Cambridge Waste Water Treatment Plant Relocation Project
Anglian Water Services Limited

Appendix 15.4: Glint and Glare Assessment

Application Document Reference: 5.4.15.4
PINS Project Reference: WW010003
APFP Regulation No. 5(2)a

Revision No. 01
April 2023

PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Anglian Water Services Limited

Cambridge Waste Water Treatment Plant Relocation





July 2022

ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	July 2022	Initial issue

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a solar photovoltaic (PV) development to be located near Horningsea, Cambridge, UK. The assessment pertains to the possible impact upon road safety, residential amenity, and aviation activity at Cambridge Airport.

Pager Power

Pager Power has undertaken over 850 glint and glare assessments in the UK, Europe and internationally. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders.

Conclusions

No significant impacts are predicted upon aviation activity at Cambridge Airport.

Further to proposed screening removing views of the reflecting panels, no impacts upon road safety or residential amenity are predicted. No further mitigation is recommended.

The assessment results are presented on the following page.

Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. The UK CAA guidance is relatively high-level and does not prescribe a formal methodology. A specific national guidance policy for determining the impact of glint and glare on road safety and residential amenity has not been produced to date. Pager Power has reviewed existing guidelines and the available studies in the process of defining its own glint and glare assessment guidance document and methodology[1]. This methodology defines a comprehensive process for determining the impact upon impact upon road safety, residential amenity, and aviation activity.

Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. For aviation activity, where a solar reflection is predicted, solar intensity calculations are undertaken in line with the Sandia National Laboratories' FAA methodology[2]. The scenario in which a solar reflection can occur for all receptors is then

[1] Pager Power Glint and Glare Guidance, Third Edition (3.1), April 2021.

[2] Formerly mandatory for on-airfield solar developments in the USA under the FAA's interim policy, superseded in 2021 with a policy that effectively requires individual airports to sign off on their on-airfield development as they see fit.

identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

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

Assessment Results – ATC Tower

No solar reflection is geometrically possible towards the ATC Tower.

No impact is predicted, and no mitigation is required.

Assessment Results – Runway Approaches 05 and 05G

No solar reflection is geometrically possible towards the runway approach paths 05 and 05G.

No impact is predicted, and no mitigation is required.

Assessment Results – Runway Approach 23

The analysis has shown that solar reflections are predicted towards the 2-mile runway approach path 23.

From the threshold to 1.2 miles from the threshold no solar reflection is geometrically possible.

From 1.2 to 1.4 miles from the threshold solar reflections are geometrically possible. Solar reflections are predicted to occur outside of a pilot's primary field of view (50 degrees either side of the approach bearing), which is acceptable considering the associated guidance (Appendix D).

From 1.4 miles to 2 miles from the threshold no solar reflections are geometrically possible. All glare intensities are no greater than 'low potential for temporary after-image', which is acceptable considering the associated guidance (Appendix D).

A low impact is predicted, and no mitigation is required.

Assessment Results – Runway Approach 23G

The analysis has shown that solar reflections are predicted towards the 2-mile runway approach path 23G.

From the threshold to 1.3 miles from the threshold no solar reflection is geometrically possible.

From 1.3 to 1.5 miles from the threshold solar reflections are geometrically possible. Solar reflections are predicted to occur outside of a pilot's primary field of view (50 degrees either

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

side of the approach bearing), which is acceptable considering the associated guidance (Appendix D).

From 1.5 miles to 2 miles from the threshold solar reflections are geometrically possible. All glare intensities are no greater than 'low potential for temporary after-image', which is acceptable considering the associated guidance (Appendix D).

A low impact is predicted, and no mitigation is required.

Assessment Results – Roads

For most of the assessed sections of the A14, the B1047 and Horningsea Road, where solar reflections are geometrically possible, screening in the form of existing vegetation and/or buildings will significantly obstruct the views of the reflecting panels. This means that observers will not experience solar reflections in practice. Furthermore, where there are gaps in existing screening, there is further screening in the form of proposed vegetation and/or terrain (proposed earth bund). Further to the proposed screening removing views of the reflecting panels, no impact is predicted. No further mitigation is recommended.

Assessment Results – Dwellings

For most of the surrounding dwellings where solar reflections are geometrically possible, screening in the form of existing vegetation will significantly obstruct the views of the reflecting panels. This means that observers will not experience solar reflections in practice. Furthermore, where there are gaps in existing screening, there is further screening in the form of proposed vegetation and/or terrain (proposed earth bund). Further to the proposed screening removing views of the reflecting panels, no impact is predicted. No further mitigation is recommended.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 51 countries within Europe, Africa, America, Asia and Australasia.

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

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

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

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

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

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from a solar photovoltaic (PV) elements of the proposed Waste Water Treatment Plant (WWTP) to be located near Horningsea, Cambridge, UK. The assessment pertains to the possible impact upon road safety, residential amenity, and aviation activity at Cambridge Airport.

This report contains the following:

- Solar development details.
- Explanation of glint and glare.
- Overview of relevant guidance.
- Overview of relevant studies.
- Overview of Sun movement.
- Assessment methodology.
- Identification of receptors.
- Glint and glare assessment for identified receptors.
- Results discussion.

1.2 Pager Power's Experience

Pager Power has undertaken over 850 glint and glare assessments in the UK, Europe and internationally. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders.

1.3 Glint and Glare Definition

The definition of glint and glare is as follows[4]:

- Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors.
- Glare – a continuous source of bright light typically received by static receptors or from large reflective surfaces.

The term 'solar reflection' is used in this report to refer to both reflection types i.e. glint and glare.

[4] These definitions are aligned with those of the Draft National Policy Statement for Renewable Energy Infrastructure and the Federal Aviation Administration (FAA) in the United States of America.

2 PROPOSED DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layout Plan

Figures 1 and 2[5] below and on the following page show the site layout plans. The black arched areas to the north of the site, within Figure 1, denote the ground mounted solar panel locations. Blue rectangular labelled areas shown within Figure 2 denote the location of the carport and rooftop solar panel locations.

