analysis Results for Tallaght Hospital Approach ESE

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	ese	FALSE	TRUE	19.2	24	3285	17:01:00	17:46:00	2021-03-28	2021-09-14	NA	NA
array_2	ese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	ese	FALSE	TRUE	16.3	22	1878	17:41:00	18:29:00	2021-03-08	2021-05-04	2021-08-09	2021-10-04
array_4	ese	FALSE	TRUE	18.9	23	3296	17:01:00	17:48:00	2021-03-27	2021-09-16	NA	NA
array_5	ese	FALSE	TRUE	16.3	22	2051	17:35:00	18:23:00	2021-03-09	2021-05-10	2021-08-03	2021-10-04
array_6	ese	FALSE	TRUE	6.4	9	96	18:48:00	19:06:00	2021-04-03	2021-04-09	2021-09-02	2021-09-09
array_7	ese	FALSE	TRUE	17.6	21	3118	16:52:00	17:23:00	2021-03-25	2021-09-17	NA	NA
array_8	ese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	ese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 12: Glint and Glare Analysis Results for Tallaght Hospital Approach ENE

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	ene	FALSE	TRUE	22.9	33	1396	16:17:00	17:24:00	2021-03-11	2021-04-10	2021-09-02	2021-10-01
array_2	ene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	ene	FALSE	TRUE	3.5	6	124	17:08:00	18:07:00	2021-02-20	2021-03-09	2021-10-04	2021-10-20
array_4	ene	FALSE	TRUE	22.5	32	1351	16:17:00	17:26:00	2021-03-10	2021-04-08	2021-09-04	2021-10-03
array_5	ene	FALSE	TRUE	12.1	19	728	16:53:00	18:07:00	2021-02-14	2021-03-15	2021-09-27	2021-10-26
array_6	ene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	ene	FALSE	TRUE	18	25	1348	16:19:00	17:22:00	2021-03-01	2021-04-06	2021-09-05	2021-10-12
array_8	ene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	ene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 13: Glint and Glare Analysis Results for Tallaght Hospital Approach NNE

Glare Result: Green

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	nne	FALSE	TRUE	20.9	28	2701	15:39:00	17:24:00	2021-02-03	2021-04-07	2021-09-04	2021-11-07
array_2	nne	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	nne	FALSE	TRUE	1	1	1	17:36:00	17:36:00	2021-10-08	2021-10-08	NA	NA
array_4	nne	FALSE	TRUE	20.4	27	2707	15:40:00	17:26:00	2021-01-31	2021-04-06	2021-09-05	2021-11-10
array_5	nne	FALSE	TRUE	5.2	10	259	17:04:00	18:06:00	2021-02-19	2021-03-15	2021-09-28	2021-10-22
array_6	nne	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	nne	FALSE	TRUE	17.5	24	2856	16:00:00	17:22:00	2021-01-12	2021-04-02	2021-09-09	2021-11-29
array_8	nne	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	nne	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 14: Glint and Glare Analysis Results for Tallaght Hospital Approach NNW

Glare Result: None

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	nnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 15: Glint and Glare Analysis Results for Tallaght Hospital Approach WNW

Glare Result: None

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	wnw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 16: Glint and Glare Analysis Results for Tallaght Hospital Approach WSW

Glare Result: None

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	wsw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 17: Glint and Glare Analysis Results for Tallaght Hospital Approach SSW

Glare Result: None

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
array_1	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_2	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_3	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_4	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_5	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_6	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_7	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_8	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
array_9	ssw	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 18: Glint and Glare Analysis Results for Casement ATC-T

Glare Result: None

Array	Receptor	Theoretical Potential for Glare		Mean Daily Duration	Max Daily Duration	Max Annual Duration	Potential Times Affected		Potential Dates Affected			
		am	pm	(mins)	(mins)	(mins)	Earliest Start Time	Latest End Time	1st Start Date	1st End Date	2nd Start Date	2nd End Date
Glare not geometrically possible from this location												

Interpreting the Results

For the purpose of aviation analysis, the methodology produced by SANDIA National Laboratories must be followed to comply with FAA guidance. This approach adopts the Solar Glare Hazard Plot (Figure 9) to measure the ocular impact of a solar array. Receptors with theoretical potential for glare can fall into one of three different areas: Green - "Low potential for after-image", Yellow - "Potential for after-image" and Red - "Potential for Permanent Eye Damage (retinal burn)".

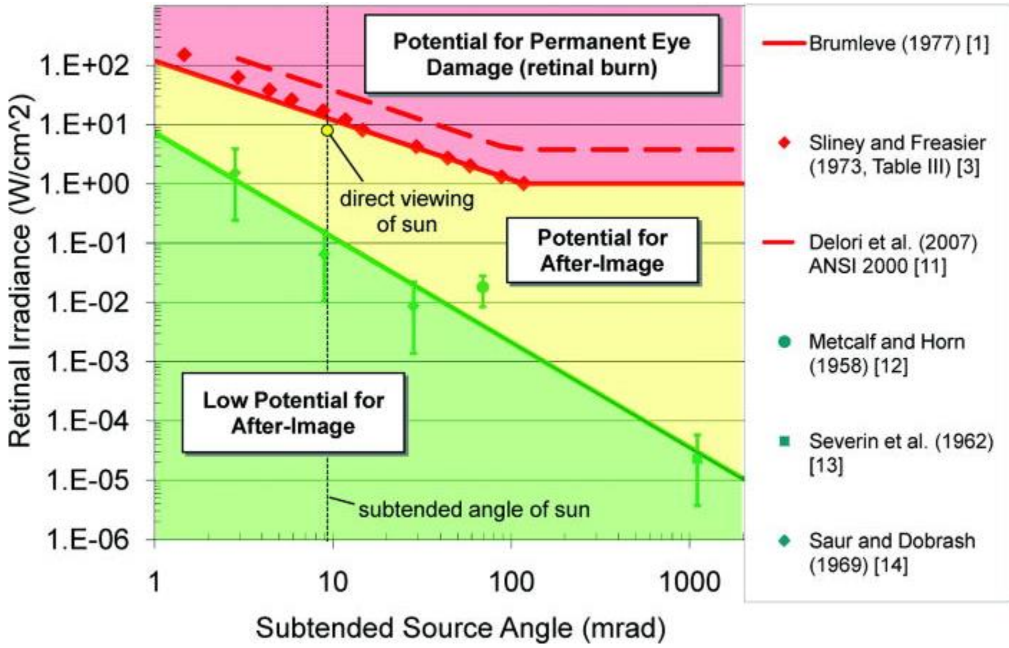


FIGURE 9: SOLAR GLARE HAZARD ANALYSIS PLOT (FIGURE 1 FROM FAA POLICY DOCUMENT)

The hazard plot above displays the ocular impact as a function of glare subtended source angle (the amount of an observer's field-of-view taken up by a glare spot) and retinal irradiance (the amount of light reaching the observer's retina). Each minute of potential glare is plotted on the chart. As a guide, a reference point which illustrates the hazard from viewing the sun without filtering is displayed on every graph.

From the 2013 FAA interim guidance, in order to obtain FAA approval for a proposed solar array the development must demonstrate that it meets the following standards:

"1. No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATCT) cab, and

2. No potential for glare or "low potential for after-image" (shown in green in Figure 1) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport

Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath."

Runway 29

From Table 2 it can be seen that four of the proposed nine arrays have the potential to impact on aircraft landing at Runway 29. Of these four arrays the maximum daily duration of potential glare is 25 minutes with a maximum average daily duration of 18 minutes. Based on Innovision's classification most of these values would fall into the **low** category. All potential glare experienced by a pilot landing at Runway 29 would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 2 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Runway 11

From Table 3 it can be seen that four of the proposed nine arrays have the potential to impact on aircraft landing at Runway 11. Of these four arrays the maximum daily duration of potential glare is 19 minutes with a maximum average daily duration of 13.5 minutes. Based on Innovision's classification these values would fall into the **very low** category. As with Runway 29, all potential glare experienced by a pilot landing at Runway 11 would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 3 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Runway 23

From Table 4 it can be seen that none of the proposed nine arrays have the potential to impact on aircraft landing at Runway 23.

Runway 05

From Table 5 above it can be seen that six of the proposed nine arrays have the potential to impact on aircraft landing at Runway 05. Of these five arrays, the maximum daily duration of potential glare is 23 minutes, with a maximum average daily duration of 20.6 minutes. Based on Innovision's classification these values would fall into the **low** category. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 5 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – South Approach

From Table 6 above it can be seen that three of the proposed nine arrays have the potential to impact on aircraft landing at Tallaght Hospital Helipad from a southern approach. Of these three arrays, the maximum daily duration of potential glare is 18 minutes, with a maximum average daily duration of 12.5 minutes. Based on Innovision's classification, one of these these values would fall into the **very low** category with two in the **negligible** category. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 6 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – East Approach

From Table 7 above it can be seen that five of the proposed nine arrays have the potential to impact on aircraft landing at Tallaght Hospital Helipad from an eastern approach. Of these arrays, the maximum daily duration of potential glare is 25 minutes, with a maximum average daily duration of 19.3 minutes. Based on Innovision's classification, these these values would fall into the **low** category. However, given the proximity of the proposal to the helipad at Tallaght Hospital this classification could be reduced down to **very low / negligible**. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 7 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – North Approach

From Table 8 above it can be seen that three of the proposed nine arrays have the potential to impact on aircraft landing at Tallaght Hospital Helipad from a northern approach. Of these three arrays, the maximum daily duration of potential glare is 29 minutes, with a maximum average daily duration of 25.3 minutes. Based on Innovision's classification, these values would fall into the **medium** category. However, given the proximity of the proposal to the helipad at Tallaght Hospital this classification could be reduced down to **very low**. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 8 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – West Approach

No potential for glare is predicted for the Western approach to Tallaght Hospital Helipad

Tallaght Hospital Helipad – South South East Approach

From Table 10 above it can be seen that six of the proposed nine arrays have the potential to impact on aircraft landing at Tallaght Hospital Helipad from a south-south-east approach. Of these six arrays, the maximum daily duration of potential glare is 24 minutes, with a maximum average daily duration of 21.4 minutes. Based on Innovision's classification, these these values would fall into the **low** category. However, given the proximity of the proposal to the helipad at Tallaght Hospital this classification could be reduced down to **very low or negligible** category. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 10 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – East South East Approach

From Table 11 above it can be seen that six of the proposed nine arrays have the potential to impact on aircraft landing at Tallaght Hospital Helipad from an east-south-east approach. Of these six arrays, the maximum daily duration of potential glare is 24 minutes, with a maximum average daily duration of 19.2 minutes. Based on Innovision's classification, five of these these values would fall into the **low** category with the other in the **negligible** category. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 11 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – East North East Approach

From Table 12 above it can be seen that five of the proposed nine arrays have the potential to impact on aircraft landing at Tallaght Hospital Helipad from an east-north-east approach. Of these five arrays, the maximum daily duration of potential glare is 33 minutes, with a maximum average daily duration of 22.9 minutes. Based on Innovision's classification, two of these these values would fall into the **medium** category with the rest in the **low**, **very low or negigible** category. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 12 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – North North East Approach

From Table 13 above it can be seen that five of the proposed nine arrays have the potential to impact on aircraft landing at Tallaght Hospital Helipad from a north-north-east approach. Of these five arrays, the maximum daily duration of potential glare is 28 minutes, with a maximum average daily duration of 20.9 minutes. Based on Innovision's classification, three of these these values would fall into the **low** category with the other two in the **very low and negligible** category. Further to this, all potential glare would fall into the green area of the hazard plot which is deemed an acceptable level of glare according to FAA guidance. Table 13 along with appendix A provides a detailed breakdown of exactly when and where this glare might occur.

Tallaght Hospital Helipad – North North West Approach

No potential for glare is predicted for the North-North-Western approach to Tallaght Hospital Helipad.

Tallaght Hospital Helipad – West North West Approach

No potential for glare is predicted for the West-North-Western approach to Tallaght Hospital Helipad.

Tallaght Hospital Helipad – West South West Approach

No potential for glare is predicted for the West-South-Western approach to Tallaght Hospital Helipad.

Tallaght Hospital Helipad – South South West Approach

No potential for glare is predicted for the South-South-Western approach to Tallaght Hospital Helipad.

Casement ATCT

No potential for glare is predicted for the Casement Aerodrome Air-Traffic-Control-Tower.

For all of the above receptors analysed a number of factors should also be noted, which add to the argument that hazardous glare as a result of the roof mounted PV panels on the proposed residential development at Cooldown Commons & Fortunestown, Citywest **can not** be expected.

Duration of Glare: While a detailed breakdown of the duration of potential glare has been provided, in reality, an aircraft will be past any reflectance in a matter of seconds.

Location of Development: While the proposed development is located relatively close to Casement aerodrome (just over 1.5km) and over 3km from Tallaght Hospital helipad, it would not be in a pilots direct field of view. A pilot landing at any of Casement's runways or Tallaght Hospital would most likely be focusing on the runway and final approach and would need to look away from this in order to observe the development which would be situated among many other developments (many of which have highly reflective materials in their make-up) and mature vegetation.

Size of Arrays: For ease of interpretation and comprehension of results, Innovision has populated the entire roof of groups of buildings with PV panels. In reality, each building will only have a small percentage of it's roof occupied by panels. Breaking each roof down into its individual sets of panels would have the effect of greatly reducing the potential impact but would result in an unmanageably large dataset of results.

Weather: As mentioned previously in this report, in order for glare to be experienced, the sun needs to be shining on the panels. From analysis of historical data it can be shown that the number of days glare could potentially be experienced at each receptor could realistically be reduced by 70% and still offer an overstated prediciton of glare.

National Vehicle Distribution Centre: The National Vehicle Distribution Centre is located directly adjacent to Casement Aerodrome. This centre contains thoudands of vehicles lined in a uniform manner. The glass windscreens and reflective metal bodies of these vehicles have the potential to generate a far more significant glint and glare impact to landing aircraft at Casement Aerodrome.

Conclusion

In conclusion, it can be shown from the above analyses that major nuisance or hazardous glare **can not** be expected for aircraft landing at any of the runways or the ATCT at Casement Aerodrome. Based on the "worst case" scenario analysed, there is the potential for very small amounts of "green" glare from certain rooftop arrays, but durations and magnitudes would be considered **negligible** to **low** by Innovision's classifications as set out in this report. More importantly however, the results achieve a pass by FAA standards based on the fact that no glare falls in or even near the "yellow" area of the hazard plot.

The level of potential glare from solar PV panels is similar to that of water and much less than that of materials such as concrete and vegetation. Many common elements of the Irish landscape offer similar, if not higher levels of glare than that caused by solar PV panels.

In order for glare to be experienced by a pilot, there needs to be direct sunlight shining on the solar PV panels. From analysis of historical sunshine data near the proposed site, the number of days glare could potentially be experienced at each receptor could realistically be reduced by 70% and still offer an overstated prediciton of glare.

Appendix A

Please note the following assumptions will apply to the following graphs:

- Please note, all references to time herein refer to Irish Standard Time (IST) which equates to UTC/GMT +1 hour. Between mid-March and early November Ireland uses Daylight Savings Time (DST) and as a result, 1 hour needs to be subtracted from any results occuring outside this time period.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Dublin Solar Array Analyses

Fortunestown Rev 1

Created April 16, 2021
Updated April 17, 2021
Time-step 1 minute
Timezone offset UTC0
Site ID 52561.9419

Project type Advanced
Project status: active
Category 100 to 500 kW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 2**
- 2-Mile Flight Path: **Version 2**
- Route: **Version 2**

Summary of Results

Glare with low potential for temporary after-image predicted

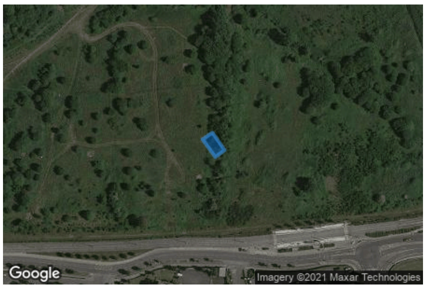
PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
array 1	15.0	138.0	13,517	0	-
array 2	15.0	231.0	3,906	0	-
array 3	15.0	139.0	13,234	0	-
array 4	15.0	139.0	13,383	0	-
array 5	15.0	167.0	7,652	0	-
array 6	15.0	200.0	4,995	0	-
array 7	22.0	150.0	10,404	0	-
array 8	22.0	230.0	2,446	0	-
array 9	22.0	230.0	2,401	0	-

PV Array(s)

Total PV footprint area: 1,565 m^2

Name: array 1
Axis tracking: Fixed (no rotation)
Tilt: 15.0 deg
Orientation: 138.0 deg
Footprint area: 150 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.284916	-6.425856	114.77	24.23	139.00
2	53.284962	-6.425739	115.30	23.70	139.00
3	53.284841	-6.425599	116.10	22.90	139.00
4	53.284794	-6.425705	115.80	23.20	139.00

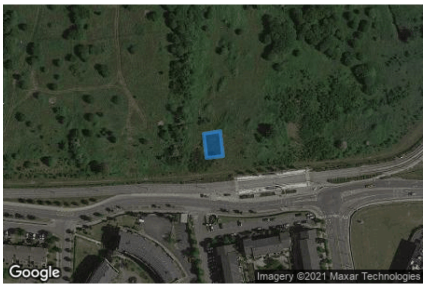


Name: array 2
Axis tracking: Fixed (no rotation)
Tilt: 15.0 deg
Orientation: 231.0 deg
Footprint area: 168 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.285090	-6.425480	114.89	16.11	131.00
2	53.285186	-6.425255	113.27	17.73	131.00
3	53.285115	-6.425180	113.50	17.50	131.00
4	53.285026	-6.425373	113.52	17.48	131.00

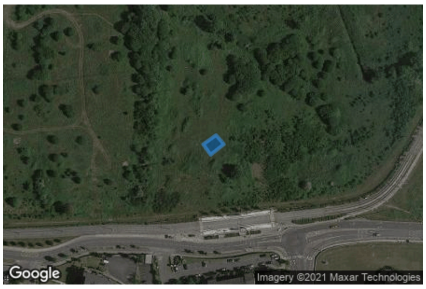
Name: array 3
Axis tracking: Fixed (no rotation)
Tilt: 15.0 deg
Orientation: 139.0 deg
Footprint area: 247 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.284583	-6.425394	114.89	26.11	141.00
2	53.284602	-6.425201	114.73	26.27	141.00
3	53.284429	-6.425169	115.14	25.86	141.00
4	53.284416	-6.425362	115.62	25.38	141.00



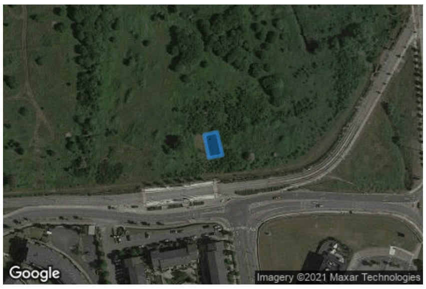
Name: array 4
Axis tracking: Fixed (no rotation)
Tilt: 15.0 deg
Orientation: 139.0 deg
Footprint area: 119 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	53.284788	-6.424999	113.90	41.10	155.00
2	53.284852	-6.424850	113.28	41.72	155.00
3	53.284789	-6.424760	113.58	41.42	155.00
4	53.284717	-6.424912	114.07	40.93	155.00



Name: array 5
Axis tracking: Fixed (no rotation)
Tilt: 15.0 deg
Orientation: 167.0 deg
Footprint area: 194 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	53.284660	-6.424332	114.46	27.54	142.00
2	53.284500	-6.424279	114.85	27.15	142.00
3	53.284519	-6.424118	115.14	26.86	142.00
4	53.284679	-6.424182	114.77	27.23	142.00



Name: array 6
Axis tracking: Fixed (no rotation)
Tilt: 15.0 deg
Orientation: 200.0 deg
Footprint area: 228 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	53.284884	-6.423152	112.92	21.08	134.00
2	53.284993	-6.423088	112.76	21.24	134.00
3	53.284936	-6.422830	112.96	21.04	134.00
4	53.284833	-6.422895	113.06	20.94	134.00

Name: array 7
Axis tracking: Fixed (no rotation)
Tilt: 22.0 deg
Orientation: 150.0 deg
Footprint area: 124 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	53.285309	-6.424185	114.45	7.55	122.00
2	53.285283	-6.424145	114.44	7.56	122.00
3	53.285472	-6.423742	112.32	9.68	122.00
4	53.285494	-6.423776	112.48	9.52	122.00

Name: array 8
Axis tracking: Fixed (no rotation)
Tilt: 22.0 deg
Orientation: 230.0 deg
Footprint area: 175 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	53.285044	-6.424551	113.51	8.49	122.00
2	53.285071	-6.424487	113.48	8.52	122.00
3	53.285301	-6.424782	112.18	9.82	122.00
4	53.285274	-6.424853	112.28	9.72	122.00

Name: array 9
Axis tracking: Fixed (no rotation)
Tilt: 22.0 deg
Orientation: 230.0 deg
Footprint area: 161 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	53.285565	-6.425247	112.75	9.25	122.00
2	53.285591	-6.425186	112.41	9.59	122.00
3	53.285381	-6.424906	112.48	9.52	122.00
4	53.285352	-6.424977	112.69	9.31	122.00

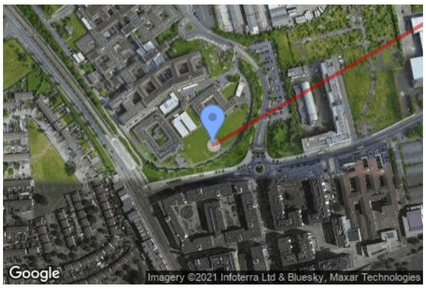
2-Mile Flight Path Receptor(s)

Name: E
Description:
Threshold height : 3 m
Direction: 270.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.289509	-6.376820	103.73	3.00	106.73
2-mile point	53.289509	-6.328396	67.82	491.27	559.09

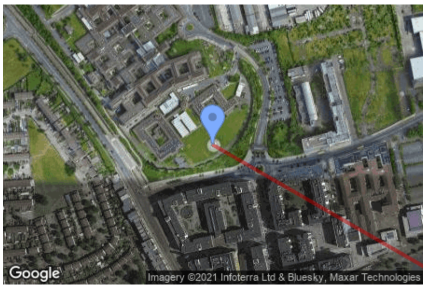
Name: ENE
Description:
Threshold height : 3 m
Direction: 240.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.289511	-6.376794	103.74	3.00	106.74
2-mile point	53.303967	-6.334858	59.67	499.43	559.10



Name: ESE
Description:
Threshold height : 3 m
Direction: 300.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.289511	-6.376796	103.74	3.00	106.74
2-mile point	53.275055	-6.334859	99.72	459.38	559.10



Name: N
Description:
Threshold height : 3 m
Direction: 180.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.289511	-6.376796	103.74	3.00	106.74
2-mile point	53.318423	-6.376796	80.38	478.72	559.10

Name: NNE
Description:
Threshold height : 3 m
Direction: 210.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.289511	-6.376797	103.74	3.00	106.74
2-mile point	53.314550	-6.352585	58.46	500.64	559.10

Name: NNW
Description:
Threshold height : 3 m
Direction: 150.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.289511	-6.376798	103.74	3.00	106.74
2-mile point	53.314550	-6.401010	72.55	486.55	559.10

Name: RW05
Description:
Threshold height : 15 m
Direction: 40.2 deg
Glide slope: 3.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.293828	-6.453448	98.24	15.24	113.48
2-mile point	53.271745	-6.484707	154.36	127.80	282.17

Name: RW11
Description:
Threshold height : 15 m
Direction: 102.3 deg
Glide slope: 3.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.304623	-6.468283	86.32	15.24	101.56
2-mile point	53.310782	-6.515612	72.86	197.38	270.24

Name: RW23
Description:
Threshold height : 15 m
Direction: 221.0 deg
Glide slope: 3.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

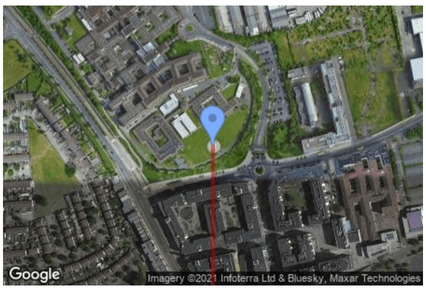
Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.303260	-6.439795	93.37	15.24	108.61
2-mile point	53.325080	-6.408016	62.39	214.91	277.29

Name: RW29
Description:
Threshold height : 15 m
Direction: 281.9 deg
Glide slope: 3.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.301694	-6.445159	96.10	15.24	111.34
2-mile point	53.295732	-6.397762	106.18	173.84	280.02

Name: S
Description:
Threshold height : 3 m
Direction: 0.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.289509	-6.376800	103.74	3.00	106.74
2-mile point	53.260597	-6.376800	161.86	397.24	559.10



Name: SSE
Description:
Threshold height : 3 m
Direction: 330.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.289511	-6.376800	103.74	3.00	106.74
2-mile point	53.264472	-6.352588	130.50	428.60	559.10

Name: SSW
Description:
Threshold height : 3 m
Direction: 30.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

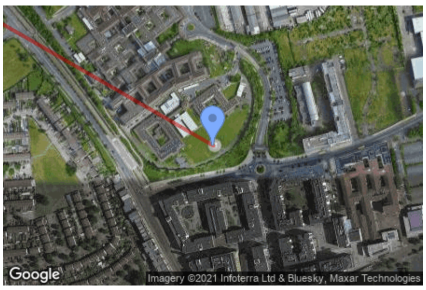
Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.289510	-6.376799	103.74	3.00	106.74
2-mile point	53.264471	-6.401011	262.49	296.61	559.10

Name: W
Description:
Threshold height : 3 m
Direction: 90.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.289511	-6.376800	103.74	3.00	106.74
2-mile point	53.289511	-6.425224	110.15	448.95	559.10

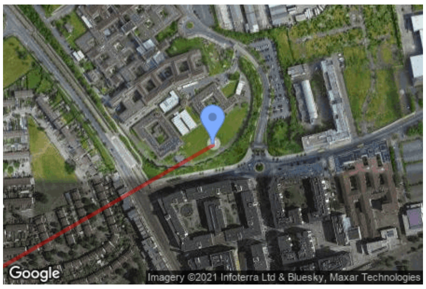
Name: WNW
Description:
Threshold height : 3 m
Direction: 120.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.289504	-6.376813	103.74	3.00	106.74
2-mile point	53.303961	-6.418749	91.40	467.70	559.10



Name: WSW
Description:
Threshold height : 3 m
Direction: 60.0 deg
Glide slope: 8.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 50.0 deg

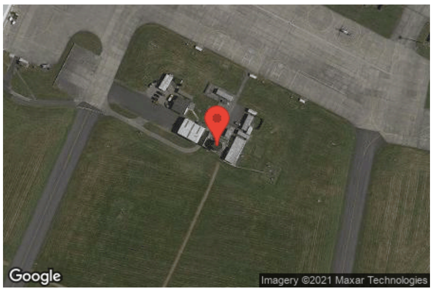
Point	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
Threshold	53.289486	-6.376797	103.76	3.00	106.76
2-mile point	53.275029	-6.418733	143.79	415.33	559.12



Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
1-ATCT	53.305499	-6.441793	93.54	6.00	99.54

1-ATCT map image



Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
array 1	15.0	138.0	13,517	0	-	
array 2	15.0	231.0	3,906	0	-	
array 3	15.0	139.0	13,234	0	-	
array 4	15.0	139.0	13,383	0	-	
array 5	15.0	167.0	7,652	0	-	
array 6	15.0	200.0	4,995	0	-	
array 7	22.0	150.0	10,404	0	-	
array 8	22.0	230.0	2,446	0	-	
array 9	22.0	230.0	2,401	0	-	

Distinct glare per month

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

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
array-1 (green)	873	720	809	737	725	886	818	709	817	776	805	889
array-1 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-2 (green)	48	329	219	24	611	1064	800	214	37	409	151	0
array-2 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-3 (green)	846	721	813	692	741	904	832	705	802	768	781	878
array-3 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-4 (green)	875	710	832	725	722	878	810	692	862	742	804	897
array-4 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-5 (green)	0	193	618	1106	867	685	700	1232	732	368	0	0
array-5 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-6 (green)	0	41	0	878	1142	612	907	1156	185	39	3	0
array-6 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-7 (green)	319	626	712	668	713	838	801	642	673	712	508	8
array-7 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-8 (green)	0	259	274	0	319	528	526	8	116	364	52	0
array-8 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
array-9 (green)	0	238	276	0	317	528	520	8	118	342	54	0
array-9 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0

PV & Receptor Analysis Results

Results for each PV array and receptor

array 1 low potential for temporary after-image

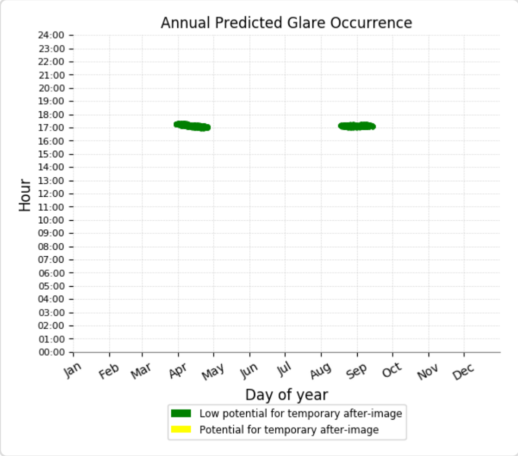
Component	Green glare (min)	Yellow glare (min)
FP: E	1060	0
FP: ENE	1396	0
FP: ESE	3285	0
FP: N	2298	0
FP: NNE	2701	0

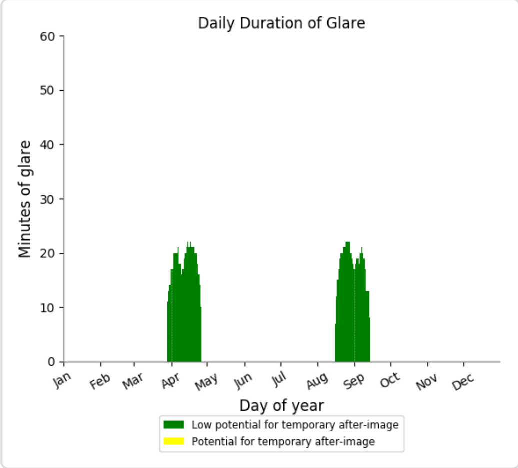
FP: NNW	0	0
FP: RW05	0	0
FP: RW11	0	0
FP: RW23	0	0
FP: RW29	1523	0
FP: S	0	0
FP: SSE	1254	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

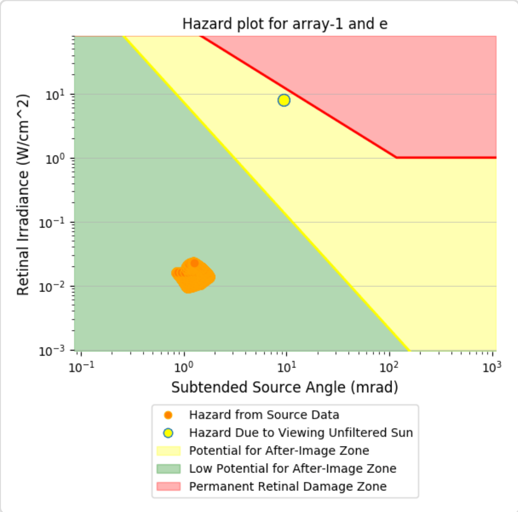
array 1 - Receptor (E)

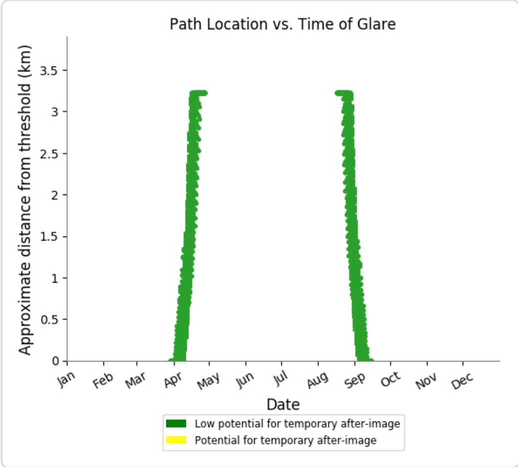
PV array is expected to produce the following glare for observers on this flight path:

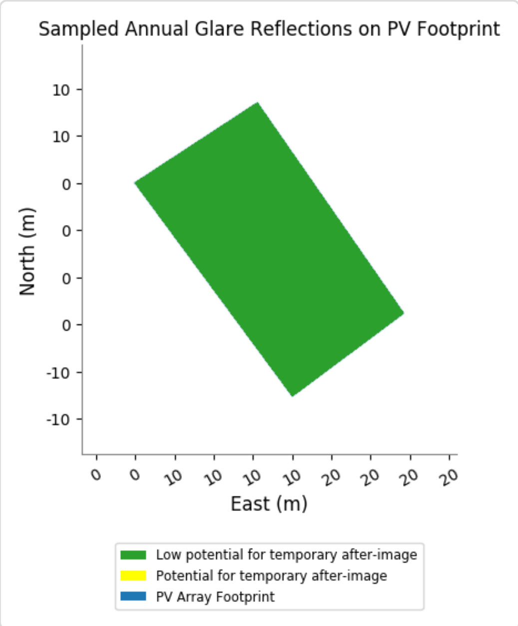
- 1,060 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

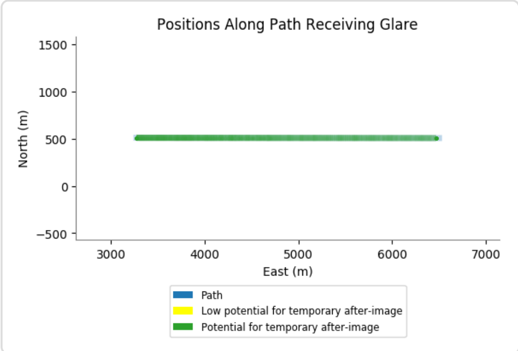






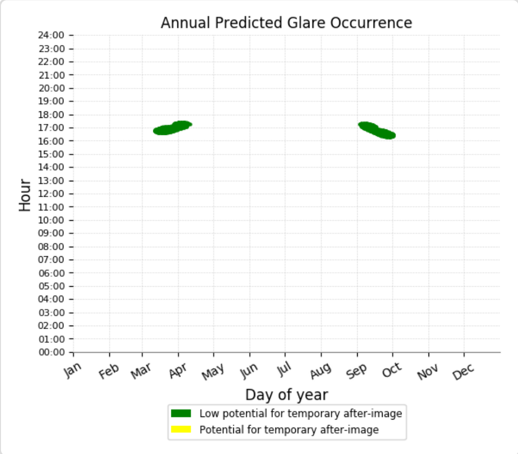


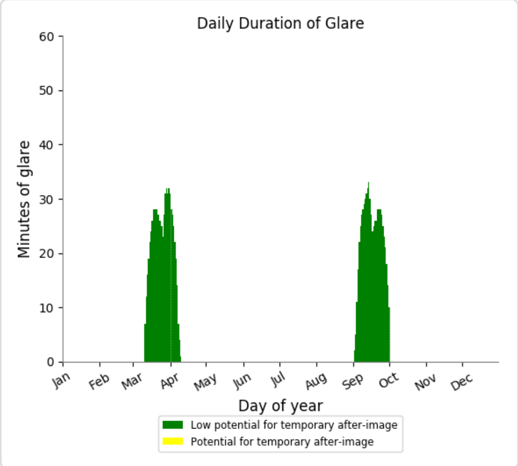


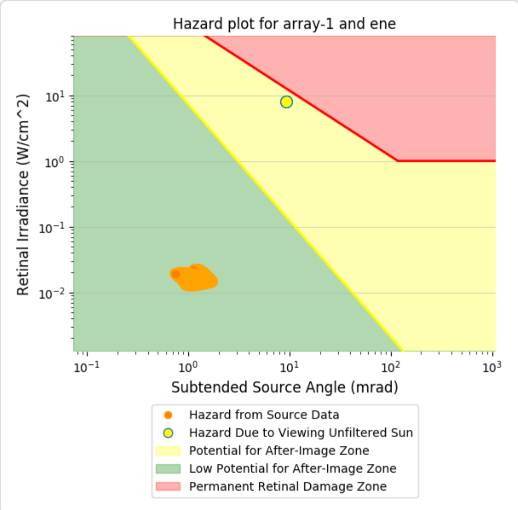


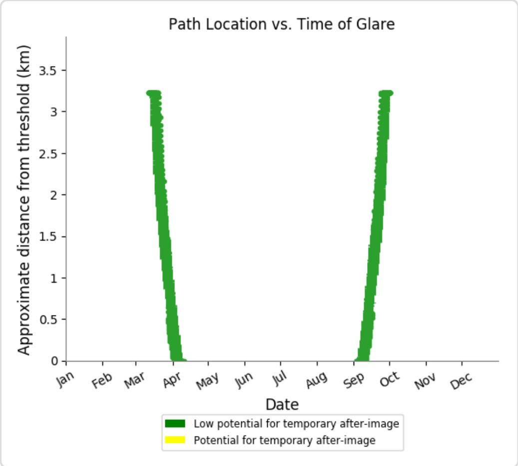
array 1 - Receptor (ENE)

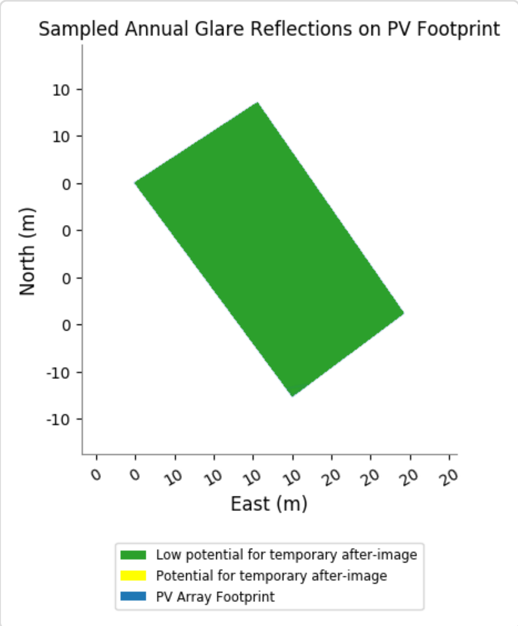
PV array is expected to produce the following glare for observers on this flight path:
- 1,396 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

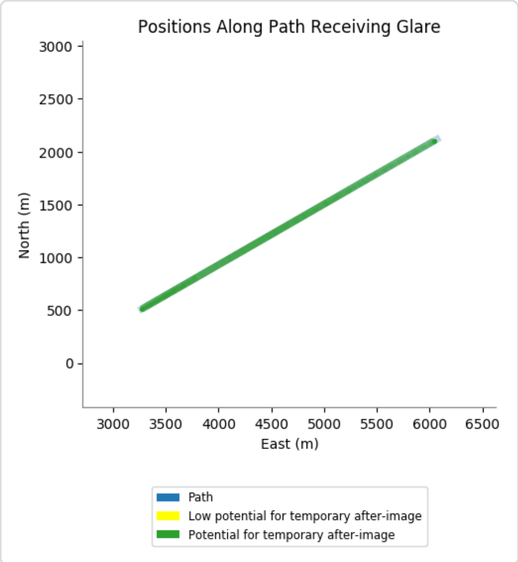








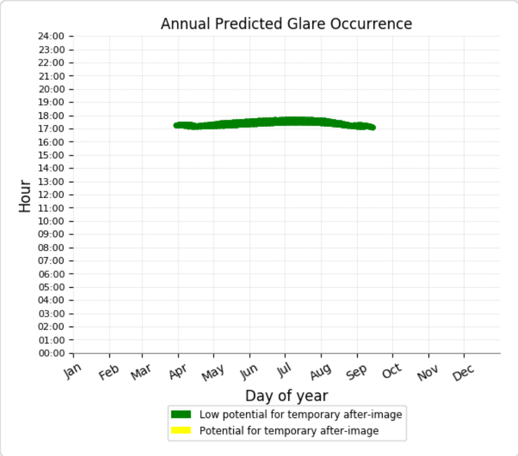


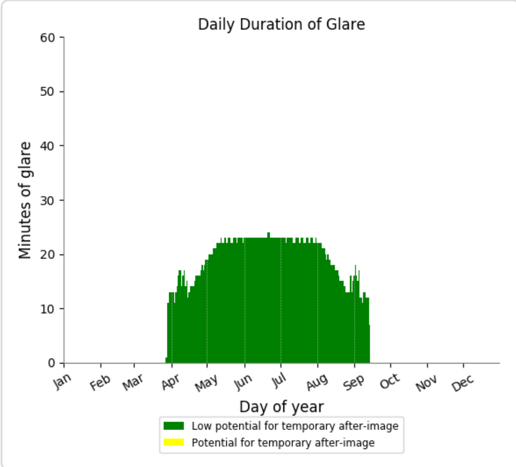


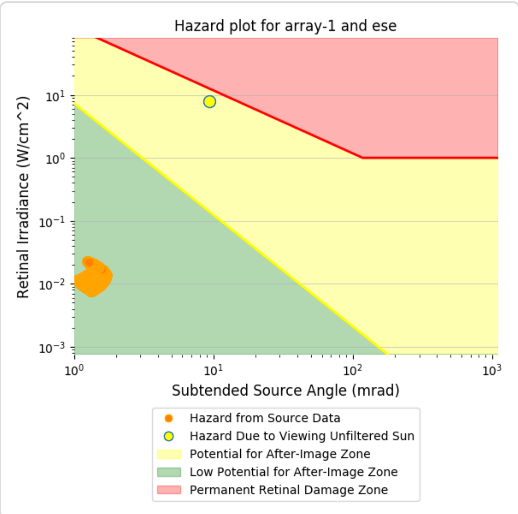
array 1 - Receptor (ESE)

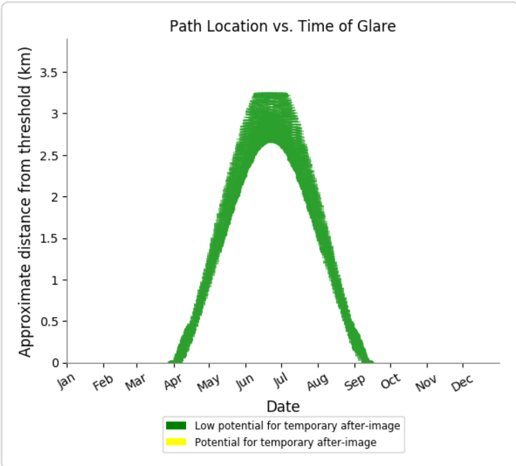
PV array is expected to produce the following glare for observers on this flight path:

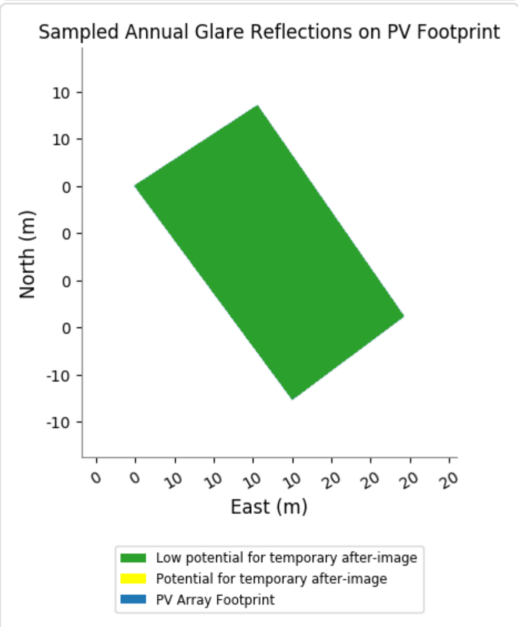
- 3,285 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

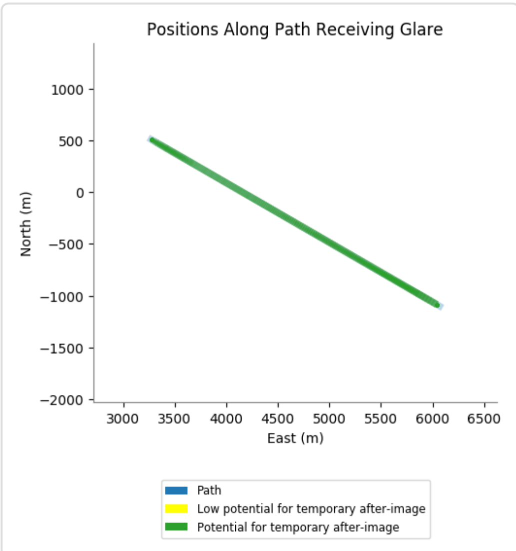








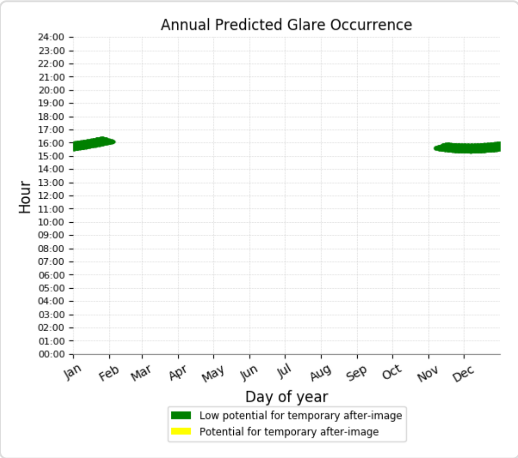


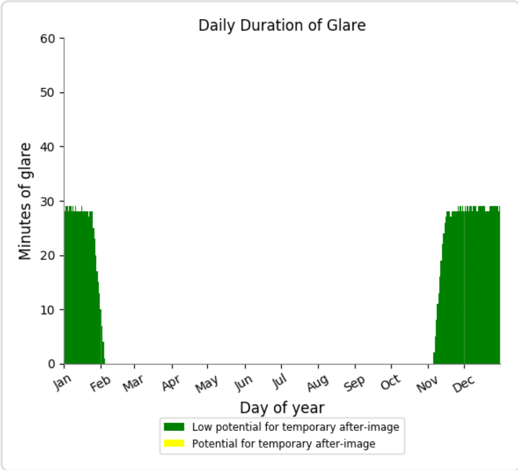


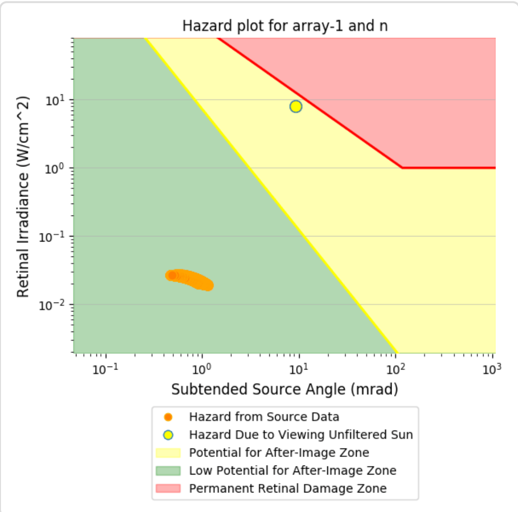
array 1 - Receptor (N)