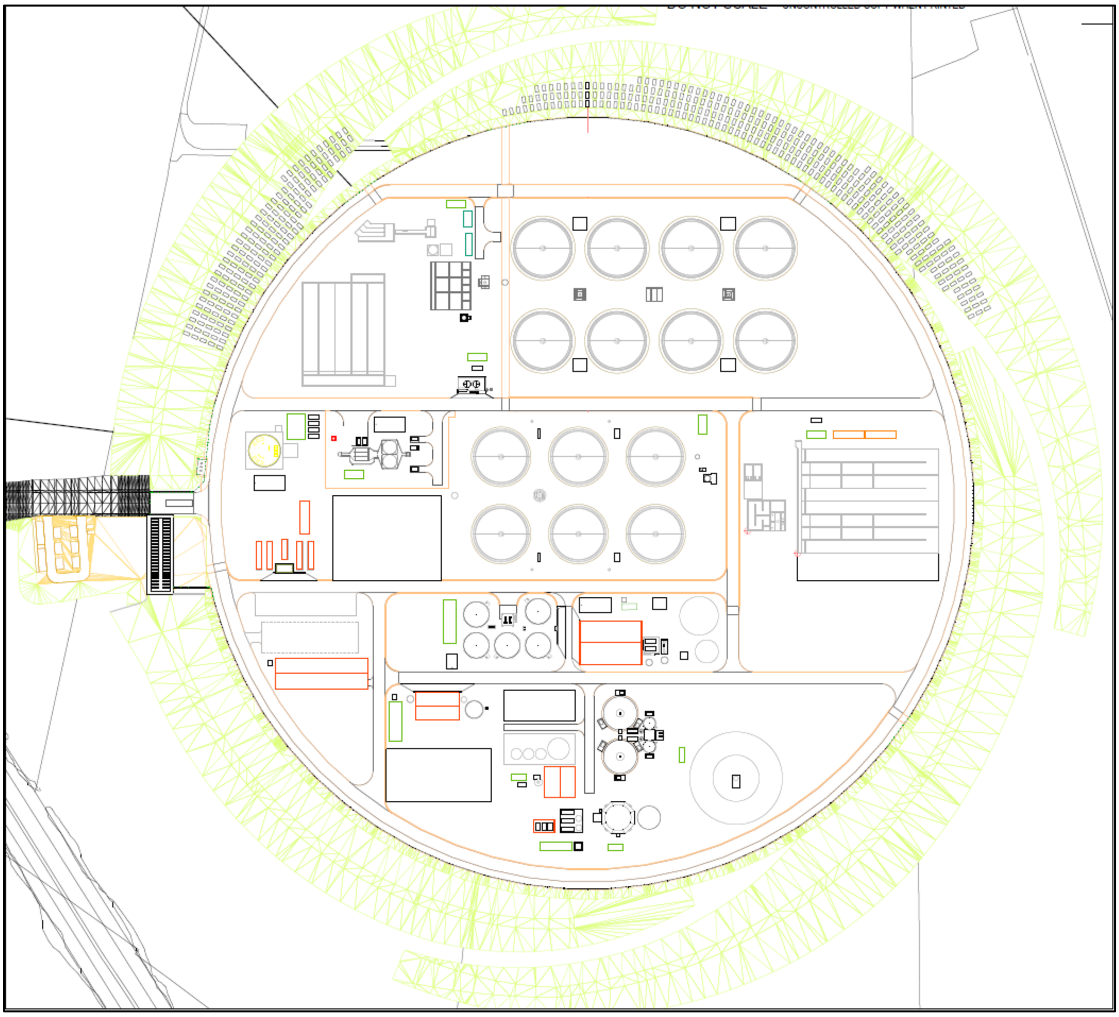


Figure 1 *Proposed WWTP layout plan – ground mounted solar panels*

[5] Source: Glint and glare PV layout 2.pdf

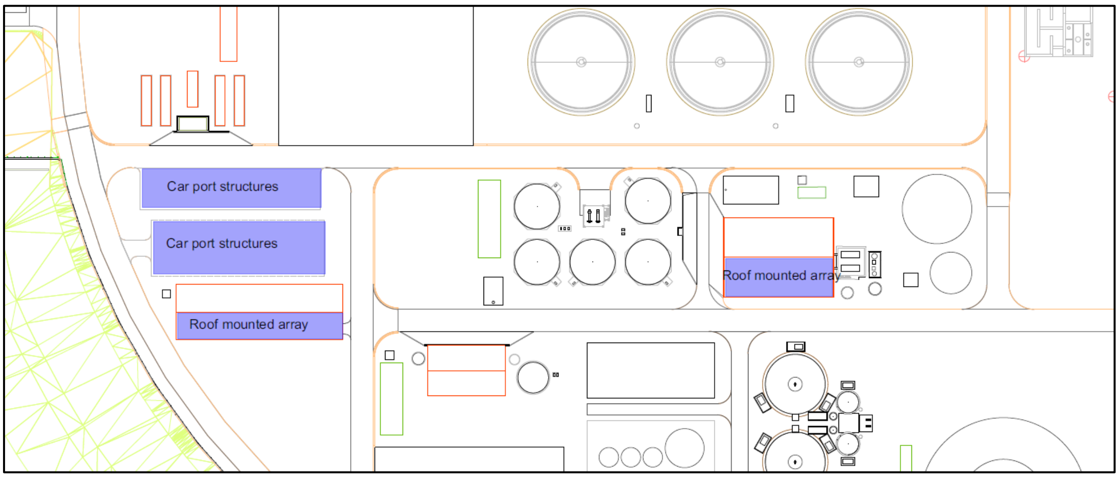


Figure 2 *Proposed WWTP site layout plan – carport and rooftop mounted solar panels*

2.2 Landscape Strategy Plan

The landscape strategy for the site is detailed in Figures 3[6] and 4[7] on the following pages. The ground mounted panels are to be located on a new 'bund' of terrain, approximately 5m above the existing ground level, as shown within Figure 4.

[6] Source: 775_01 (MP)003 Landscape Masterplan WWTP I11.pdf

[7] Source: 00001-100006-CAMEST-ZZZ-LAY-C-4025 Work in progress.pdf

Figure 3 *Landscape Strategy Plan*

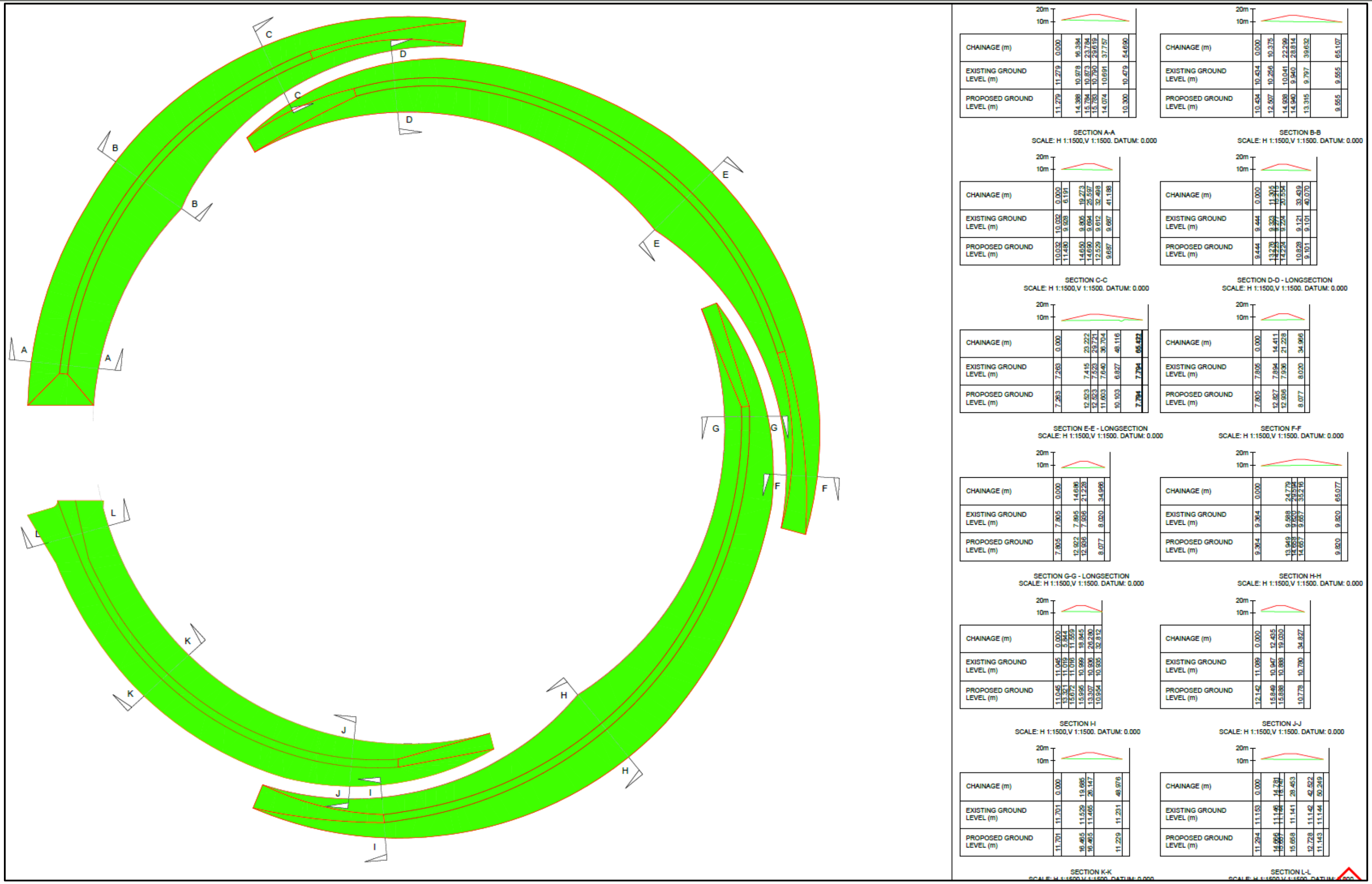


Figure 4 *New Earth Bund*

2.3 Landscape Strategy Plan Key Details – Aerial Imagery

The landscape strategy indicates the location of proposed vegetation and new terrain (earth 'bund') screening. Whilst not a full review, the following key details are:

- Proposed areas of woodland (dark green outline areas).
- Earth bund at a height of approximately 5m above ground level (black outline areas).
- Native hedgerow and trees (light green outline areas on top of earth bund) to be maintained at 5m to 6m in height.
- Other key areas of proposed hedgerow and trees (light green outline areas).
- Existing retained hedgerow adjacent to the A14 (as indicated within Figure 5).

Key details of the landscape strategy are shown in Figure 5 on the following page. The location of proposed vehicular route (grey outlined area) and modelled panel areas (blue outlined areas, see Section 6 for further details) are shown within Figure 5 for reference.