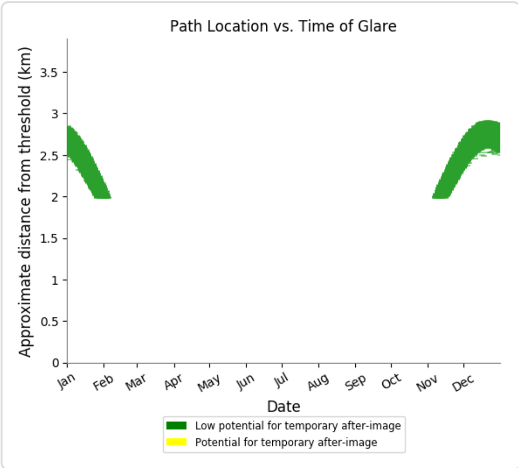
PV array is expected to produce the following glare for observers on this flight path:

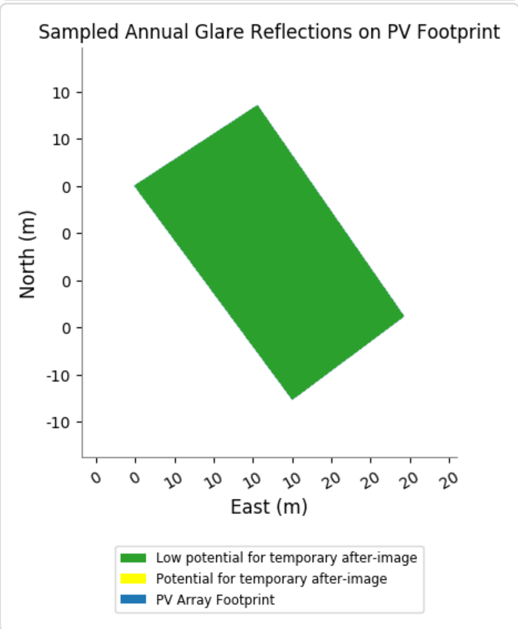
- 2,298 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

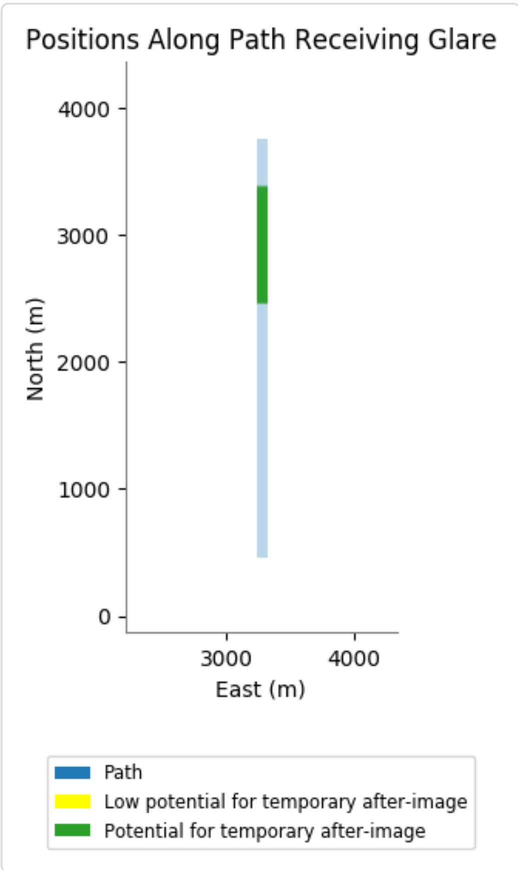








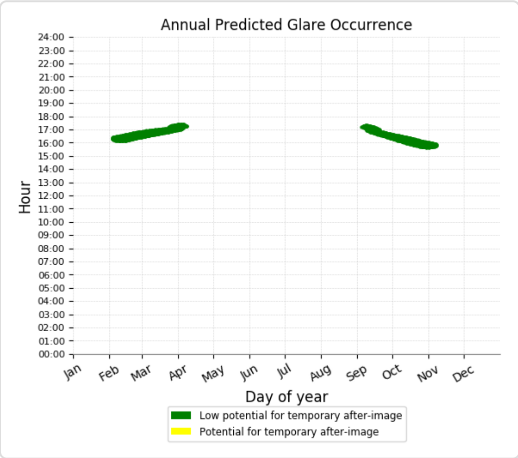


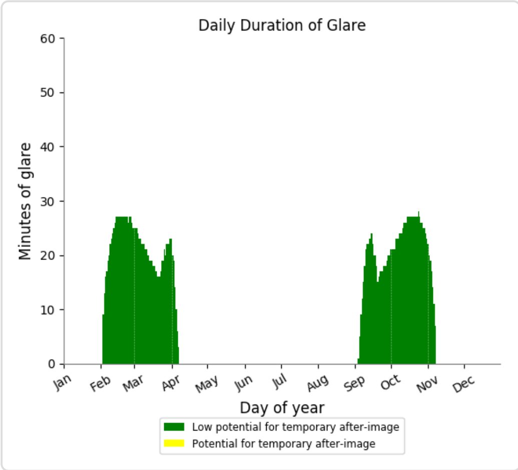


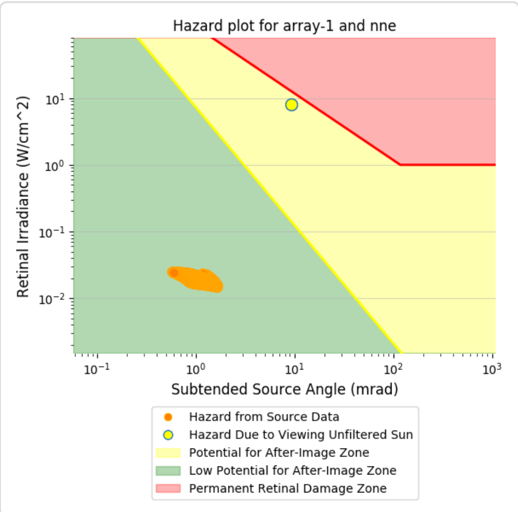
array 1 - Receptor (NNE)

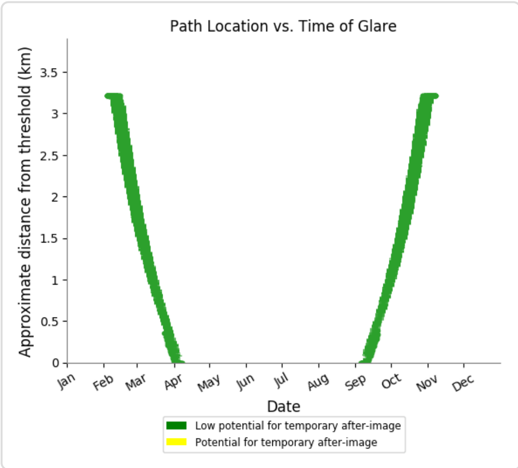
PV array is expected to produce the following glare for observers on this flight path:

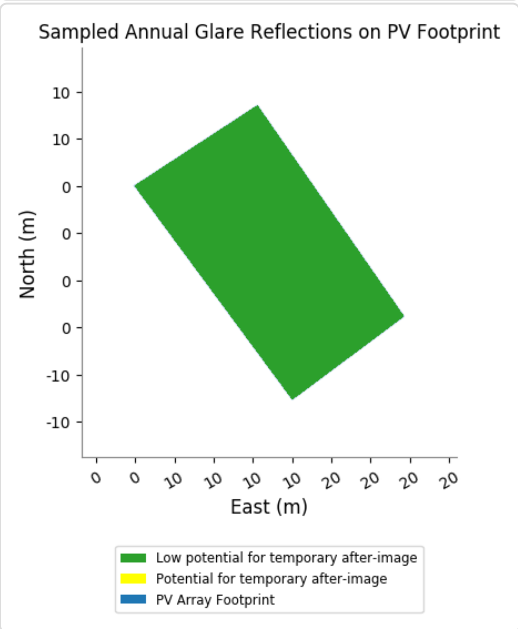
- 2,701 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

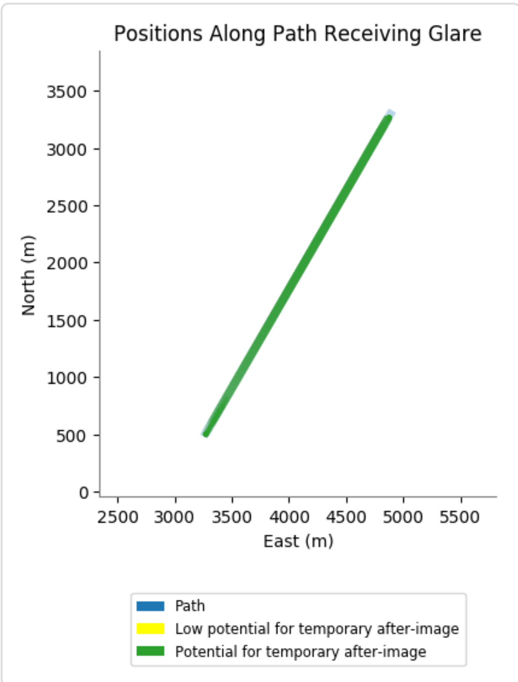












array 1 - Receptor (NNW)

No glare found

array 1 - Receptor (RW05)

No glare found

array 1 - Receptor (RW11)

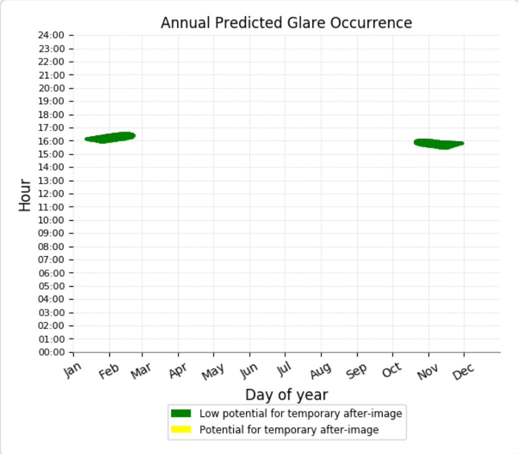
No glare found

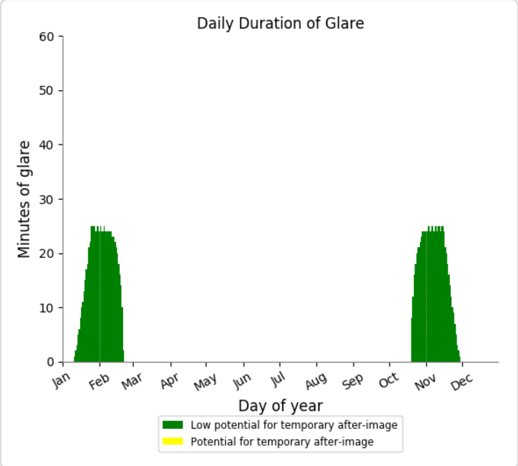
array 1 - Receptor (RW23)

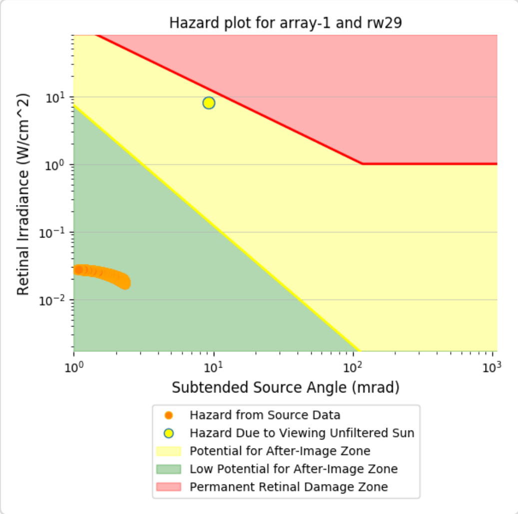
No glare found

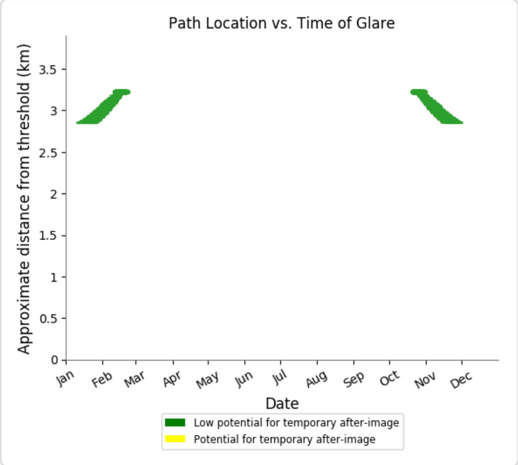
array 1 - Receptor (RW29)

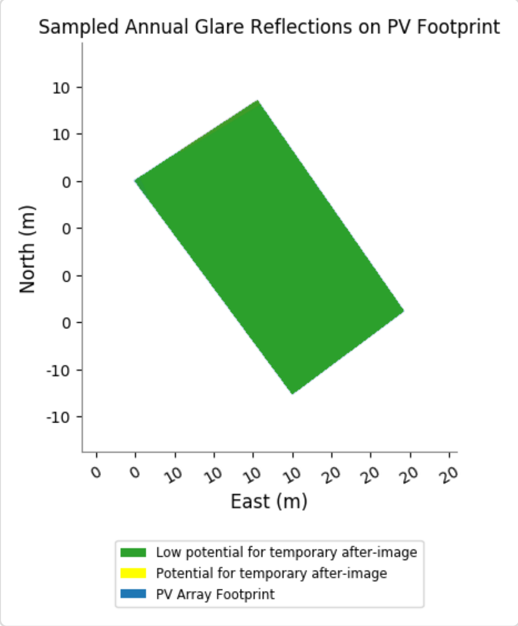
PV array is expected to produce the following glare for observers on this flight path:
- 1,523 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

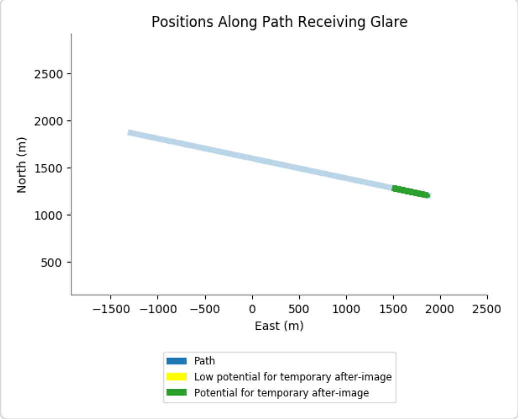












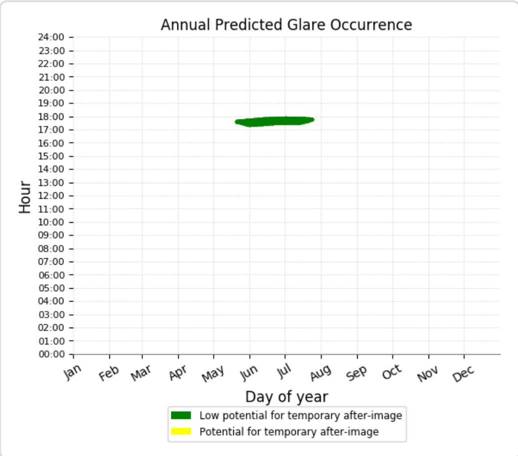
array 1 - Receptor (S)

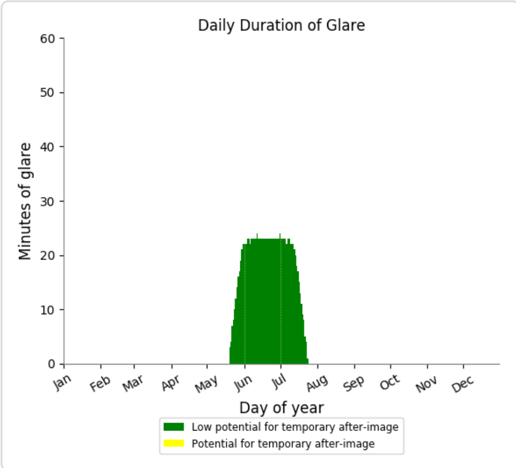
No glare found

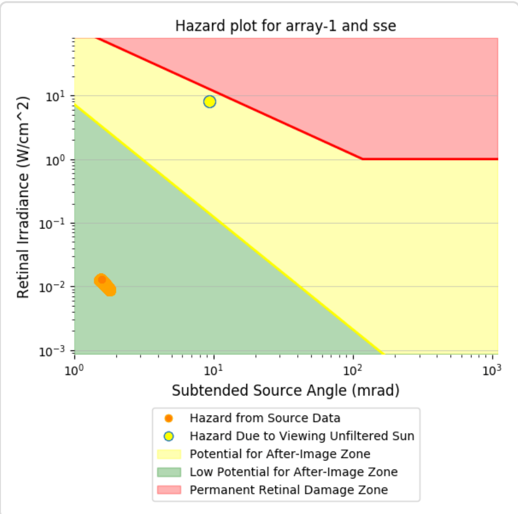
array 1 - Receptor (SSE)

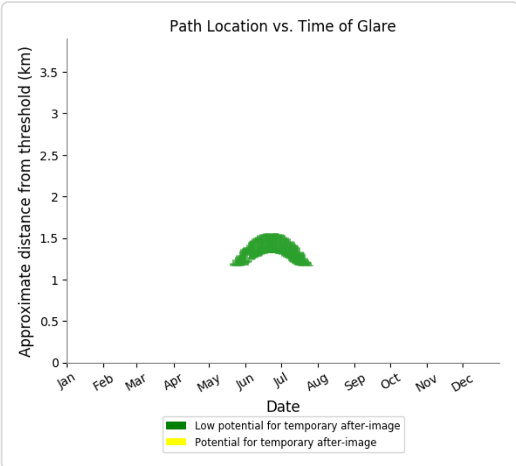
PV array is expected to produce the following glare for observers on this flight path:

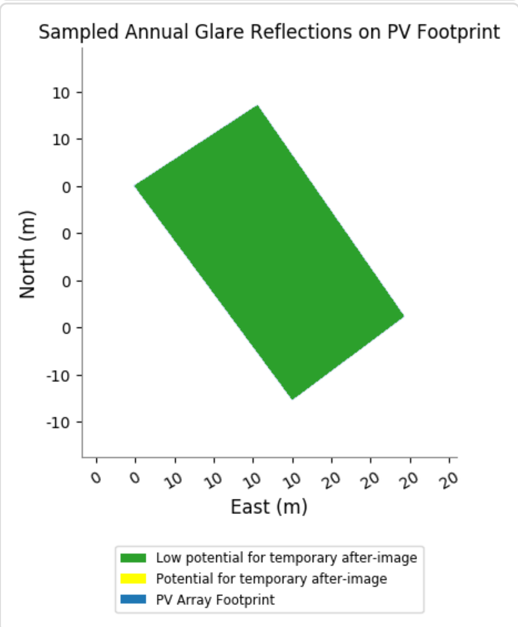
- 1,254 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

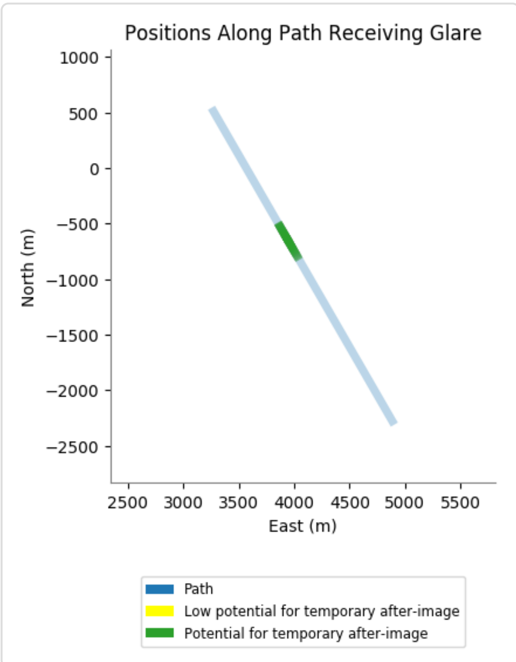












array 1 - Receptor (SSW)

No glare found

array 1 - Receptor (W)

No glare found

array 1 - Receptor (WNW)

No glare found

array 1 - Receptor (WSW)

No glare found

array 1 - OP Receptor (1-ATCT)

No glare found

array 2 low potential for temporary after-image

Component	Green glare (min)	Yellow glare (min)
FP: E	0	0
FP: ENE	0	0
FP: ESE	0	0
FP: N	0	0
FP: NNE	0	0
FP: NNW	0	0
FP: RW05	1949	0
FP: RW11	1193	0
FP: RW23	0	0
FP: RW29	0	0
FP: S	764	0
FP: SSE	0	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

array 2 - Receptor (E)

No glare found

array 2 - Receptor (ENE)

No glare found

array 2 - Receptor (ESE)

No glare found

array 2 - Receptor (N)

No glare found

array 2 - Receptor (NNE)

No glare found

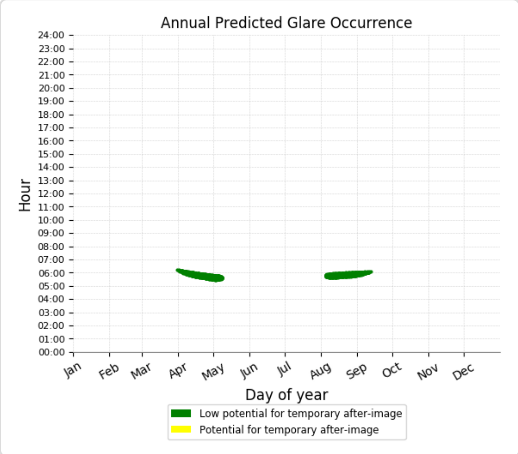
array 2 - Receptor (NNW)

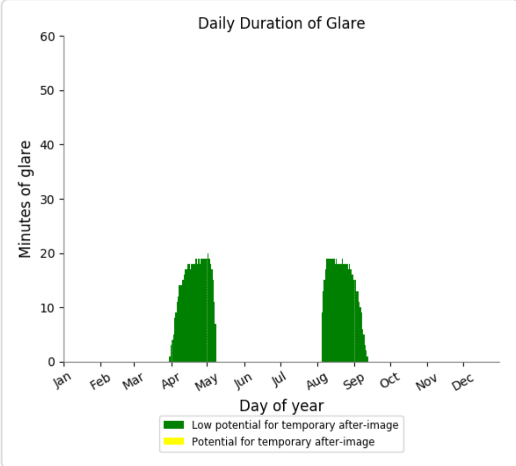
No glare found

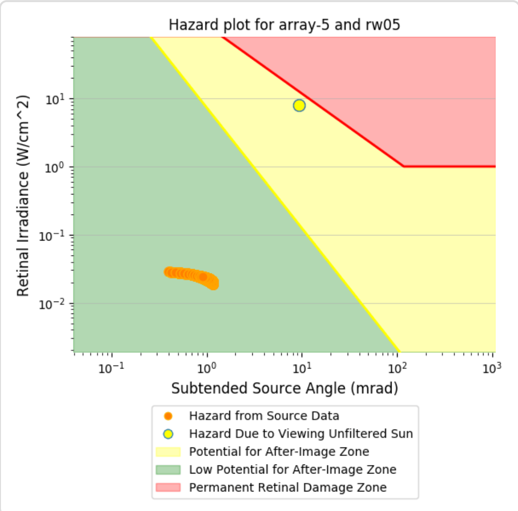
array 2 - Receptor (RW05)

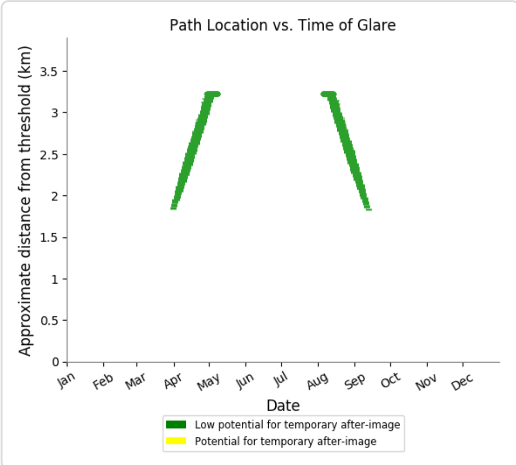
PV array is expected to produce the following glare for observers on this flight path:

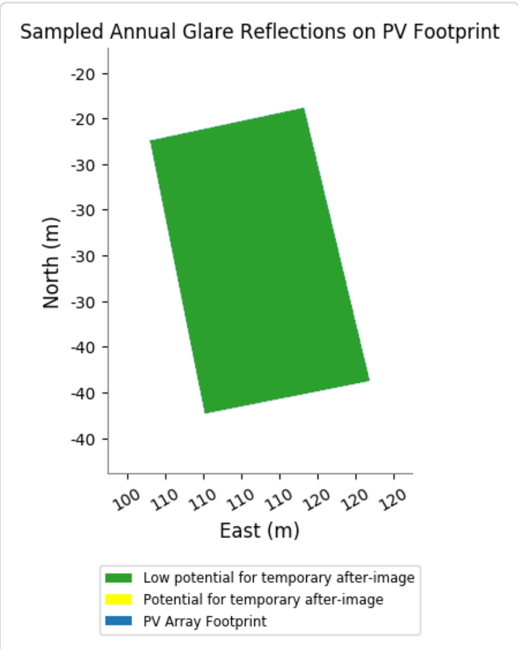
- 1,949 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

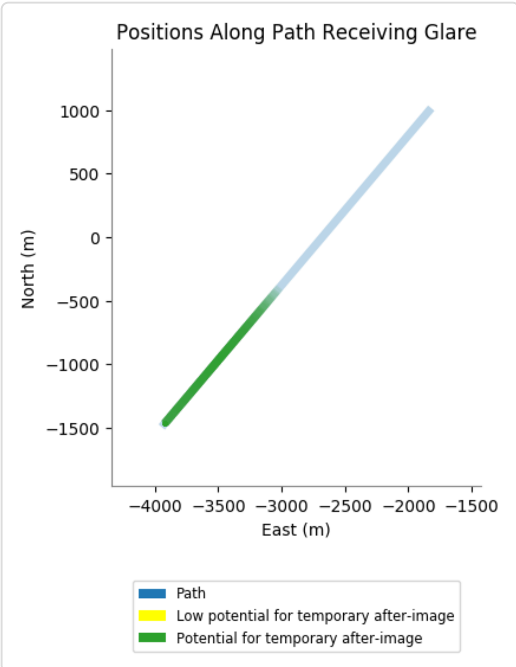








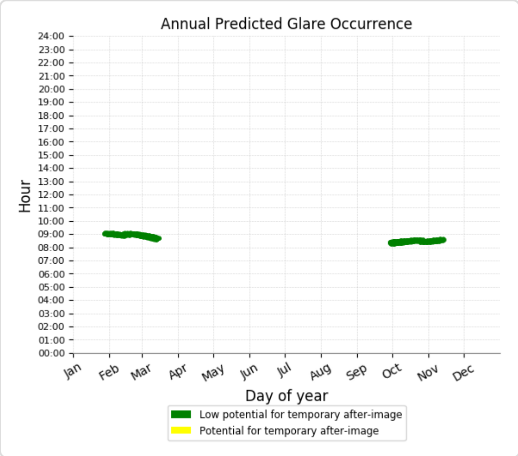


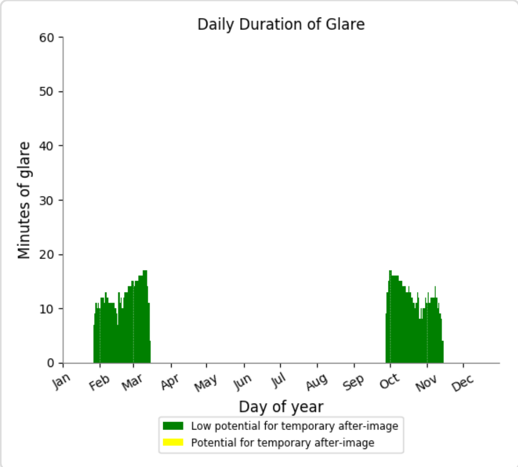


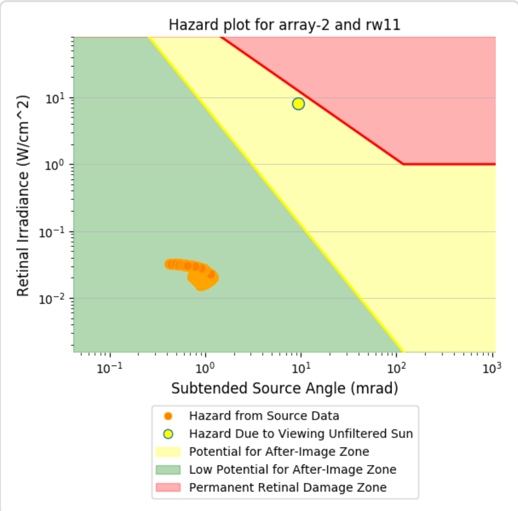
array 2 - Receptor (RW11)

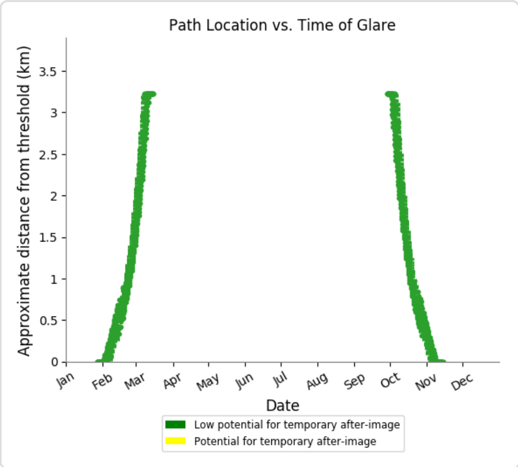
PV array is expected to produce the following glare for observers on this flight path:

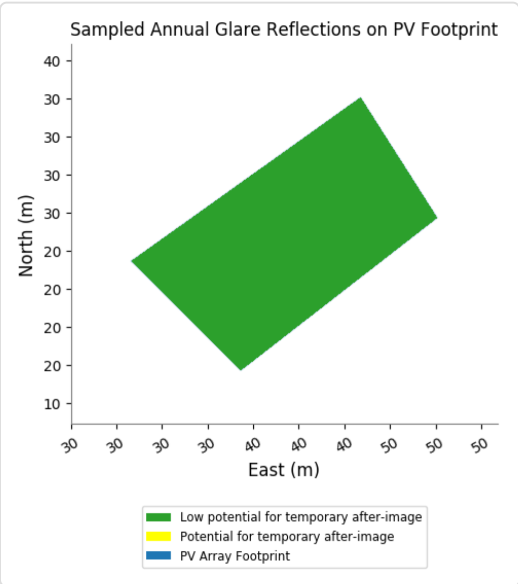
- 1,193 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

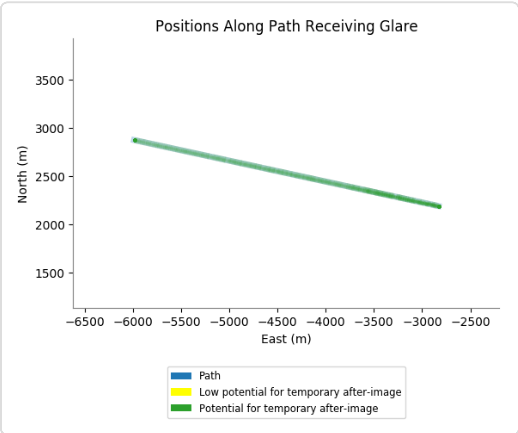












array 2 - Receptor (RW23)

No glare found

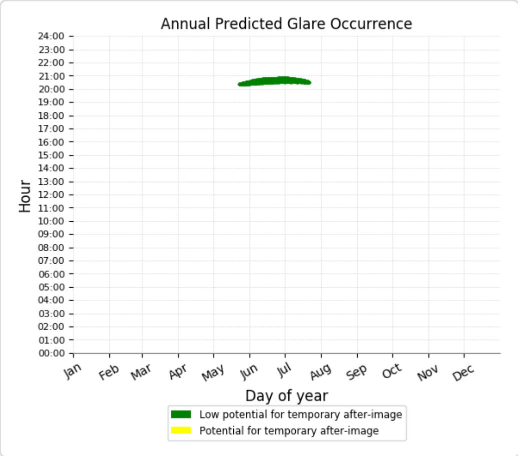
array 2 - Receptor (RW29)

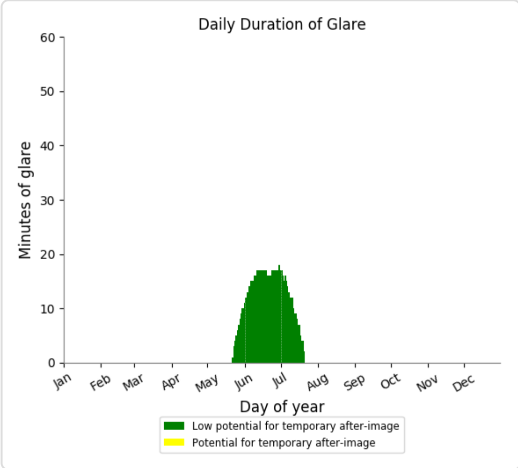
No glare found

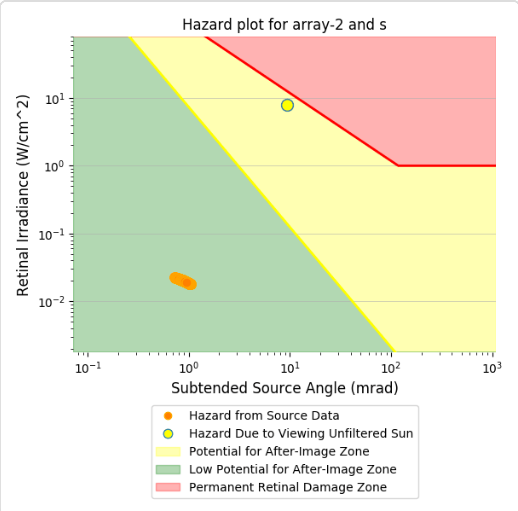
array 2 - Receptor (S)

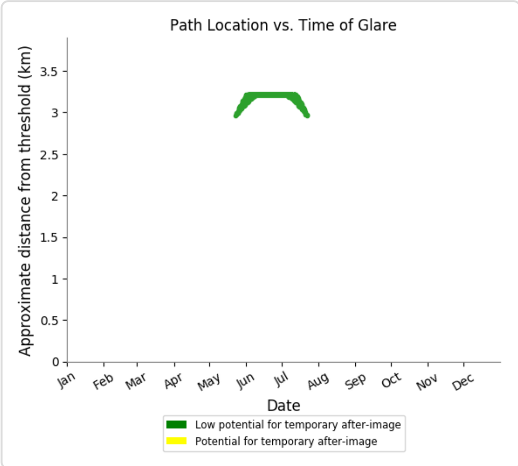
PV array is expected to produce the following glare for observers on this flight path:

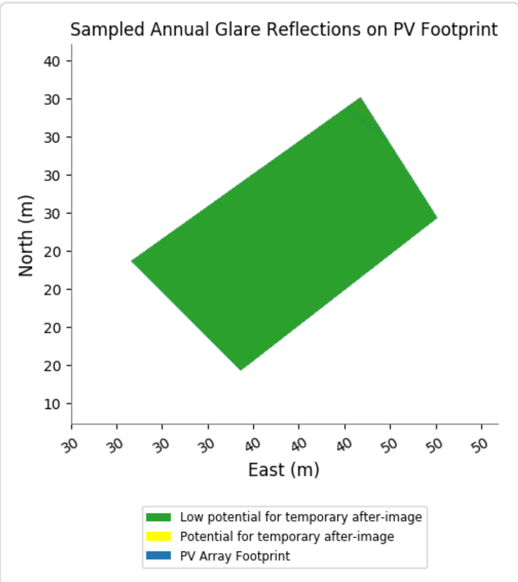
- 764 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

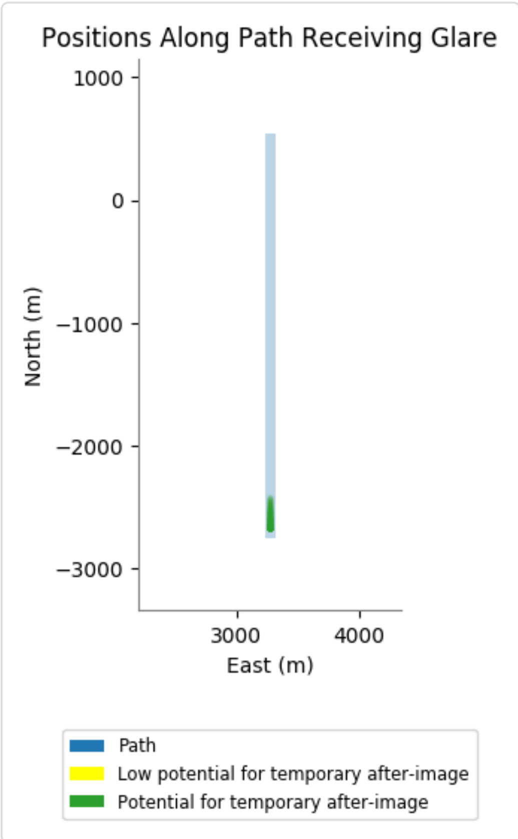












array 2 - Receptor (SSE)
No glare found

array 2 - Receptor (SSW)
No glare found

array 2 - Receptor (W)
No glare found

array 2 - Receptor (WNW)
No glare found

array 2 - Receptor (WSW)
No glare found

array 2 - OP Receptor (1-ATCT)
No glare found

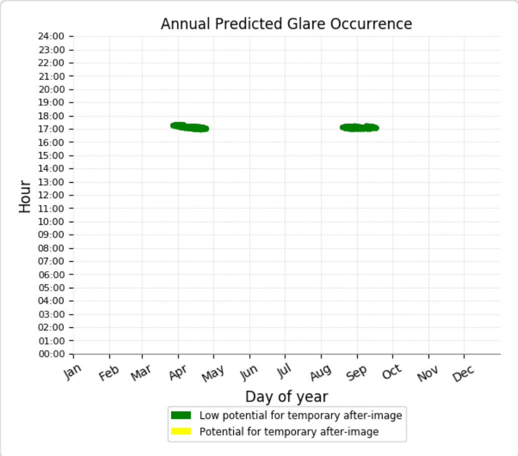
array 3 low potential for temporary after-image

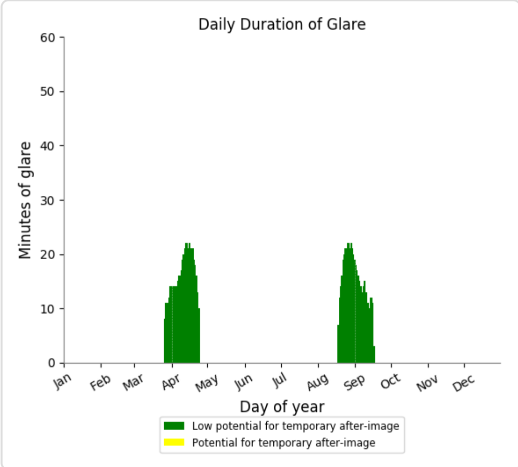
Component	Green glare (min)	Yellow glare (min)
FP: E	971	0
FP: ENE	1270	0
FP: ESE	3301	0
FP: N	2163	0
FP: NNE	2762	0
FP: NNW	0	0
FP: RW05	0	0
FP: RW11	0	0
FP: RW23	0	0
FP: RW29	1421	0
FP: S	0	0
FP: SSE	1346	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

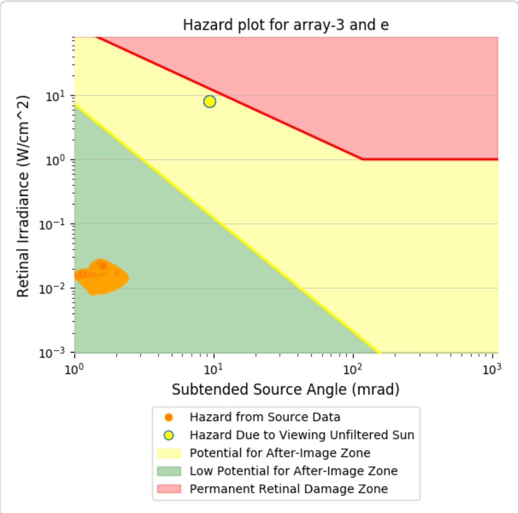
array 3 - Receptor (E)

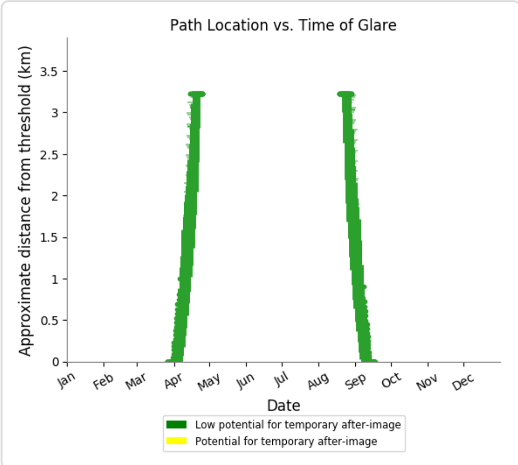
PV array is expected to produce the following glare for observers on this flight path:

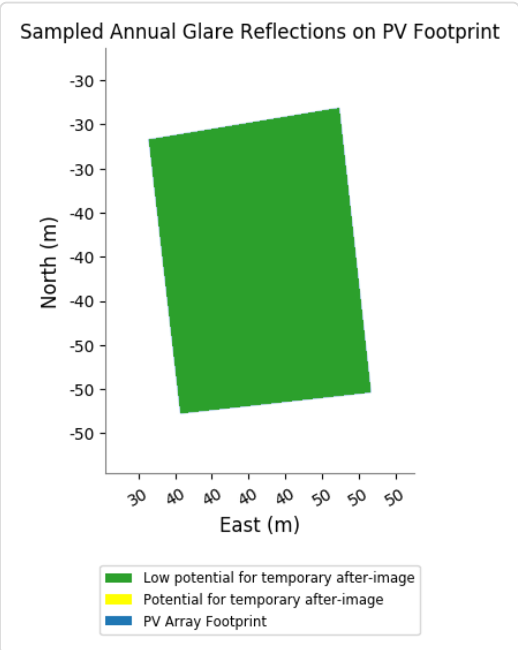
- 971 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

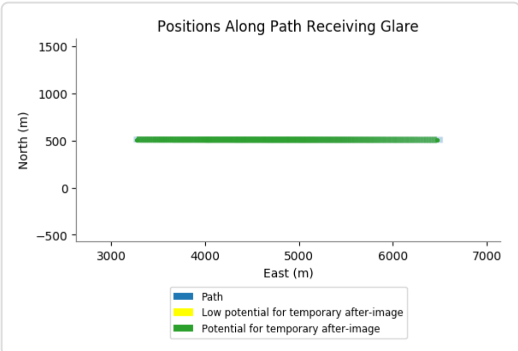








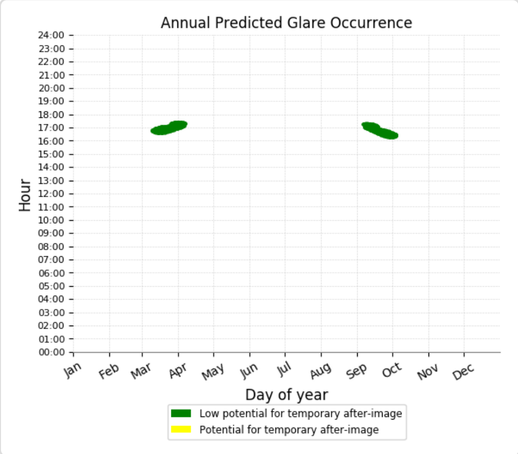


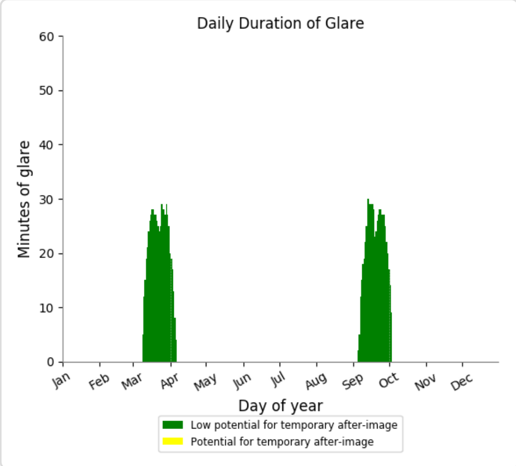


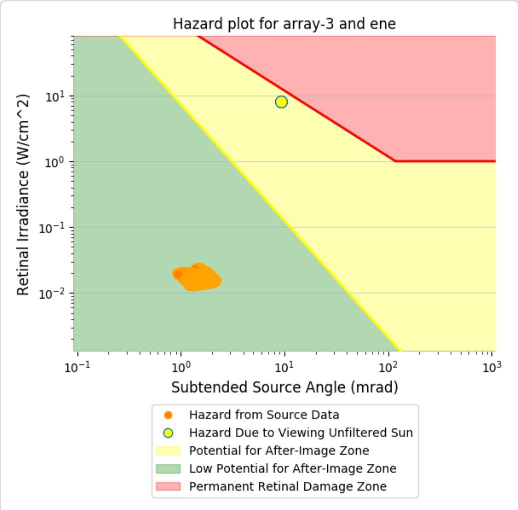
array 3 - Receptor (ENE)

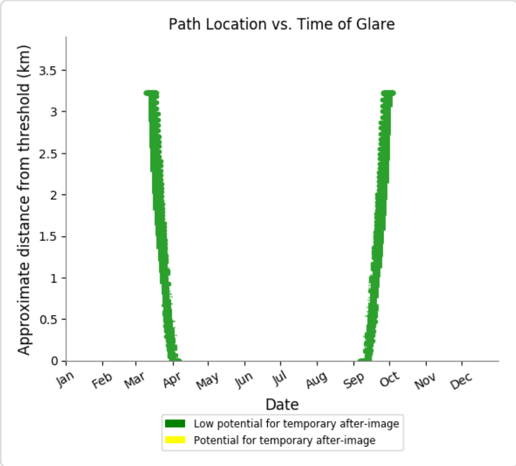
PV array is expected to produce the following glare for observers on this flight path:

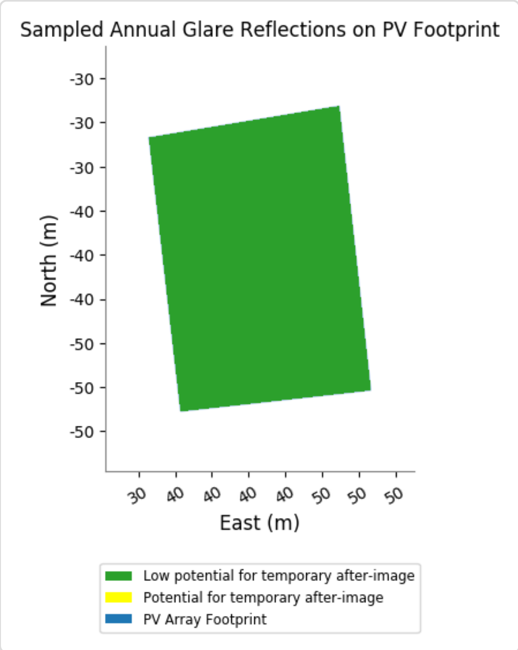
- 1,270 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

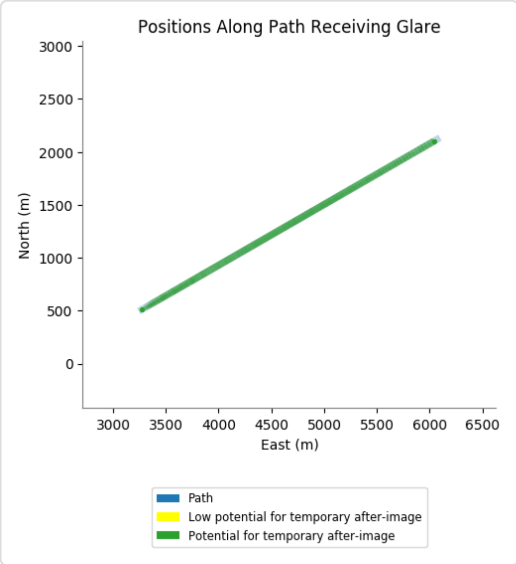








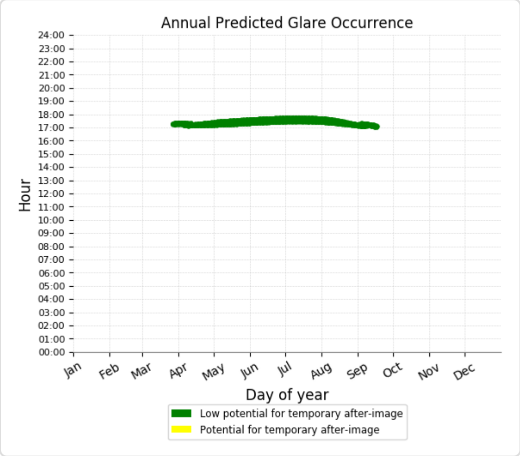


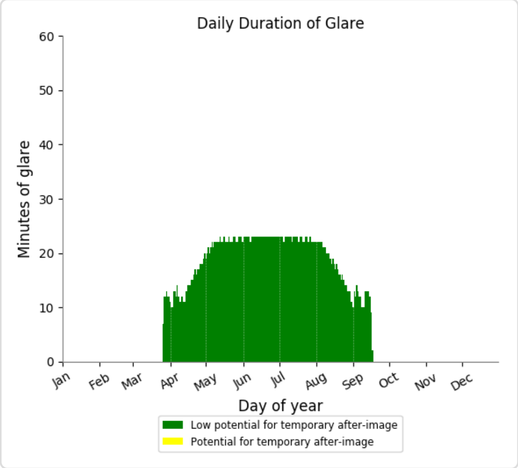


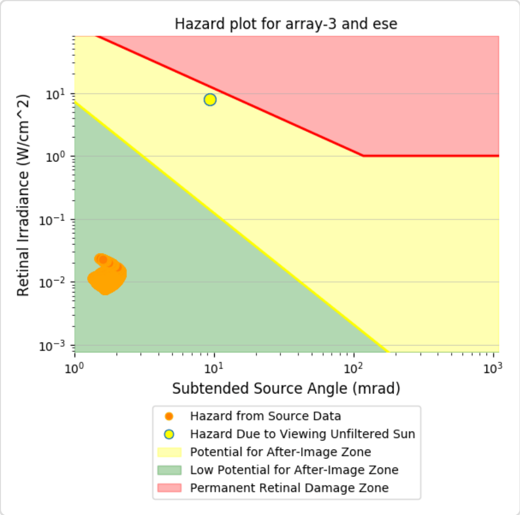
array 3 - Receptor (ESE)

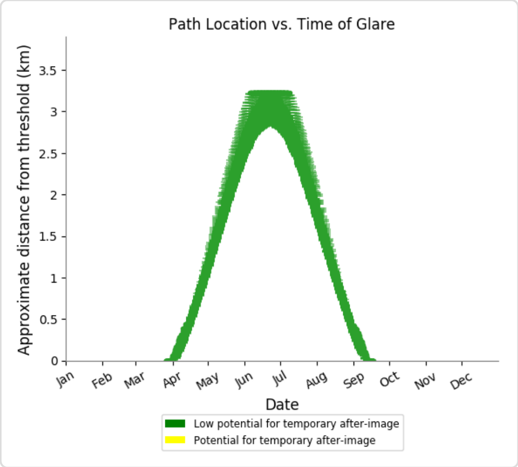
PV array is expected to produce the following glare for observers on this flight path:

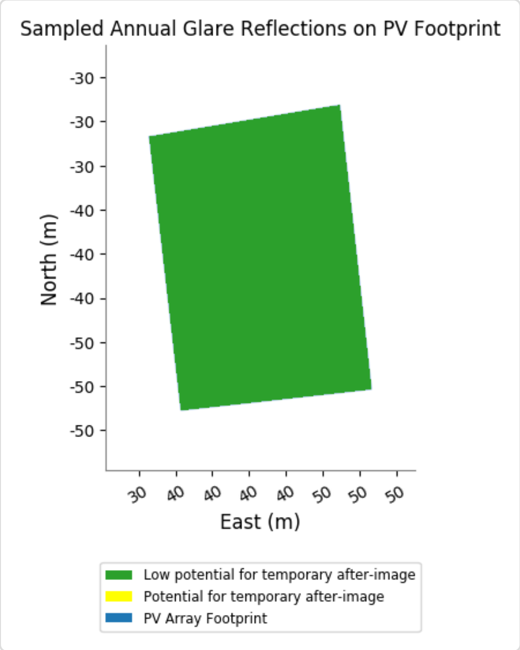
- 3,301 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

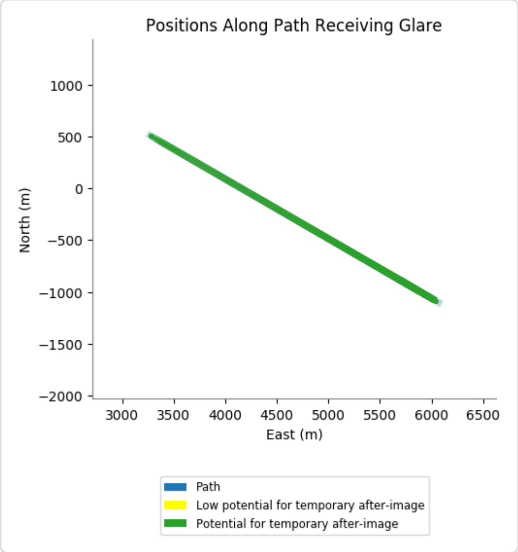






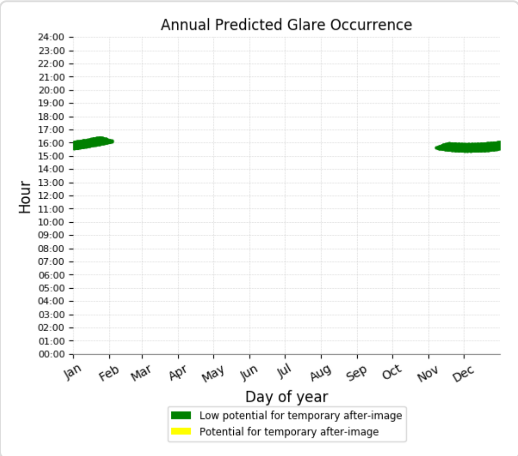


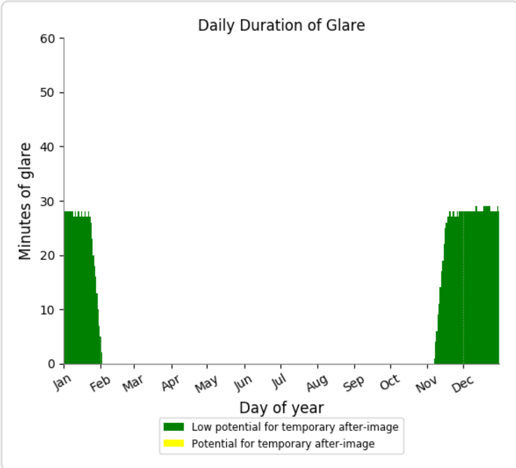


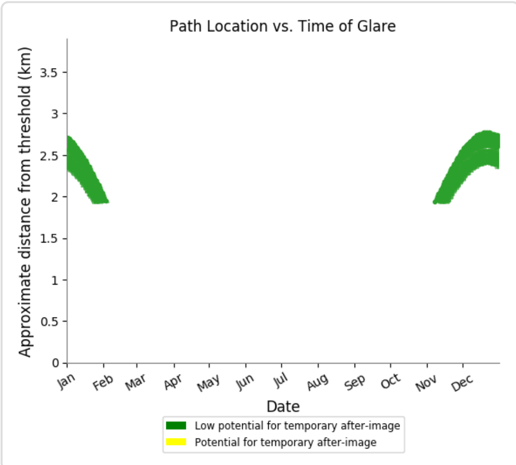


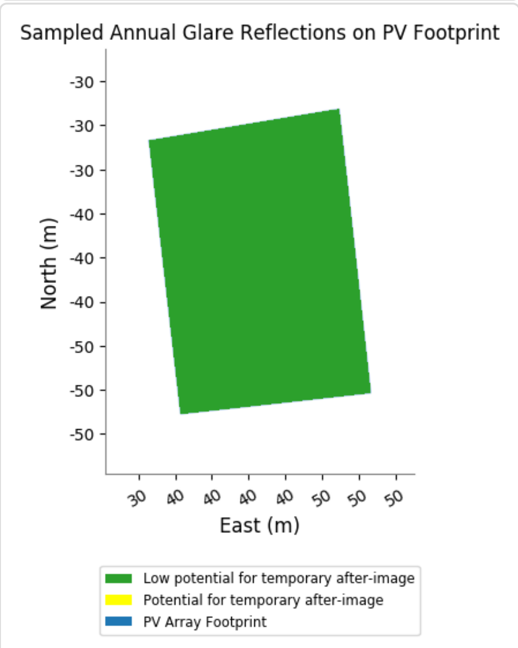
array 3 - Receptor (N)

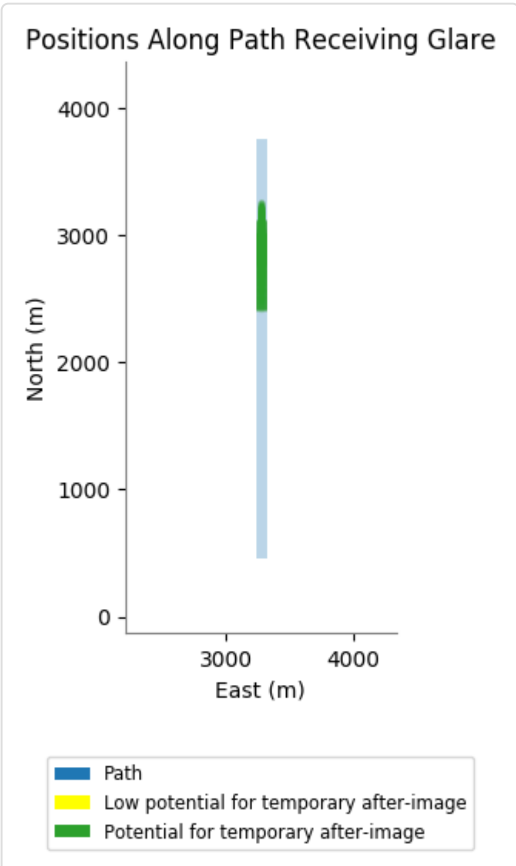
PV array is expected to produce the following glare for observers on this flight path:
- 2,163 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.







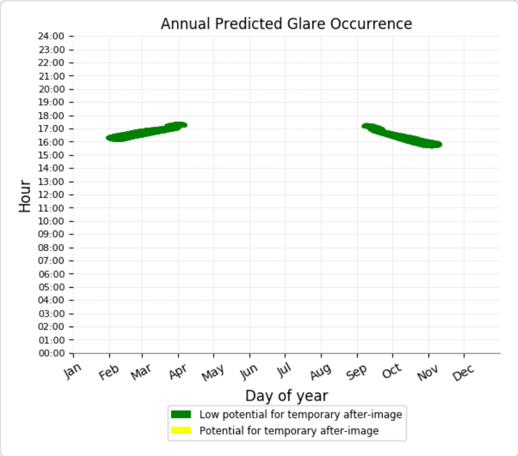


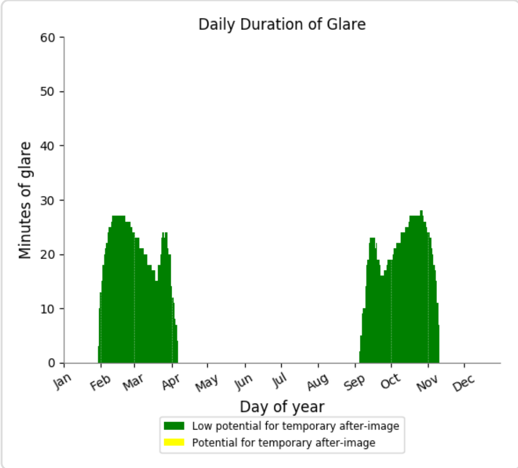


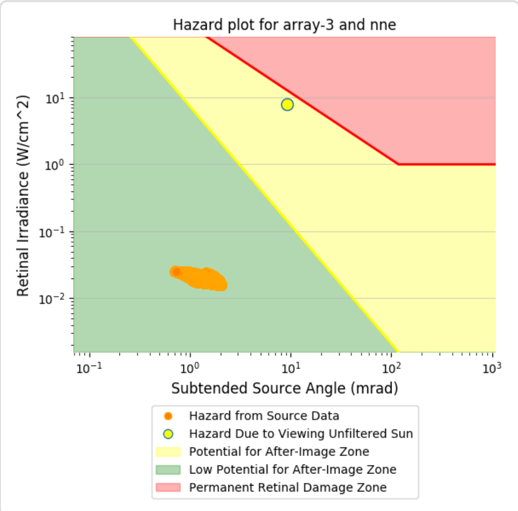
array 3 - Receptor (NNE)

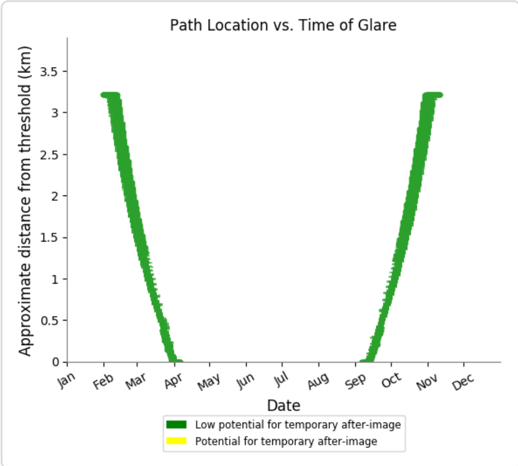
PV array is expected to produce the following glare for observers on this flight path:

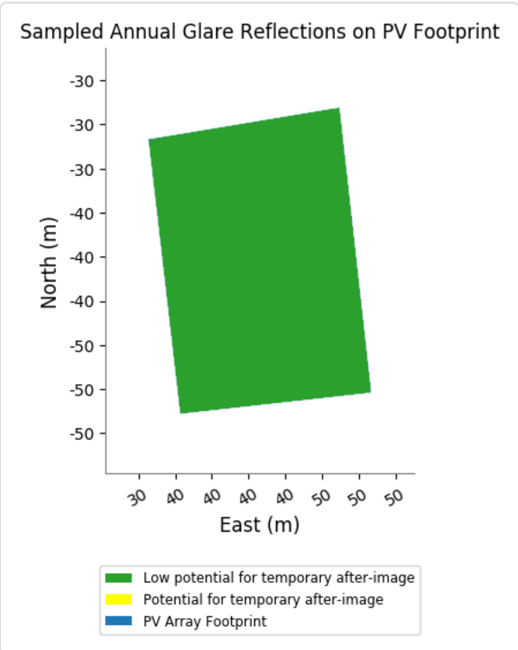
- 2,762 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

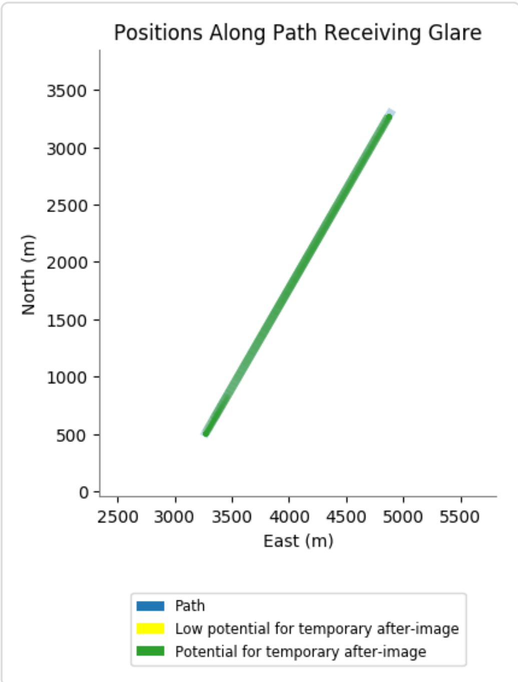












array 3 - Receptor (NNW)

No glare found

array 3 - Receptor (RW05)

No glare found

array 3 - Receptor (RW11)

No glare found

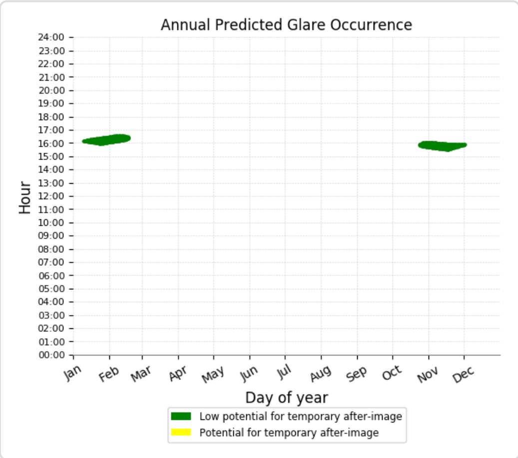
array 3 - Receptor (RW23)

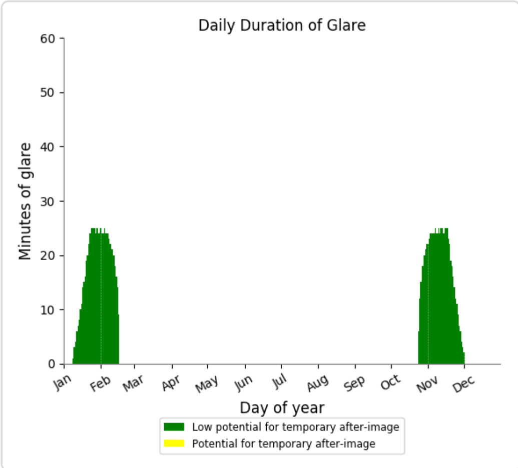
No glare found

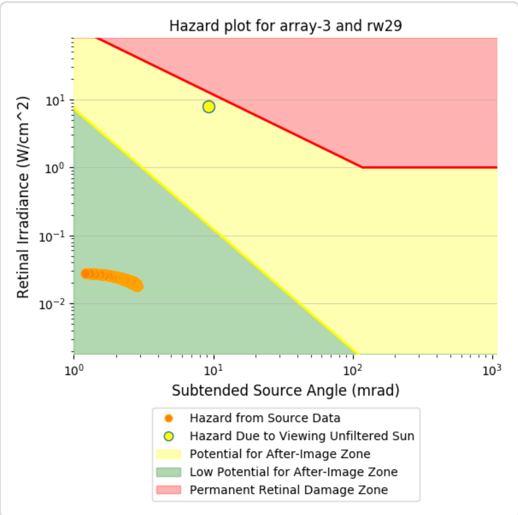
array 3 - Receptor (RW29)

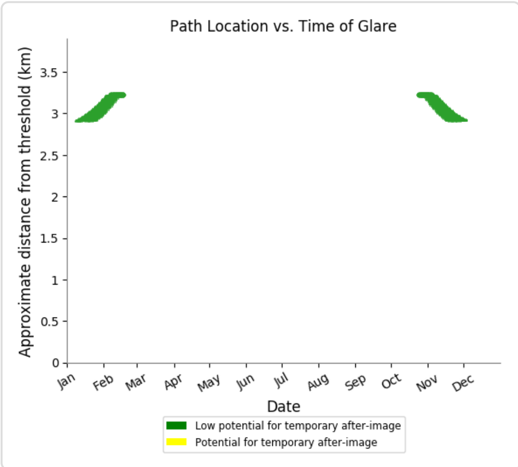
PV array is expected to produce the following glare for observers on this flight path:

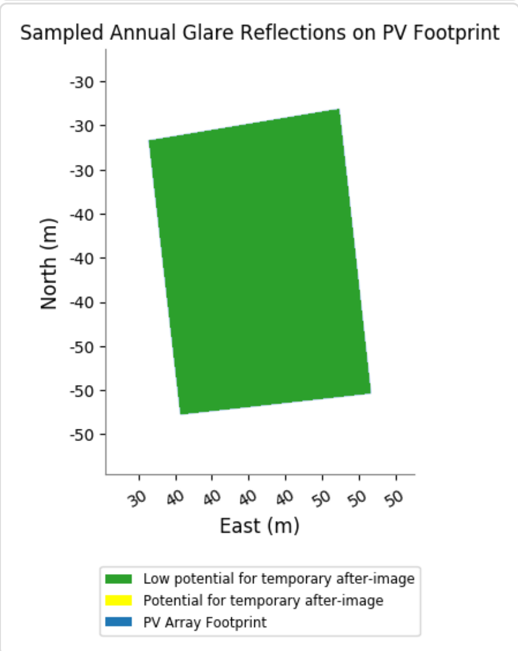
- 1,421 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

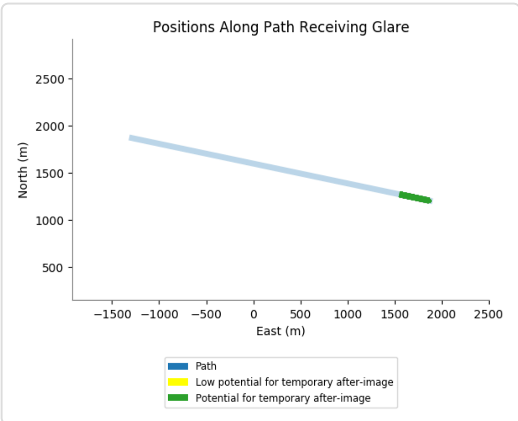












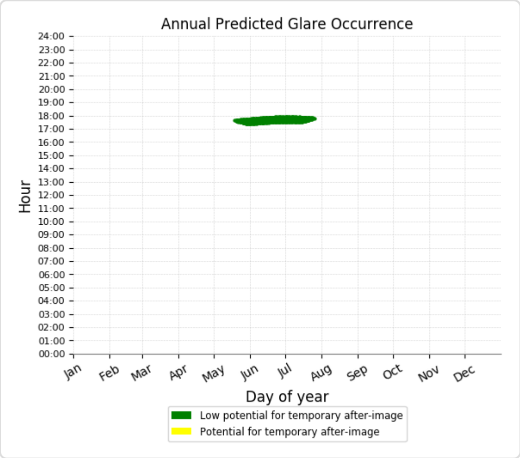
array 3 - Receptor (S)

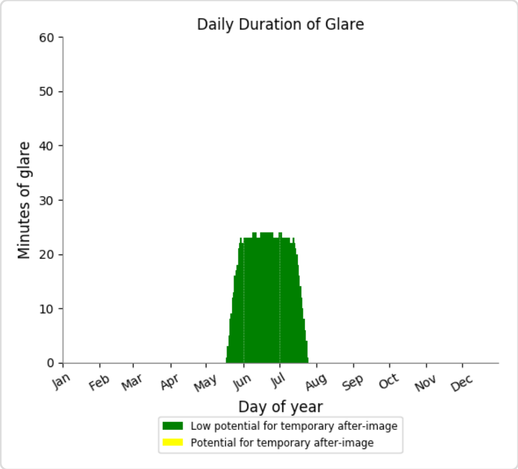
No glare found

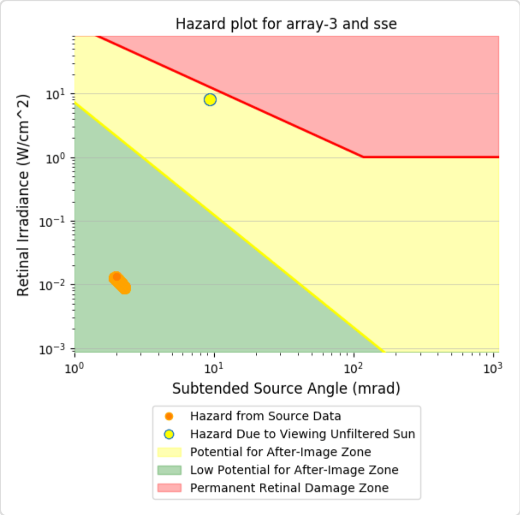
array 3 - Receptor (SSE)

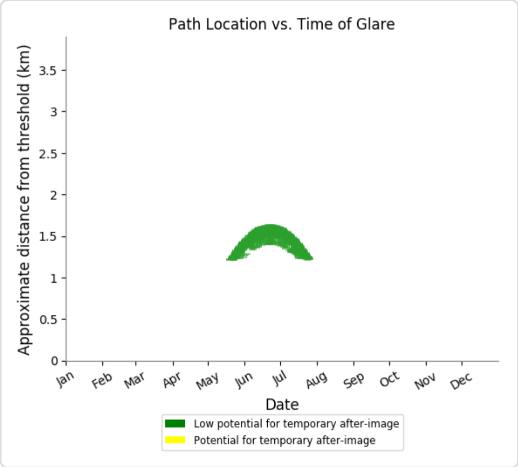
PV array is expected to produce the following glare for observers on this flight path:

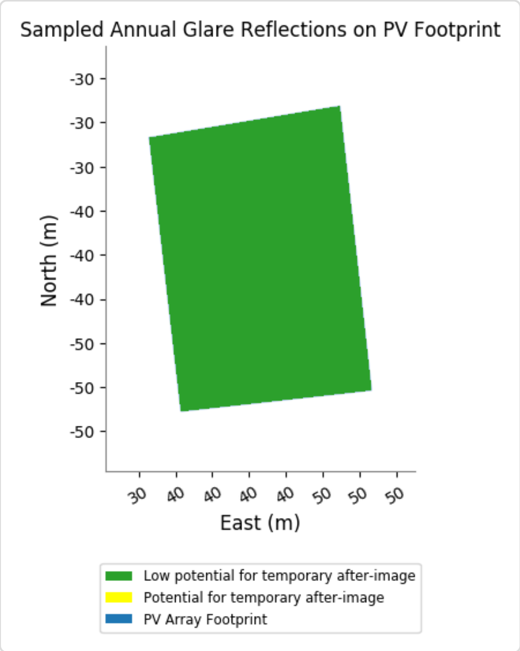
- 1,346 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

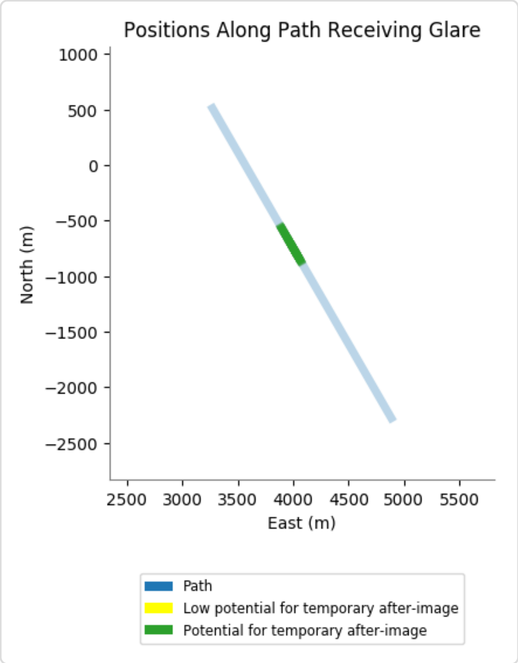












array 3 - Receptor (SSW)

No glare found

array 3 - Receptor (W)

No glare found

array 3 - Receptor (WNW)

No glare found

array 3 - Receptor (WSW)

No glare found

array 3 - OP Receptor (1-ATCT)

No glare found

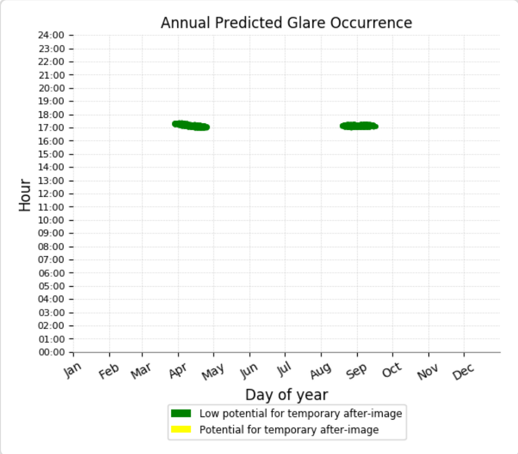
array 4 low potential for temporary after-image

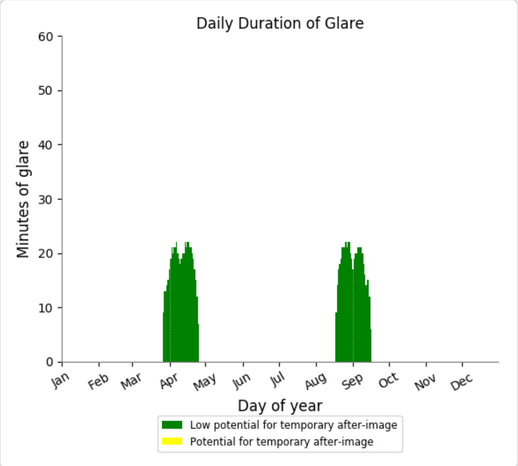
Component	Green glare (min)	Yellow glare (min)
FP: E	1082	0
FP: ENE	1351	0
FP: ESE	3296	0
FP: N	2186	0
FP: NNE	2707	0
FP: NNW	0	0
FP: RW05	0	0
FP: RW11	0	0
FP: RW23	0	0
FP: RW29	1468	0
FP: S	0	0
FP: SSE	1293	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

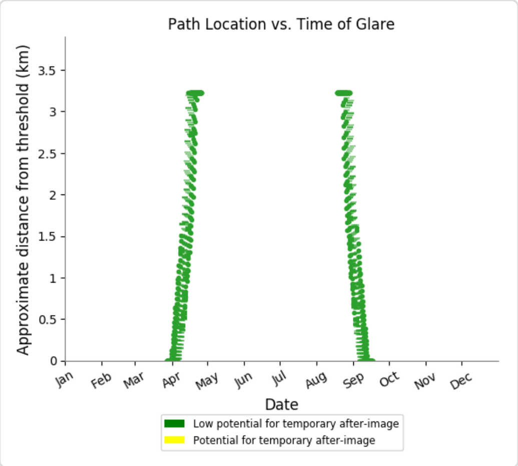
array 4 - Receptor (E)

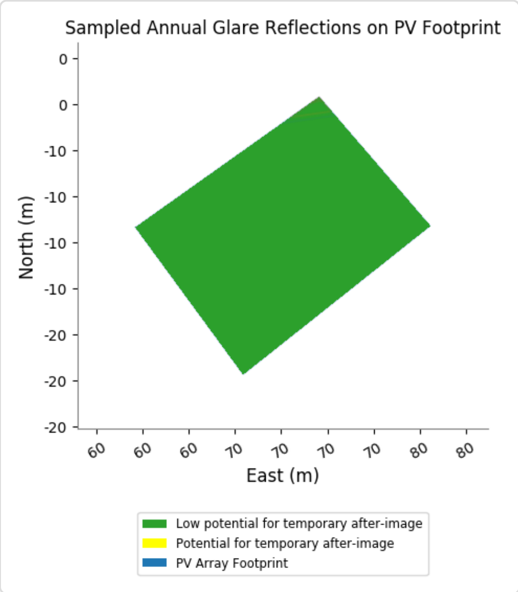
PV array is expected to produce the following glare for observers on this flight path:

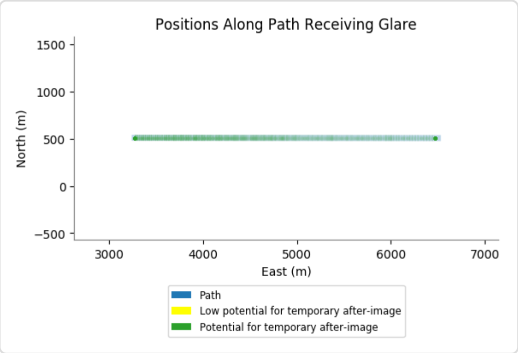
- 1,082 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.







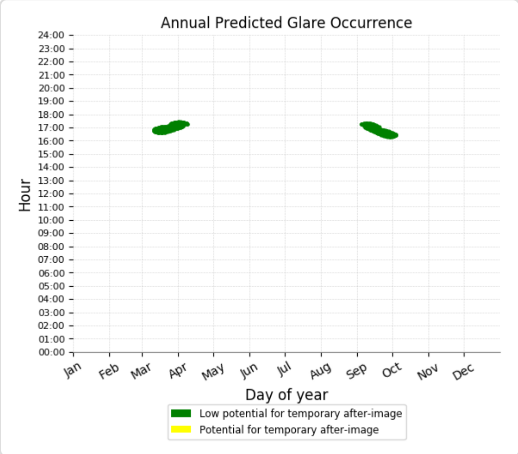


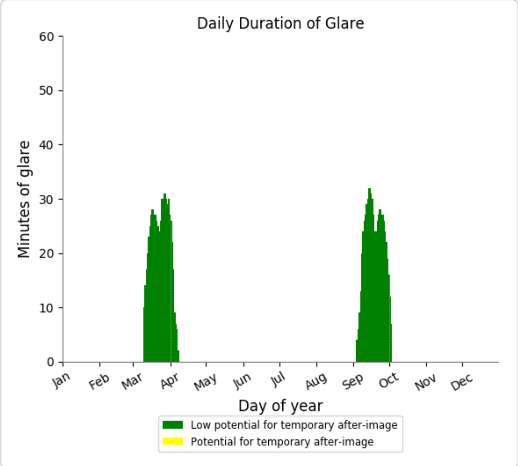


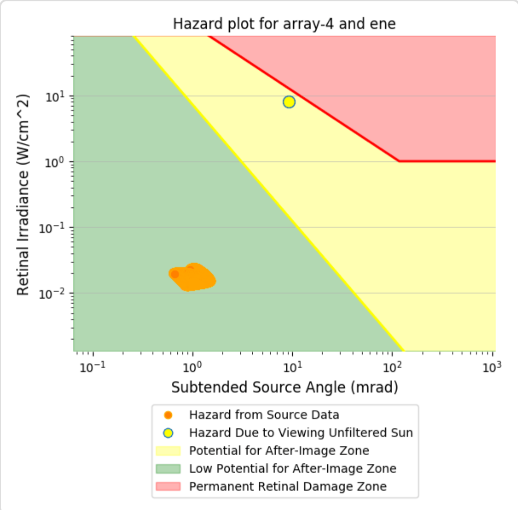
array 4 - Receptor (ENE)

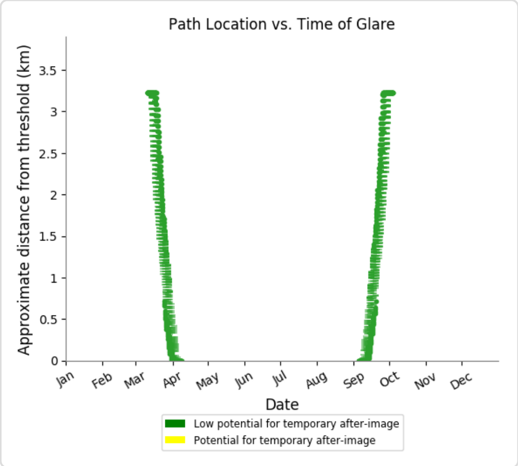
PV array is expected to produce the following glare for observers on this flight path:

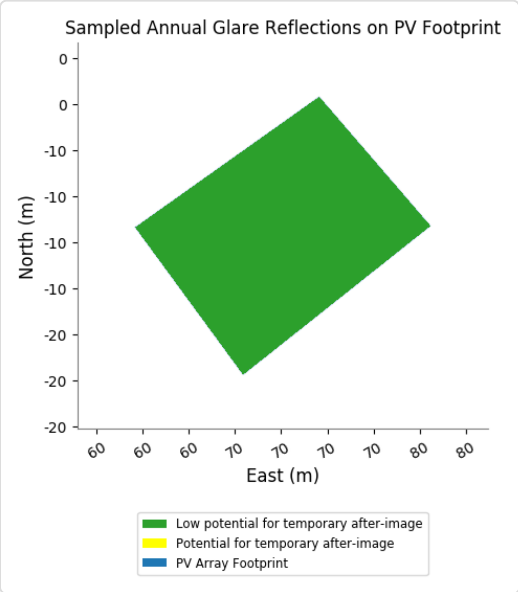
- 1,351 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

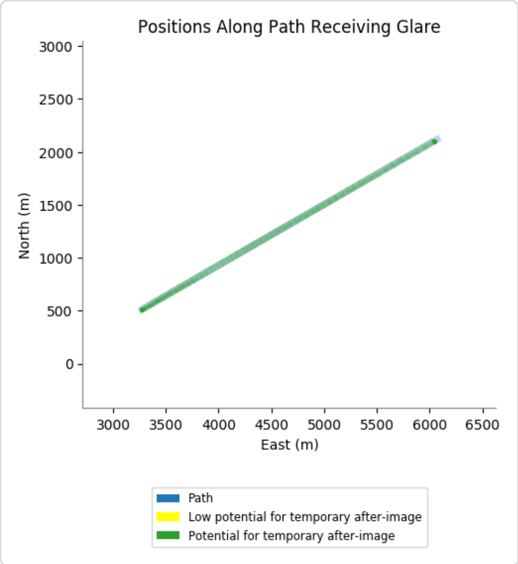






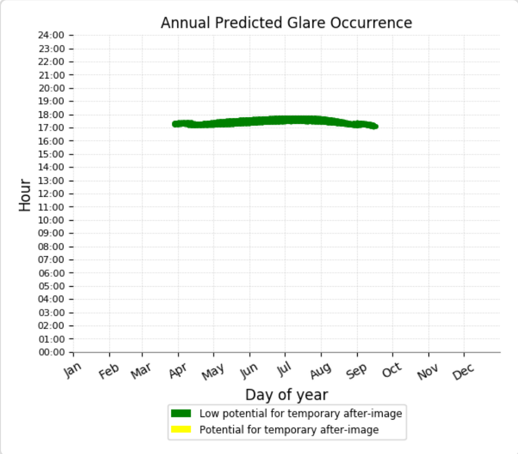


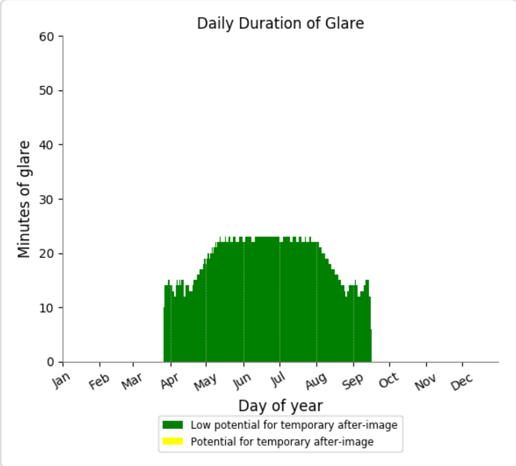


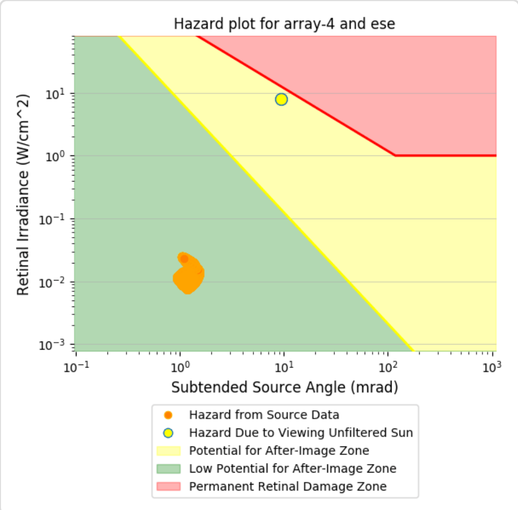


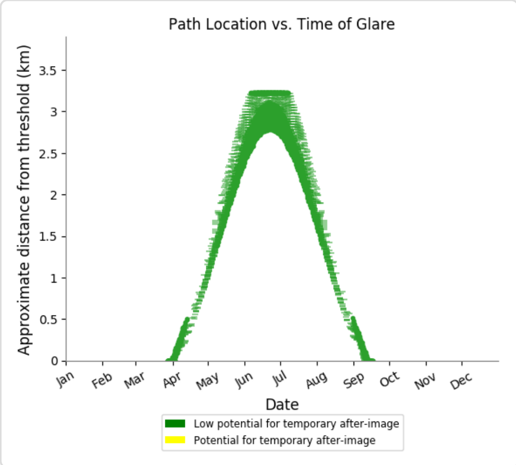
array 4 - Receptor (ESE)

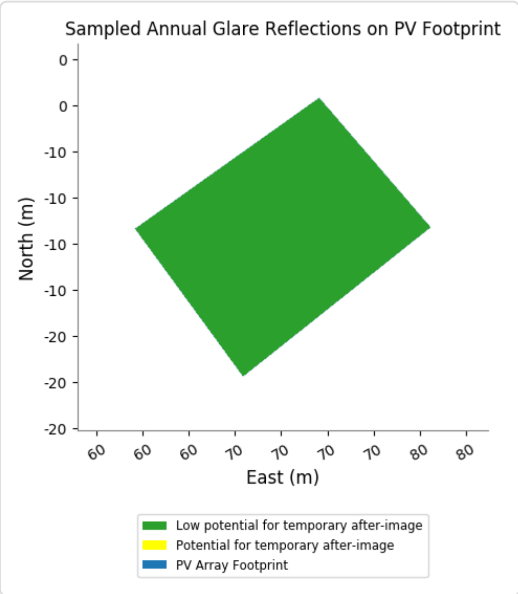
PV array is expected to produce the following glare for observers on this flight path:
- 3,296 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

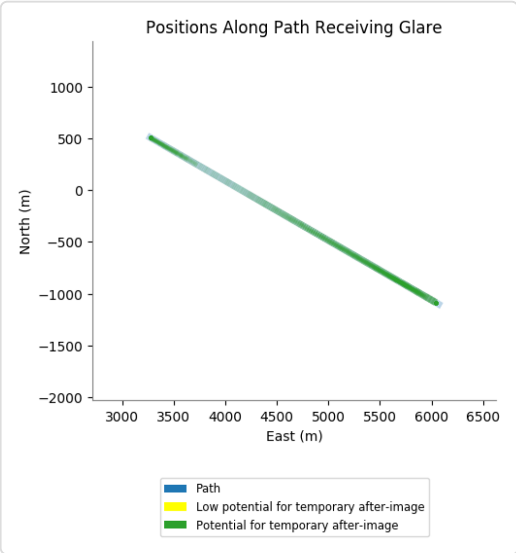








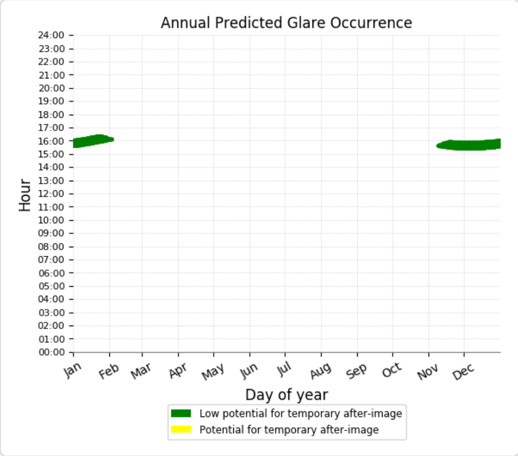


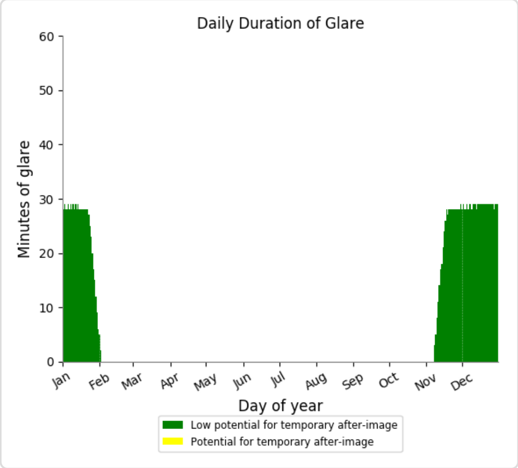


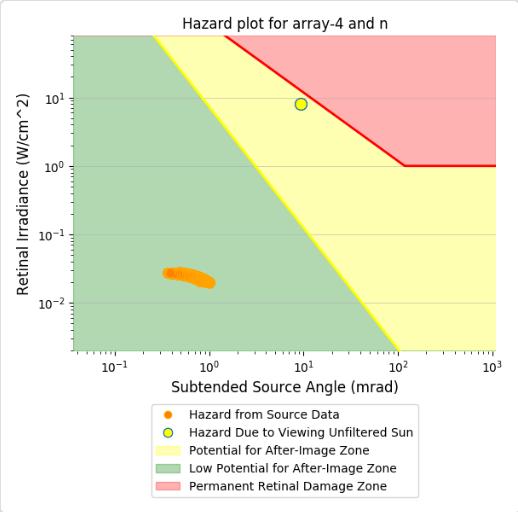
array 4 - Receptor (N)