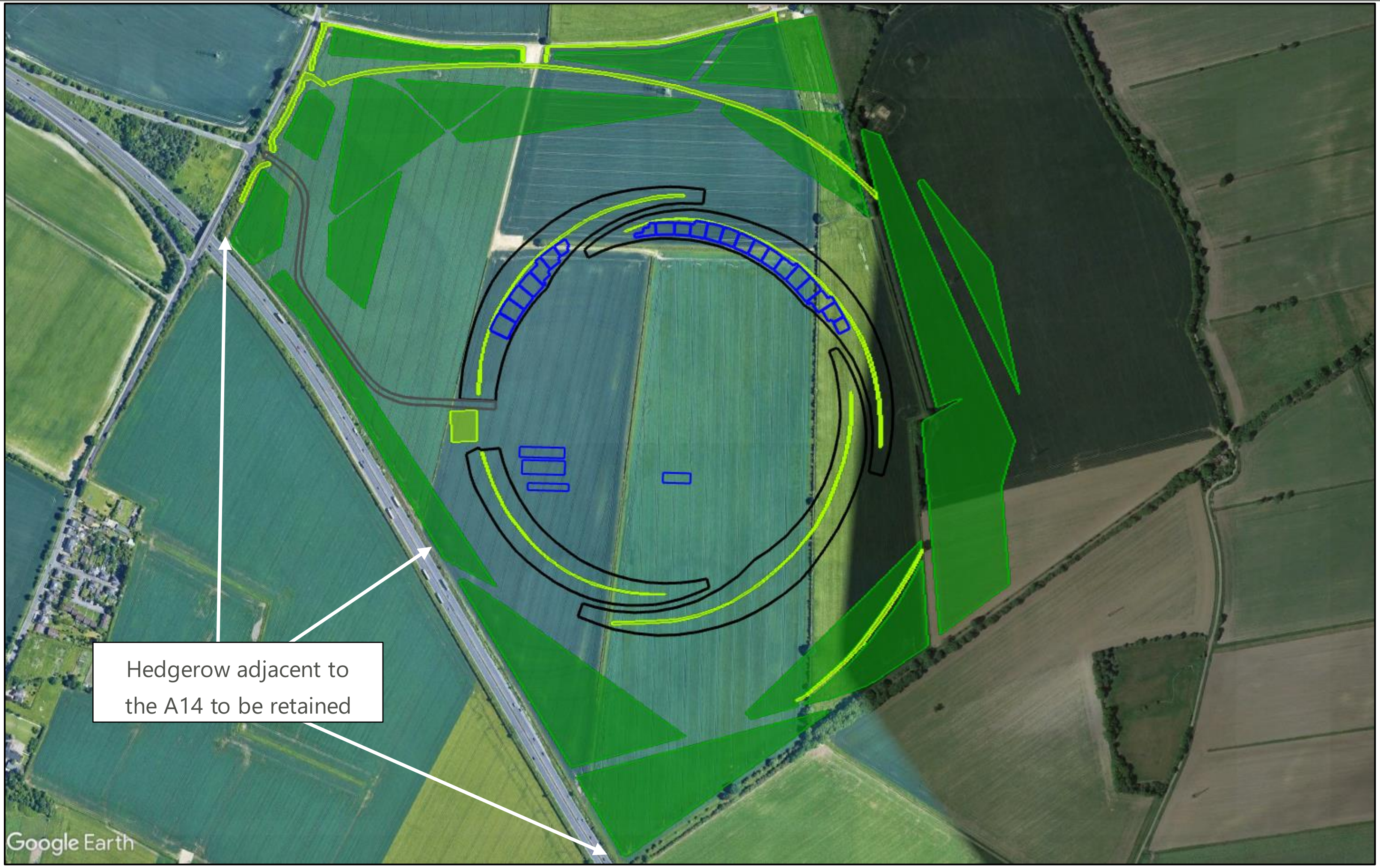


Figure 5 *Landscape Strategy Plan Key Details – aerial image*

3 CAMBRIDGE AIRPORT DETAILS

3.1 Overview

The following section presents general details regarding Cambridge Airport.

3.2 Airport Information

Cambridge Airport is a Civil Aviation Authority (CAA) licensed aerodrome.

3.3 Runway Details

Cambridge Airport has two runways, the details of which are presented below:

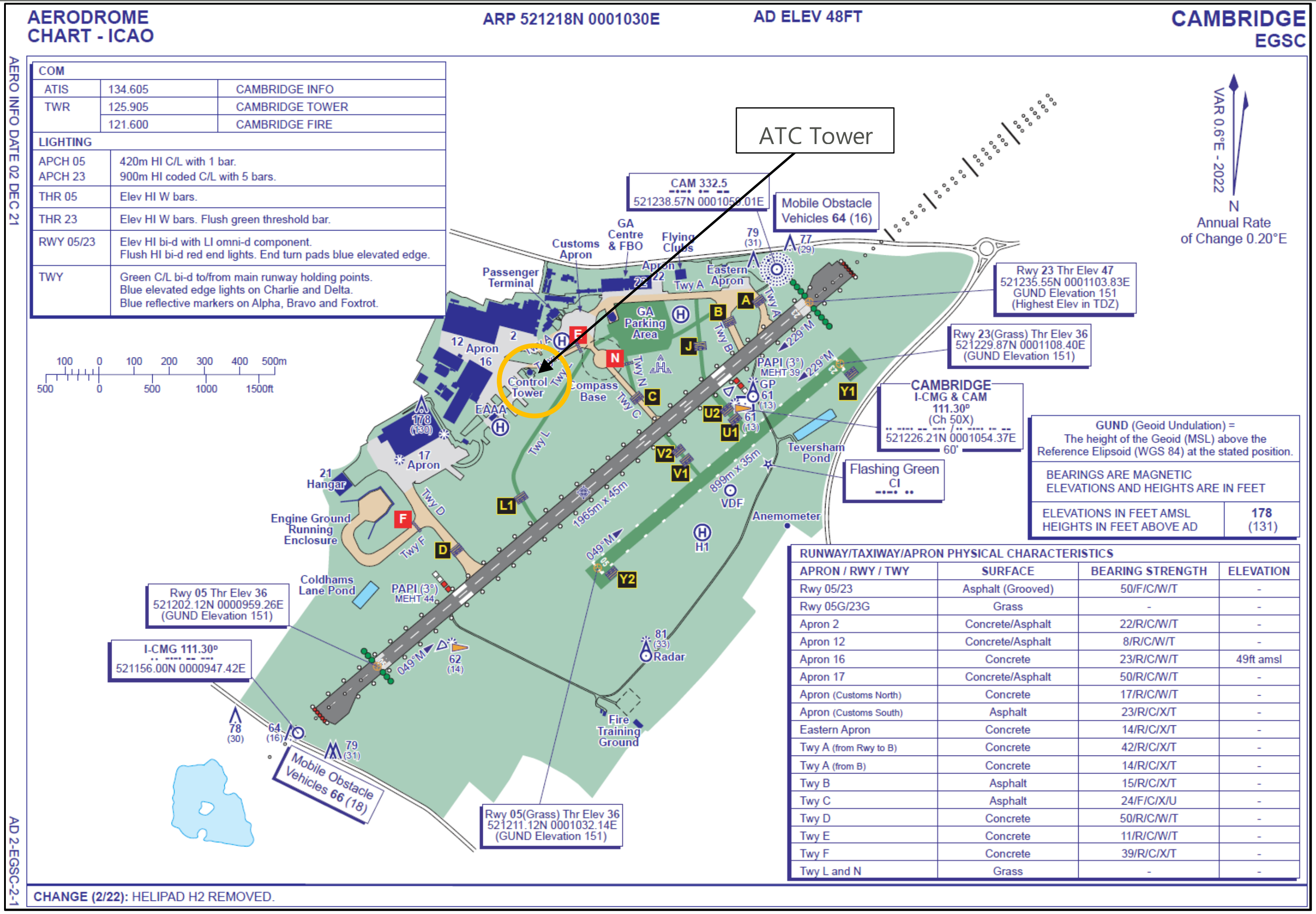
- 05/23 measuring 1,965m by 45m (asphalt).
- 05G/23G measuring 899m by 35m (grass).

The runway is shown on the aerodrome chart in Figure 6[8] on the following page.

3.4 Air Traffic Control Tower

The Air Traffic Control Tower (ATC Tower) is located approximately 365m to the north northwest of the midpoint of runway 05/23 and is highlighted by the orange circle in Figure 6 on the following page.

[8] Source: NATS AIP.



COM		
ATIS	134.605	CAMBRIDGE INFO
TWR	125.905	CAMBRIDGE TOWER
	121.600	CAMBRIDGE FIRE
LIGHTING		
APCH 05 / APCH 23	420m HI C/L with 1 bar. 900m HI coded C/L with 5 bars.	
THR 05	Elev HI W bars.	
THR 23	Elev HI W bars. Flush green threshold bar.	
RWY 05/23	Elev HI bi-d with LI omni-d component. Flush HI bi-d red end lights. End turn pads blue elevated edge.	
TWY	Green C/L bi-d to/from main runway holding points. Blue elevated edge lights on Charlie and Delta. Blue reflective markers on Alpha, Bravo and Foxtrot.	

RUNWAY/TAXIWAY/APRON PHYSICAL CHARACTERISTICS

APRON / RWY / TWY	SURFACE	BEARING STRENGTH	ELEVATION
Rwy 05/23	Asphalt (Grooved)	50/F/C/W/T	-
Rwy 05G/23G	Grass	-	-
Apron 2	Concrete/Asphalt	22/R/C/W/T	-
Apron 12	Concrete/Asphalt	8/R/C/W/T	-
Apron 16	Concrete	23/R/C/W/T	49ft amsl
Apron 17	Concrete/Asphalt	50/R/C/W/T	-
Apron (Customs North)	Concrete	17/R/C/W/T	-
Apron (Customs South)	Asphalt	23/R/C/X/T	-
Eastern Apron	Concrete	14/R/C/X/T	-
Twy A (from Rwy to B)	Concrete	42/R/C/X/T	-
Twy A (from B)	Concrete	14/R/C/X/T	-
Twy B	Asphalt	15/R/C/X/T	-
Twy C	Asphalt	24/F/C/X/U	-
Twy D	Concrete	50/R/C/W/T	-
Twy E	Concrete	11/R/C/W/T	-
Twy F	Concrete	39/R/C/X/T	-
Twy L and N	Grass	-	-

Figure 6 *Cambridge Airport Aerodrome Chart*

4 GLINT AND GLARE ASSESSMENT METHODOLOGY

4.1 Guidance and Studies

Appendices A and B present a review of relevant guidance and independent studies with regard to glint and glare issues from solar panels. The overall conclusions from the available studies are as follows:

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

4.2 Background

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

4.3 Methodology

The glint and glare assessment methodology has been derived from the information provided to Pager Power through consultation with stakeholders and by reviewing the available guidance and studies. The methodology for a glint and glare assessments is as follows:

- Identify receptors in the area surrounding the solar development.
- Consider direct solar reflections from the solar development towards the identified receptors by undertaking geometric calculations.
- Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor then no reflection can occur.
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur.
- Consider both the solar reflection from the solar development and the location of the direct sunlight with respect to the receptor's position.
- Consider the solar reflection with respect to the published studies and guidance.
- Determine whether a significant detrimental impact is expected in line with the process presented in Appendix D.

4.4 Assessment Methodology and Limitations

Further technical details regarding the methodology of the geometric calculations and limitations are presented in Appendix E and F.

5 IDENTIFICATION OF RECEPTORS

5.1 Overview

The following section presents the relevant receptors assessed within this report.

5.2 Aviation Receptors

5.2.1 Airborne Receptors - Approaching Aircraft

Cambridge Airport has two operational runways. Each runway has two associated approach paths, one for each bearing. It is Pager Power's methodology to assess whether a solar reflection can be experienced on the approach paths for the associated runways. This is considered to be the most critical stage of the flight.

A geometric glint and glare assessment has been undertaken for both aircraft approach paths. The Pager Power approach for determining receptor (aircraft) locations on the approach path is to select locations along the extended runway centre line from 50ft above the runway threshold out to a distance of 2 miles. The altitude of the aircraft is determined by using a 3-degree descent path relative to the runway threshold height. The receptor details for each runway approach are presented in Appendix G.

Figure 7 on the following page shows the assessed aircraft approach paths. The location of the ATC Tower is shown within the figure for reference.

Figure 7 *Runway approach paths (light blue lines) – aerial image*

5.2.2 ATC Tower

It is standard practice to determine whether a solar reflection can be experienced by personnel within the ATC Tower. The detailed receptor details are presented in Appendix G.

Figure 8 below shows the location of the ATC Tower.

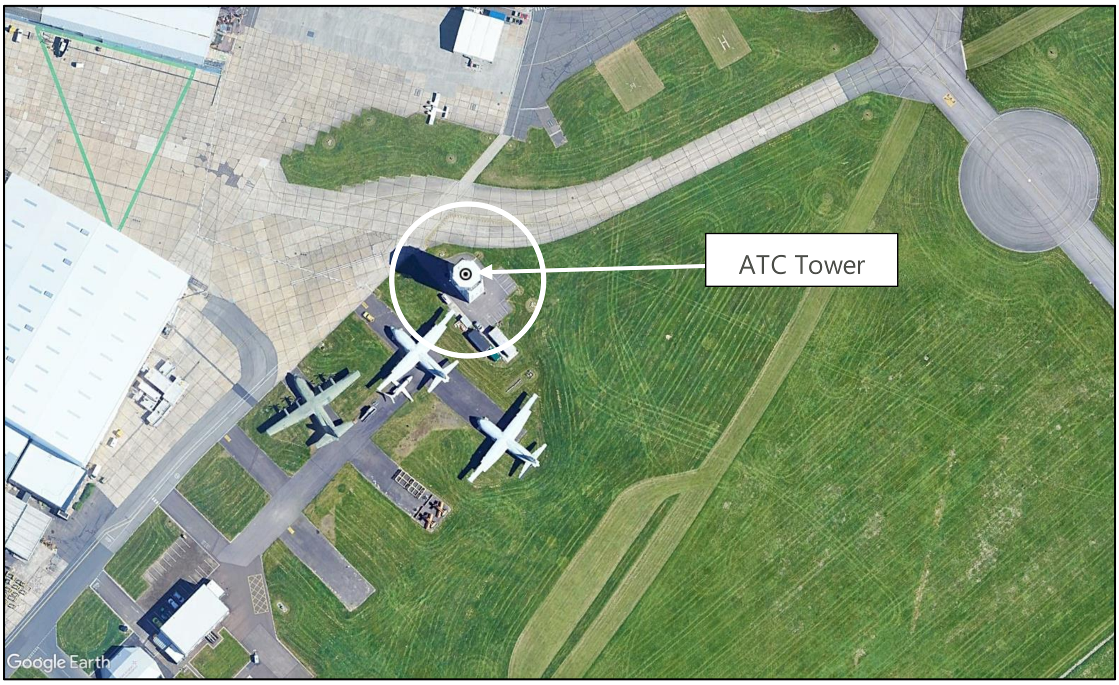


Figure 8 *ATC Tower location – aerial image*

5.3 Ground-Based Receptors – Overview

There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. From a technical perspective, there is no maximum distance for potential reflections. The significance of a reflection however decreases with distance because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. Terrain and shielding by vegetation are also more likely to obstruct an observer's view at longer distances.

The above parameters and industry experience over a significant number of glint and glare assessments undertaken, shows that a 1km assessment area from the proposed development is considered appropriate for glint and glare effects on road users and dwellings. The assessment area (orange outlined area in the proceeding figures) has been designed accordingly as a 1km from the proposed development (blue outlined areas).

Potential receptors within the associated assessment areas are identified based on mapping and aerial photography of the region. The initial judgement is made based on high-level consideration of aerial photography and mapping i.e. receptors are excluded if it is clear from the outset that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible.

Terrain elevation heights have been interpolated based on OSGB36 terrain data. Receptor details can be found in Appendix G.

5.4 Road Receptors

Road types can generally be categorised as:

- Major National – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 70mph. These roads typically have fast moving vehicles with busy traffic.
- National – Typically a road with a one or more carriageways with a maximum speed limit of up to 60mph or 70mph. These roads typically have fast moving vehicles with moderate to busy traffic density.
- Regional – Typically a single carriageway with a maximum speed limit of up to 60mph. The speed of vehicles will vary with a typical traffic density of low to moderate.
- Local – Typically roads and lanes with the lowest traffic densities. Speed limits vary.

Technical modelling is not recommended for local roads, where traffic densities are likely to be relatively low. Any solar reflections from the proposed development that are experienced by a road user along a local road would be considered low impact in the worst case in accordance with the guidance presented in Appendix D.

The analysis has therefore considered major national, national, and regional roads that:

- Are within the 1km assessment area.
- Have a potential view of the panels.

The assessed road receptor points along the A14 (1 to 30)[9], and the B1047 and Horningsea Road (31 to 51) are shown in Figure 9 on the following page. A height of 1.5 metres above ground level has been taken as typical eye level for a road user. The distance between road receptors is circa 100m positioned along the purple line.

[9] A14 exit is road receptors 24 to 30.