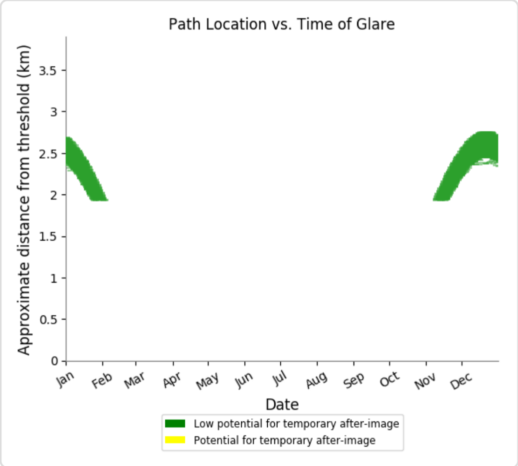
PV array is expected to produce the following glare for observers on this flight path:

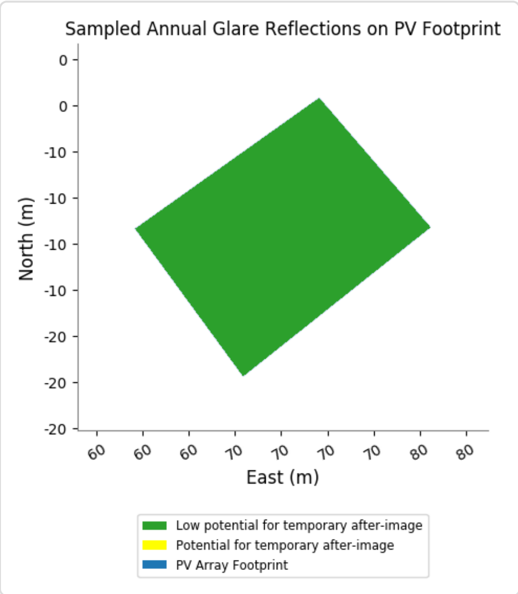
- 2,186 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

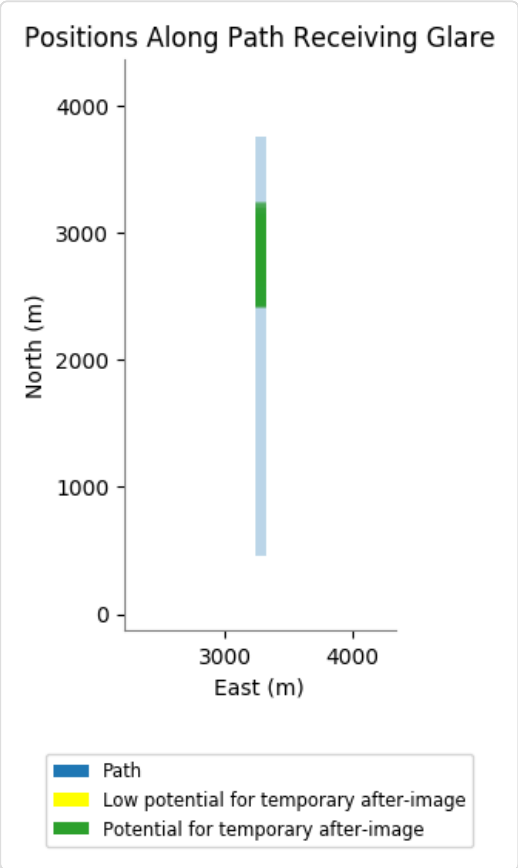








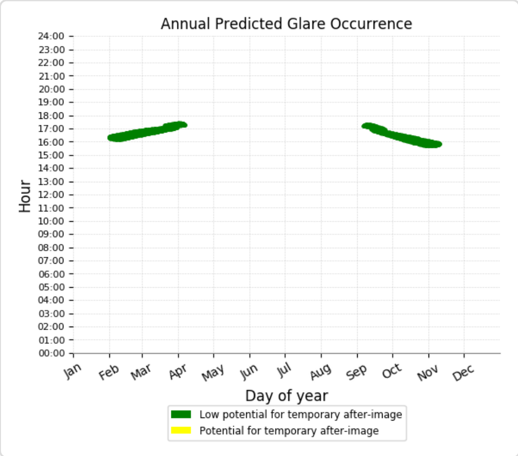


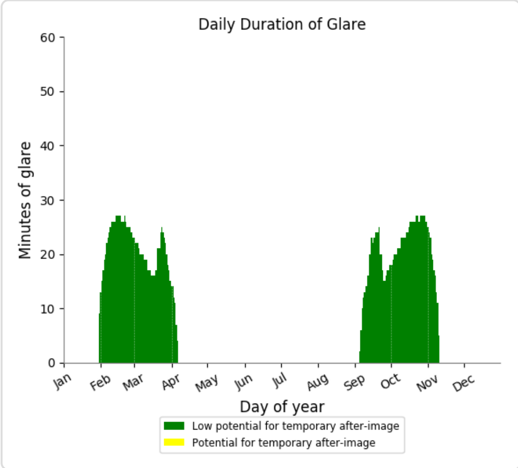


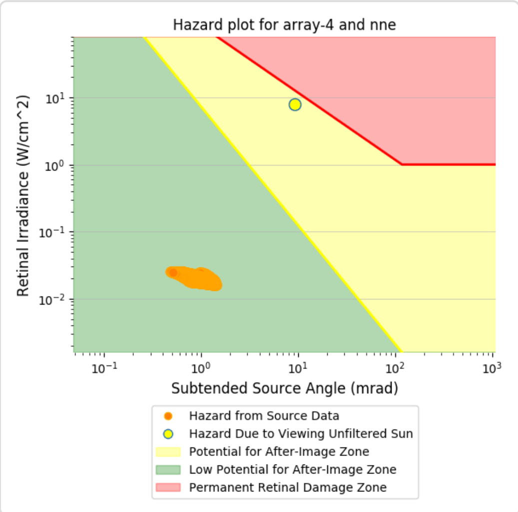
array 4 - Receptor (NNE)

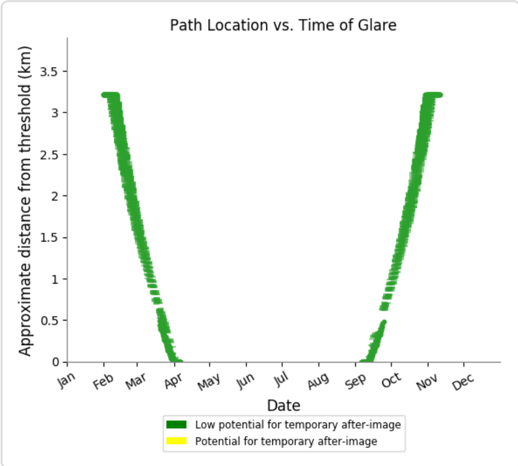
PV array is expected to produce the following glare for observers on this flight path:

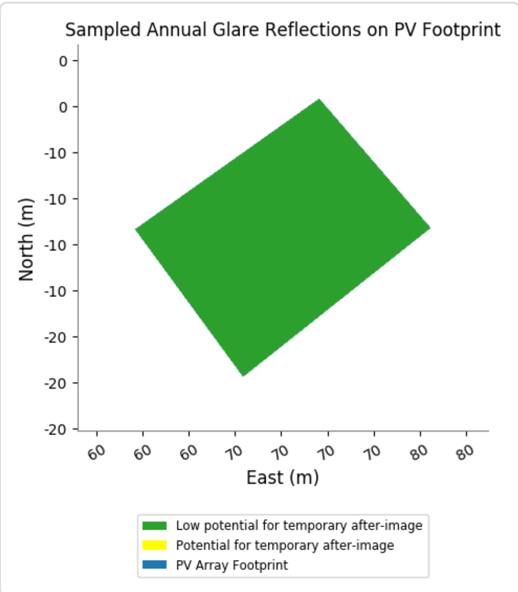
- 2,707 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

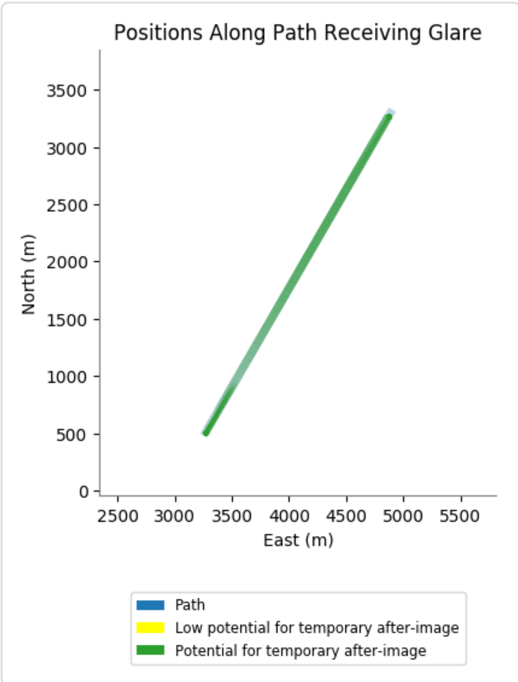












array 4 - Receptor (NNW)

No glare found

array 4 - Receptor (RW05)

No glare found

array 4 - Receptor (RW11)

No glare found

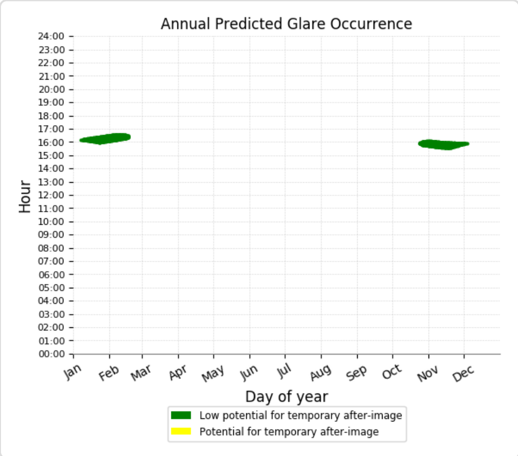
array 4 - Receptor (RW23)

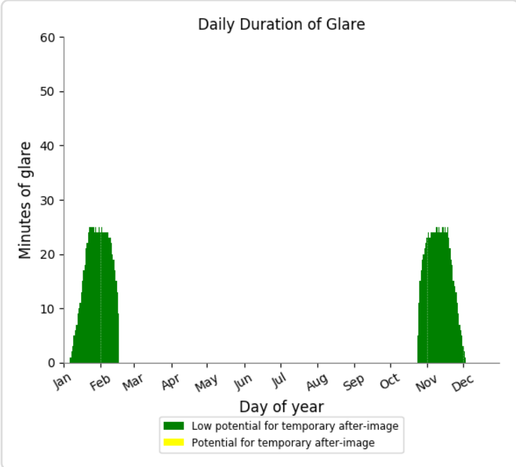
No glare found

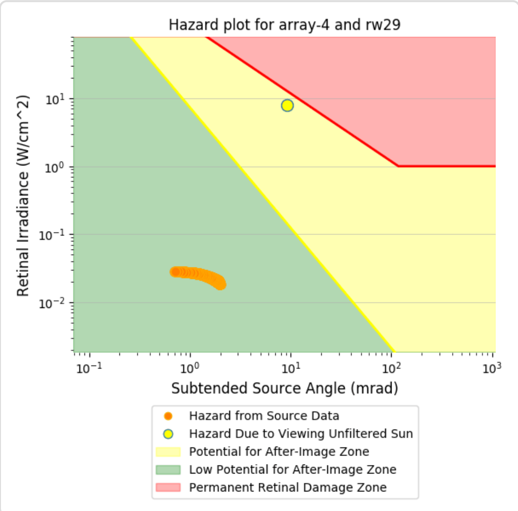
array 4 - Receptor (RW29)

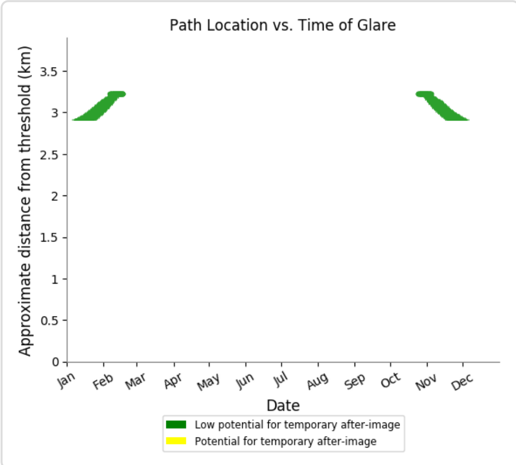
PV array is expected to produce the following glare for observers on this flight path:

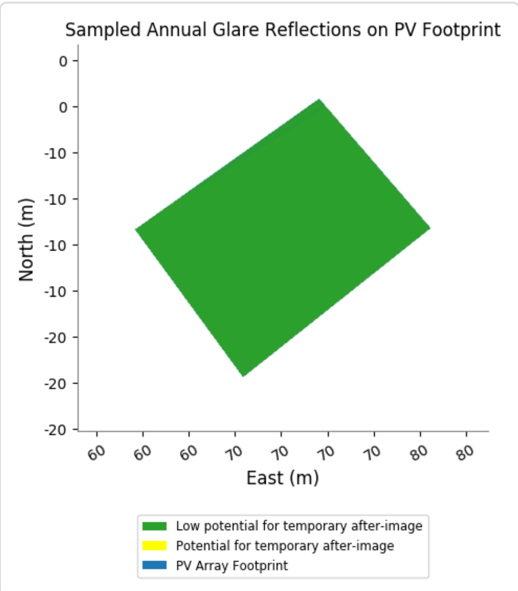
- 1,468 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

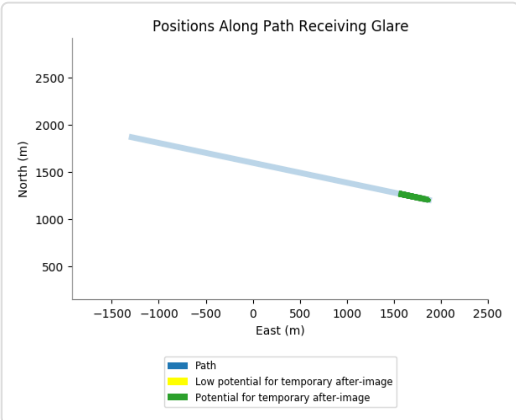












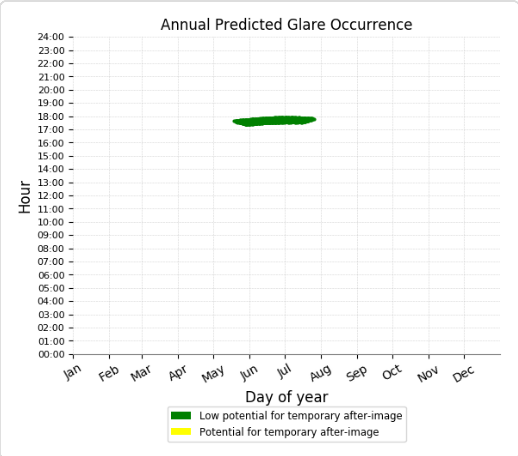
array 4 - Receptor (S)

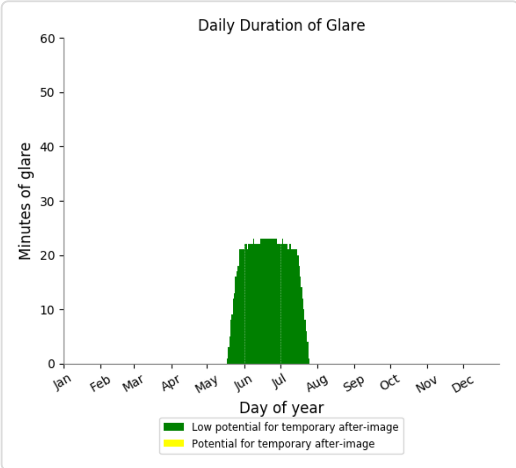
No glare found

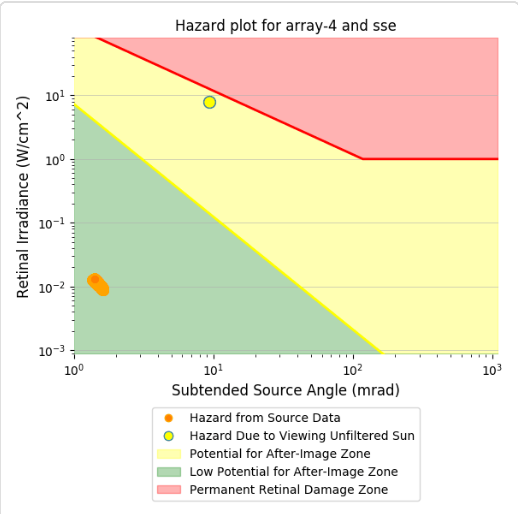
array 4 - Receptor (SSE)

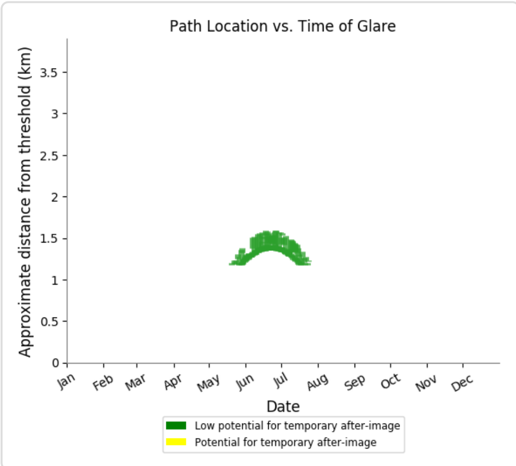
PV array is expected to produce the following glare for observers on this flight path:

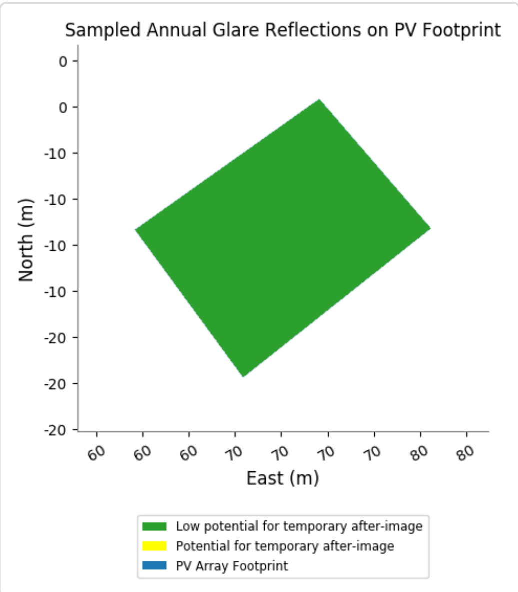
- 1,293 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

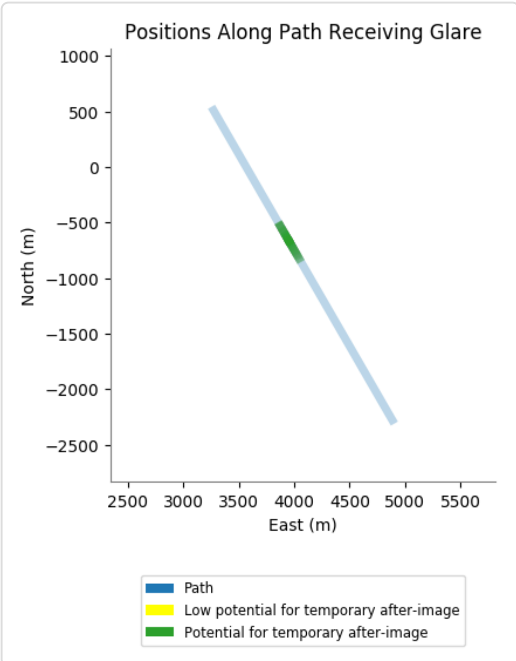












array 4 - Receptor (SSW)

No glare found

array 4 - Receptor (W)

No glare found

array 4 - Receptor (WNW)

No glare found

array 4 - Receptor (WSW)

No glare found

array 4 - OP Receptor (1-ATCT)

No glare found

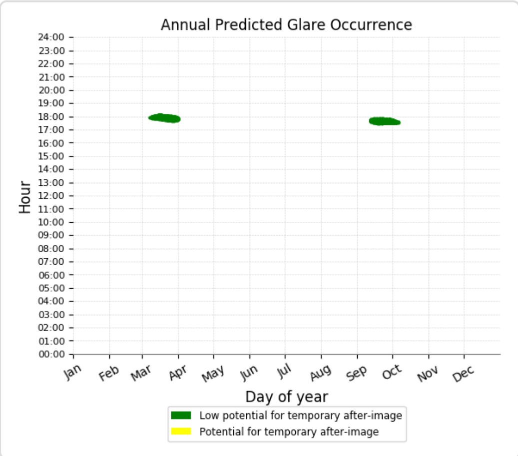
array 5 low potential for temporary after-image

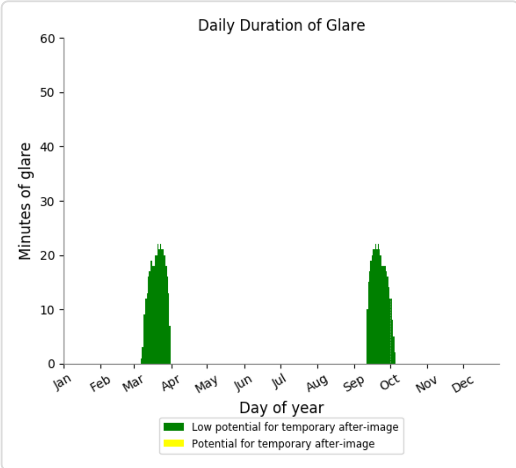
Component	Green glare (min)	Yellow glare (min)
FP: E	782	0
FP: ENE	728	0
FP: ESE	2051	0
FP: N	0	0
FP: NNE	259	0
FP: NNW	0	0
FP: RW05	1154	0
FP: RW11	0	0
FP: RW23	0	0
FP: RW29	0	0
FP: S	0	0
FP: SSE	2678	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

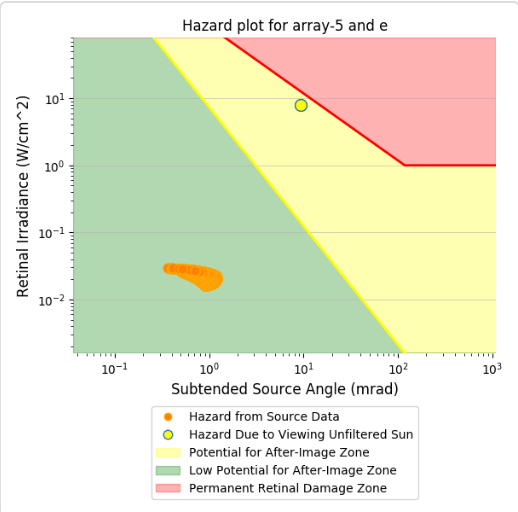
array 5 - Receptor (E)

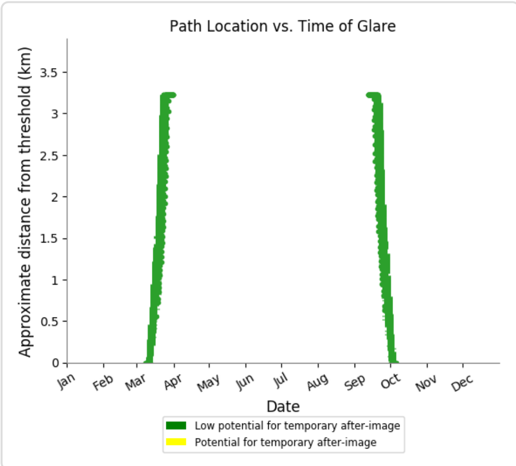
PV array is expected to produce the following glare for observers on this flight path:

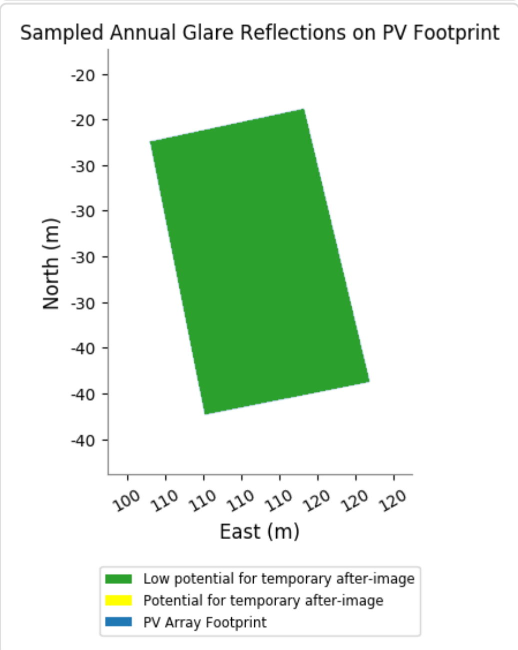
- 782 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

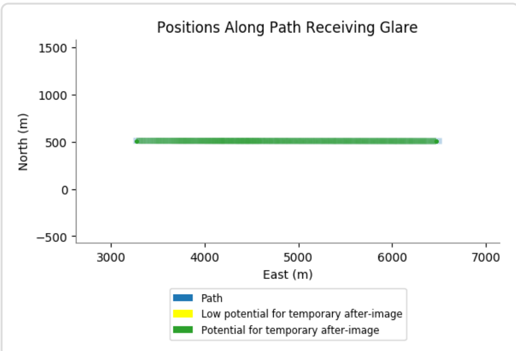








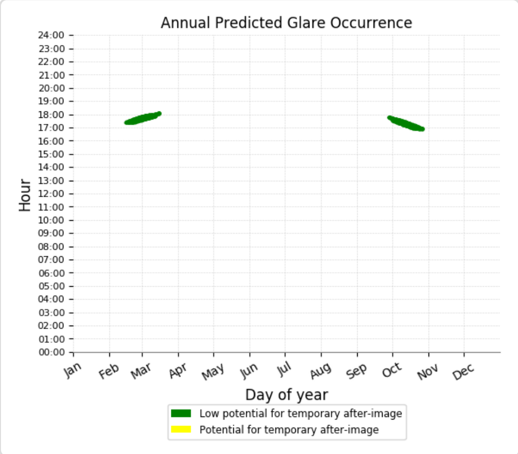


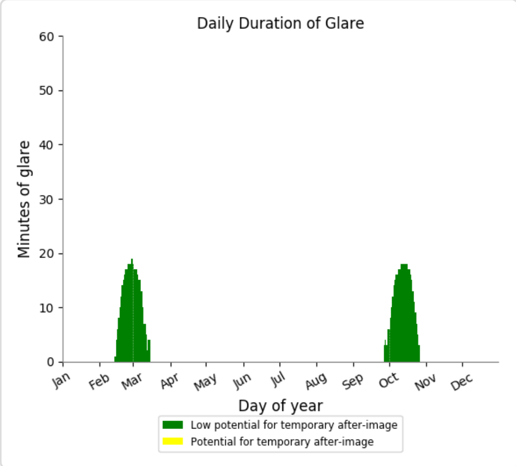


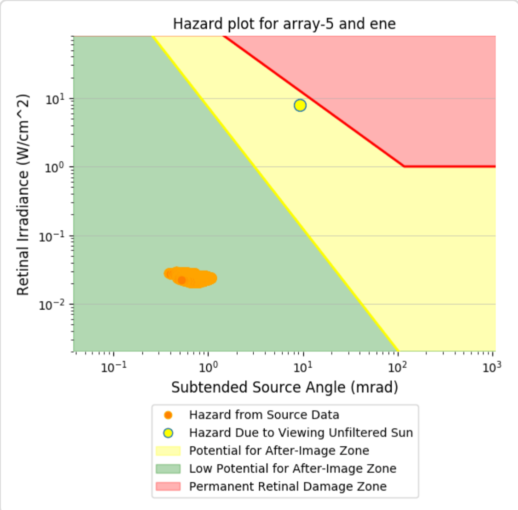
array 5 - Receptor (ENE)

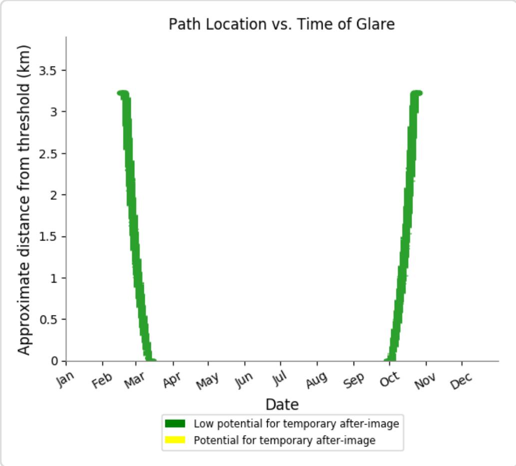
PV array is expected to produce the following glare for observers on this flight path:

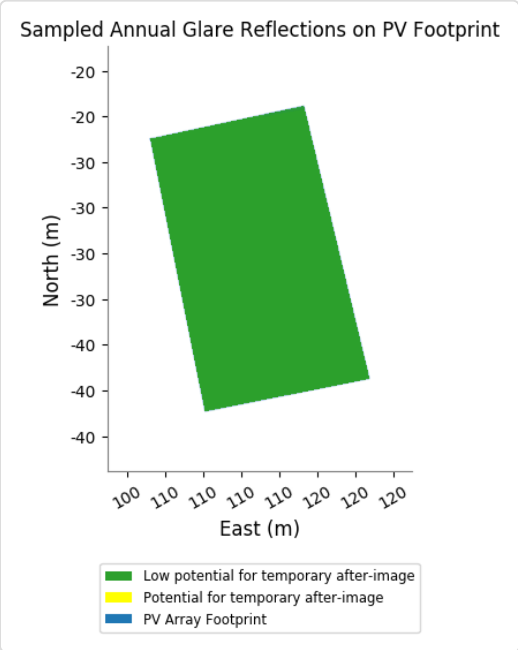
- 728 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

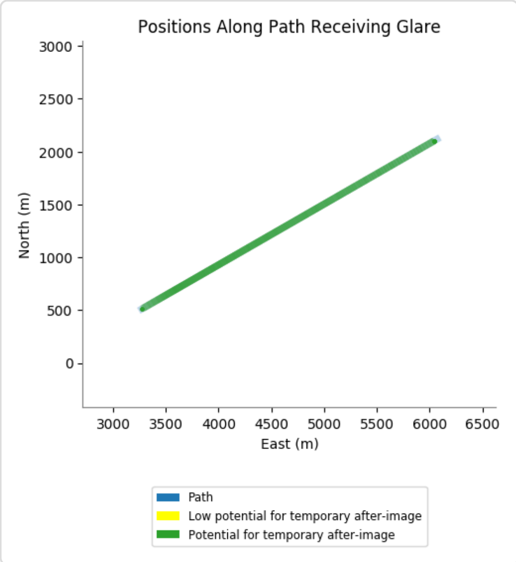






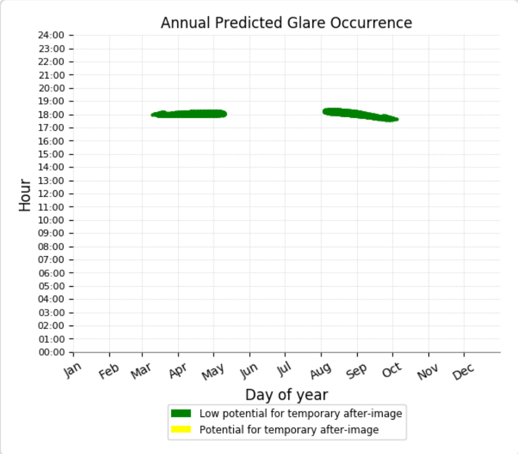


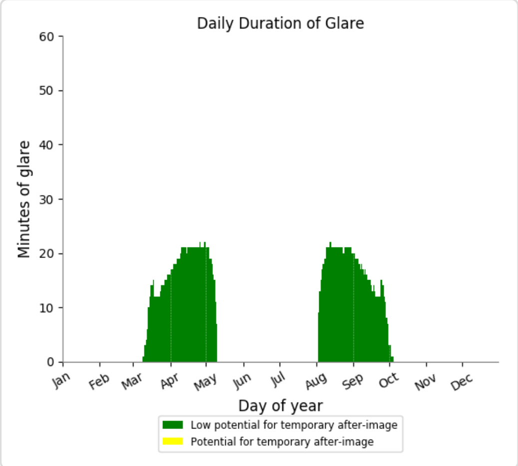


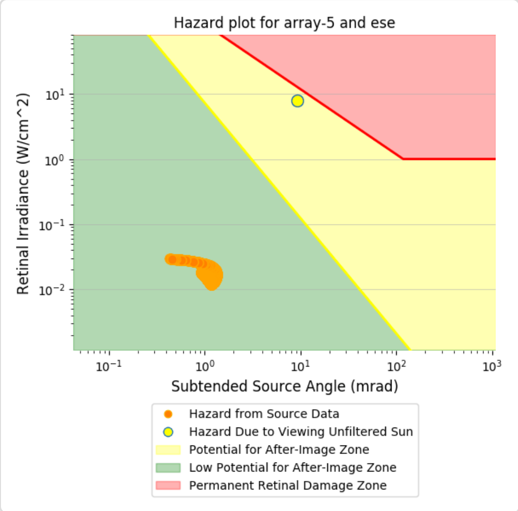


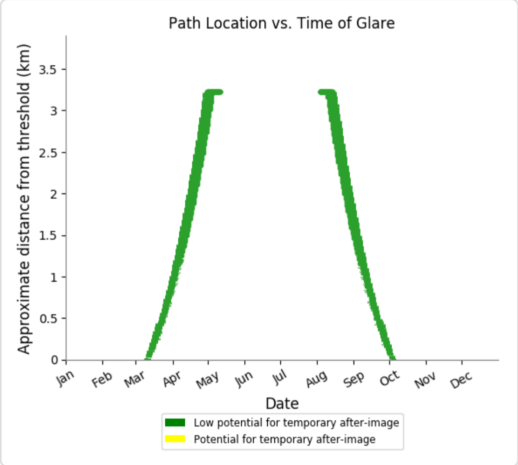
array 5 - Receptor (ESE)

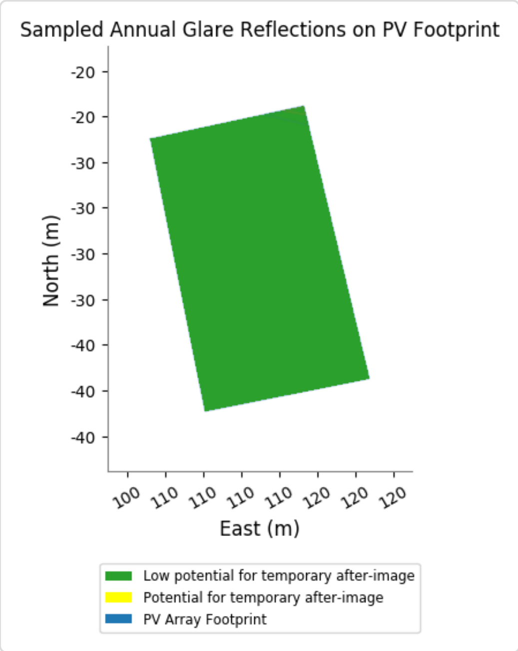
PV array is expected to produce the following glare for observers on this flight path:
- 2,051 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

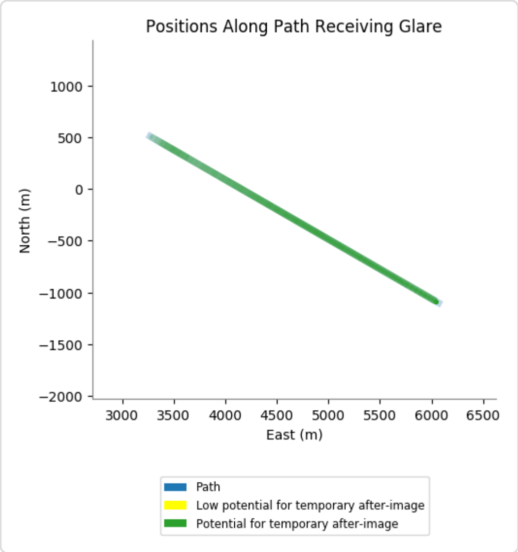












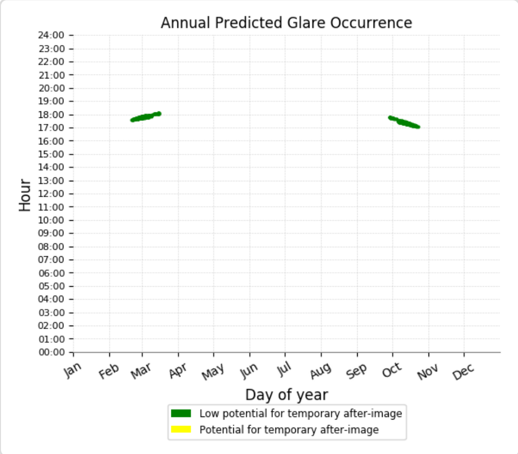
array 5 - Receptor (N)

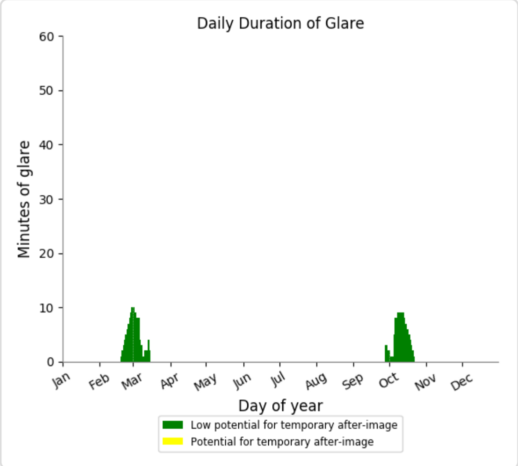
No glare found

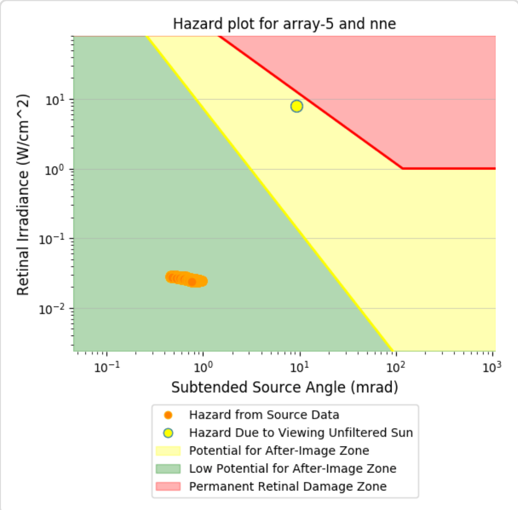
array 5 - Receptor (NNE)

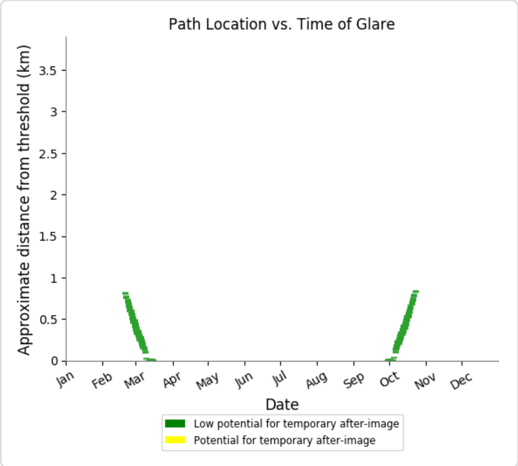
PV array is expected to produce the following glare for observers on this flight path:

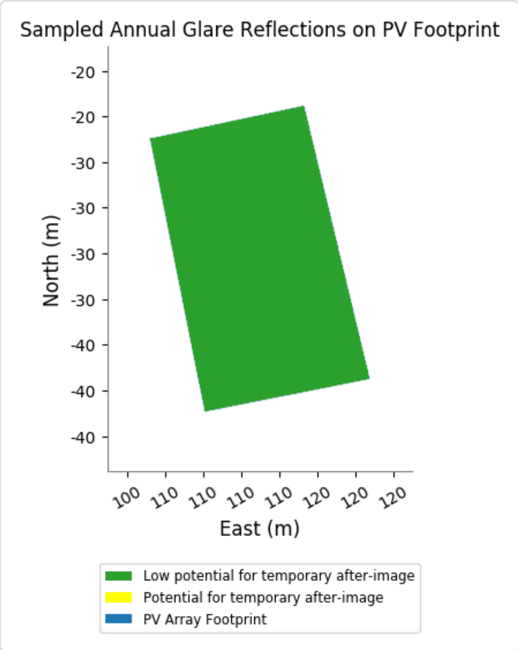
- 259 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

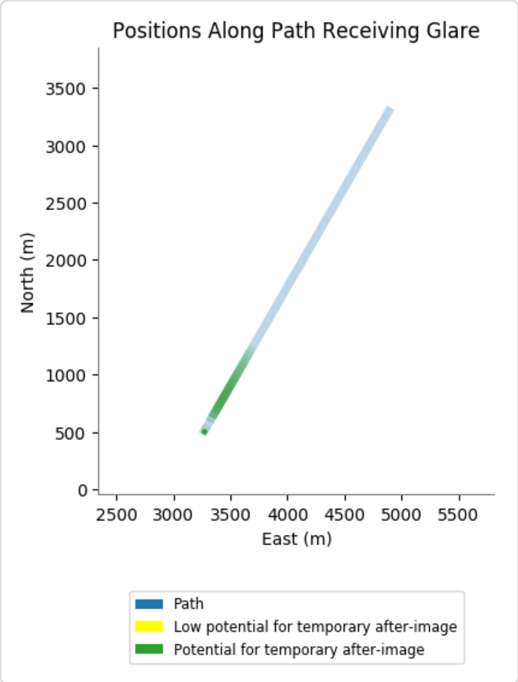












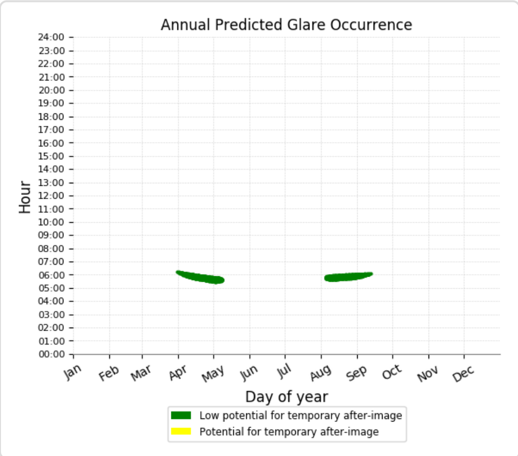
array 5 - Receptor (NNW)

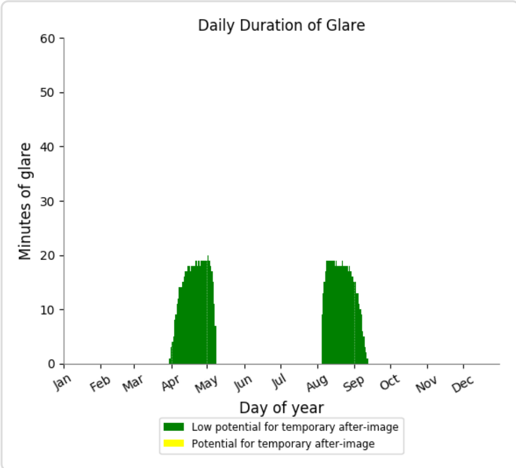
No glare found

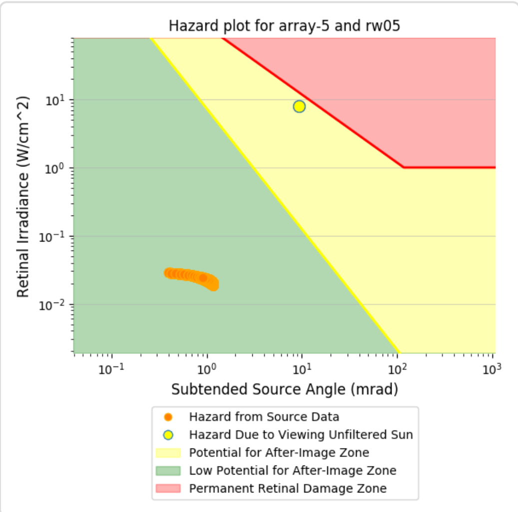
array 5 - Receptor (RW05)

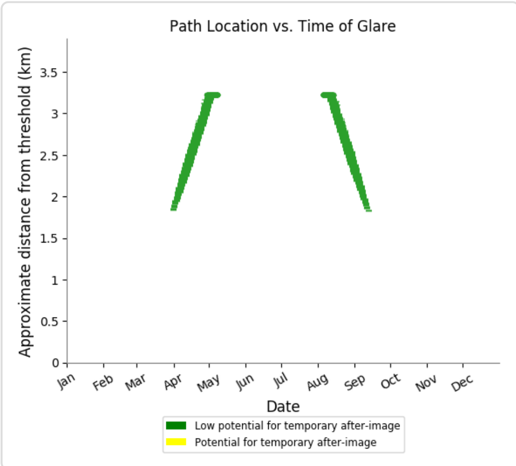
PV array is expected to produce the following glare for observers on this flight path:

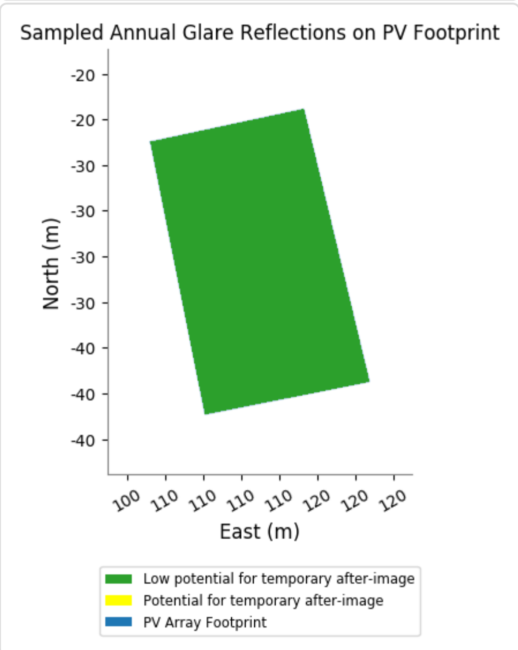
- 1,154 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

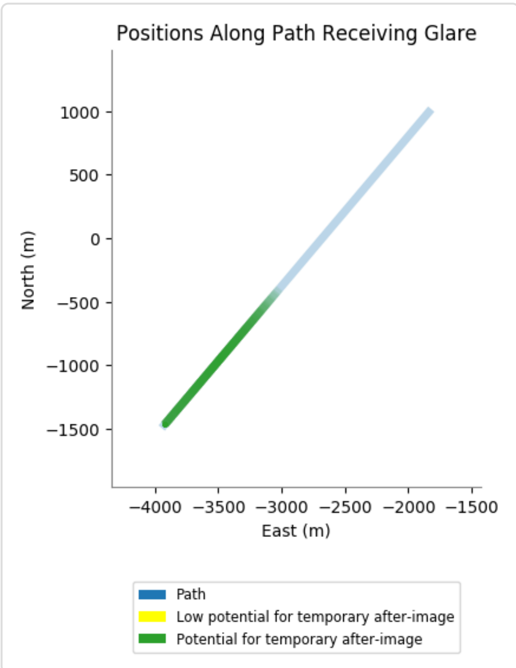












array 5 - Receptor (RW11)