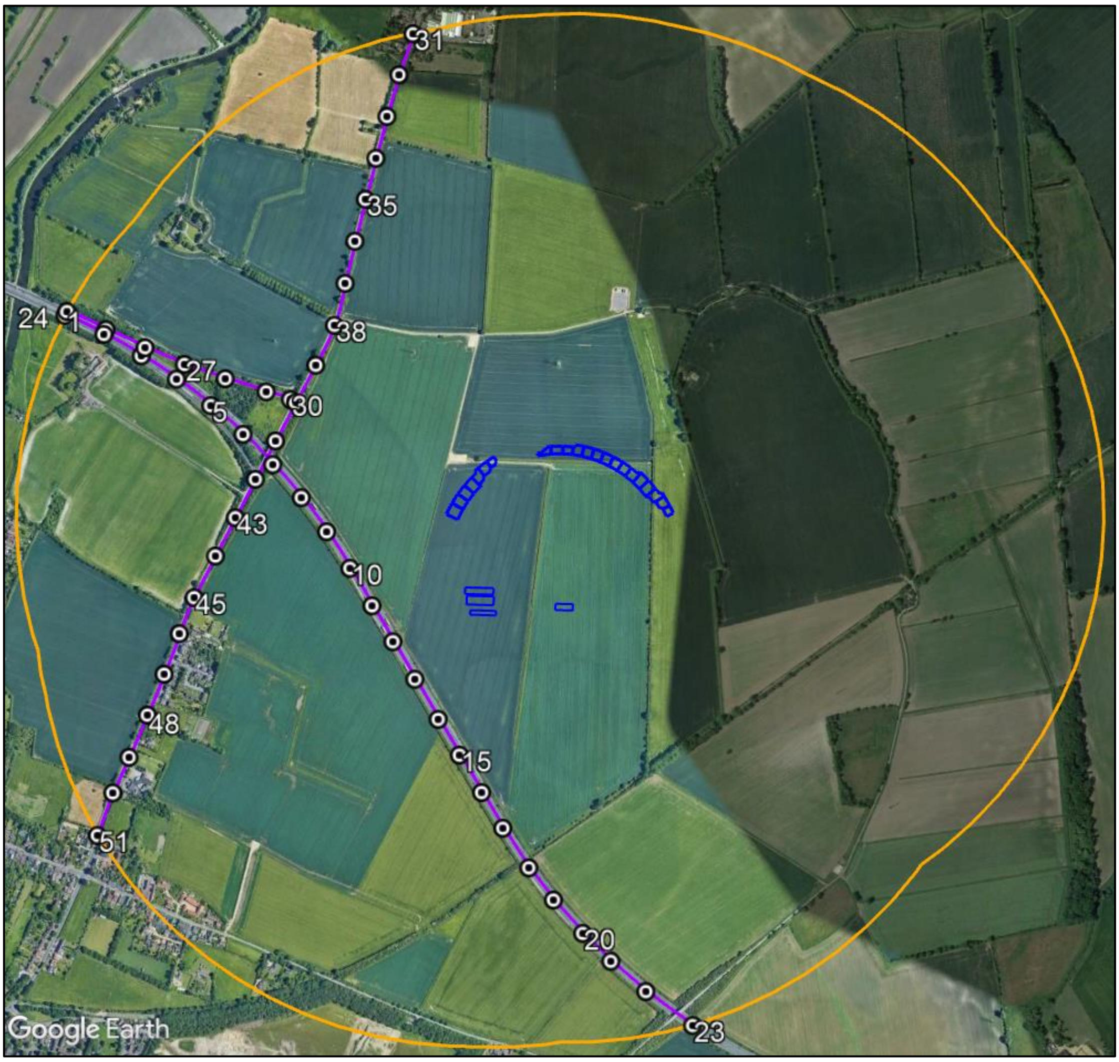


Figure 9 *Assessed road receptors*

5.5 Dwelling Receptors

The analysis has considered dwellings that:

- Are within the 1km assessment area.
- Have a potential view of the panels.

The individual assessed dwelling receptors and an overview of all dwelling receptors are shown in Figures 10 to 20 below and on the following pages. In total, 60 dwelling receptor locations[10,11] have been considered for the assessment. A height of 1.8 metres above ground level has been taken as typical eye level for an observer on the ground floor of the dwellings[12].

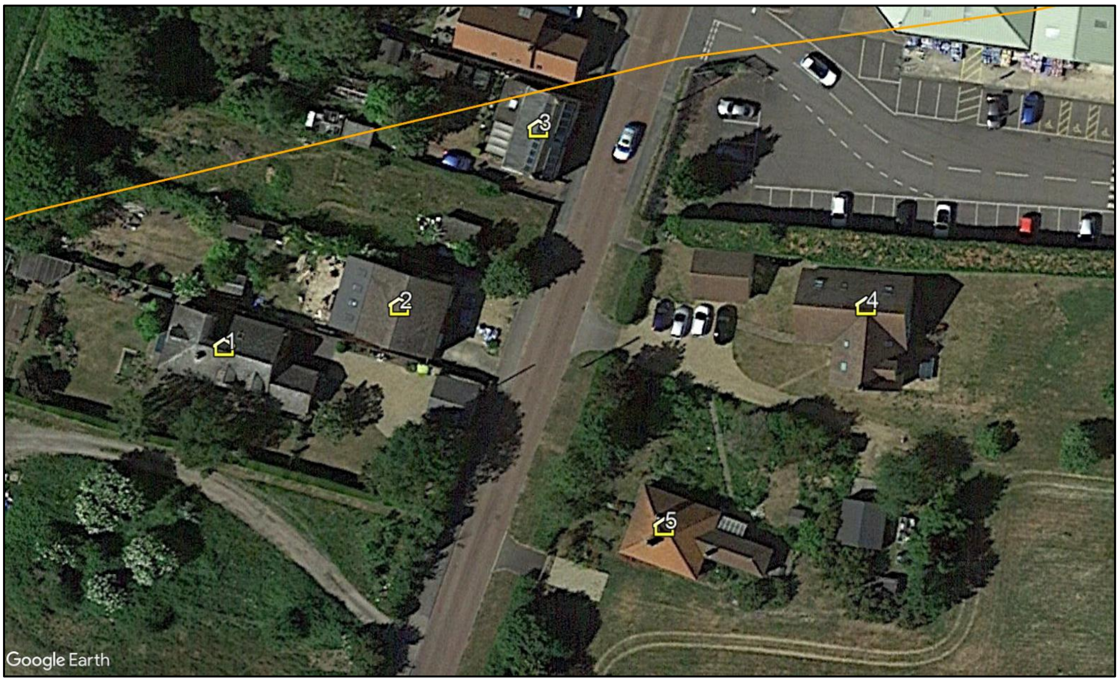


Figure 10 *Assessed dwelling receptors – 1 to 5*

[10] In some cases, one physical structure is split into multiple separate addresses. In such cases, the results for the assessed location will be applicable to all associated addresses. The sampling resolution is sufficiently high to capture the level of effect for all potentially affected dwellings.

[11] In residential areas with multiple layers of dwellings, only the outer dwellings have been considered for assessment. This is because they will mostly obscure views of the solar panels to the dwellings behind them, which will therefore not be impacted by the proposed development because line of sight will be removed, or they will experience comparable effects to the closest assessed dwelling.

[12] This fixed height for the dwelling receptors is for modelling purposes. Changes to the modelling height by a few metres is not expected to significantly change the modelling results. Views above ground floor are considered in the results discussion where necessary.