No glare found

array 5 - Receptor (RW23)

No glare found

array 5 - Receptor (RW29)

No glare found

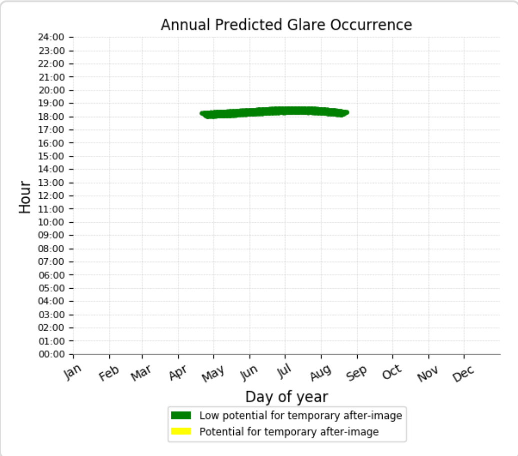
array 5 - Receptor (S)

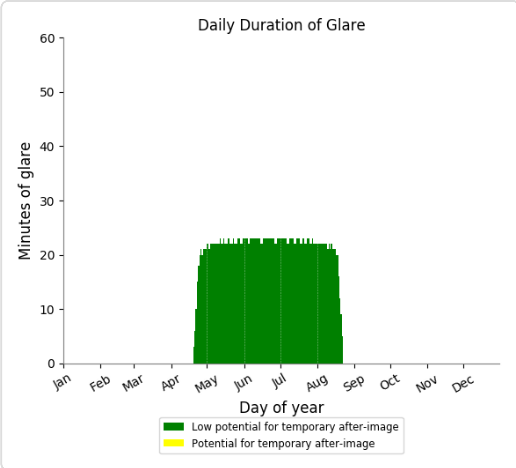
No glare found

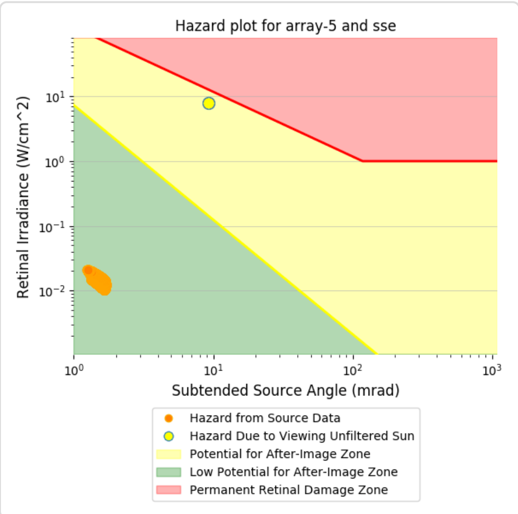
array 5 - Receptor (SSE)

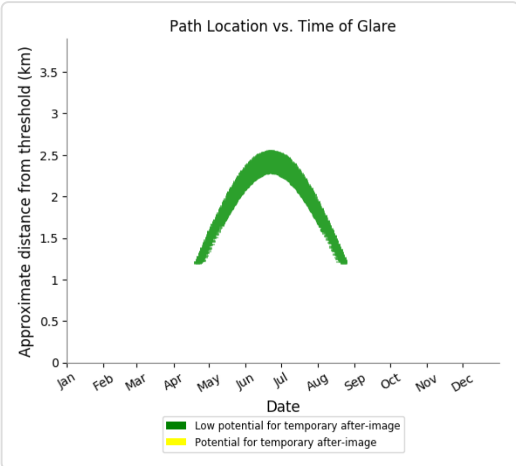
PV array is expected to produce the following glare for observers on this flight path:

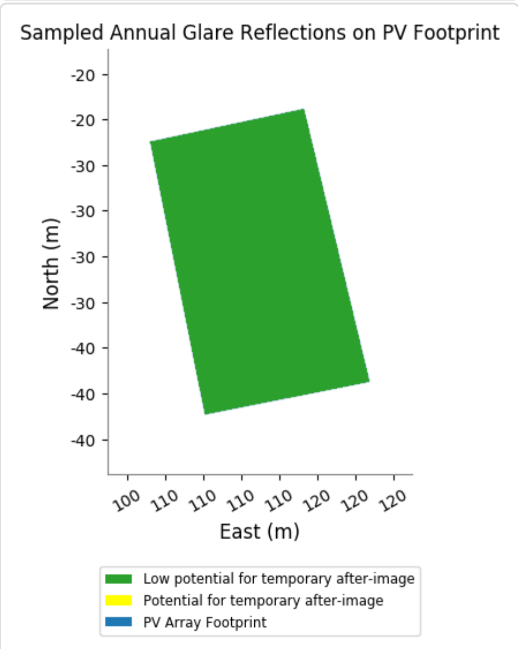
- 2,678 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

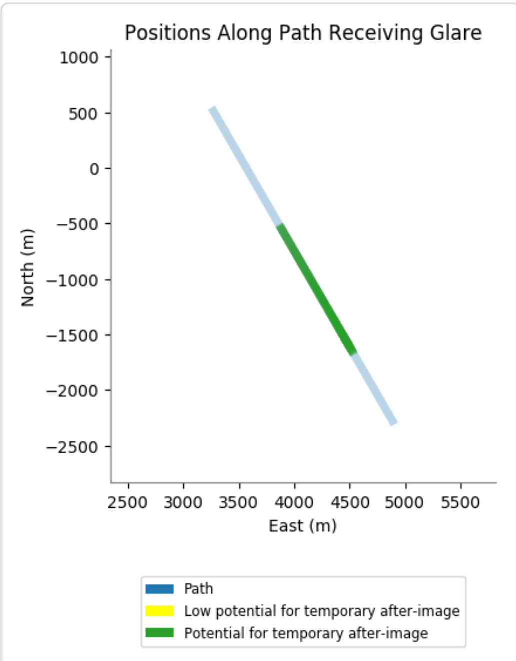












array 5 - Receptor (SSW)

No glare found

array 5 - Receptor (W)

No glare found

array 5 - Receptor (WNW)

No glare found

array 5 - Receptor (WSW)

No glare found

array 5 - OP Receptor (1-ATCT)

No glare found

array 6 low potential for temporary after-image

Component	Green glare (min)	Yellow glare (min)
FP: E	0	0
FP: ENE	0	0
FP: ESE	96	0
FP: N	0	0
FP: NNE	0	0
FP: NNW	0	0
FP: RW05	2881	0
FP: RW11	83	0
FP: RW23	0	0
FP: RW29	0	0
FP: S	0	0
FP: SSE	1935	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

array 6 - Receptor (E)

No glare found

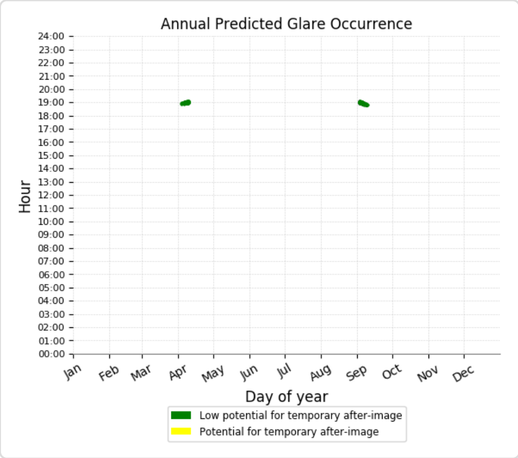
array 6 - Receptor (ENE)

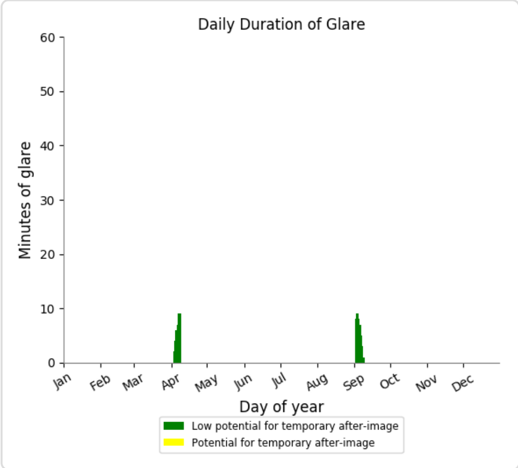
No glare found

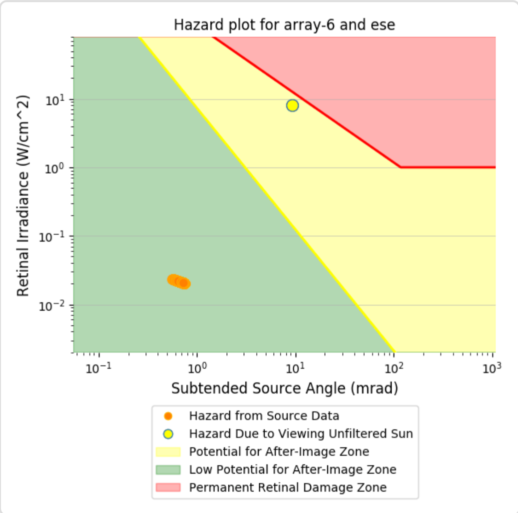
array 6 - Receptor (ESE)

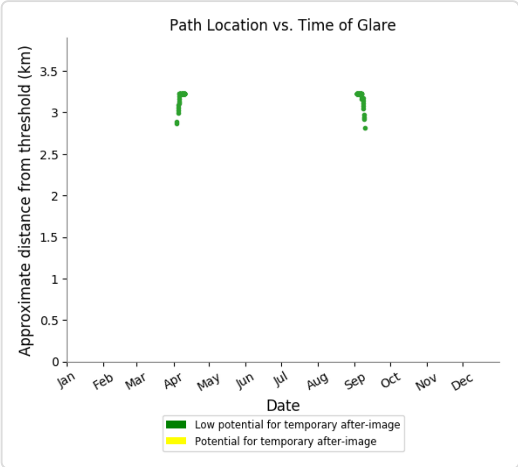
PV array is expected to produce the following glare for observers on this flight path:

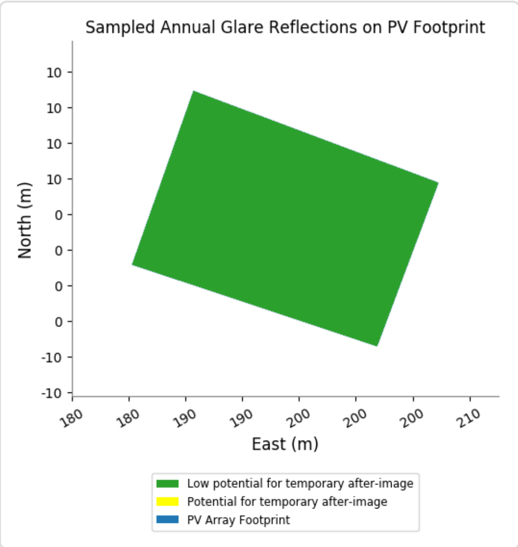
- 96 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

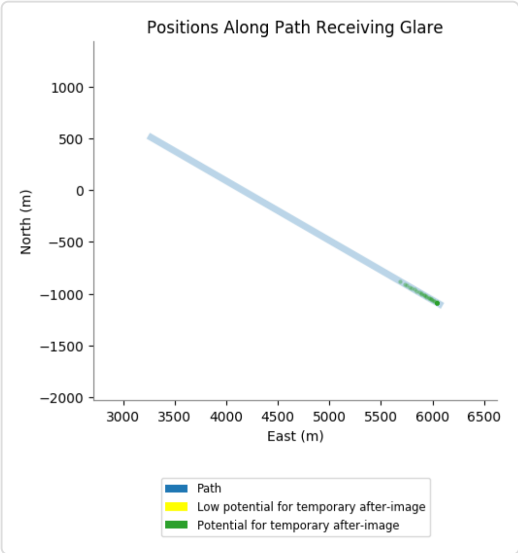












array 6 - Receptor (N)

No glare found

array 6 - Receptor (NNE)

No glare found

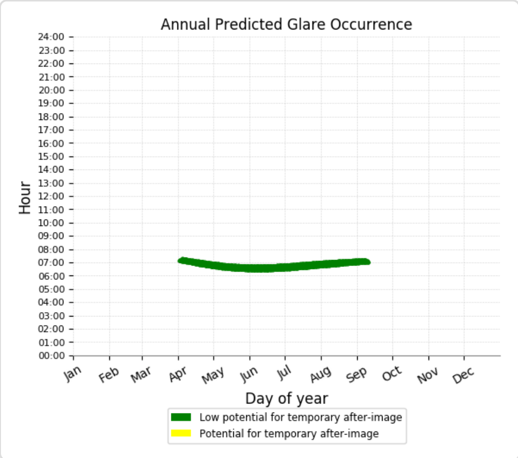
array 6 - Receptor (NNW)

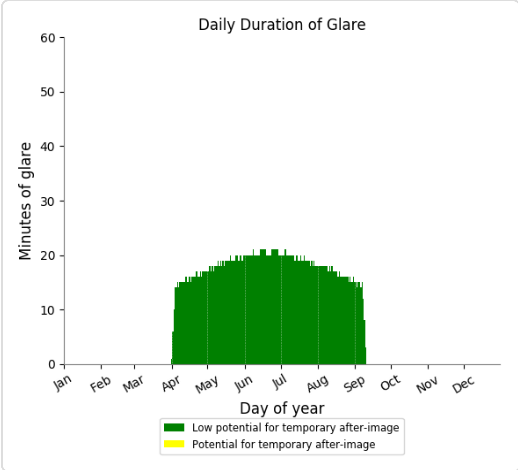
No glare found

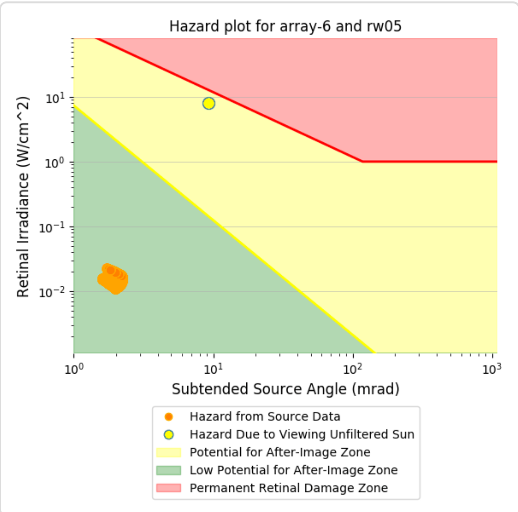
array 6 - Receptor (RW05)

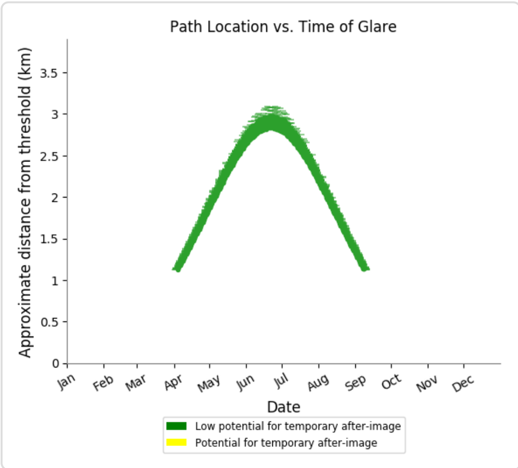
PV array is expected to produce the following glare for observers on this flight path:

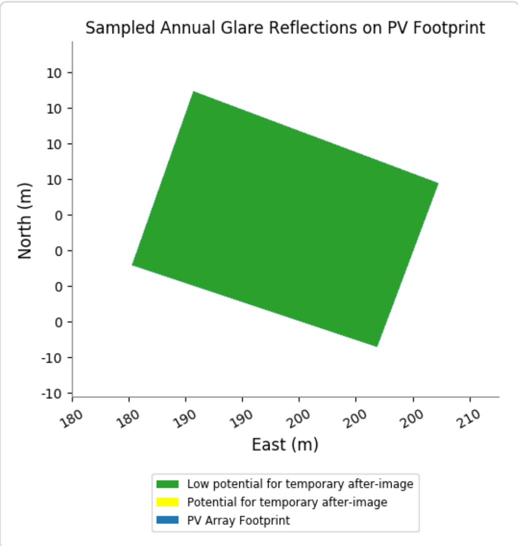
- 2,881 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

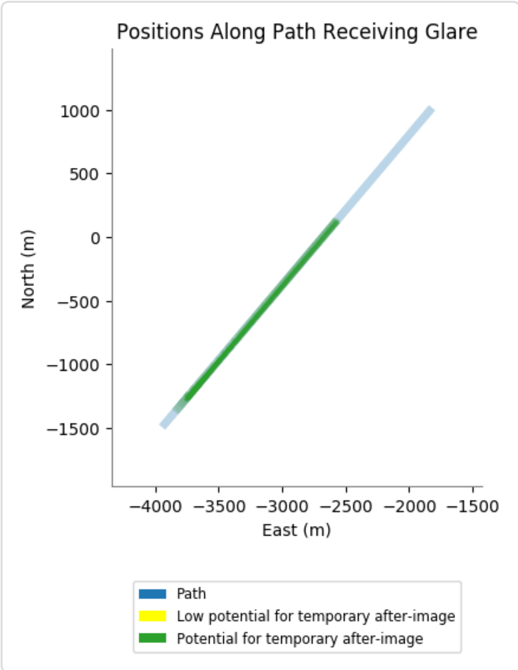






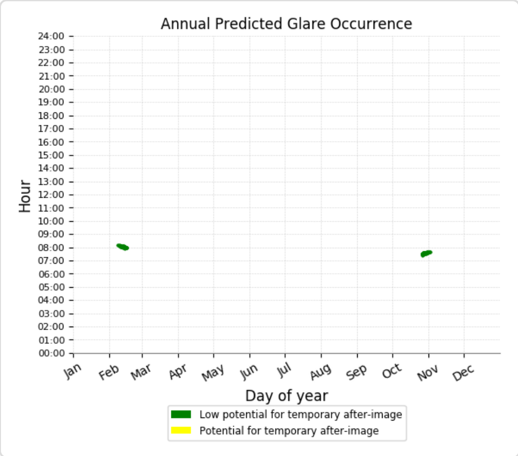


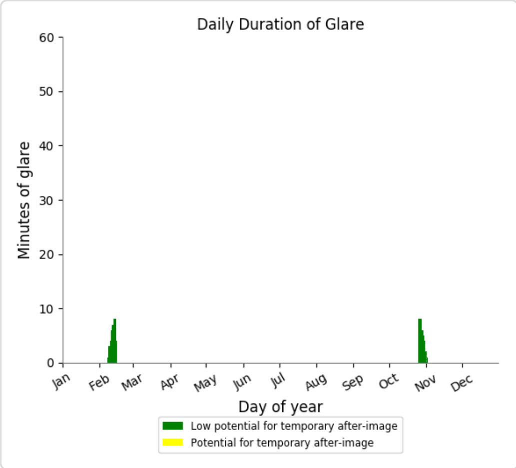


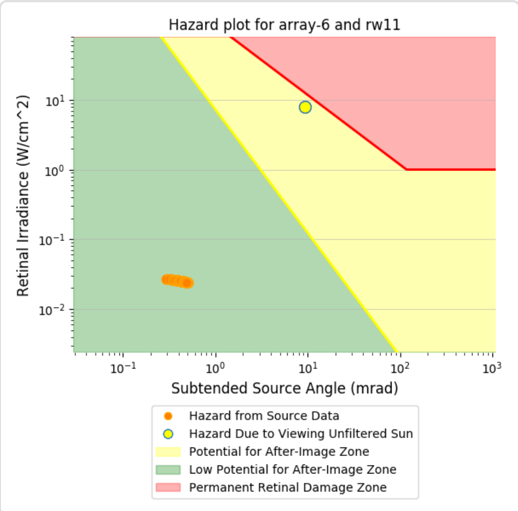


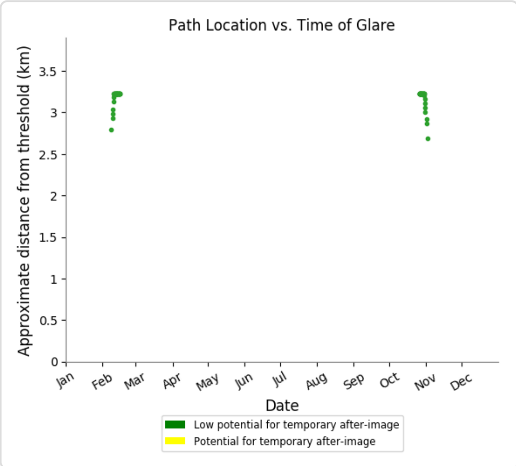
array 6 - Receptor (RW11)

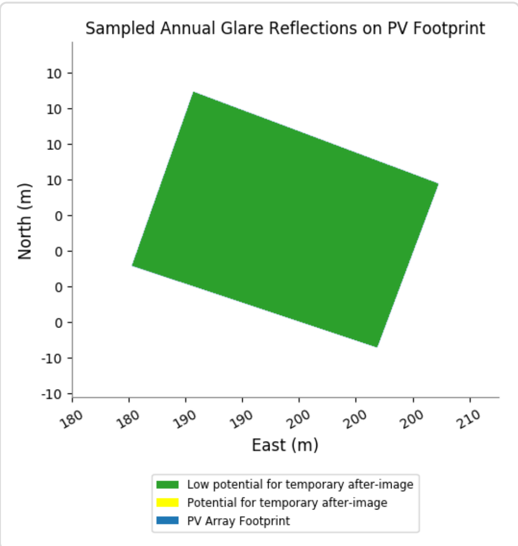
PV array is expected to produce the following glare for observers on this flight path:
- 83 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

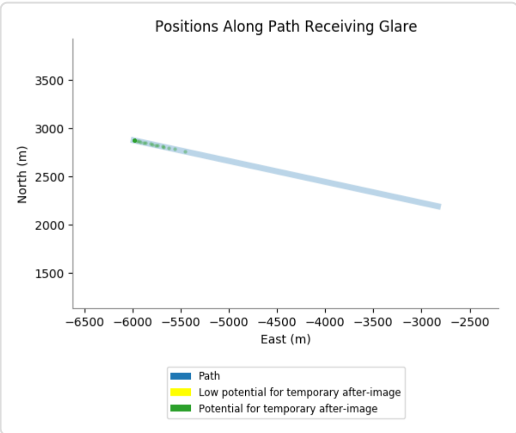












array 6 - Receptor (RW23)

No glare found

array 6 - Receptor (RW29)

No glare found

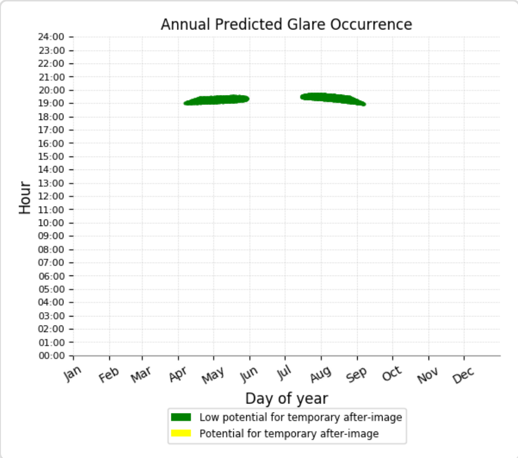
array 6 - Receptor (S)

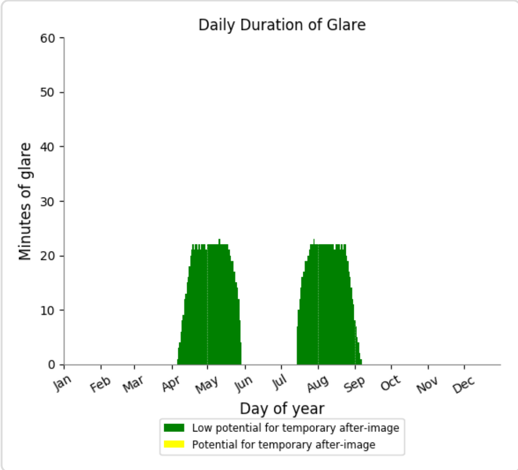
No glare found

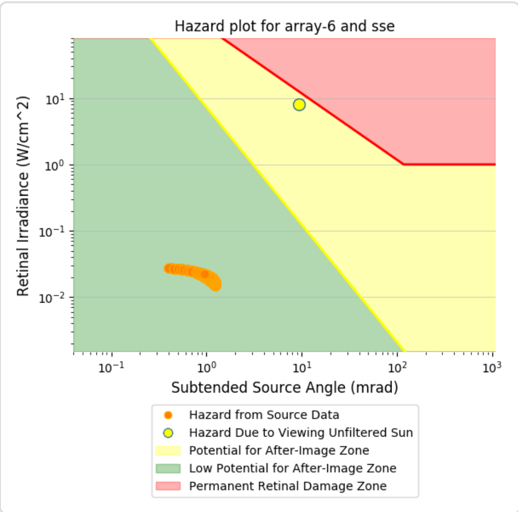
array 6 - Receptor (SSE)

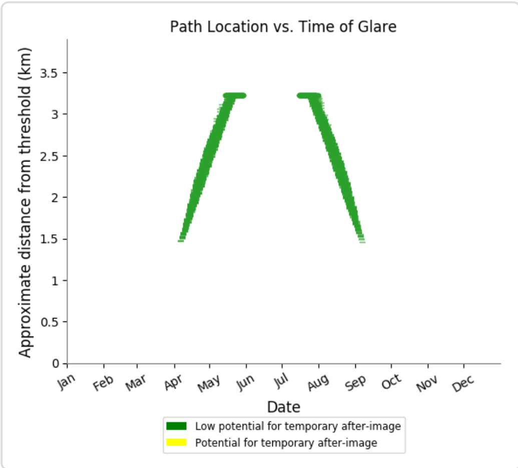
PV array is expected to produce the following glare for observers on this flight path:

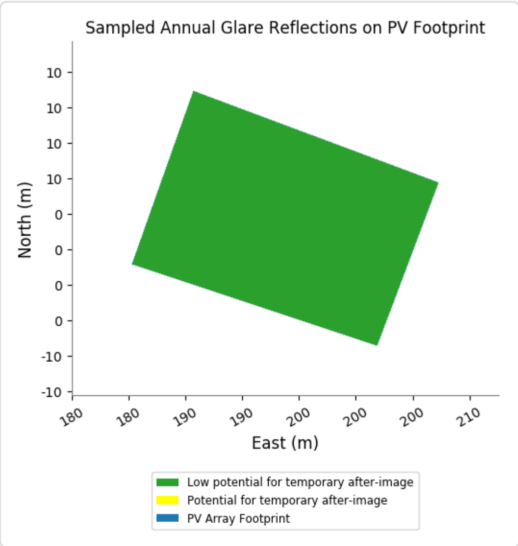
- 1,935 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

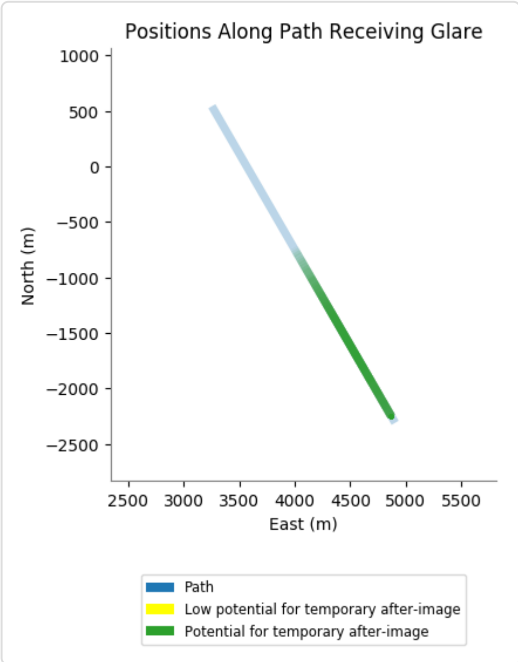












array 6 - Receptor (SSW)

No glare found

array 6 - Receptor (W)

No glare found

array 6 - Receptor (WNW)

No glare found

array 6 - Receptor (WSW)

No glare found

array 6 - OP Receptor (1-ATCT)

No glare found

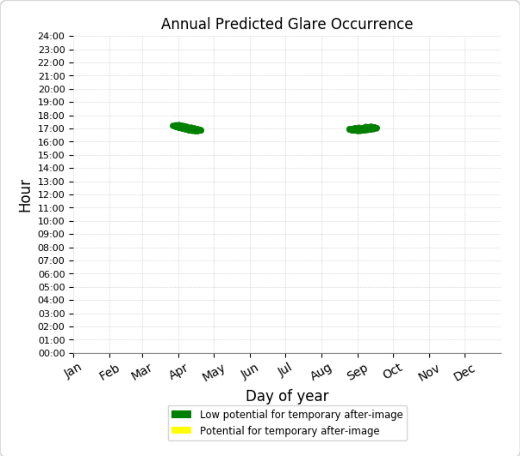
array 7 low potential for temporary after-image

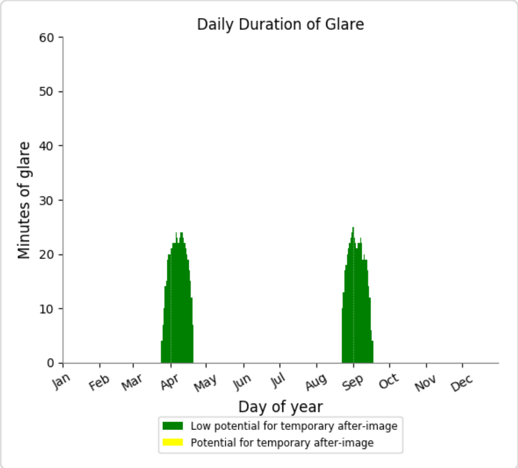
Component	Green glare (min)	Yellow glare (min)
FP: E	970	0
FP: ENE	1348	0
FP: ESE	3154	0
FP: N	0	0
FP: NNE	2864	0
FP: NNW	0	0
FP: RW05	0	0
FP: RW11	0	0
FP: RW23	0	0
FP: RW29	630	0
FP: S	0	0
FP: SSE	1438	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

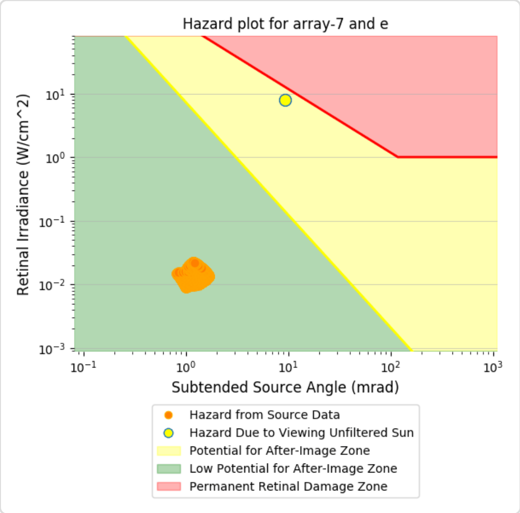
array 7 - Receptor (E)

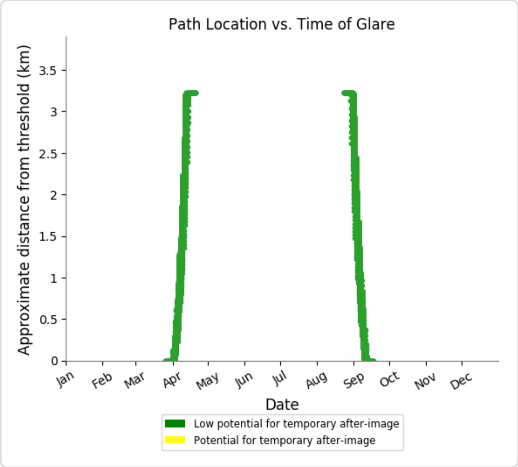
PV array is expected to produce the following glare for observers on this flight path:

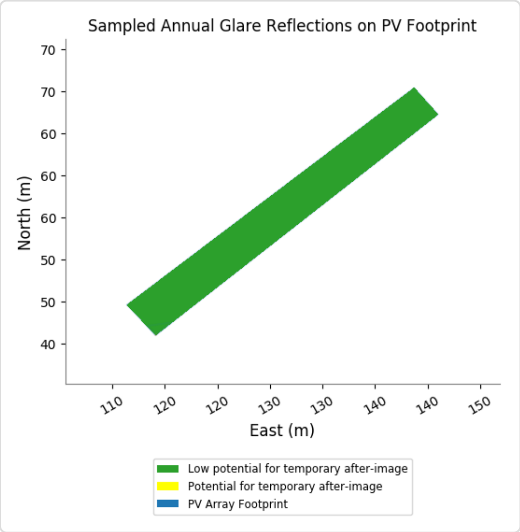
- 970 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

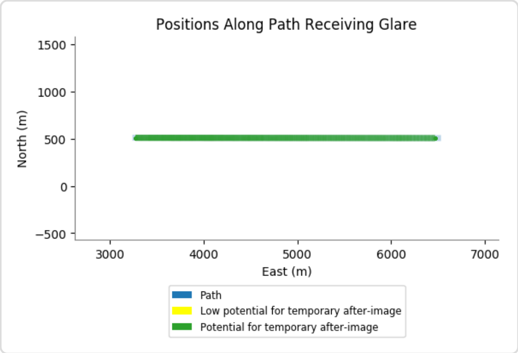








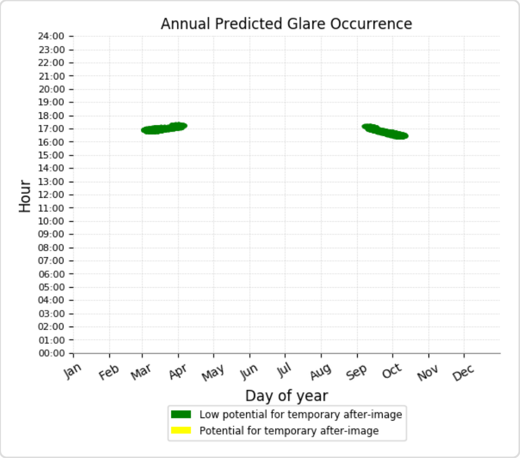


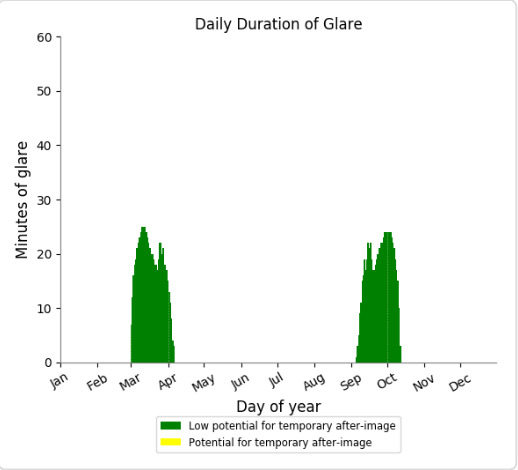


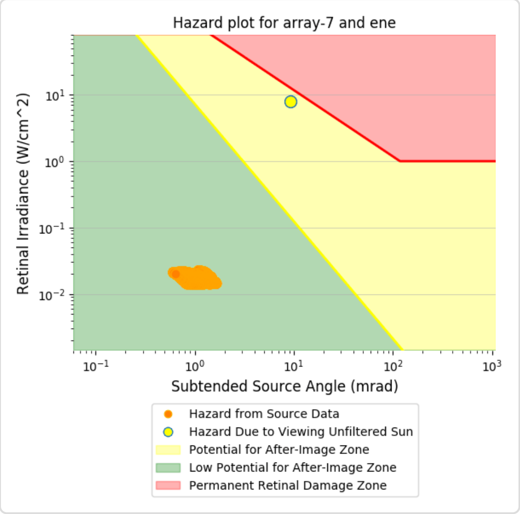
array 7 - Receptor (ENE)

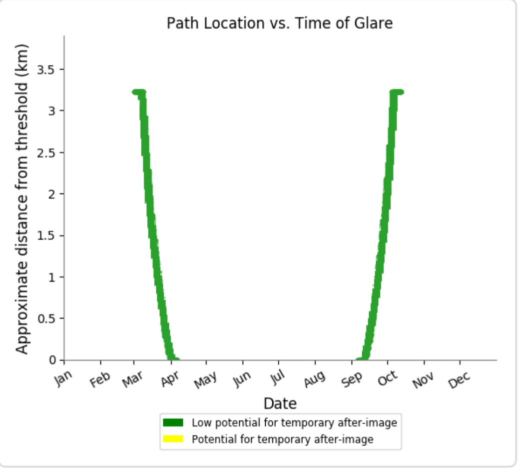
PV array is expected to produce the following glare for observers on this flight path:

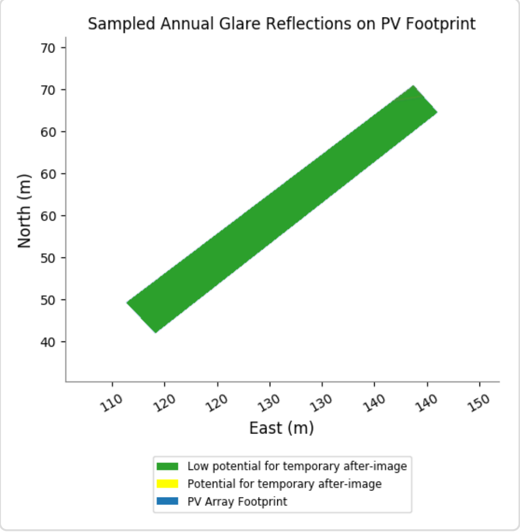
- 1,348 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

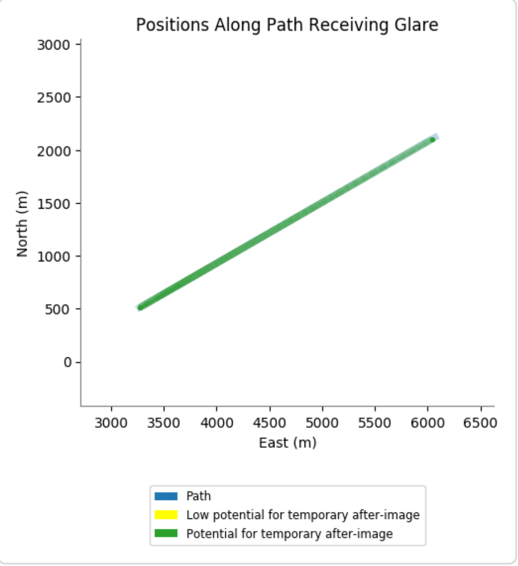








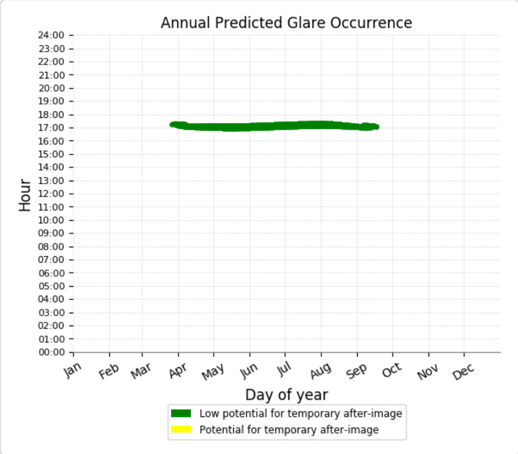


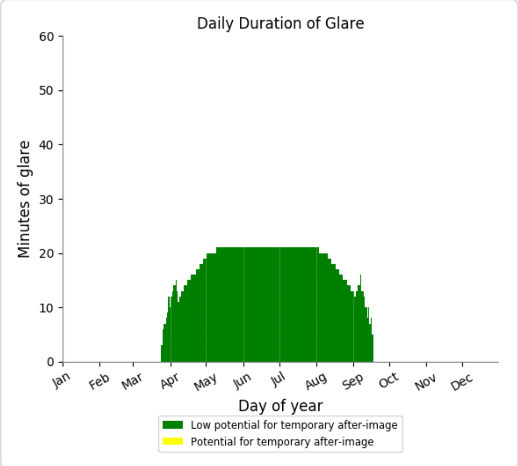


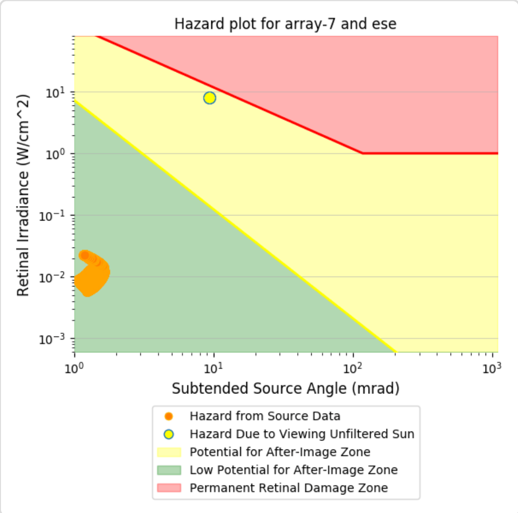
array 7 - Receptor (ESE)

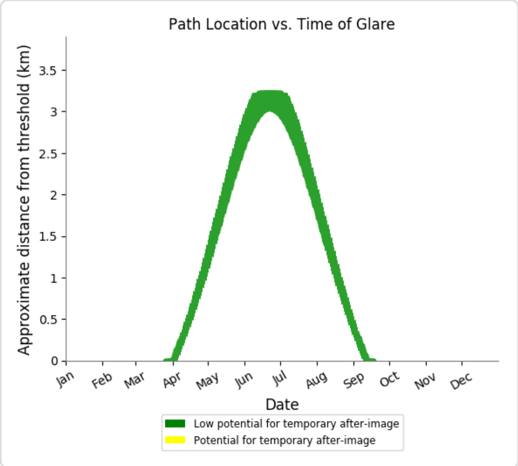
PV array is expected to produce the following glare for observers on this flight path:

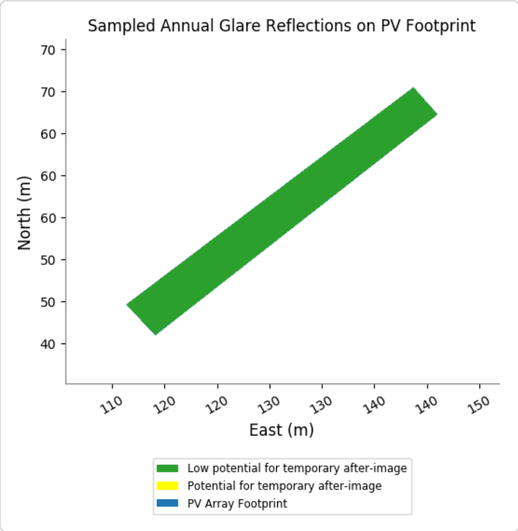
- 3,154 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

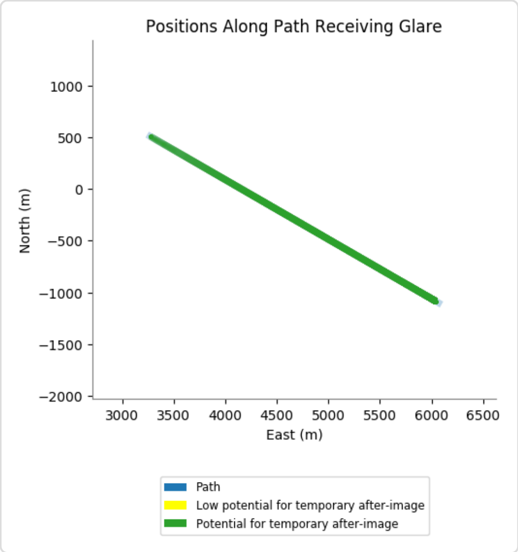












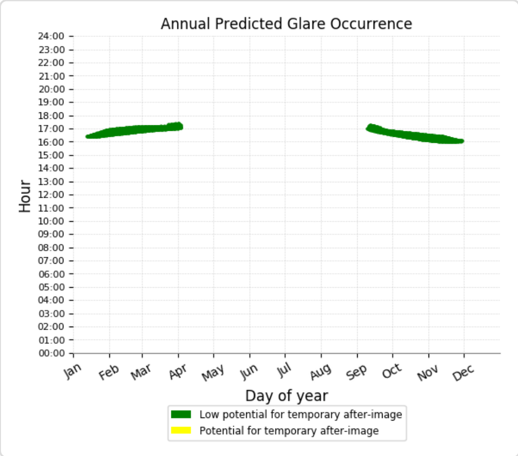
array 7 - Receptor (N)

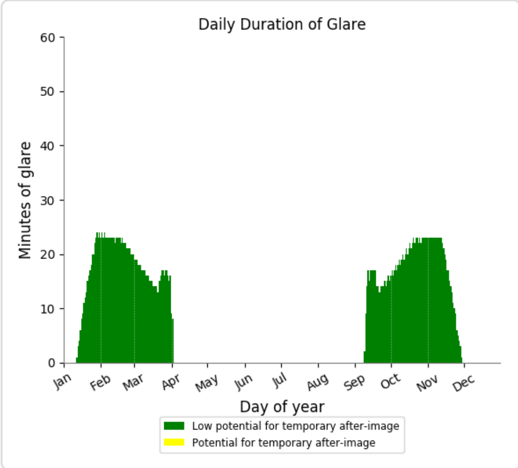
No glare found

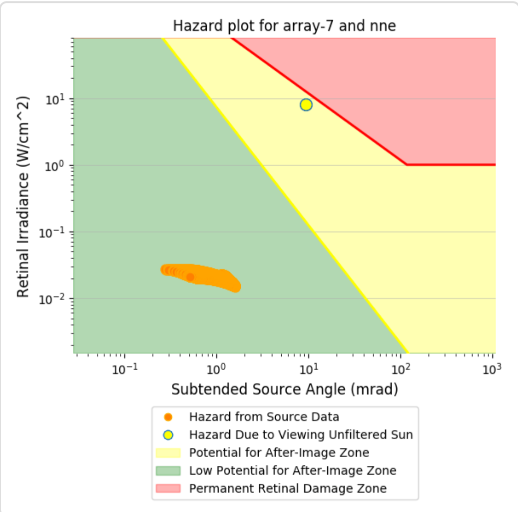
array 7 - Receptor (NNE)