Figure 11 *Assessed dwelling receptor – 6*

Figure 12 *Assessed dwelling receptors – 7 to 9*

Figure 13 *Assessed dwelling receptors – 10 to 23*

Figure 14 *Assessed dwelling receptors – 24 to 27*

Figure 15 *Assessed dwelling receptors – 28 and 29*

Figure 16 *Assessed dwelling receptors – 30 to 48*

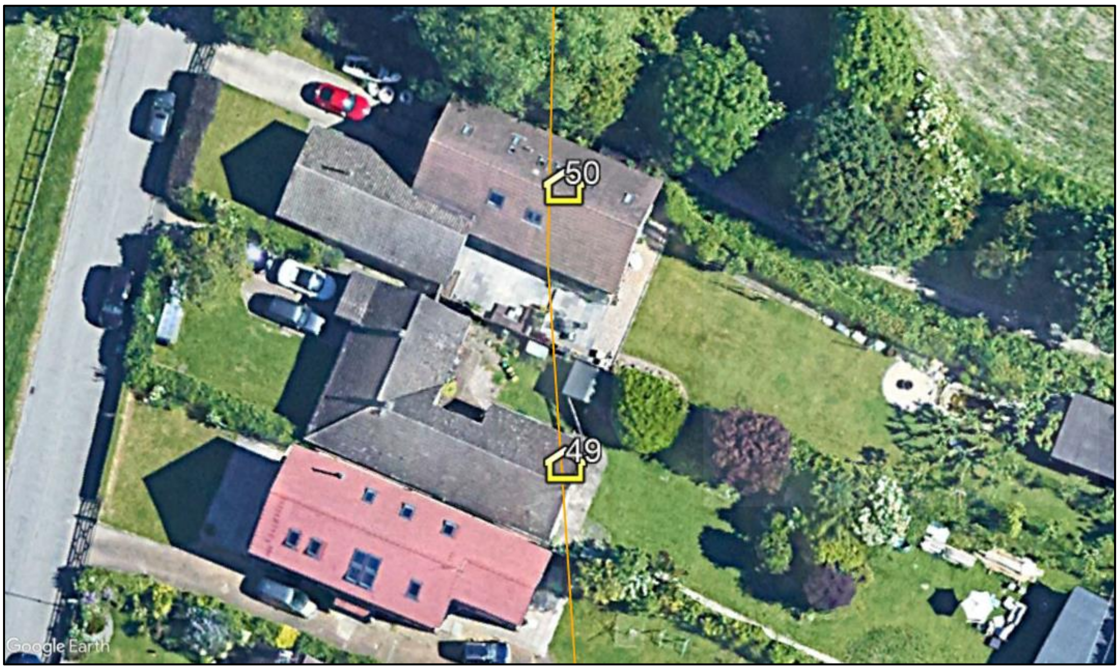


Figure 17 *Assessed dwelling receptors – 49 and 50*

Figure 18 *Assessed dwelling receptors – 51 to 55*

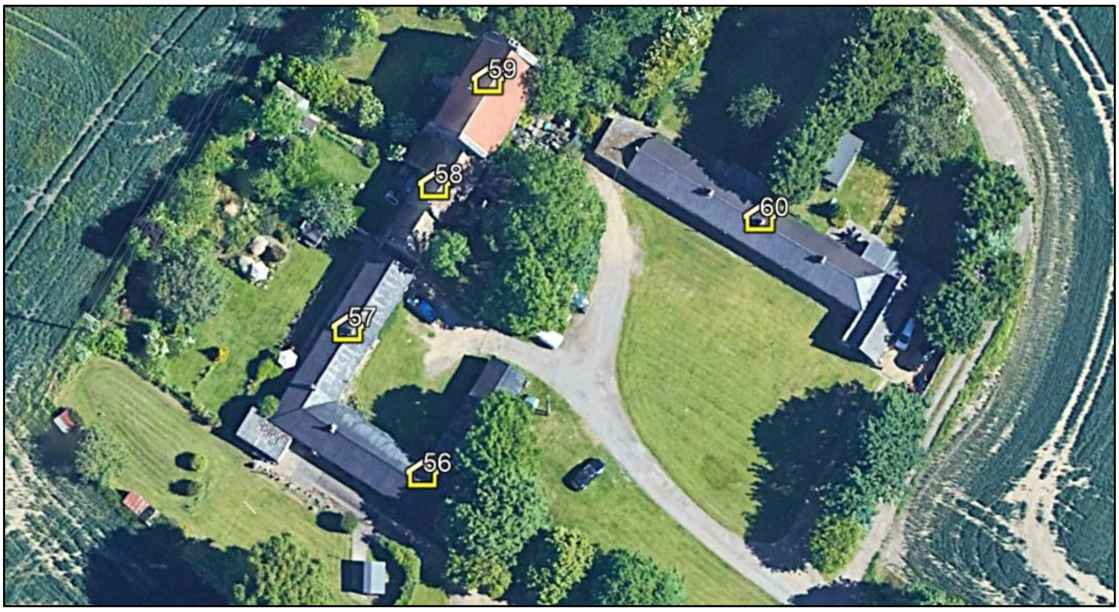


Figure 19 *Assessed dwelling receptors – 56 to 60*

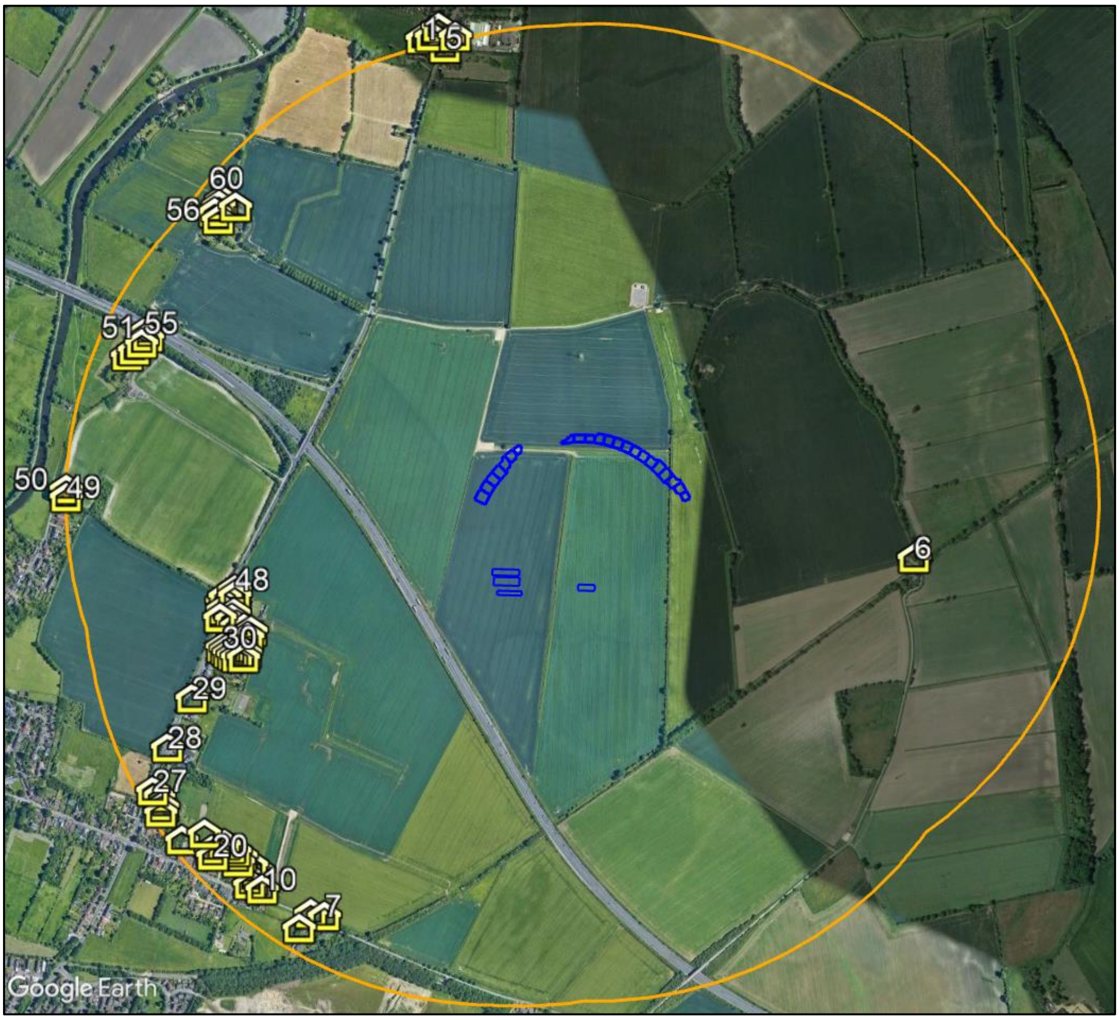


Figure 20 *Dwelling receptors overview*

6 ASSESSED REFLECTOR AREAS AND SOLAR PANEL DETAILS

6.1 Overview

The following section presents the modelled reflector areas and solar panel details.

6.2 Reflector Areas

A resolution of 3m has been chosen for this assessment. This means that a geometric calculation is undertaken for each identified receptor from a point every 3m from within the defined areas. This resolution is sufficiently high to maximise the accuracy of the results, increasing the resolution further would not significantly change the modelling output. The number of modelled reflector points are determined by the size of the reflector areas and the assessment resolution. The bounding co-ordinates for the proposed solar development have been extrapolated from the site plans. The data can be found in Appendix G.

The assessed reflector areas are shown in Figures 21 and 22 below and on the following page.

Figure 21 *Assessed reflector areas – ground mounted panels*

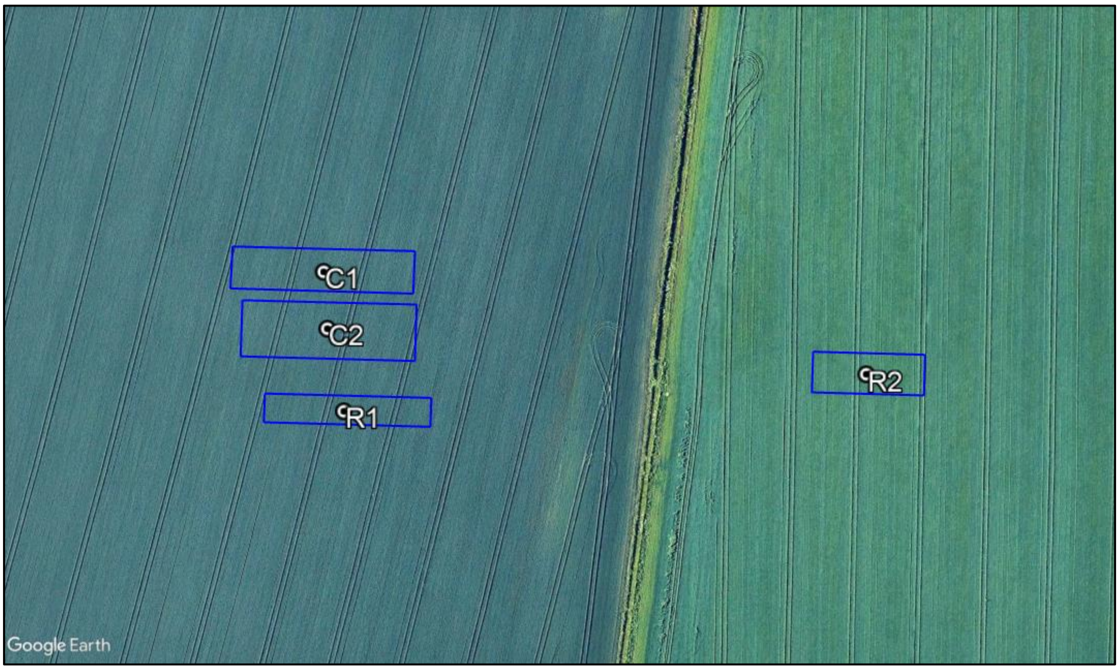


Figure 22 *Assessed reflector areas – car port and rooftop panels*

6.3 Solar Panel Information – Ground-Mounted Panels

The azimuth angles used in the assessment for the ground-mounted panels are presented in Table 1 below. All ground-mounted panel areas have been assessed at the height of 2.7m[13] agl (above ground level) and elevation angle 18.4349º[14].

Panel Area	Azimuth angle[15]
G1	117º
G2	122º
G3	127º
G4	132º
G5	137º
G6	142º
G7	146 º
G8	174º
G9	179º
G10	184º
G11	189º
G12	194º
G13	199º
G14	204º
G15	209º

[13] Mid-height of the panels on the proposed earth bund is 2.5m (see Section 2.2) with an additional height of 0.2m for the height of the solar panels above the earth bund.

[14] Equivalent to an elevation ratio of 1:3.

[15] The modelling results (see Section 7) for aviation receptors were also checked cumulatively when considering the ground mounted panels as two large panel areas (with an average azimuth angle for each).

Panel Area	Azimuth angle[15]
G16	214°
G17	219°
G18	224°
G19	229°
G20	234°
G21	239°
G22	244°

Table 1 *Panel information – ground mounted panels*

6.4 Solar Panel Information – Carport Panels

The solar panel characteristics for the carport panels are presented in Table 2 below.

Panel Area	C1	C2
Azimuth angle	0° / 180°	
Elevation angle	10°	
Assessed height above ground level (agl)	3.5m	

Table 2 *Panel information – carport panels*

6.5 Solar Panel Information – Rooftop Panels

The solar panel characteristics for the rooftop panels are presented in Table 3 below.

Panel Area	R1	R2
Azimuth angle	180°	
Elevation angle	15°	10°
Assessed height above ground level (agl)	8m	

Table 3 *Panel information – rooftop panels*

7 GLINT AND GLARE ASSESSMENT – TECHNICAL RESULTS

7.1 Overview

The Pager Power and Forge models has been used to determine whether reflections are possible. Intensity calculations (Forge model) in line with the Sandia National Laboratories methodology have been undertaken for aviation receptors. These calculations are routinely required for solar photovoltaic developments on or near aerodromes. The intensity model calculates the expected intensity of a reflection with respect to the potential for an after-image (or worse) occurring. The designation used by the model is presented in Table 4 below along with the associated colour coding.

Coding Used	Intensity Key
Glare beyond 50°	Glare beyond 50 deg from pilot line-of-sight
Low potential	Low potential for temporary after-image
Potential	Potential for temporary after-image
Potential for permanent eye damage	Potential for permanent eye damage

Table 4 *Glare intensity designation*

This coding has been used in the table where a reflection has been calculated and is in accordance with Sandia National Laboratories' methodology.

In addition, the intensity model allows for assessment of a variety of solar panel surface materials. In the first instance, a surface material of 'smooth glass without an anti-reflective coating' is assessed. This is the most reflective surface and allows for a 'worst case' assessment. Other surfaces that could be modelled include:

- Smooth glass with an anti-reflective coating.
- Light textured glass without an anti-reflective coating.
- Light textured glass with an anti-reflective coating.
- Deeply textured glass.

If significant glare is predicted, modelling of less reflective surfaces could be undertaken.

7.2 Summary of Results

The tables in the following sub-sections summarise the geometric modelling results. The tables are based solely on bare-earth terrain i.e., without consideration of screening from buildings and vegetation. Whether a reflection will be experienced in practice, and the significance of any impacts are discussed in the subsequent report sections.

The modelling output showing the precise predicted times and the reflecting panel areas are shown in Appendix H.

7.3 Geometric Calculation Results – ATC Tower

The results of the geometric calculation for the ATC Tower is presented in Table 5 below.

Receptor	Reflection possible toward the ATC Tower? (GMT)		Glare Type (Forge)	Comment
	am	pm		
ATC Tower.	No.	No.	N/A.	No solar reflections geometrically possible.

Table 5 *Geometric analysis results - ATC tower*

7.4 Geometric Calculation Results Overview – Approach for Runway 05

The results of the geometric calculations for the approach towards runway 05 are presented in Table 6 below.

Receptor	Reflection possible toward the Runway 05 Approach? (GMT)		Glare Type (Forge)	Comment
	am	pm		
Threshold – 2 miles.	No.	No.	N/A.	No solar reflections geometrically possible.

Table 6 *Geometric analysis results for the Runway 05 Approach*

7.5 Geometric Calculation Results Overview – Approach for Runway 05G

The results of the geometric calculations for the approach towards runway 05G are presented in Table 7 below.

Receptor	Reflection possible toward the Runway 05G Approach? (GMT)		Glare Type (Forge)	Comment
	am	pm		
Threshold – 2 miles.	No.	No.	N/A.	No solar reflections geometrically possible.

Table 7 *Geometric analysis results for the Runway 05G Approach*

7.6 Geometric Calculation Results Overview – Approach for Runway 23

The results of the geometric calculations for the approach towards runway 23 are presented in Table 8 below[16].

Receptor	Reflection possible toward the Runway 23 Approach? (GMT)		Glare Type (Forge)	Comment
	am	pm		
Threshold – 1.2 miles.	No.	No.	N/A.	No solar reflections geometrically possible.
1.2 – 1.4 miles.	No.	Yes.		Solar reflections are predicted to occur outside of a pilot's primary field of view.

[16] Results were also checked cumulatively when considering the ground mounted panels as two large panel areas (with an average azimuth angle for each). The results again showed solar reflection with a maximum of 'low potential for temporary after-image' is predicted.

Receptor	Reflection possible toward the Runway 23 Approach? (GMT)		Glare Type (Forge)	Comment
	am	pm		
1.4 – 2 miles.	No.	Yes.		Solar reflections with 'low potential for temporary after-image' is predicted.

Table 8 *Geometric analysis results for the Runway 23 Approach*

7.7 Geometric Calculation Results Overview – Approach for Runway 23G

The results of the geometric calculations for the approach towards runway 23G are presented in Table 9 below[17].

Receptor	Reflection possible toward the Runway 23G Approach? (GMT)		Glare Type (Forge)	Comment
	am	pm		
Threshold – 1.3 miles.	No.	No.	N/A.	No solar reflections geometrically possible.
1.3 – 1.5 miles.	No.	Yes.		Solar reflections are predicted to occur outside of a pilot's primary field of view.
1.5 – 2 miles.	No.	Yes.		Solar reflections with 'low potential for temporary after-image' is predicted.

Table 9 *Geometric analysis results for the Runway 23G Approach*

[17] Results were also checked cumulatively when considering the ground mounted panels as two large panel areas (with an average azimuth angle for each). The results again showed solar reflection with a maximum of 'low potential for temporary after-image' is predicted.

7.8 Geometric Calculation Results – Road Receptors

The results of the geometric calculations for the road receptors are presented in Table 10 below.

Receptor	Reflection possible towards receptor? (GMT)		Modelling results (bare earth terrain i.e. **no screening considered**)
	am	pm	
1 – 10.	Yes.	No.	Solar reflections would originate from **inside** a road user's main field of view.
11 – 13.	Yes.	No.	Solar reflections would originate from **outside** a road user's main field of view.
14 – 23.	No.	No.	No solar reflections geometrically possible.
24 – 38.	Yes.	No.	Solar reflections would originate from **inside** a road user's main field of view.
39 – 43.	Yes.	No.	Solar reflections would originate from **outside** a road user's main field of view.
44 – 46.	Yes.	No.	Solar reflections would originate from **inside** a road user's main field of view.
47.	Yes.	No.	Solar reflections would originate from **outside** a road user's main field of view.
48 – 51.	Yes.	No.	Solar reflections would originate from **inside** a road user's main field of view.

Table 10 *Geometric calculation results – road receptors*

7.9 Geometric Calculation Results – Dwelling Receptors

The results of the geometric calculations for the dwelling receptors are presented in Table 11 below.

Receptor	Reflection possible towards receptor? (GMT)		Modelling results (bare earth terrain i.e. **no screening considered**)
	am	pm	
1 – 5.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **less** than 3 months of the year.
6.	No.	Yes.	Solar reflections predicted for **less** than 60 minutes per day and for **more** than 3 months of the year.
7 – 24.	No.	No.	No solar reflections geometrically possible.
25 – 28.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **less** than 3 months of the year.
29.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **more** than 3 months of the year.
30 – 31.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **less** than 3 months of the year.
32 – 37.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **more** than 3 months of the year.
38 – 48.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **less** than 3 months of the year.
49 – 55.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **more** than 3 months of the year.
56 – 60.	Yes.	No.	Solar reflections predicted for **less** than 60 minutes per day and for **less** than 3 months of the year.