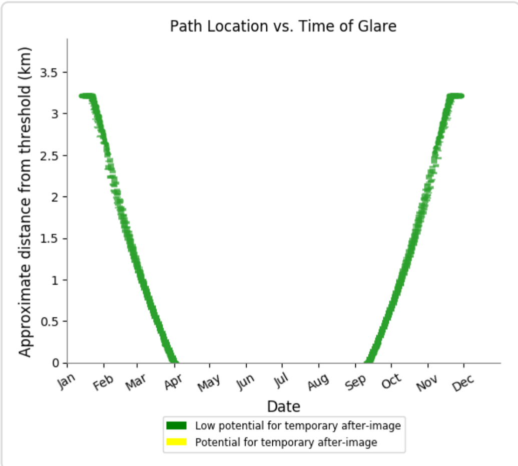
PV array is expected to produce the following glare for observers on this flight path:

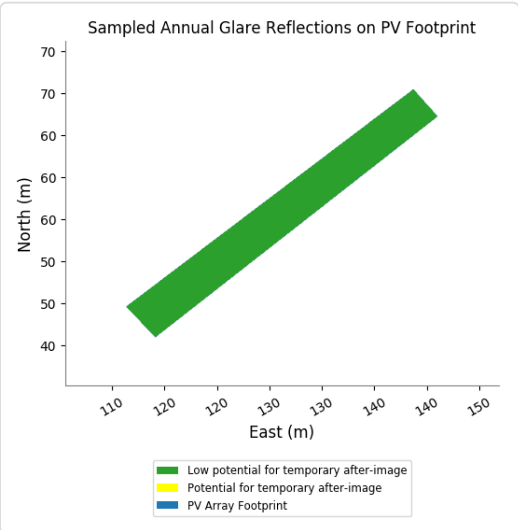
- 2,864 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

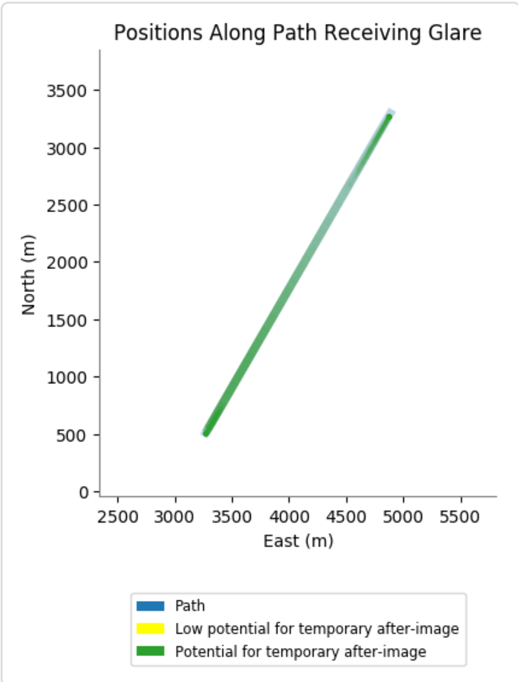












array 7 - Receptor (NNW)

No glare found

array 7 - Receptor (RW05)

No glare found

array 7 - Receptor (RW11)

No glare found

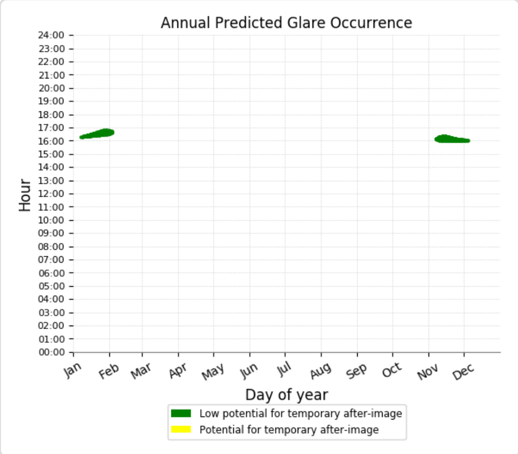
array 7 - Receptor (RW23)

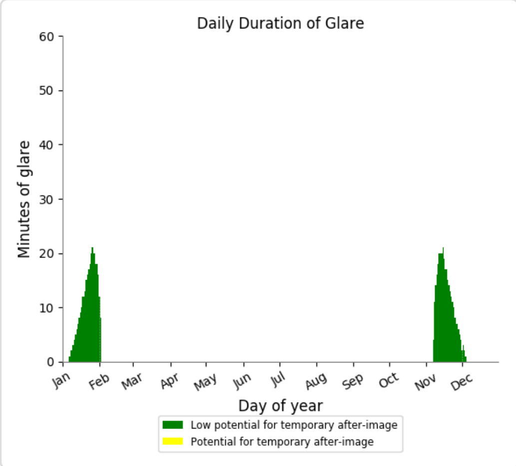
No glare found

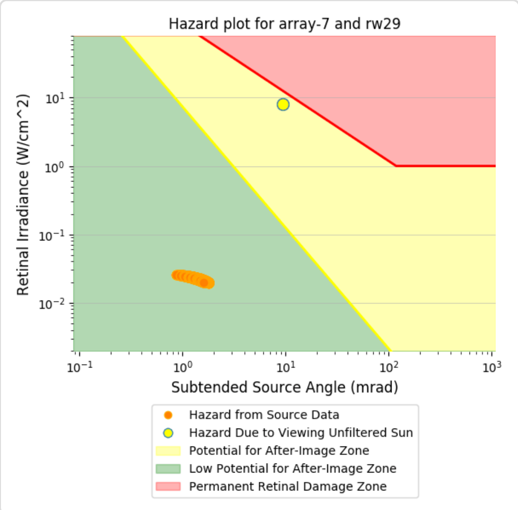
array 7 - Receptor (RW29)

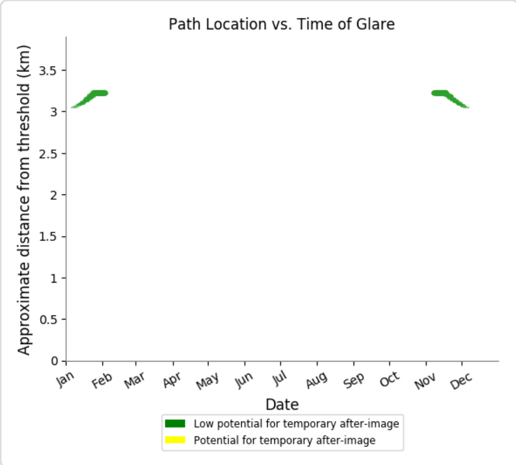
PV array is expected to produce the following glare for observers on this flight path:

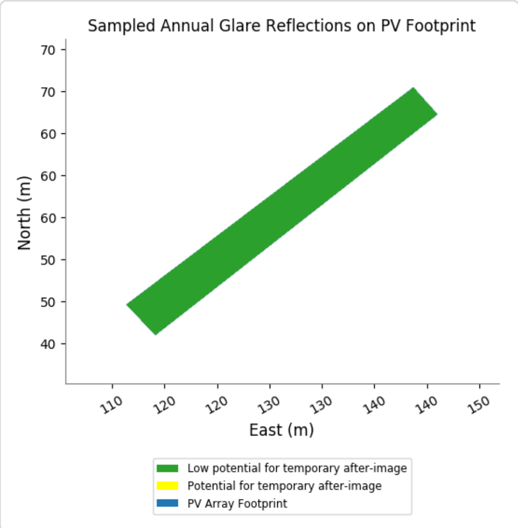
- 630 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

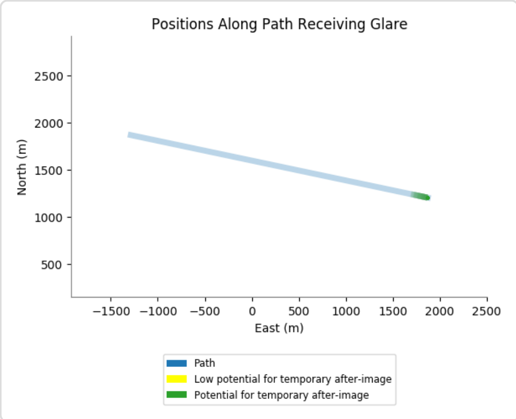












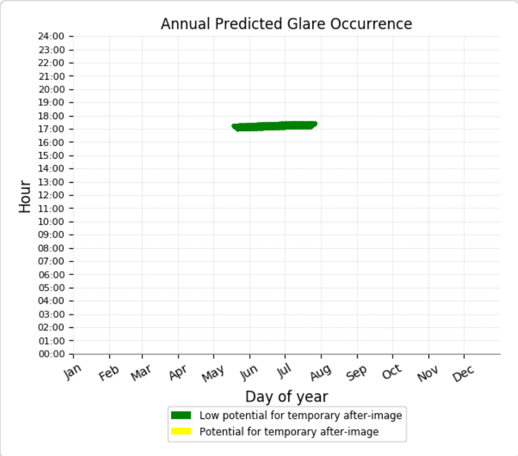
array 7 - Receptor (S)

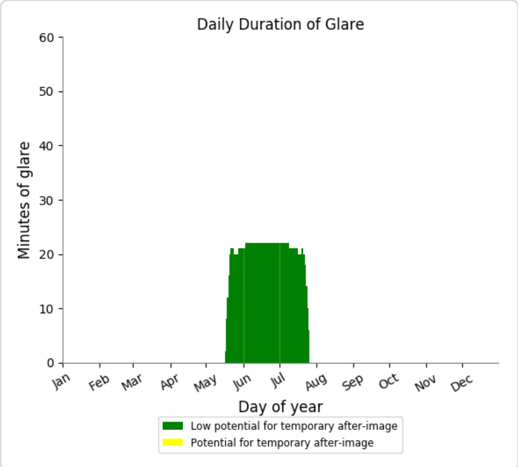
No glare found

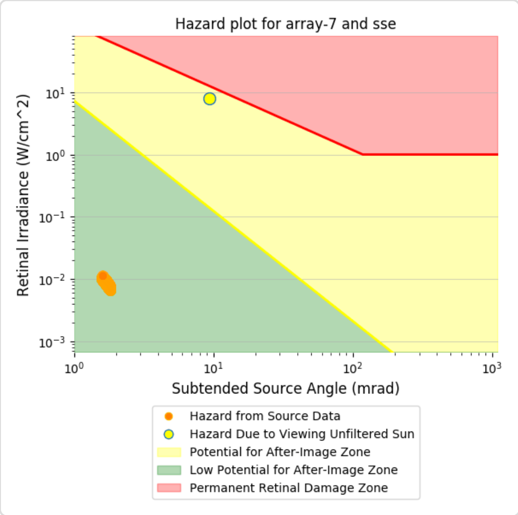
array 7 - Receptor (SSE)

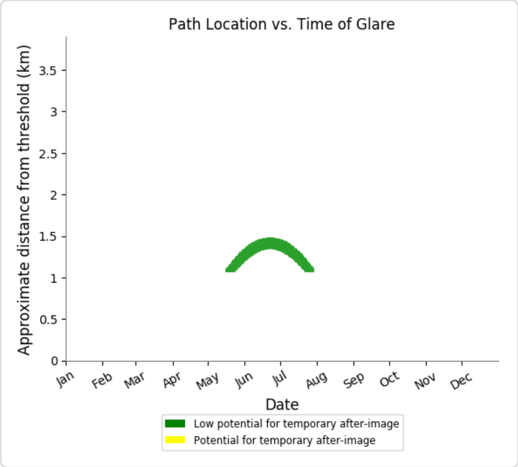
PV array is expected to produce the following glare for observers on this flight path:

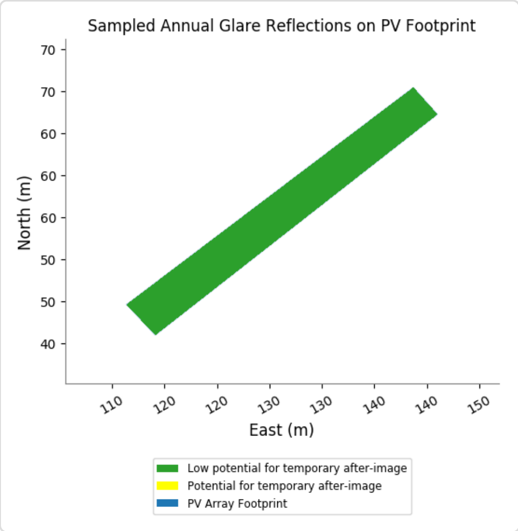
- 1,438 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

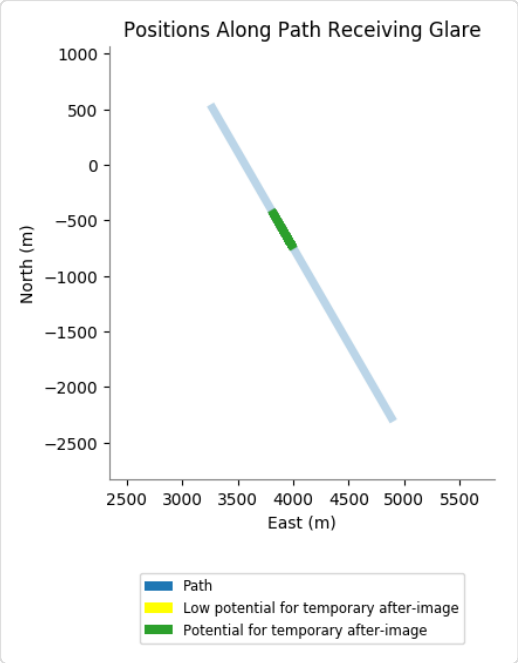












array 7 - Receptor (SSW)

No glare found

array 7 - Receptor (W)

No glare found

array 7 - Receptor (WNW)

No glare found

array 7 - Receptor (WSW)

No glare found

array 7 - OP Receptor (1-ATCT)

No glare found

array 8 low potential for temporary after-image

Component	Green glare (min)	Yellow glare (min)
FP: E	0	0
FP: ENE	0	0
FP: ESE	0	0
FP: N	0	0
FP: NNE	0	0
FP: NNW	0	0
FP: RW05	1339	0
FP: RW11	1065	0
FP: RW23	0	0
FP: RW29	0	0
FP: S	42	0
FP: SSE	0	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

array 8 - Receptor (E)

No glare found

array 8 - Receptor (ENE)

No glare found

array 8 - Receptor (ESE)

No glare found

array 8 - Receptor (N)

No glare found

array 8 - Receptor (NNE)

No glare found

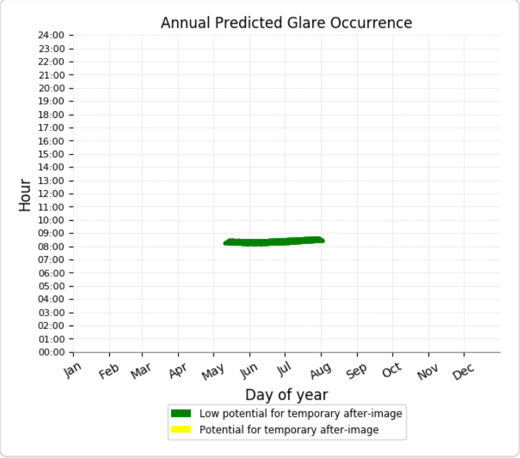
array 8 - Receptor (NNW)

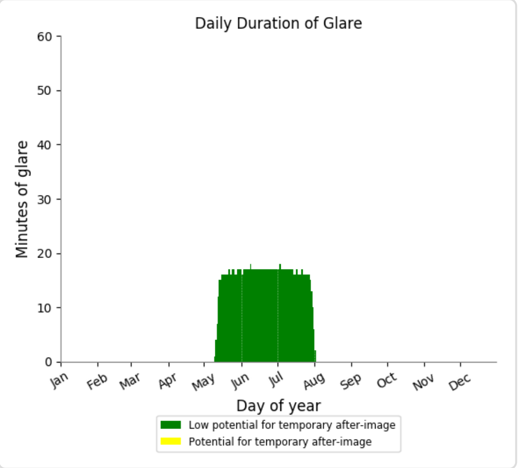
No glare found

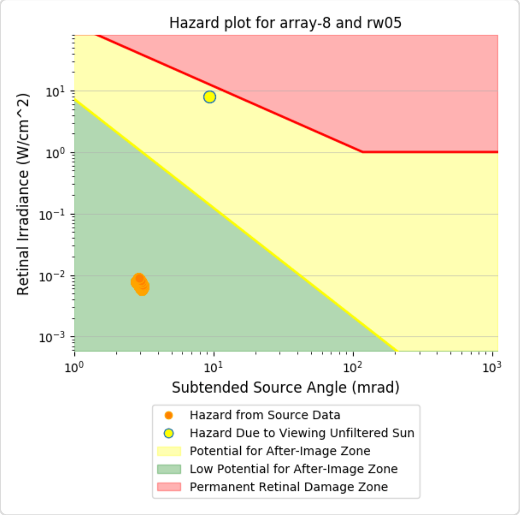
array 8 - Receptor (RW05)

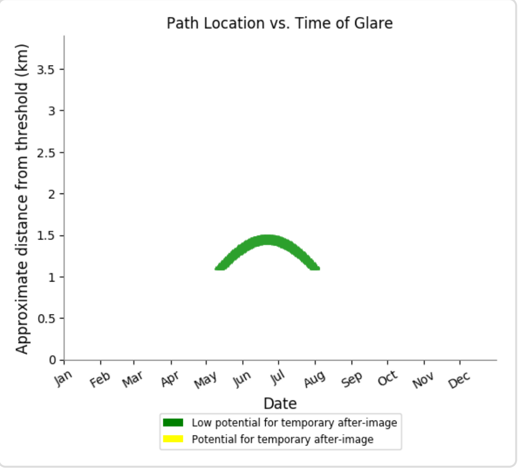
PV array is expected to produce the following glare for observers on this flight path:

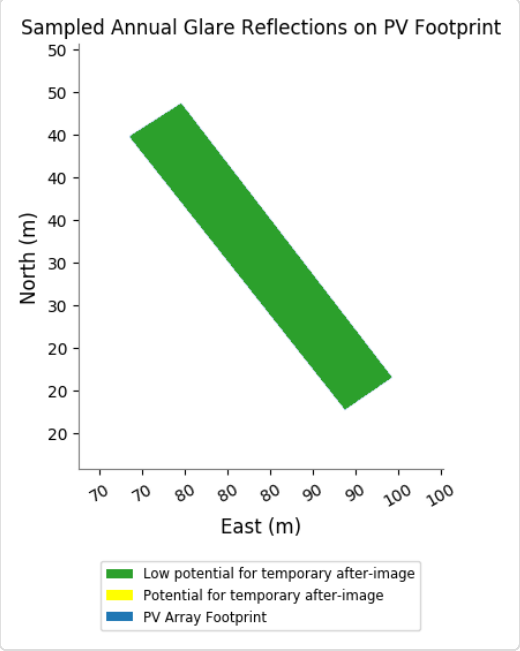
- 1,339 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

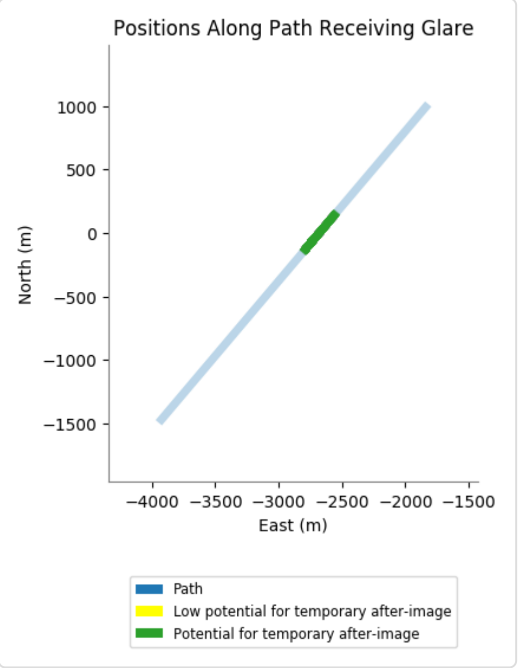








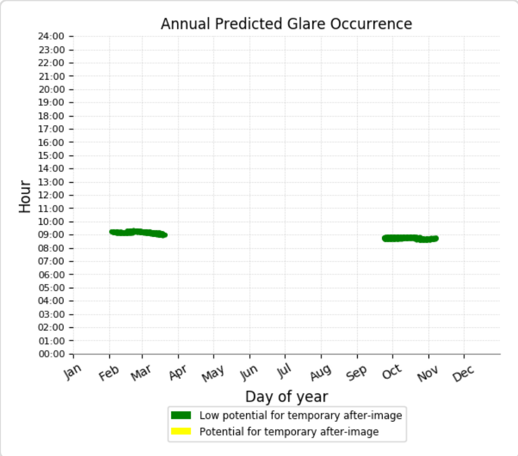


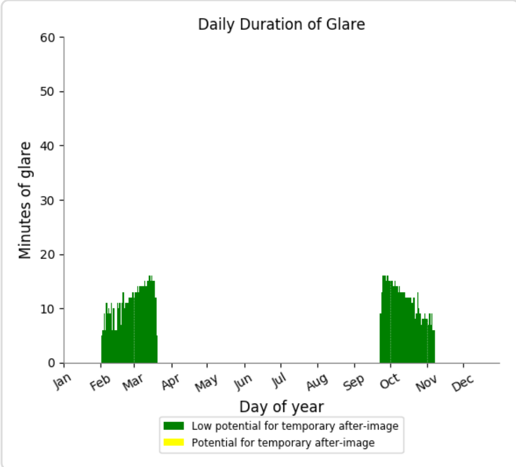


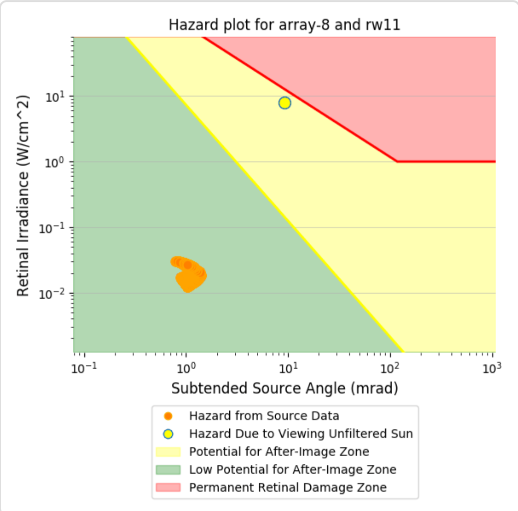
array 8 - Receptor (RW11)

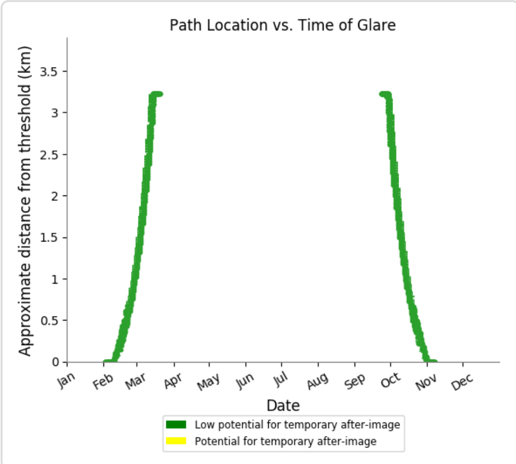
PV array is expected to produce the following glare for observers on this flight path:

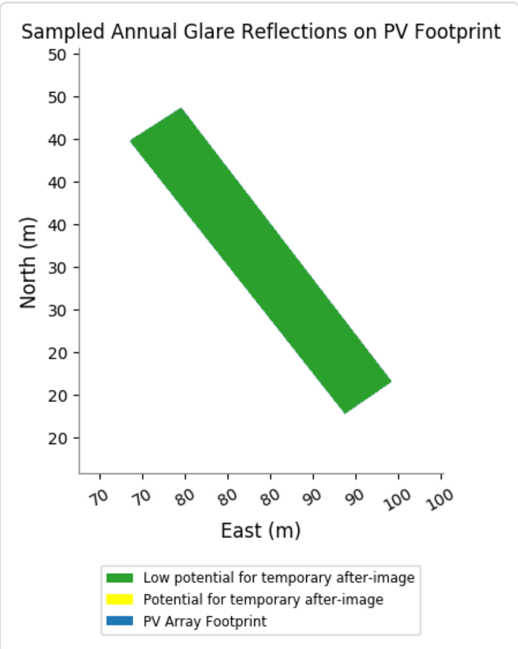
- 1,065 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

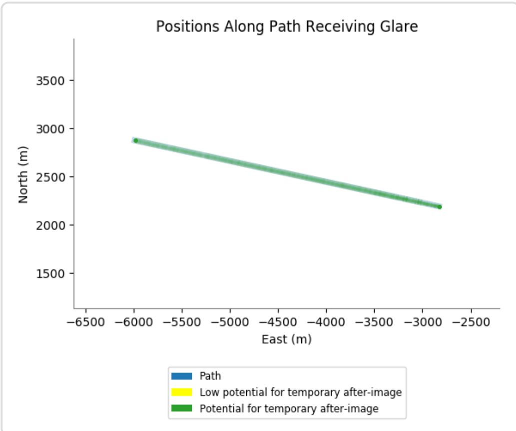












array 8 - Receptor (RW23)

No glare found

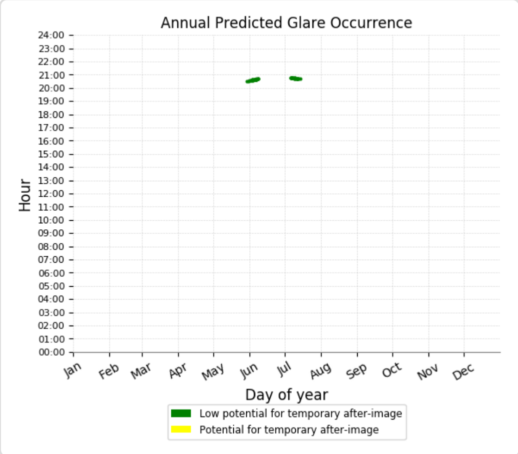
array 8 - Receptor (RW29)

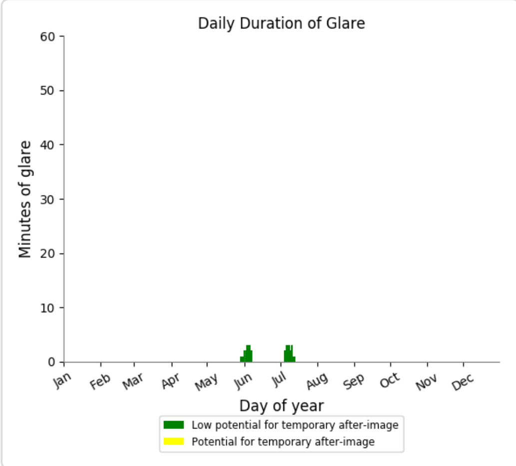
No glare found

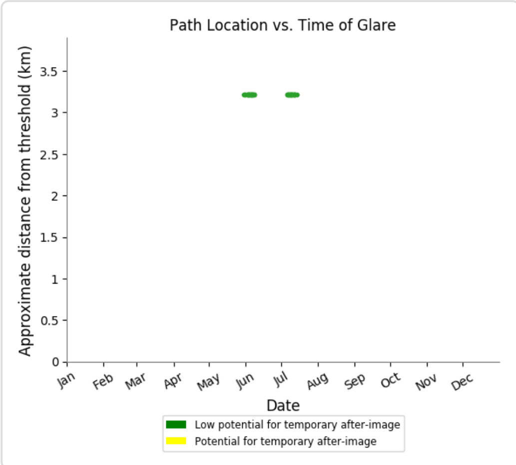
array 8 - Receptor (S)

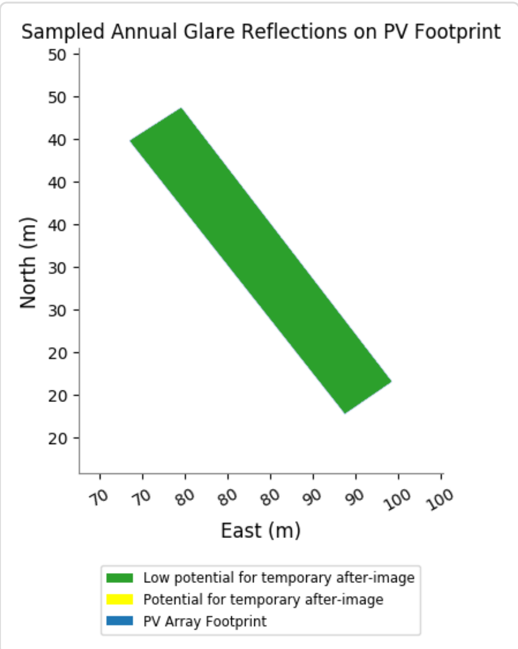
PV array is expected to produce the following glare for observers on this flight path:

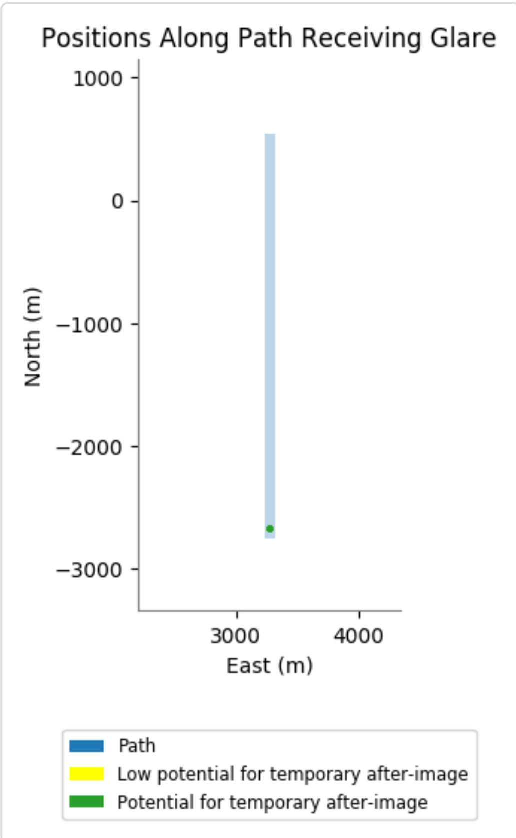
- 42 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.











array 8 - Receptor (SSE)
No glare found

array 8 - Receptor (SSW)
No glare found

array 8 - Receptor (W)
No glare found

array 8 - Receptor (WNW)
No glare found

array 8 - Receptor (WSW)
No glare found

array 8 - OP Receptor (1-ATCT)
No glare found

array 9 low potential for temporary after-image

Component	Green glare (min)	Yellow glare (min)
FP: E	0	0
FP: ENE	0	0
FP: ESE	0	0
FP: N	0	0
FP: NNE	0	0
FP: NNW	0	0
FP: RW05	1328	0
FP: RW11	1028	0
FP: RW23	0	0
FP: RW29	0	0
FP: S	45	0
FP: SSE	0	0
FP: SSW	0	0
FP: W	0	0
FP: WNW	0	0
FP: WSW	0	0
OP: 1-ATCT	0	0

array 9 - Receptor (E)
No glare found

array 9 - Receptor (ENE)
No glare found

array 9 - Receptor (ESE)
No glare found

array 9 - Receptor (N)
No glare found

array 9 - Receptor (NNE)

No glare found

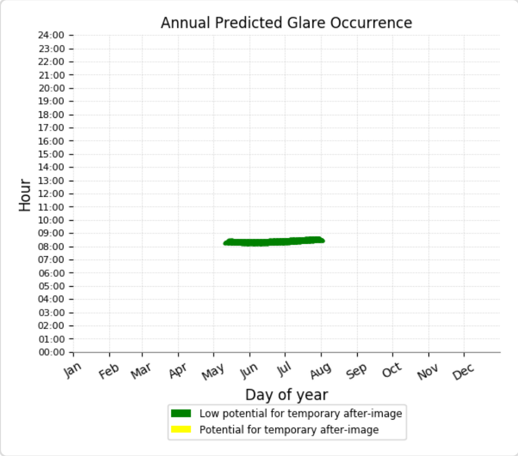
array 9 - Receptor (NNW)

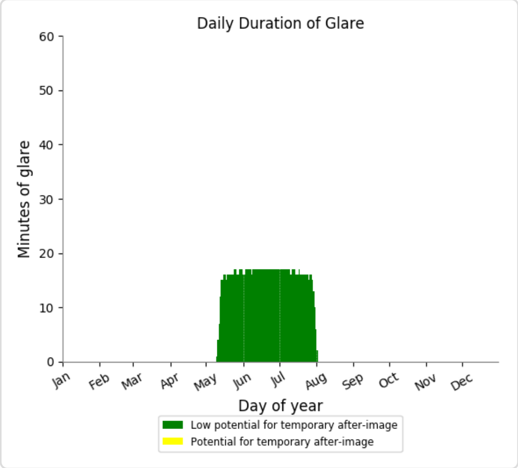
No glare found

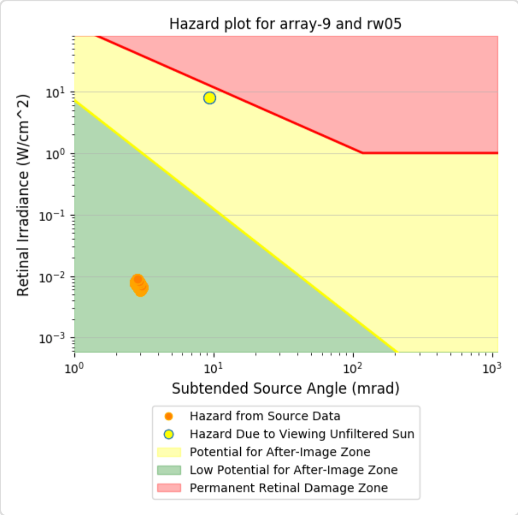
array 9 - Receptor (RW05)

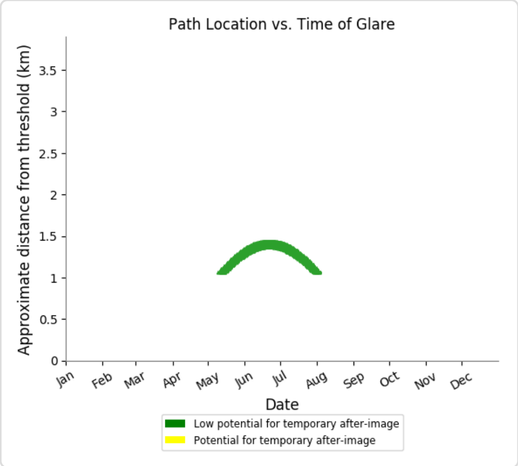
PV array is expected to produce the following glare for observers on this flight path:

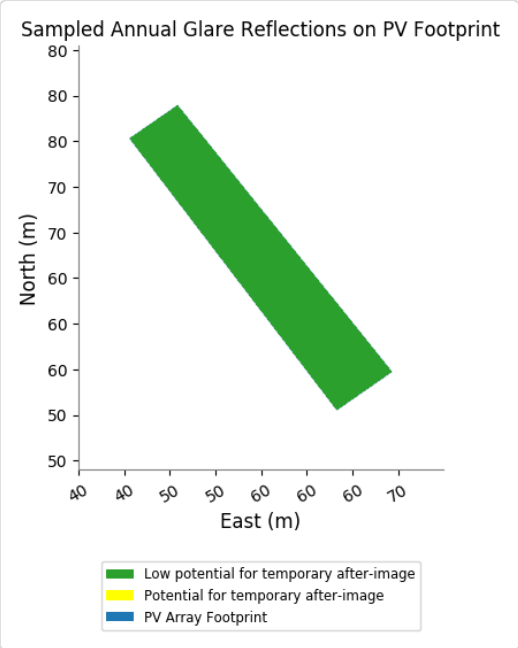
- 1,328 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

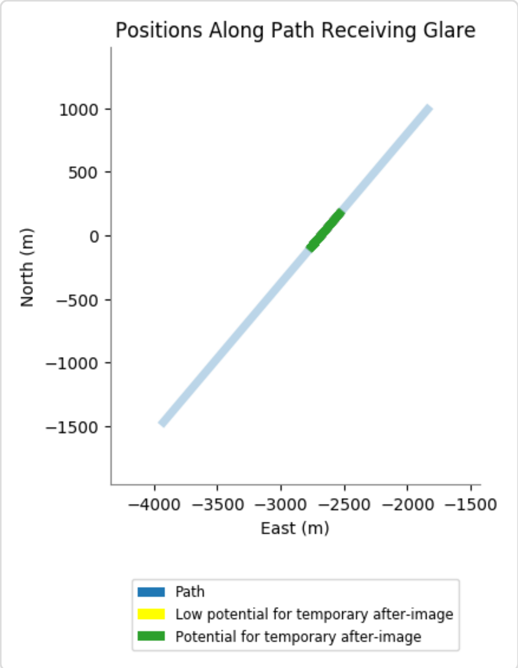








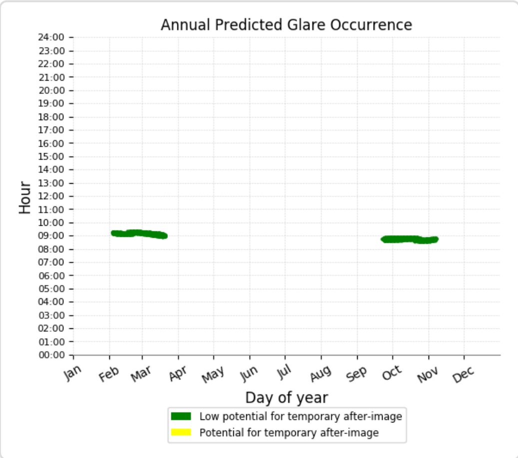


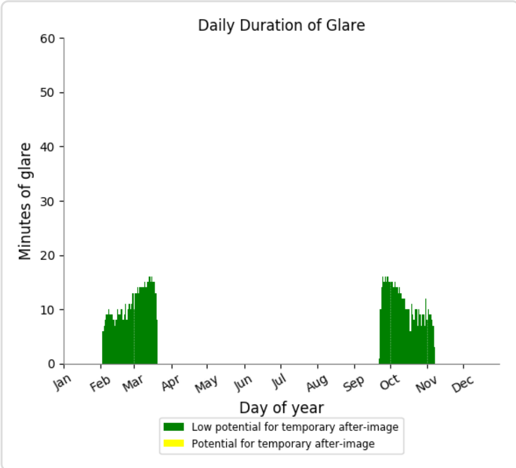


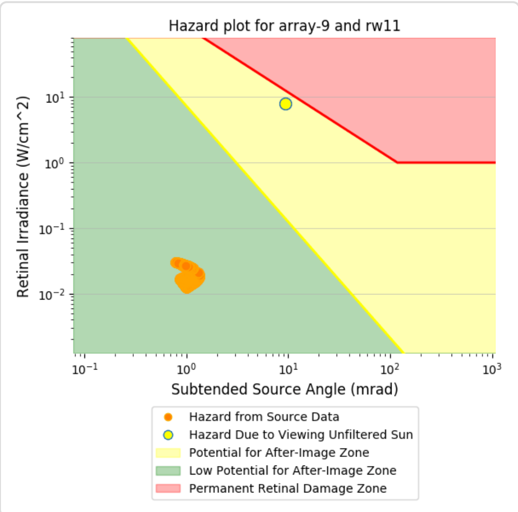
array 9 - Receptor (RW11)

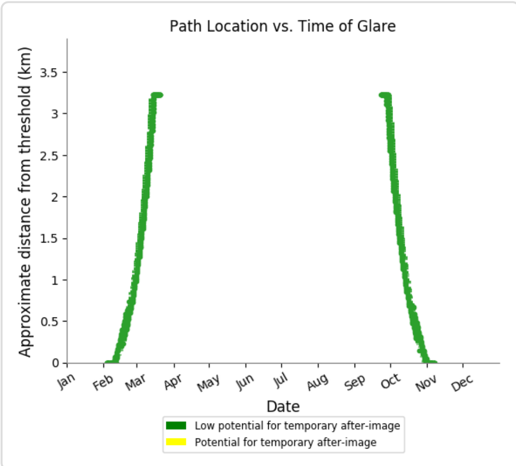
PV array is expected to produce the following glare for observers on this flight path:

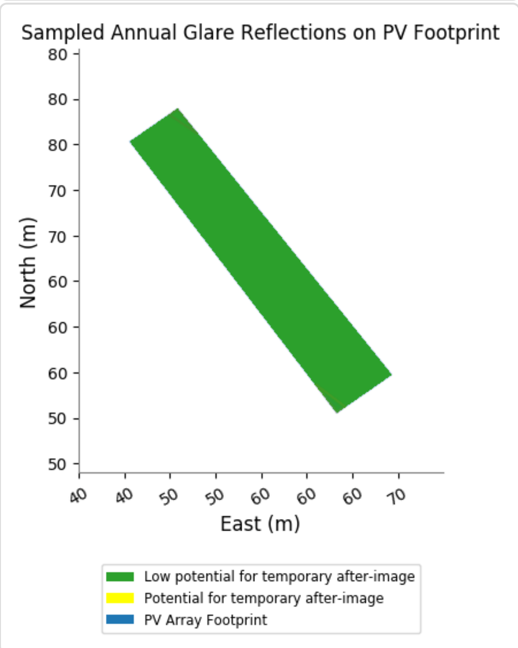
- 1,028 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

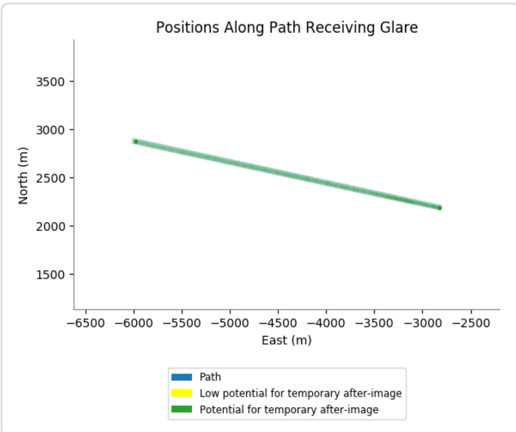












array 9 - Receptor (RW23)

No glare found

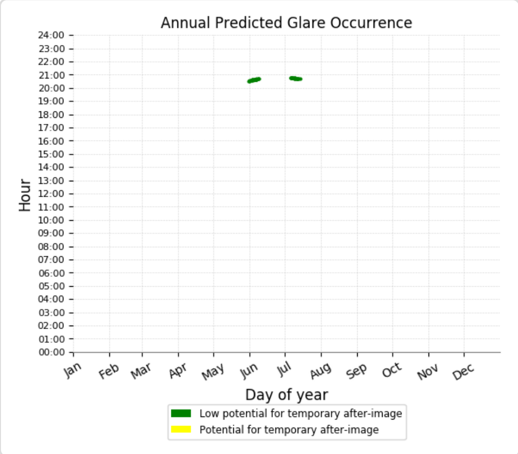
array 9 - Receptor (RW29)

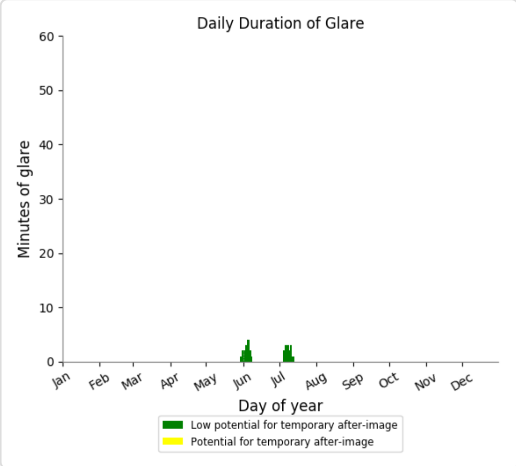
No glare found

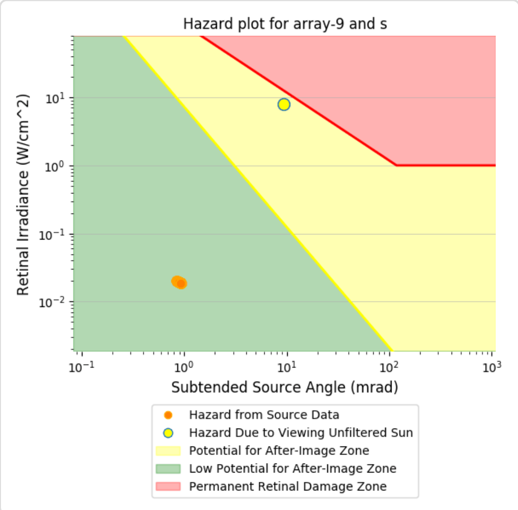
array 9 - Receptor (S)

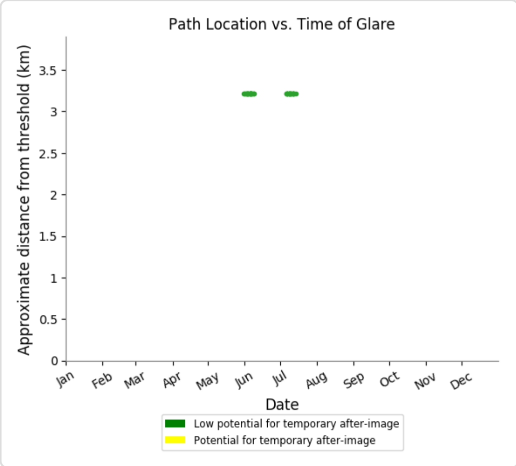
PV array is expected to produce the following glare for observers on this flight path:

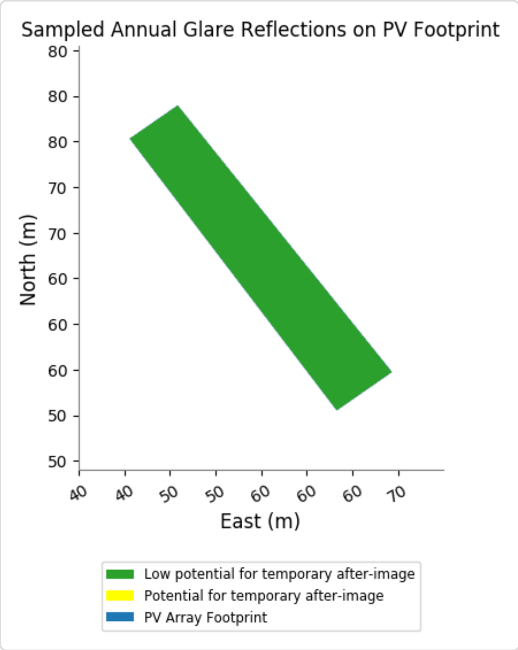
- 45 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

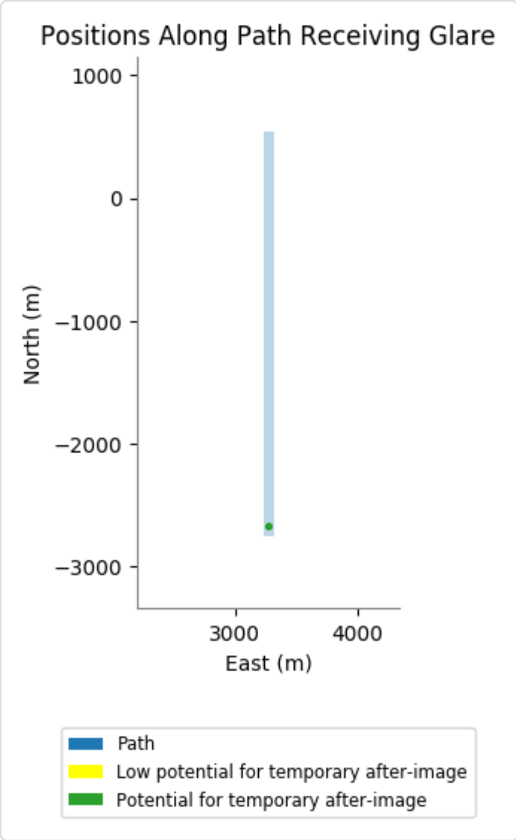












array 9 - Receptor (SSE)

No glare found

array 9 - Receptor (SSW)

No glare found

array 9 - Receptor (W)

No glare found

array 9 - Receptor (WNW)

No glare found

array 9 - Receptor (WSW)

No glare found

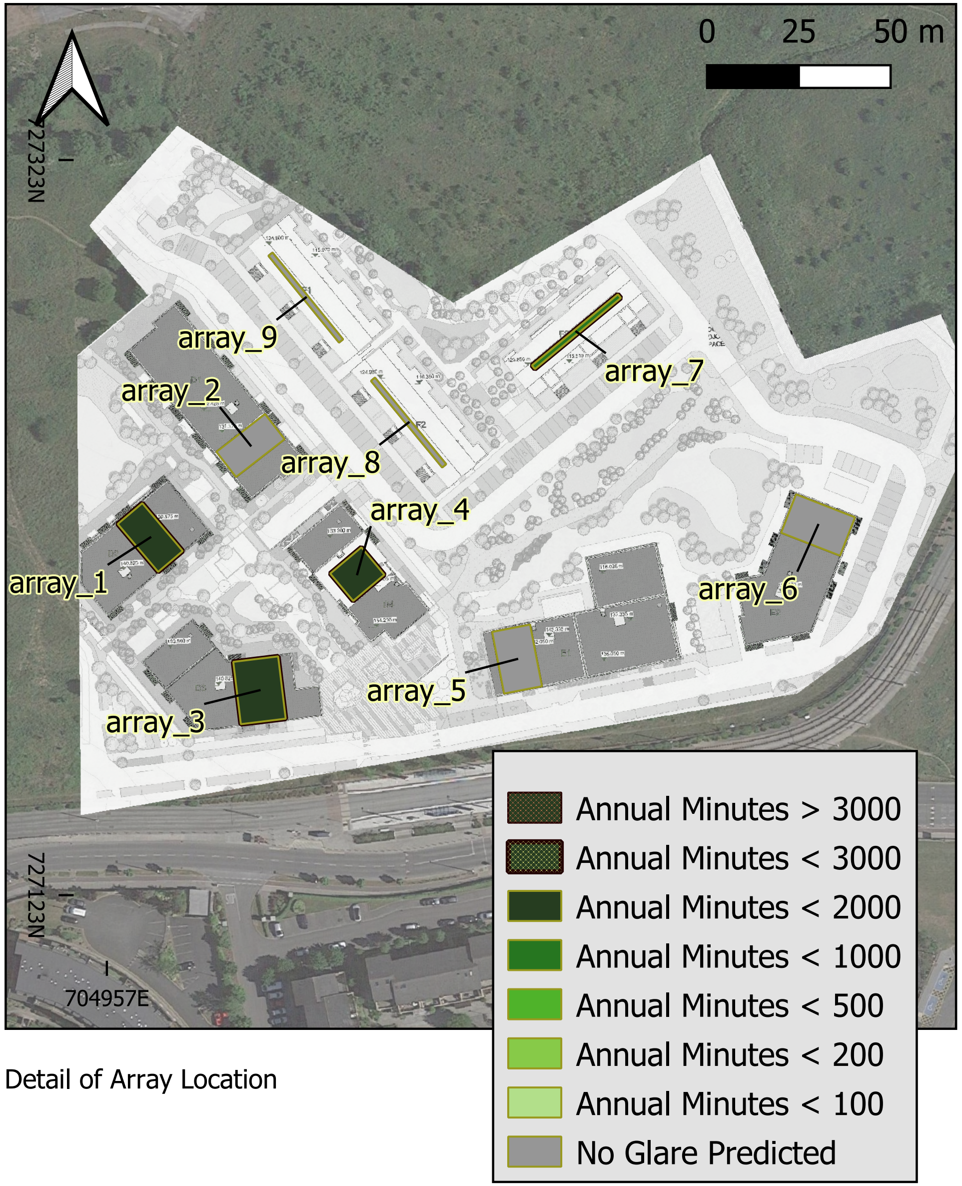
array 9 - OP Receptor (1-ATCT)

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

Map 2 Potential Glint and Glare Impact on Approach to Casement Runway 29 as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

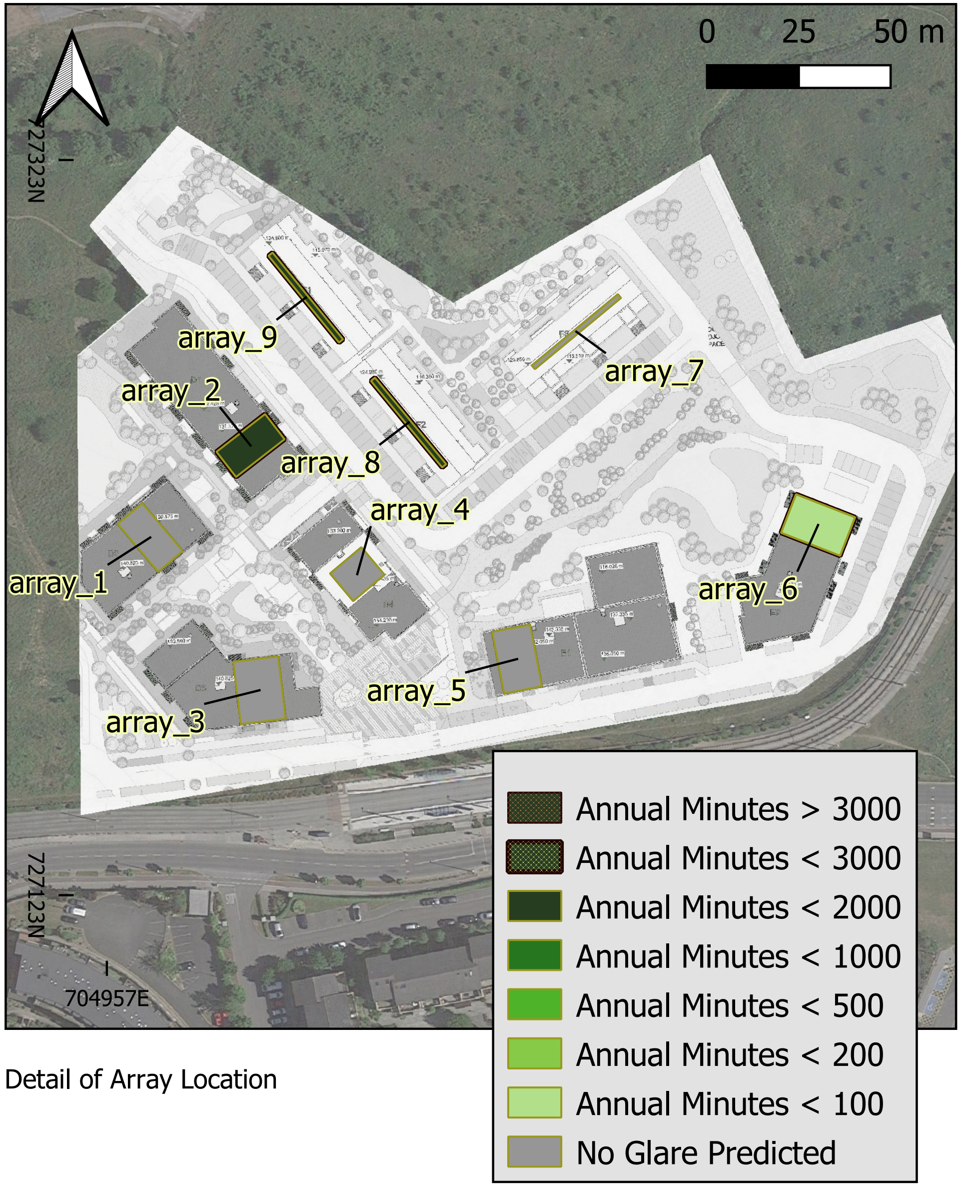
Approach to Casement Runway 29

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	18.3	25	1523	Green
array_2	NA	NA	NA	NA
array_3	18.2	25	1421	Green
array_4	17.9	25	1468	Green
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	11.3	21	623	Green
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Distance from approach threshold to Proposed Site: 2297 metres

Bearing from approach threshold to Proposed Site: 143 degrees

Map 3 Potential Glint and Glare Impact on Approach to Casement Runway 11 as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

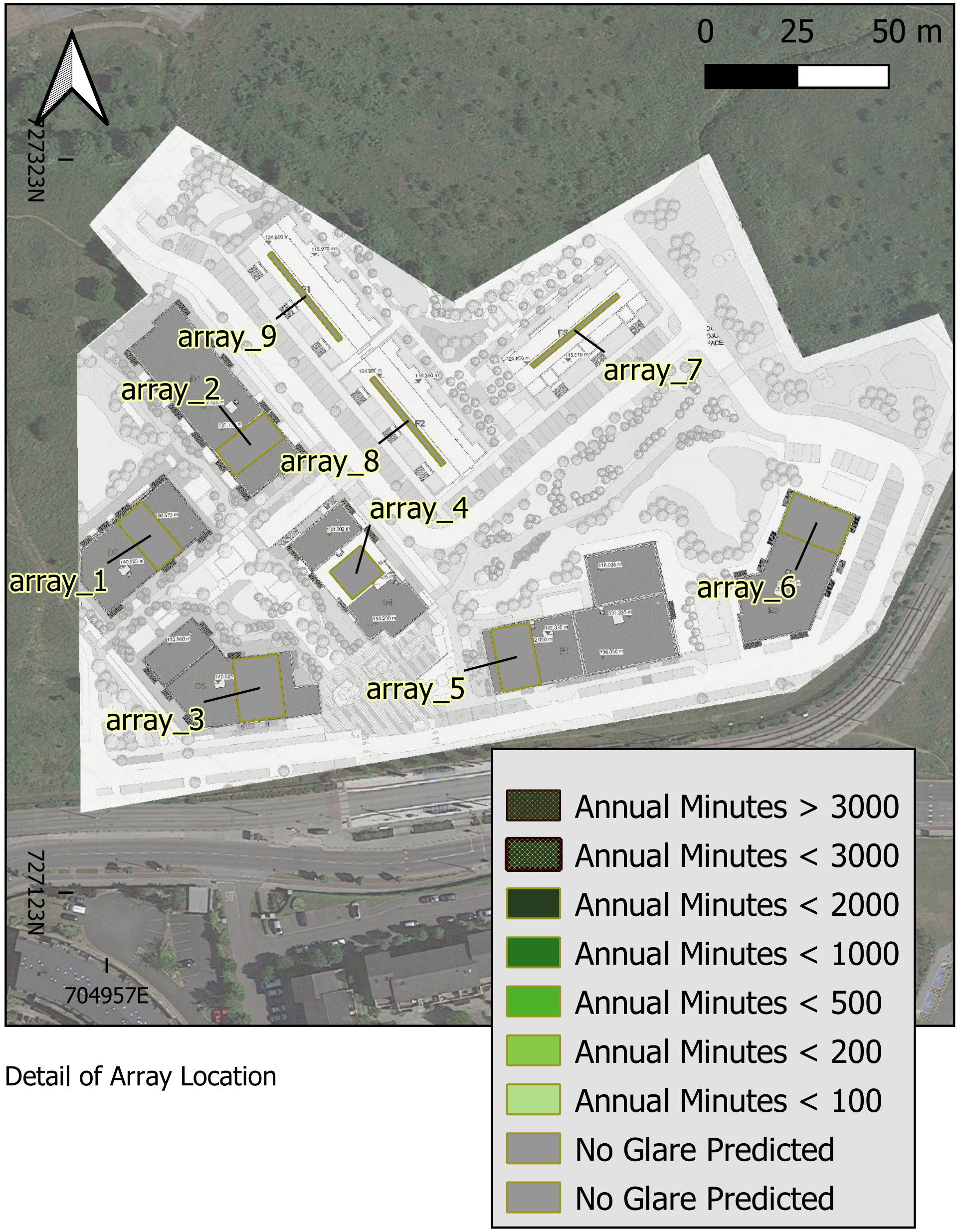
Approach to Casement Runway 11

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	12.4	17	1193	Green
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	5.2	8	83	Green
array_7	NA	NA	NA	NA
array_8	11.1	17	1036	Green
array_9	13.5	19	1184	Green

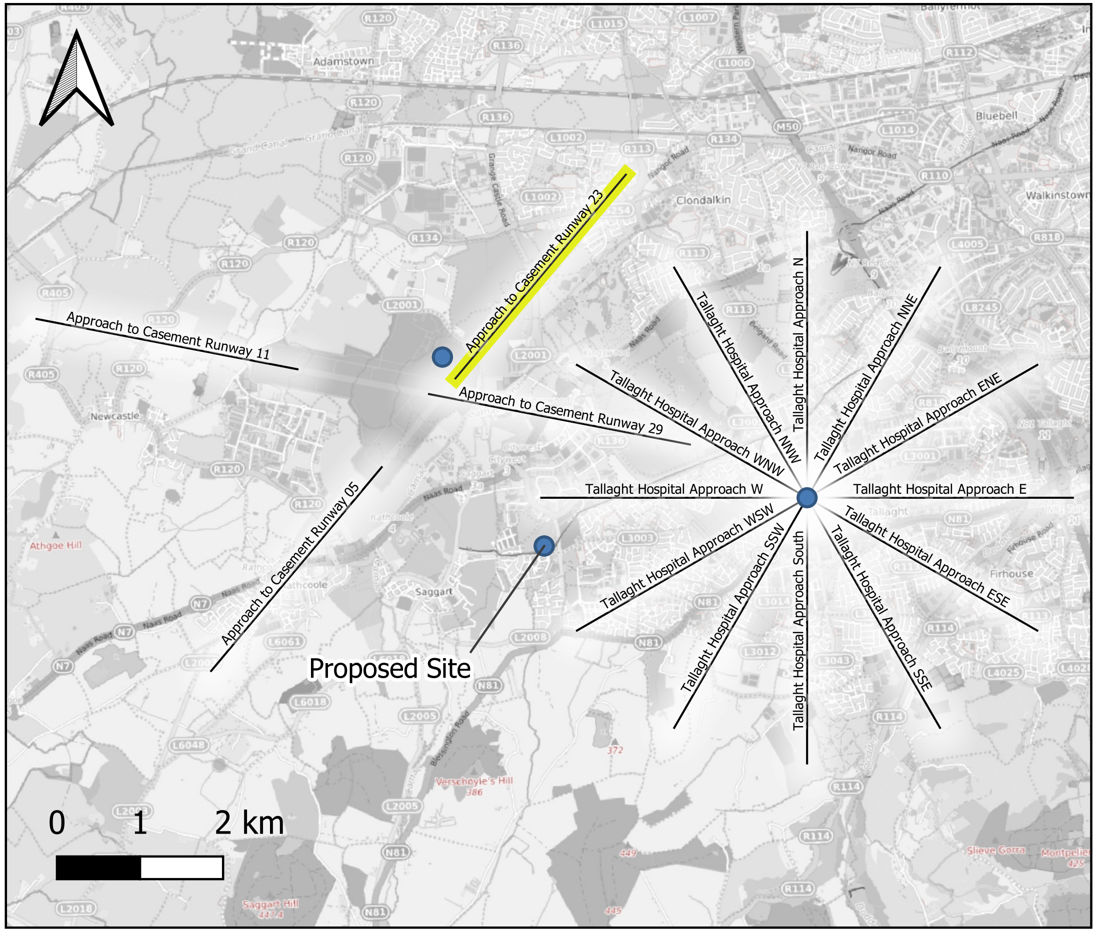
Distance from approach threshold to Proposed Site: 3655 metres

Bearing from approach threshold to Proposed Site: 126 degrees

Map 4 Potential Glint and Glare Impact on Approach to Casement Runway 23 as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location



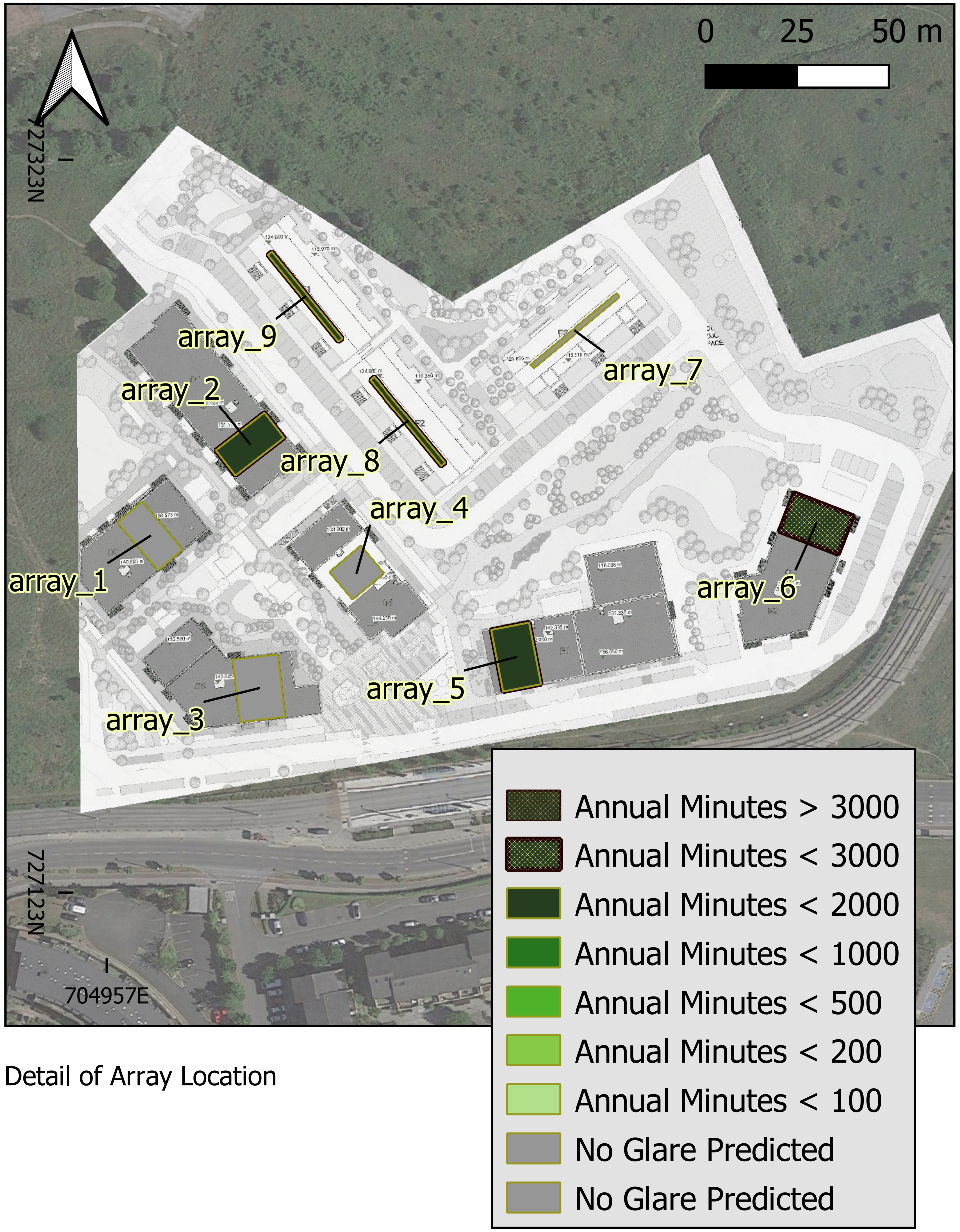
Approach to Casement Runway 23

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	NA	NA	NA	NA
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

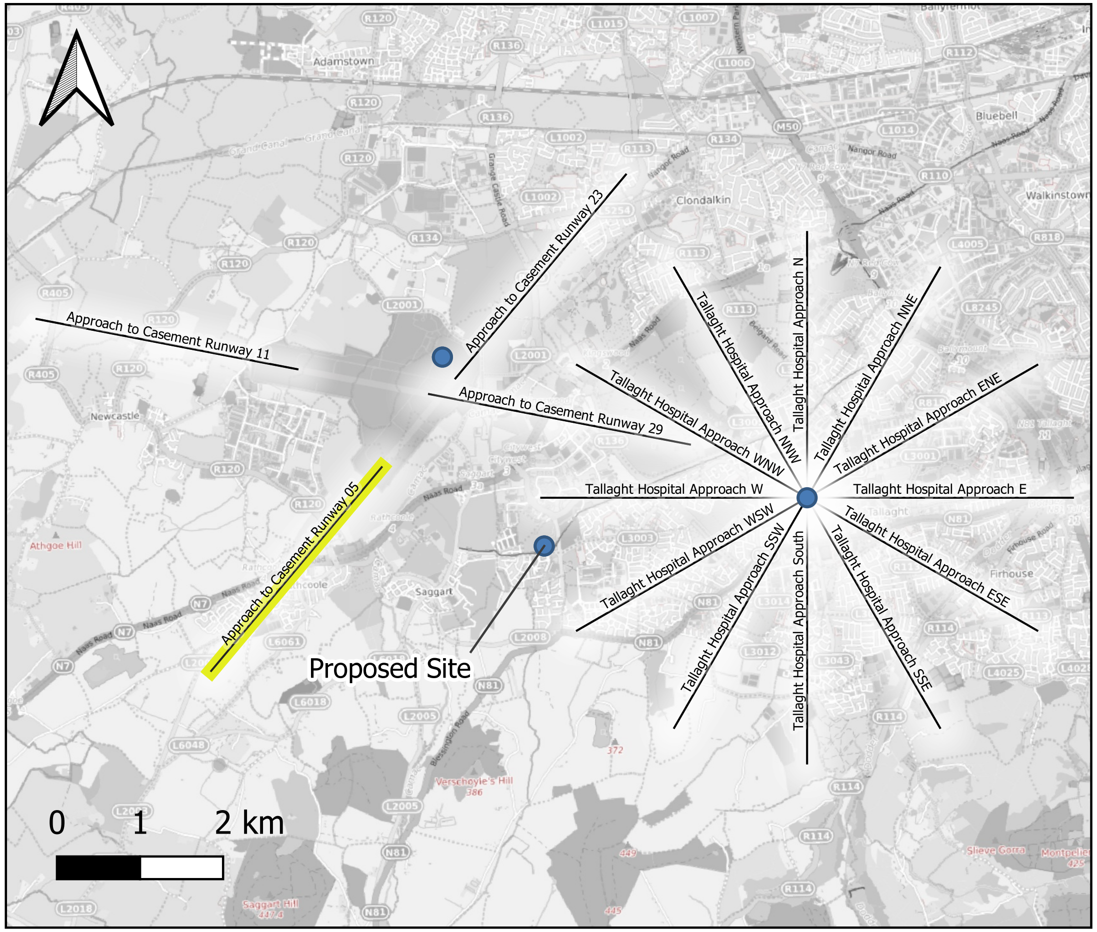
Distance from approach threshold to Proposed Site: 2284 metres

Bearing from approach threshold to Proposed Site: 152 degrees

Map 5 Potential Glint and Glare Impact on Approach to Casement Runway 05 as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location



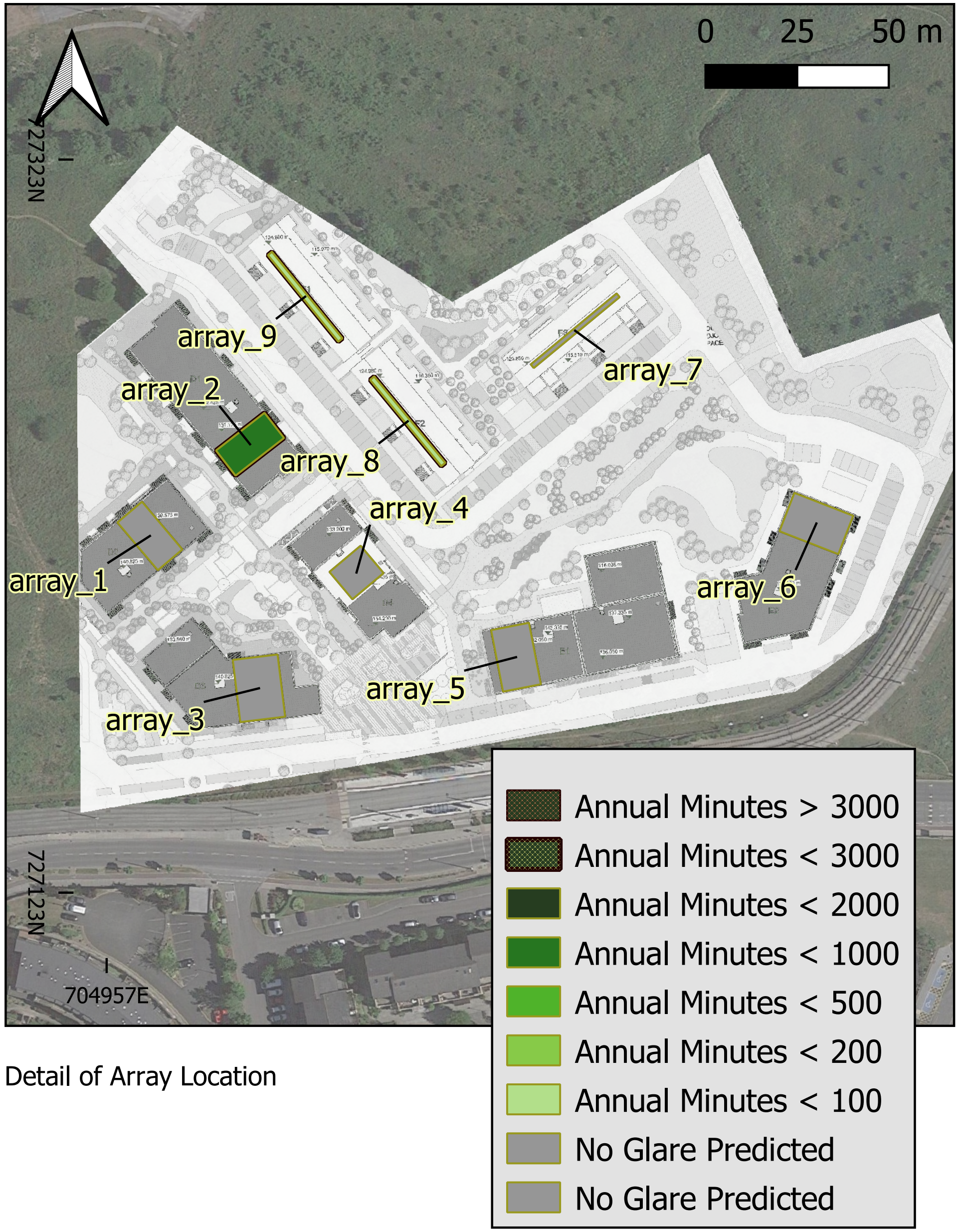
Approach to Casement Runway 05

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	17.6	20	1949	Green
array_3	15.5	20	1643	Green
array_4	NA	NA	NA	NA
array_5	14.8	20	1154	Green
array_6	17.7	21	2881	Green
array_7	NA	NA	NA	NA
array_8	18.1	20	1535	Green
array_9	20.6	23	1796	Green

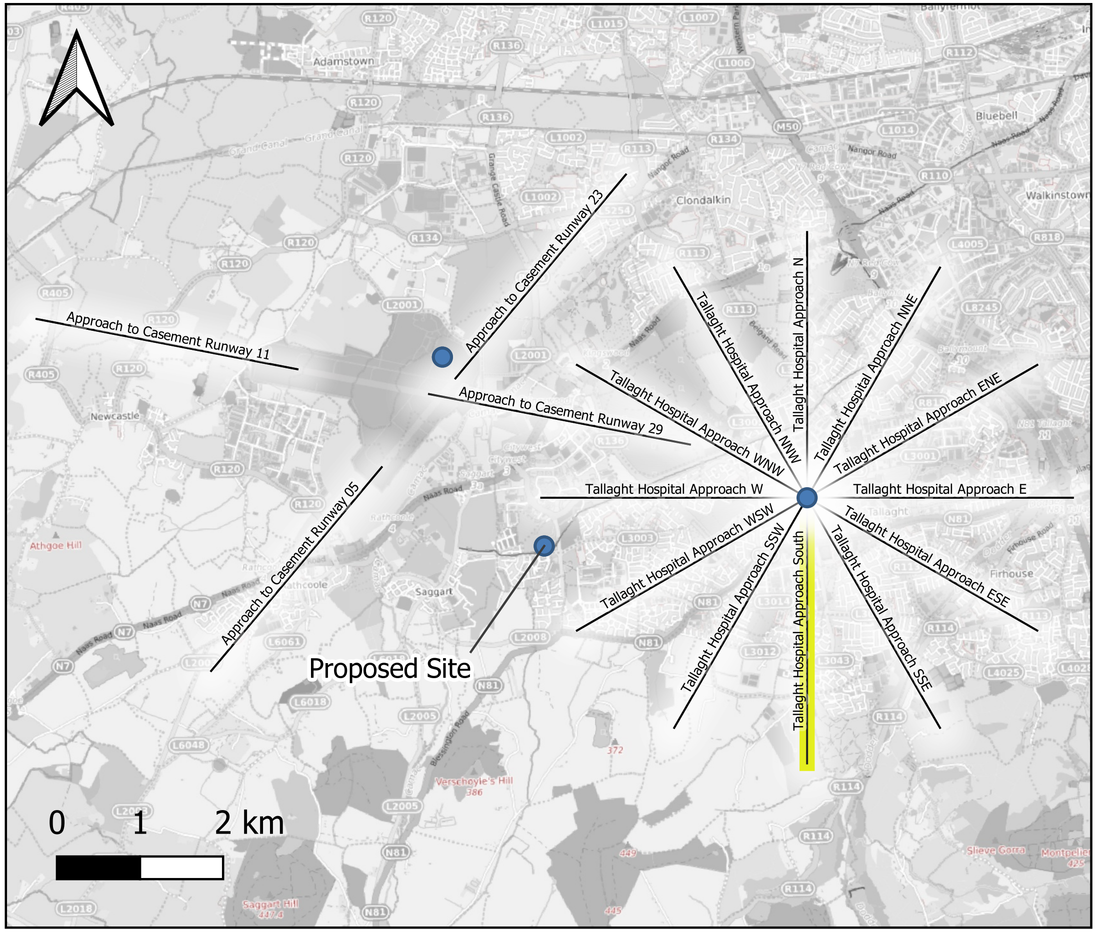
Distance from approach threshold to Proposed Site: 2175 metres

Bearing from approach threshold to Proposed Site: 116 degrees

Map 6 Potential Glint and Glare Impact on Tallaght Hospital Approach South as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location



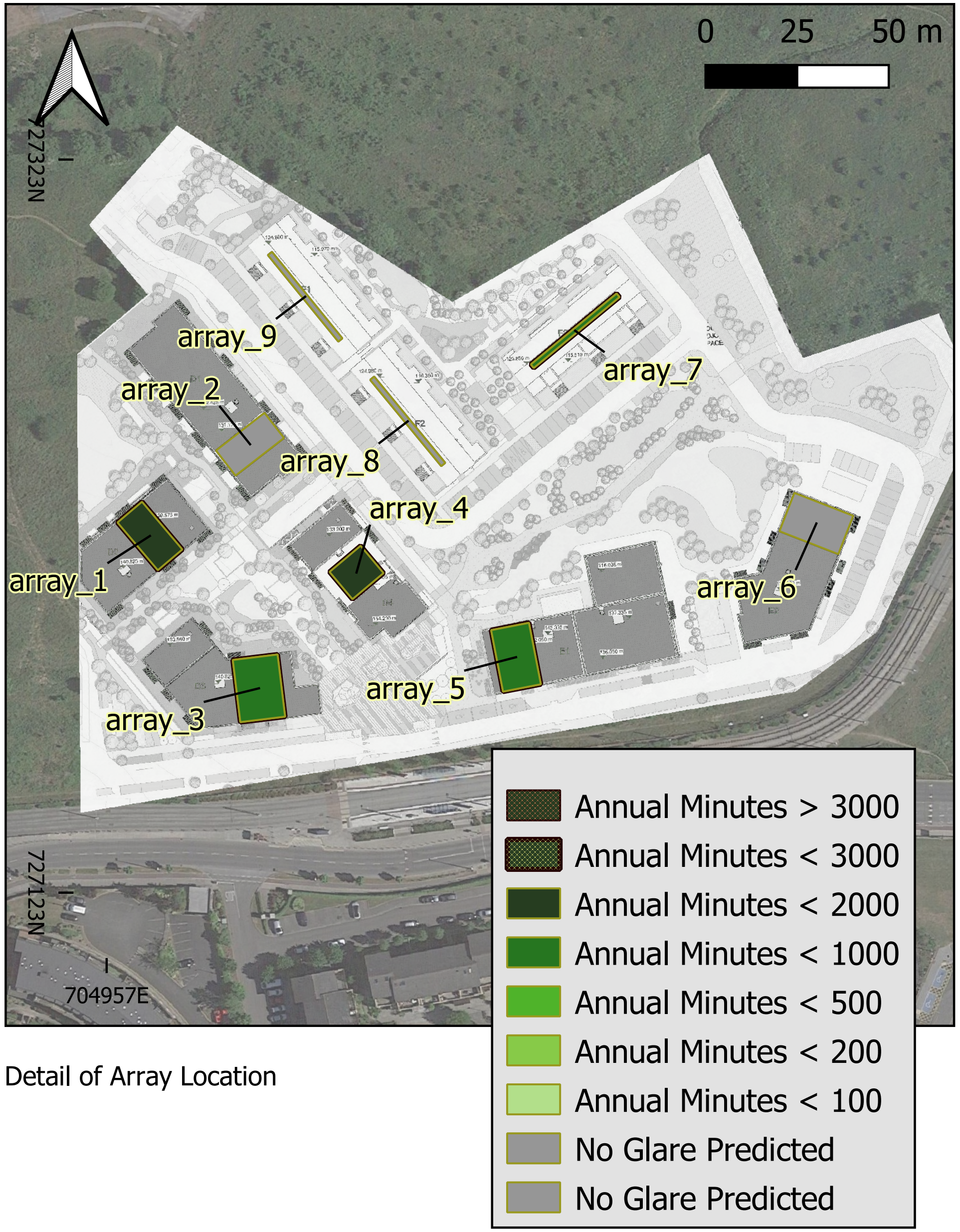
Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Tallaght Hospital Approach South

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	12.5	18	764	Green
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	2.1	3	39	Green
array_9	2.2	3	41	Green

Map 7 Potential Glint and Glare Impact on Tallaght Hospital Approach E as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

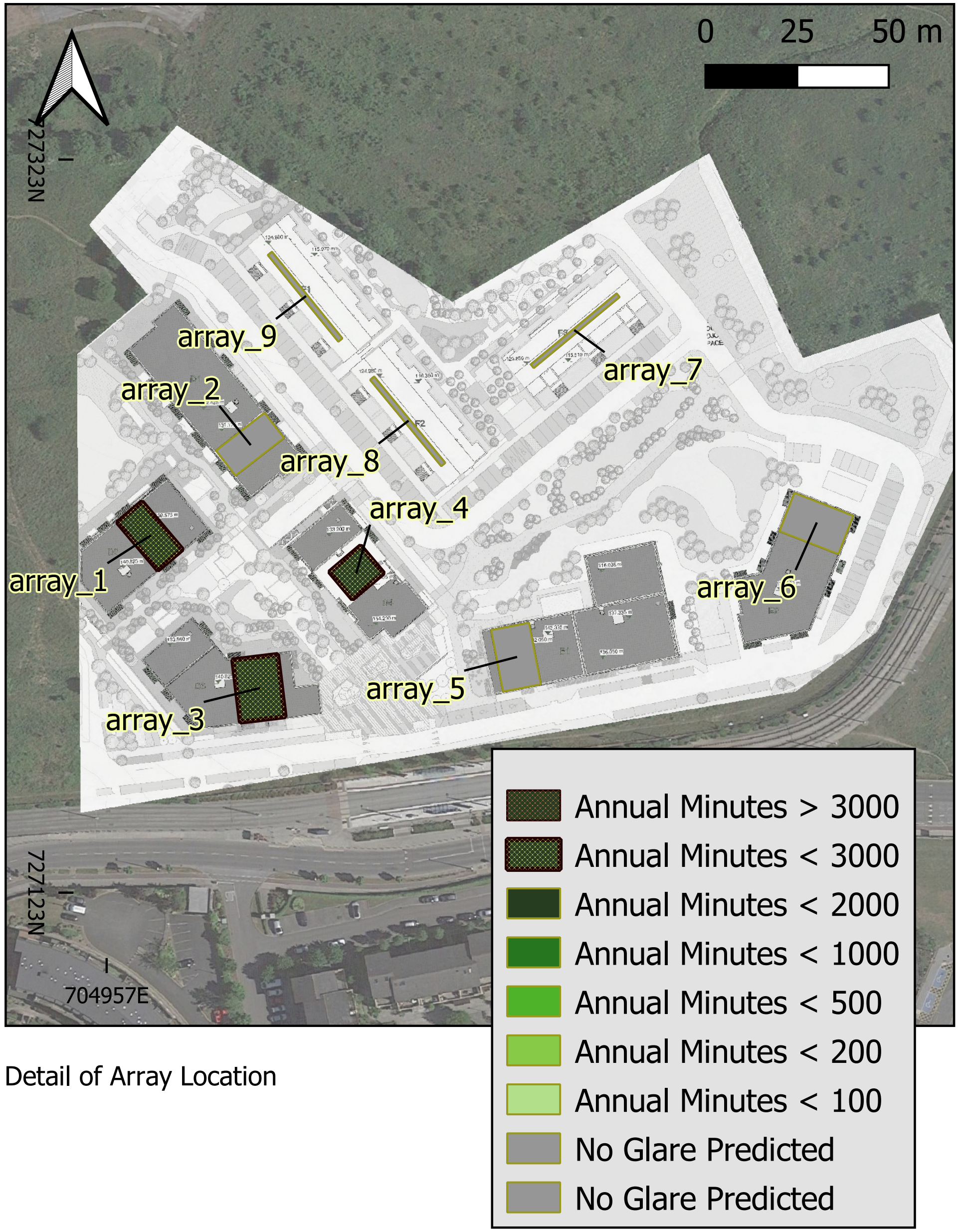
Tallaght Hospital Approach E

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	18	22	1060	Green
array_2	NA	NA	NA	NA
array_3	15	22	674	Green
array_4	18	22	1082	Green
array_5	16	22	782	Green
array_6	NA	NA	NA	NA
array_7	19.3	25	1025	Green
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

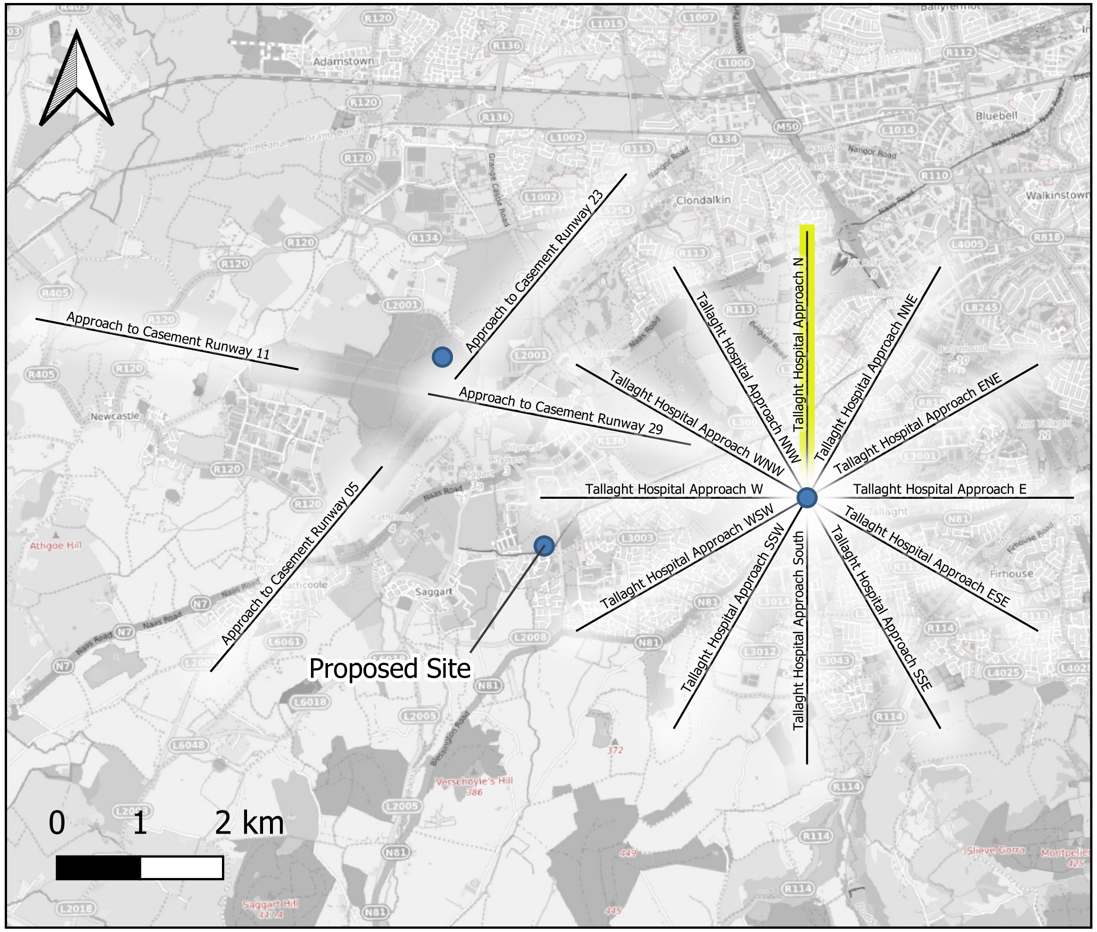
Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Map 8 Potential Glint and Glare Impact on Tallaght Hospital Approach N as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location



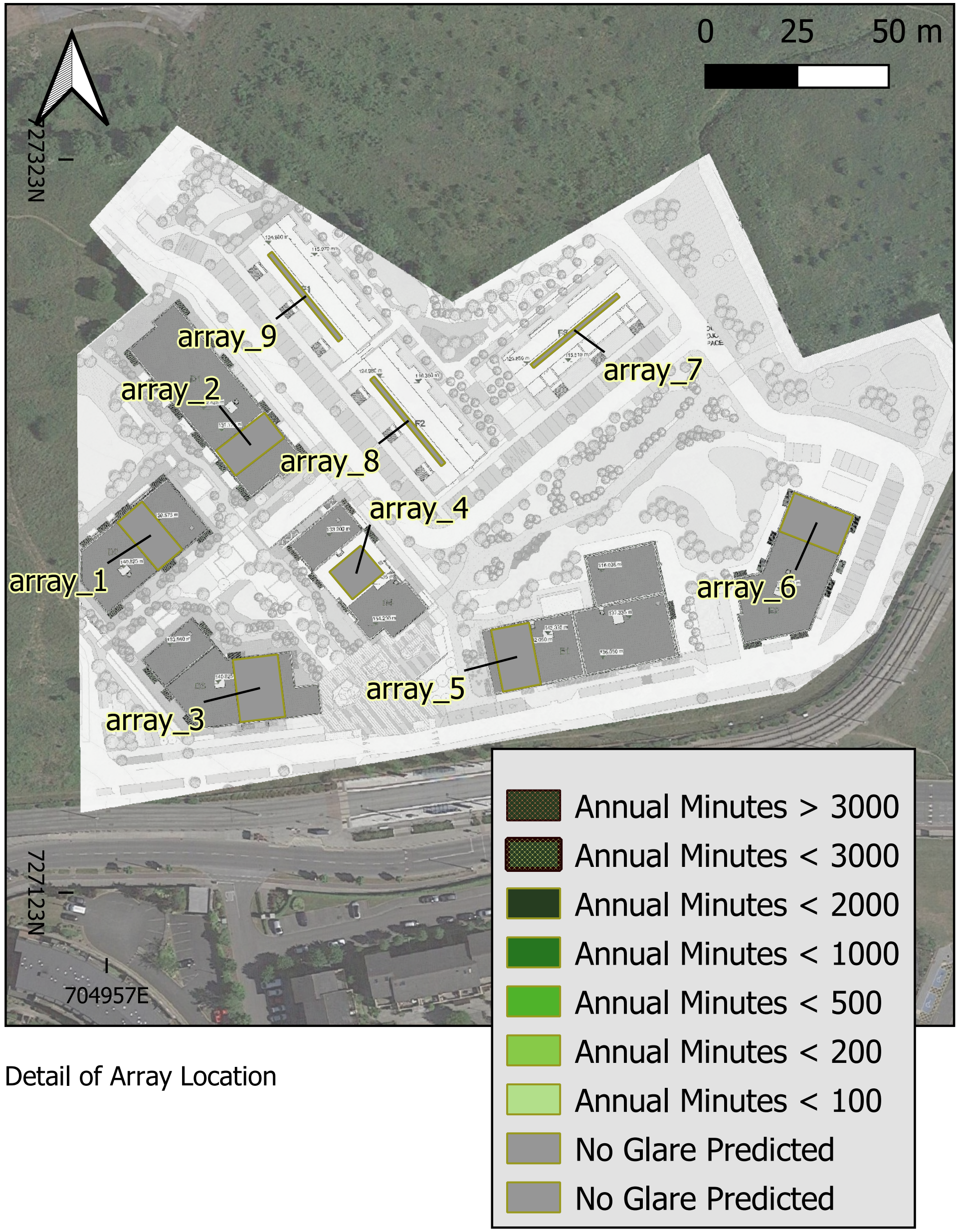
Tallaght Hospital Approach N

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	25.3	29	2298	Green
array_2	NA	NA	NA	NA
array_3	24.6	29	2163	Green
array_4	25.1	29	2186	Green
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Map 9 Potential Glint and Glare Impact on Tallaght Hospital Approach W as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

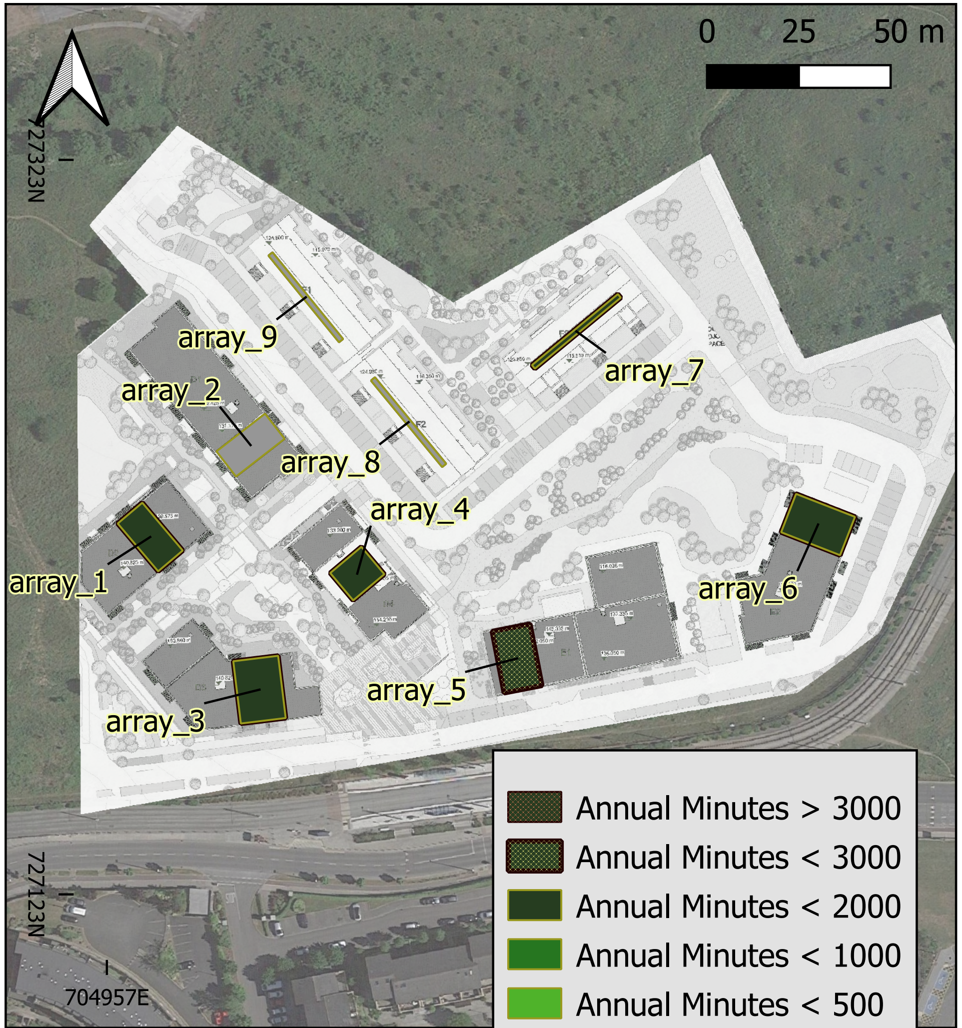
Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

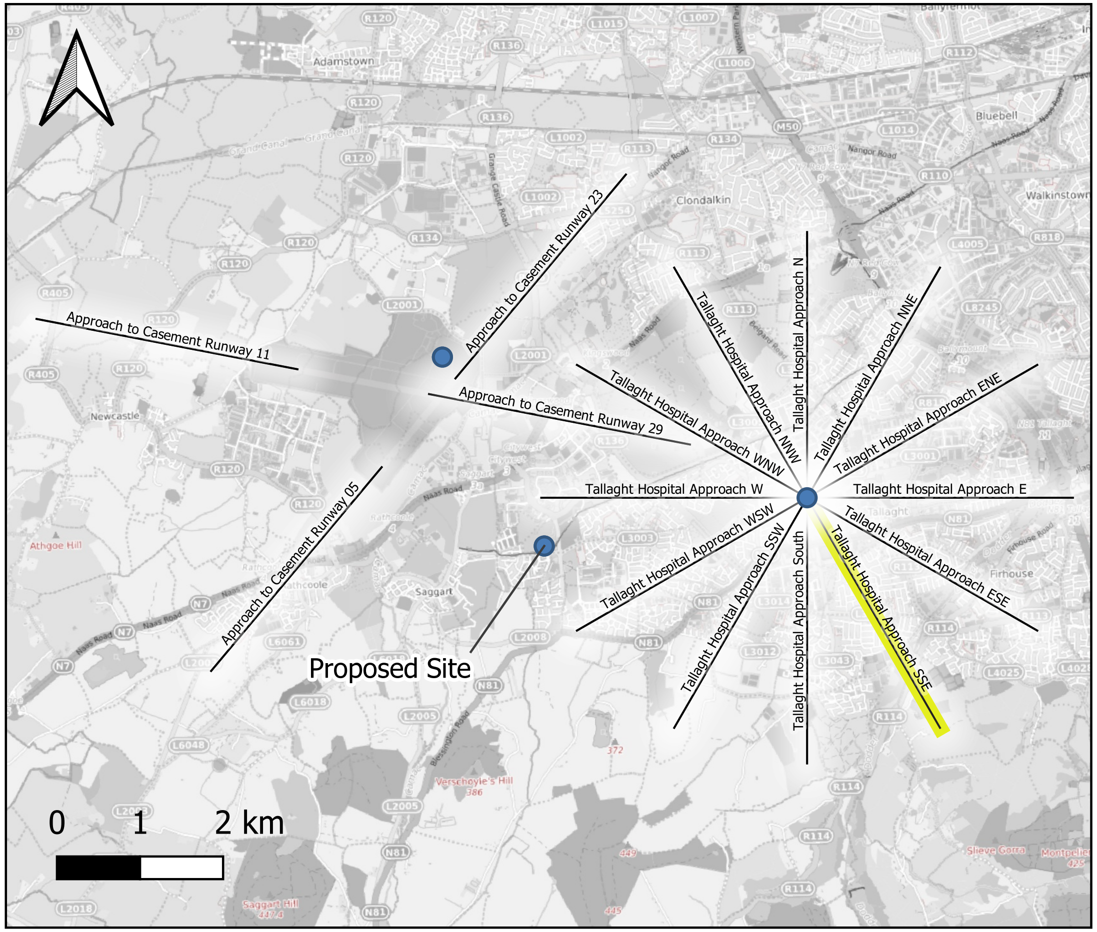
Tallaght Hospital Approach W

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	NA	NA	NA	NA
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Map 10 Potential Glint and Glare Impact on Tallaght Hospital Approach SSE as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location



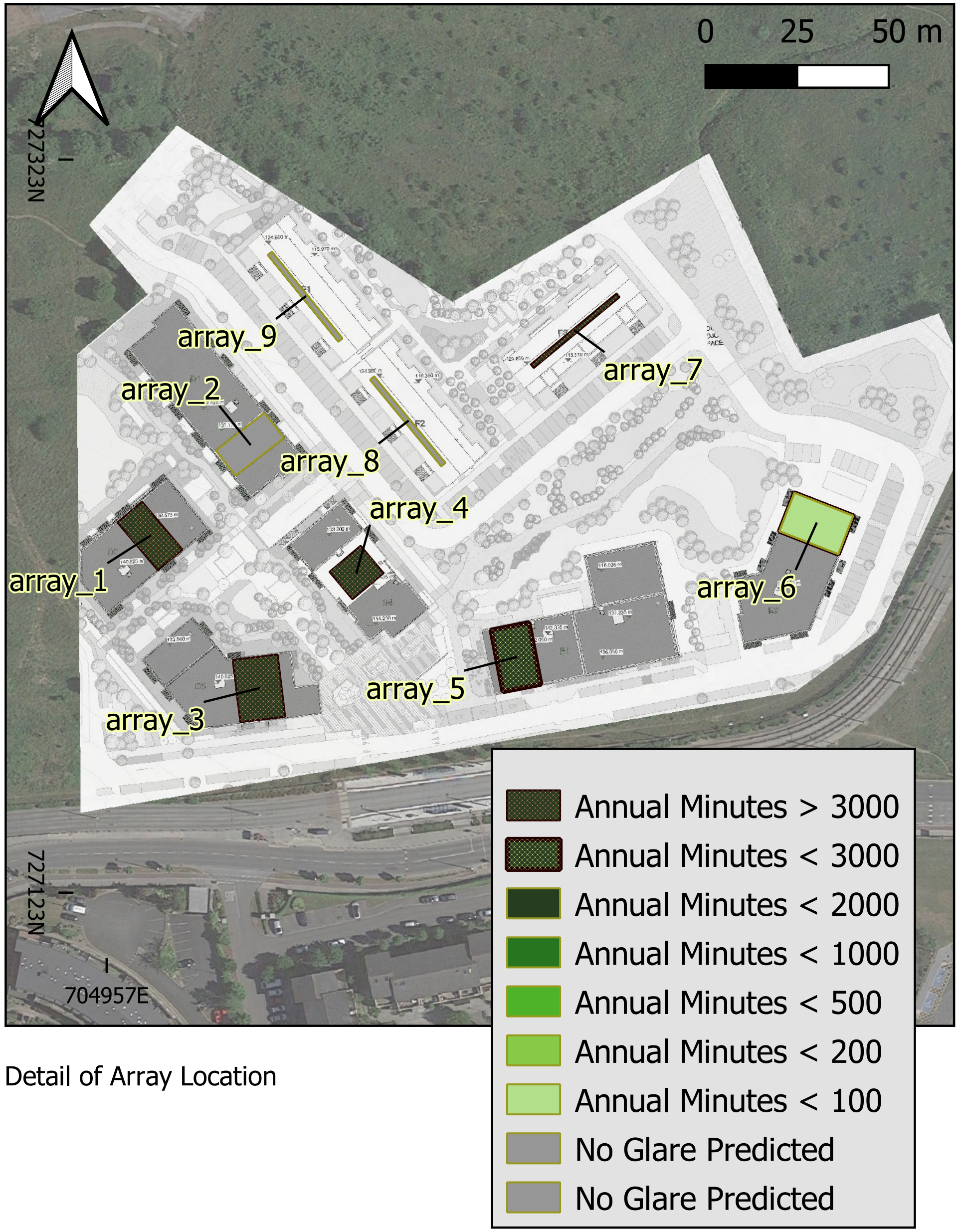
Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Tallaght Hospital Approach SSE

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	19	24	1254	Green
array_2	NA	NA	NA	NA
array_3	21.4	23	2870	Green
array_4	18.7	23	1293	Green
array_5	21.4	23	2678	Green
array_6	17.9	23	1935	Green
array_7	18.4	20	1291	Green
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Map 11 Potential Glint and Glare Impact on Tallaght Hospital Approach ESE as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

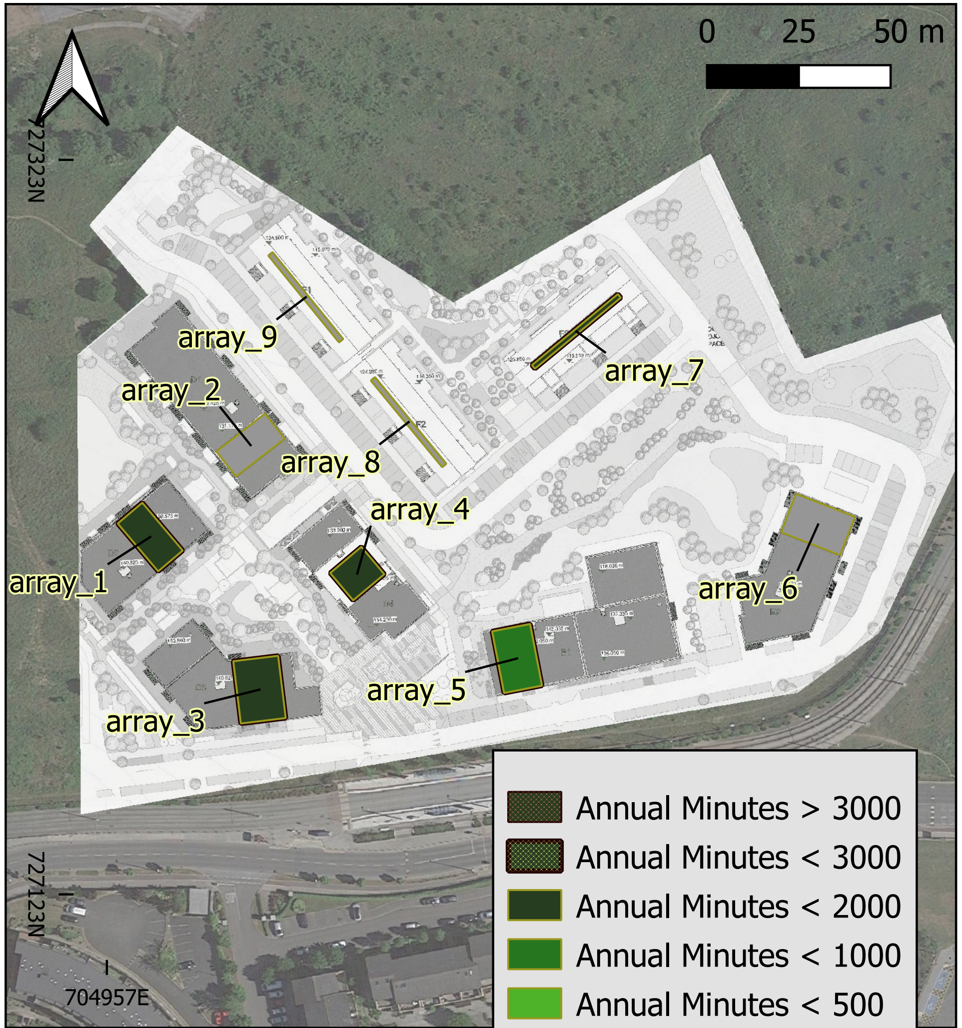
Tallaght Hospital Approach ESE

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	19.2	24	3285	Green
array_2	NA	NA	NA	NA
array_3	16.3	22	1878	Green
array_4	18.9	23	3296	Green
array_5	16.3	22	2051	Green
array_6	6.4	9	96	Green
array_7	17.6	21	3118	Green
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Distance from approach threshold to Proposed Site: 3218 metres

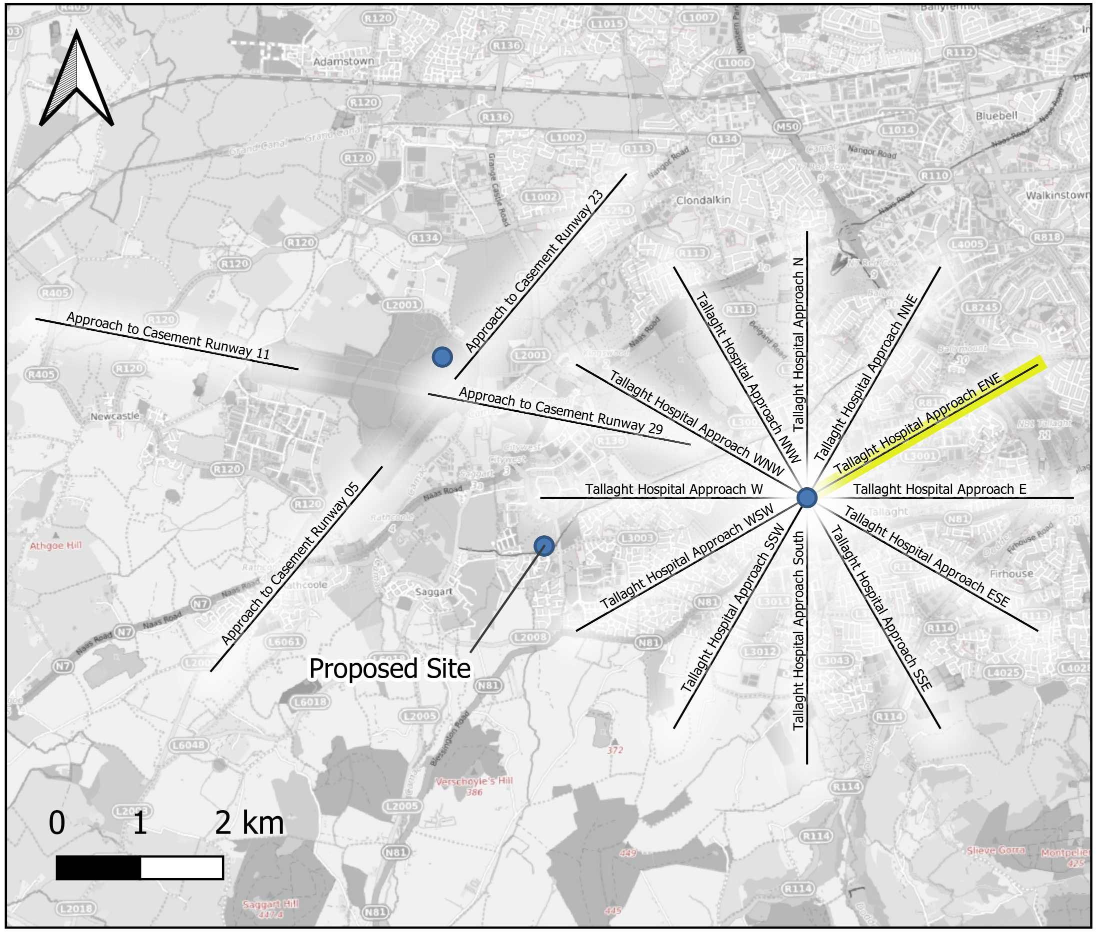
Bearing from approach threshold to Proposed Site: 260 degrees

Map 12 Potential Glint and Glare Impact on Tallaght Hospital Approach ENE as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Annual Minutes > 3000
Annual Minutes < 3000
Annual Minutes < 2000
Annual Minutes < 1000
Annual Minutes < 500
Annual Minutes < 200
Annual Minutes < 100
No Glare Predicted
No Glare Predicted

Detail of Array Location



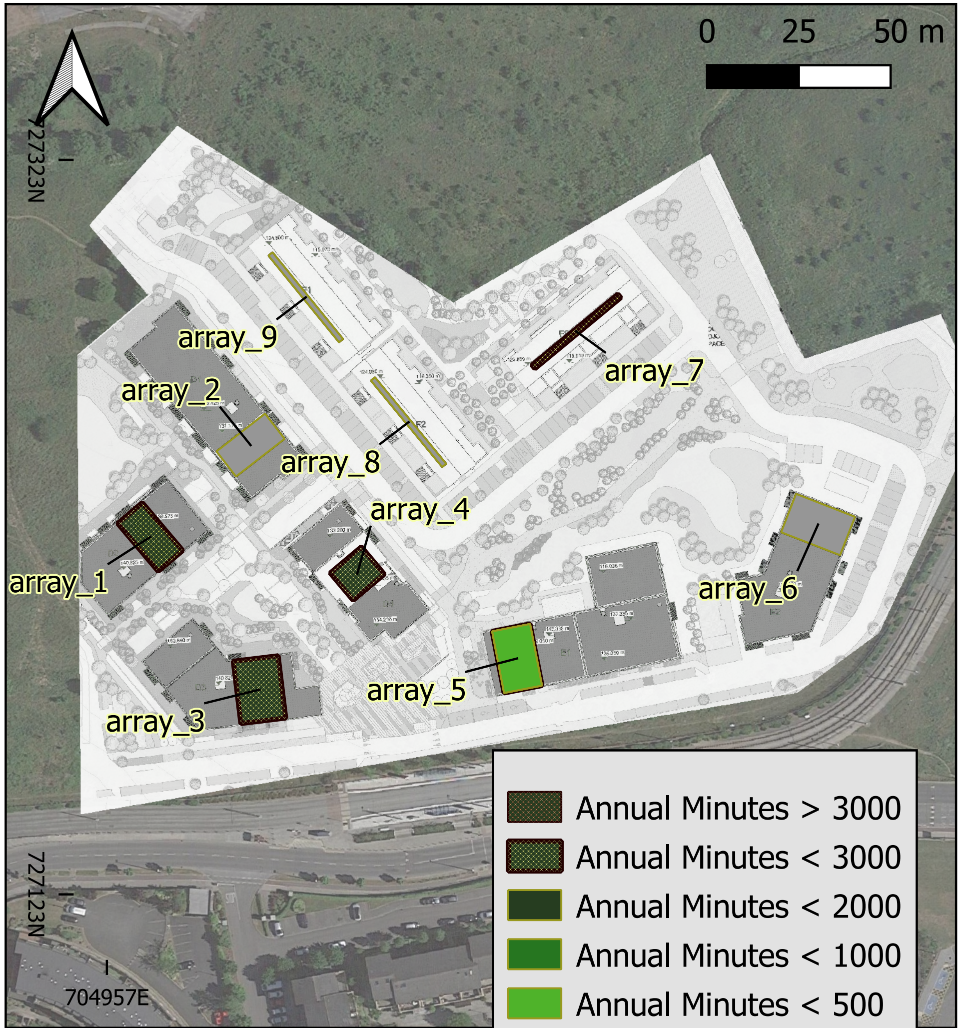
Tallaght Hospital Approach ENE

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	22.9	33	1396	Green
array_2	NA	NA	NA	NA
array_3	3.5	6	124	Green
array_4	22.5	32	1351	Green
array_5	12.1	19	728	Green
array_6	NA	NA	NA	NA
array_7	18	25	1348	Green
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Map 13 Potential Glint and Glare Impact on Tallaght Hospital Approach NNE as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

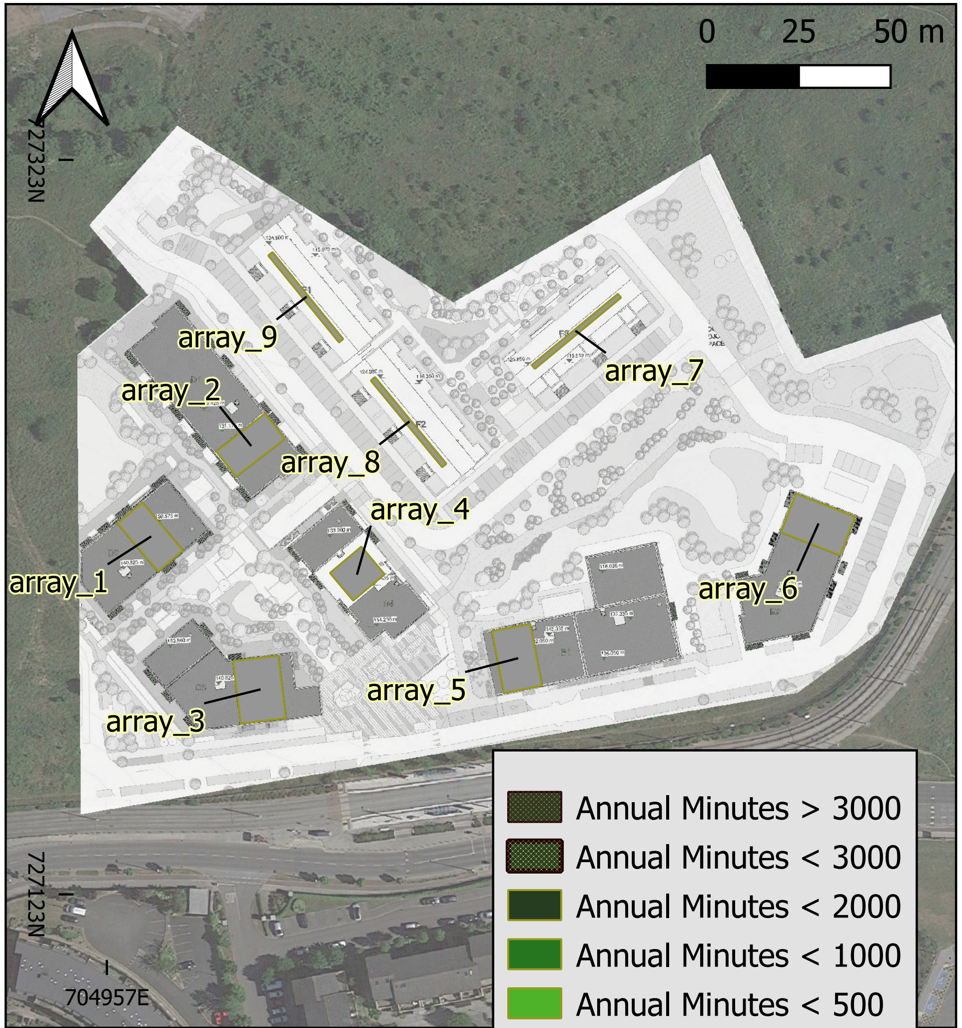
Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Tallaght Hospital Approach NNE

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	20.9	28	2701	Green
array_2	NA	NA	NA	NA
array_3	1	1	1	Green
array_4	20.4	27	2707	Green
array_5	5.2	10	259	Green
array_6	NA	NA	NA	NA
array_7	17.5	24	2856	Green
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Map 14 Potential Glint and Glare Impact on Tallaght Hospital Approach NNW as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

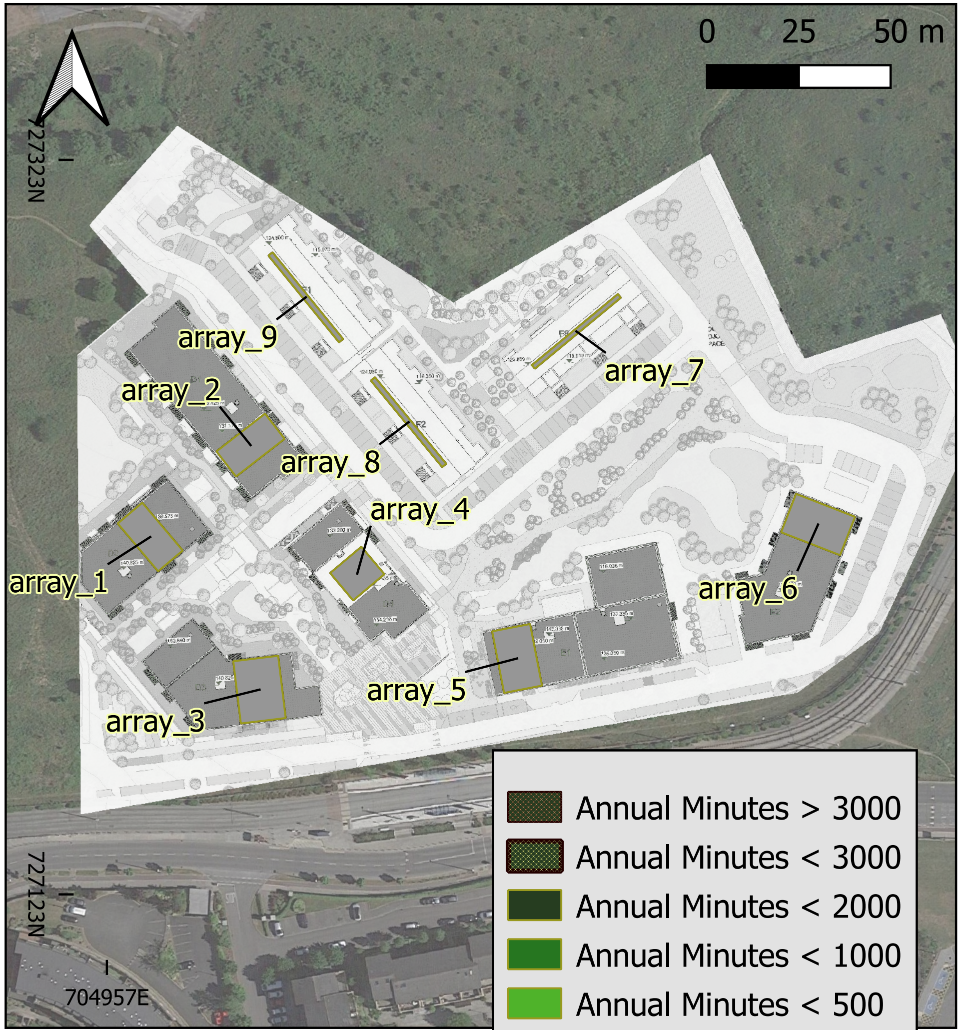
Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Tallaght Hospital Approach NNW

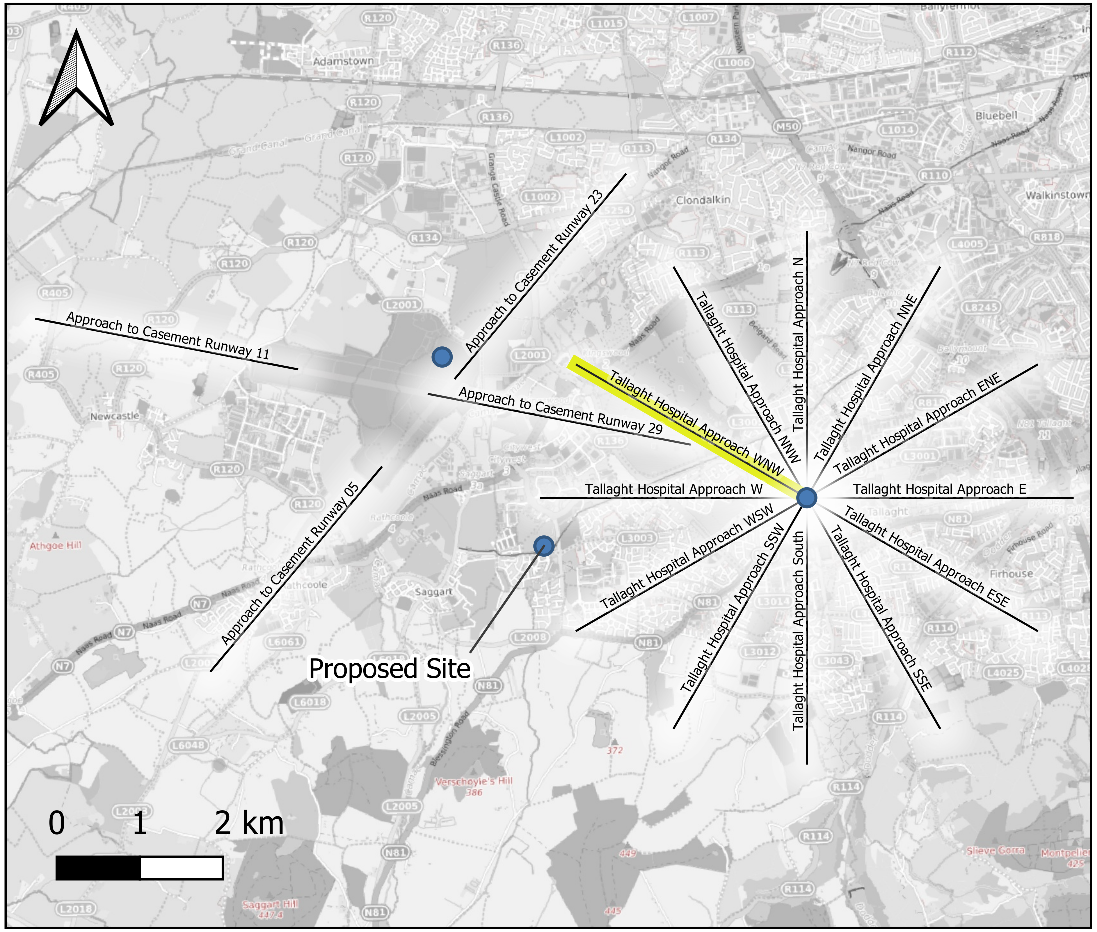
Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	NA	NA	NA	NA
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Map 15 Potential Glint and Glare Impact on Tallaght Hospital Approach WNW as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Annual Minutes > 3000
Annual Minutes < 3000
Annual Minutes < 2000
Annual Minutes < 1000
Annual Minutes < 500
Annual Minutes < 200
Annual Minutes < 100
No Glare Predicted
No Glare Predicted

Detail of Array Location



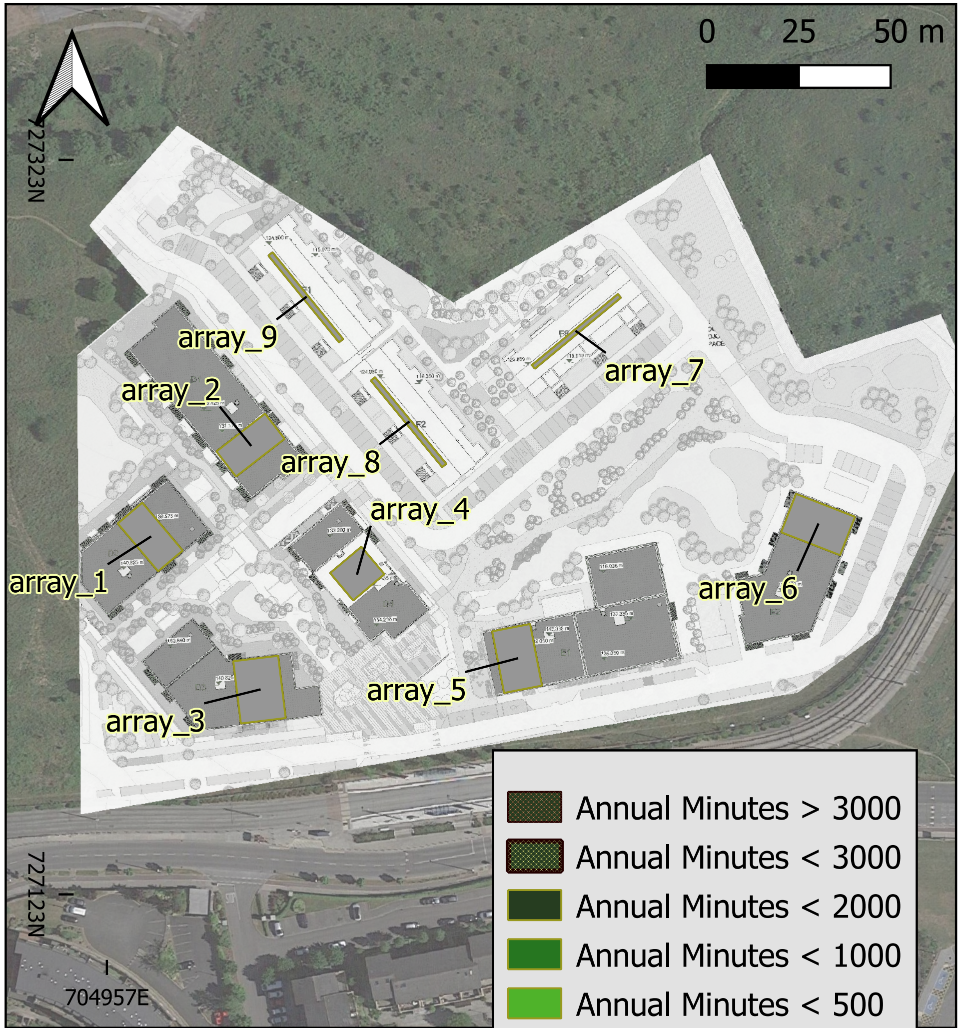
Tallaght Hospital Approach WNW

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	NA	NA	NA	NA
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Map 16 Potential Glint and Glare Impact on Tallaght Hospital Approach WSW as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



- Annual Minutes > 3000
- Annual Minutes < 3000
- Annual Minutes < 2000
- Annual Minutes < 1000
- Annual Minutes < 500
- Annual Minutes < 200
- Annual Minutes < 100
- No Glare Predicted
- No Glare Predicted

Detail of Array Location

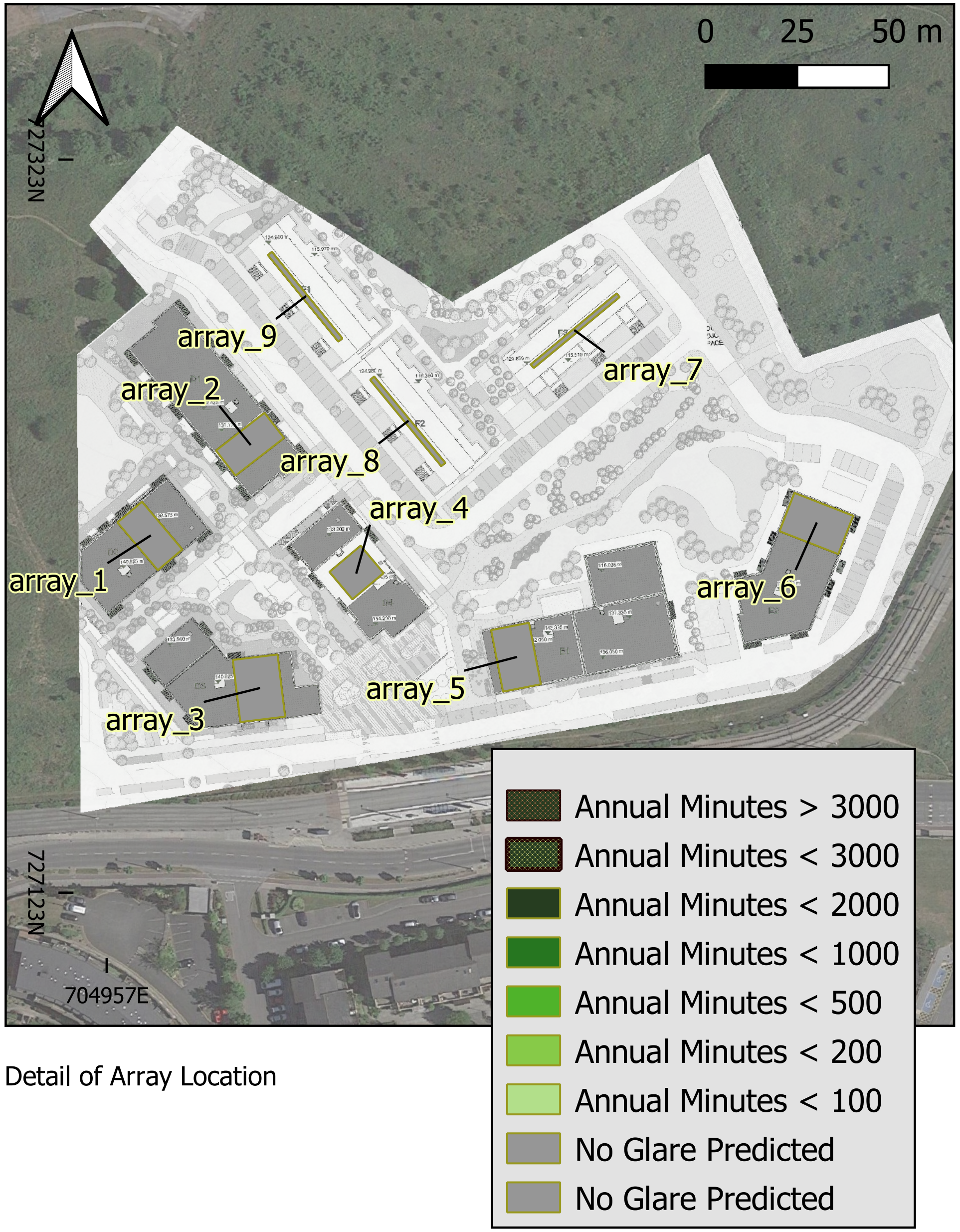
Tallaght Hospital Approach WSW

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	NA	NA	NA	NA
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

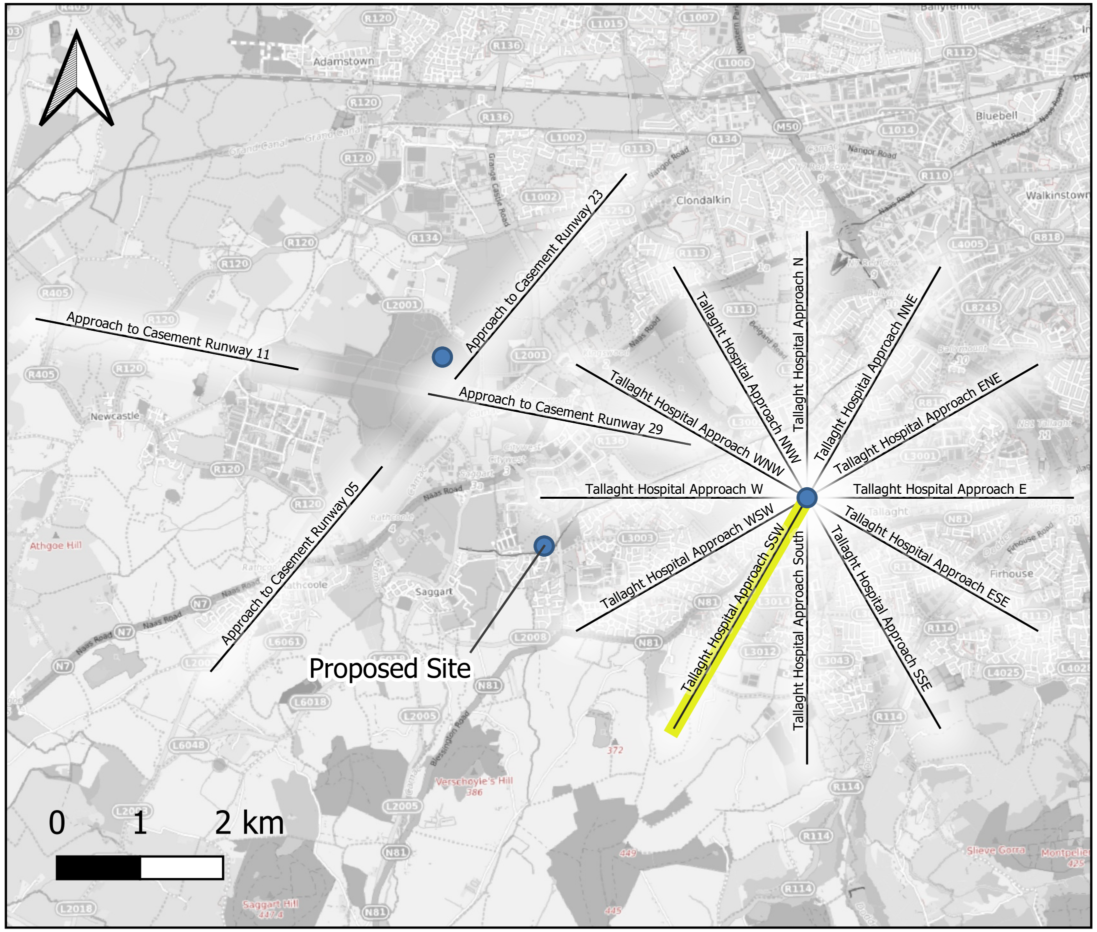
Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Map 17 Potential Glint and Glare Impact on Tallaght Hospital Approach SSW as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location



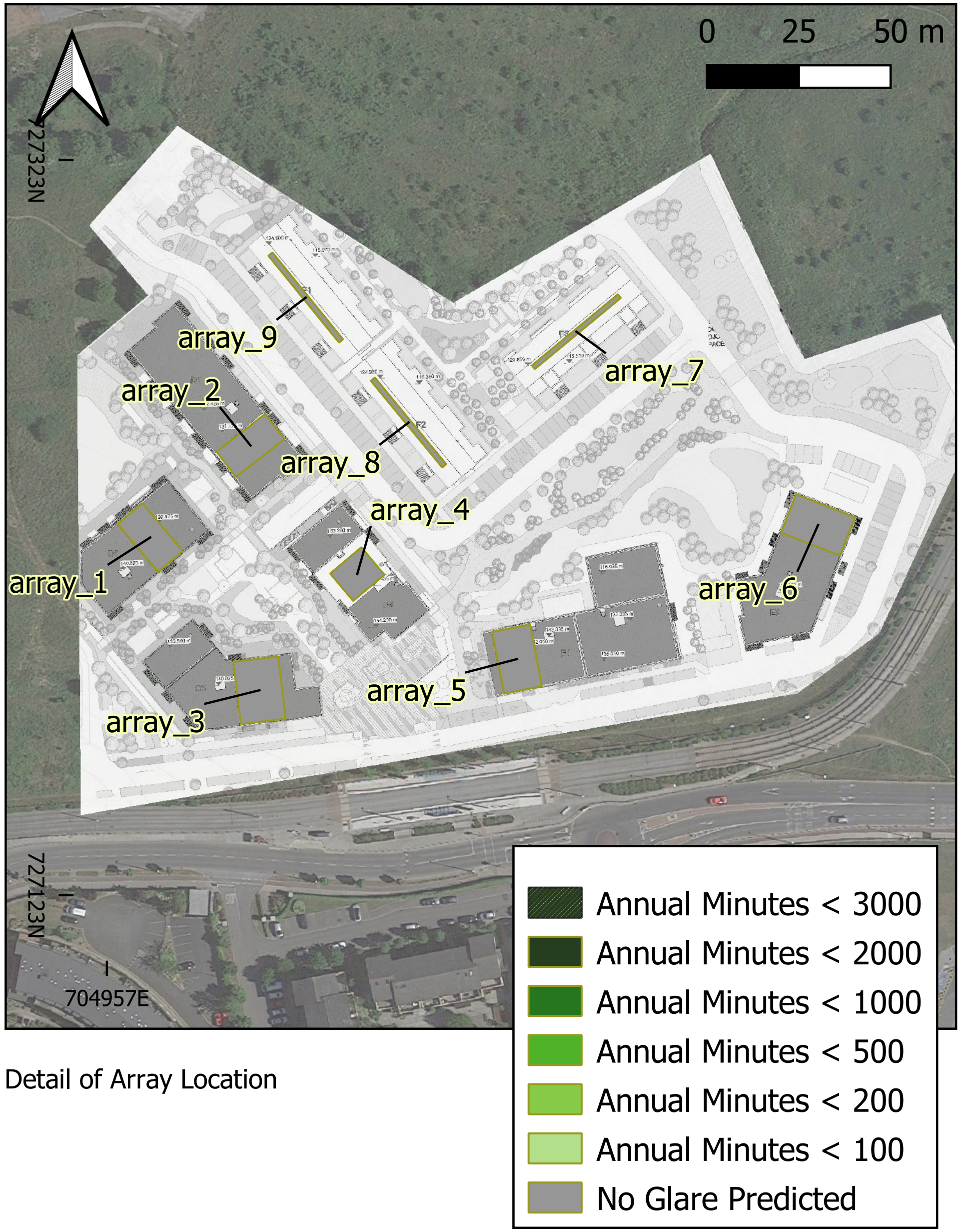
Tallaght Hospital Approach SSW

Array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
array_1	NA	NA	NA	NA
array_2	NA	NA	NA	NA
array_3	NA	NA	NA	NA
array_4	NA	NA	NA	NA
array_5	NA	NA	NA	NA
array_6	NA	NA	NA	NA
array_7	NA	NA	NA	NA
array_8	NA	NA	NA	NA
array_9	NA	NA	NA	NA

Distance from approach threshold to Proposed Site: 3218 metres

Bearing from approach threshold to Proposed Site: 260 degrees

Map 18 Potential Glint and Glare Impact on Casement ATC-T as a result of Roof Mounted PV Arrays at the proposed residential developments at Cooldown Commons Phase 3.



Detail of Array Location

Casement ATC-T

array	Average Daily Duration	Max Daily Duration	Max Annual Duration	Glare Result
Glare not geometrically possible at this array				

Distance from ATC Tower to Array: 2567 metres

Bearing from ATC Tower to Array: 152 degrees