Table 11 *Geometric calculation results – dwelling receptors*

8 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

8.1 Overview

The following sub-section presents the significance of any predicted impact in the context of existing screening and the relevant criteria set out in each sub-section. The criteria are determined by the assessment process for each receptor, which are set out in Appendix D.

When determining the visibility of the reflecting panels for an observer, a conservative review of the available imagery and landscape strategy plan is undertaken, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing screening will remove effects.

8.2 ATC Tower

No solar reflection is geometrically possible towards the ATC Tower.

No impact is predicted, and no mitigation is required.

8.3 Runway Approaches 05 and 05G

No solar reflection is geometrically possible towards the runway approach paths 05 and 05G.

No impact is predicted, and no mitigation is required.

8.4 Runway Approach 23

The analysis has shown that solar reflections are predicted towards the 2-mile runway approach path 23.

From the threshold to 1.2 miles from the threshold no solar reflection is geometrically possible.

From 1.2 to 1.4 miles from the threshold solar reflections are geometrically possible. Solar reflections are predicted to occur outside of a pilot’s primary field of view (50 degrees either side of the approach bearing), which is acceptable considering the associated guidance (Appendix D).

From 1.4 miles to 2 miles from the threshold solar reflections are geometrically possible. All glare intensities are no greater than ‘low potential for temporary after-image’, which is acceptable considering the associated guidance (Appendix D).

A low impact is predicted, and no mitigation is required.

8.5 Runway Approach 23G

The analysis has shown that solar reflections are predicted towards the 2-mile runway approach path 23G.

From the threshold to 1.3 miles from the threshold no solar reflection is geometrically possible.

From 1.3 to 1.5 miles from the threshold solar reflections are geometrically possible. Solar reflections are predicted to occur outside of a pilot's primary field of view (50 degrees either side of the approach bearing), which is acceptable considering the associated guidance (Appendix D).

From 1.5 miles to 2 miles from the threshold solar reflections are geometrically possible. All glare intensities are no greater than 'low potential for temporary after-image', which is acceptable considering the associated guidance (Appendix D). A low impact is predicted, and no mitigation is required.

8.6 Road Receptors

The results of the modelling indicate that solar reflections are geometrically possible towards:

- 20 of the 30 assessed road receptors (1 to 13 and 24 to 30)[18] along 2.25km of the A14.
- All 20 of the assessed road receptors (31 to 51) along 2km of the B1047 and Horningsea Road.

The sections of road where solar reflections are geometrically possible are shown as yellow lines in Figure 23 below.

[18] Receptors 1 to 13 are on the A14 and 24 to 30 are on the A14 exit.

Figure 23 *Section of road where solar reflections are geometrically possible*

The key considerations for quantifying impact significance for road users along major national, national, and regional roads are:

- Whether a reflection is predicted to be experienced in practice.
- The location of the reflecting panel relative to a road user's direction of travel.

Where reflections originate from outside of a road user's main field of view (50 degrees either side of the direction of travel), or where the separation distance to the nearest visible reflecting panel is over 1km, the impact significance is low, and mitigation is not required.

Where reflections are predicted to be experienced from inside of a road user's field of view the impact significance is moderate, expert assessment of the following mitigating factors is required to determine the mitigation requirement:

- Whether visibility is likely for elevated drivers (relevant to dual carriageways and motorways[19]);
- Whether the solar reflection originates from directly in front of a road user. Solar reflections that are directly in front of a road user are more hazardous;
- The separation distance to the panel area. Larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun. Effects that coincide with direct sunlight appear less prominent than those that do not. The Sun is a far more significant source of light.

Where reflections originate from directly in front of a road user and there are no further mitigating circumstances, the impact significance is high, and mitigation is required.

The desk-based review is shown in Figures 24 to 39 on the following pages. Representative visual points ('VP' blue icons) indicating the location of street view imagery, facing towards the direction of the reflecting panels, are marked on the aerial images. The yellow radial icons shown within the figures represent the location of the reflecting areas associated with the receptors. The green outlined areas within the figures represent the location of proposed vegetation screening adjacent to the proposed development. The black outlined areas within the figures represent the location of the proposed earth bund providing terrain screening adjacent to the proposed development (see Section 2.3 for further details). Specifically, each figure shows representative viewpoints.

For most of the assessed sections of the A14, the B1047 and Horningsea Road, where solar reflections are geometrically possible, screening in the form of existing vegetation and/or buildings will significantly obstruct the views of the reflecting panels. This means that observers will not experience solar reflections in practice. Furthermore, where there are gaps in existing screening, there is further screening in the form of proposed vegetation and/or terrain (proposed earth bund). Further to the proposed screening removing views of the reflecting panels, no impact is predicted. No further mitigation is recommended.

[19] There is typically a higher density of elevated drivers (such as HGVs) along dual carriageways and motorways compared to other types of road.

Figure 24 *Viewpoint and reflecting areas - adjacent to road receptor 1 and 24*

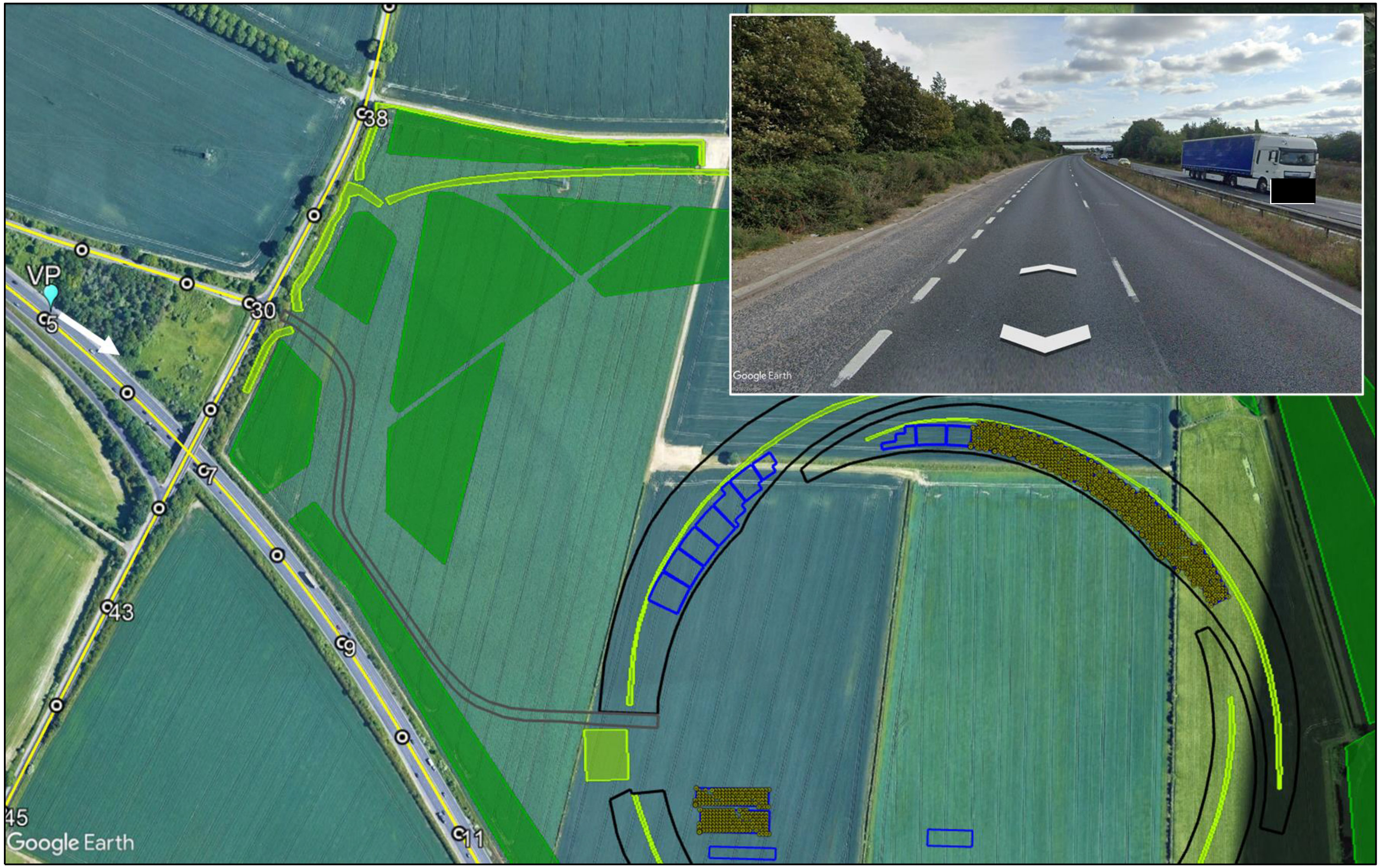


Figure 25 *Viewpoint and reflecting areas - adjacent to road receptor 5*

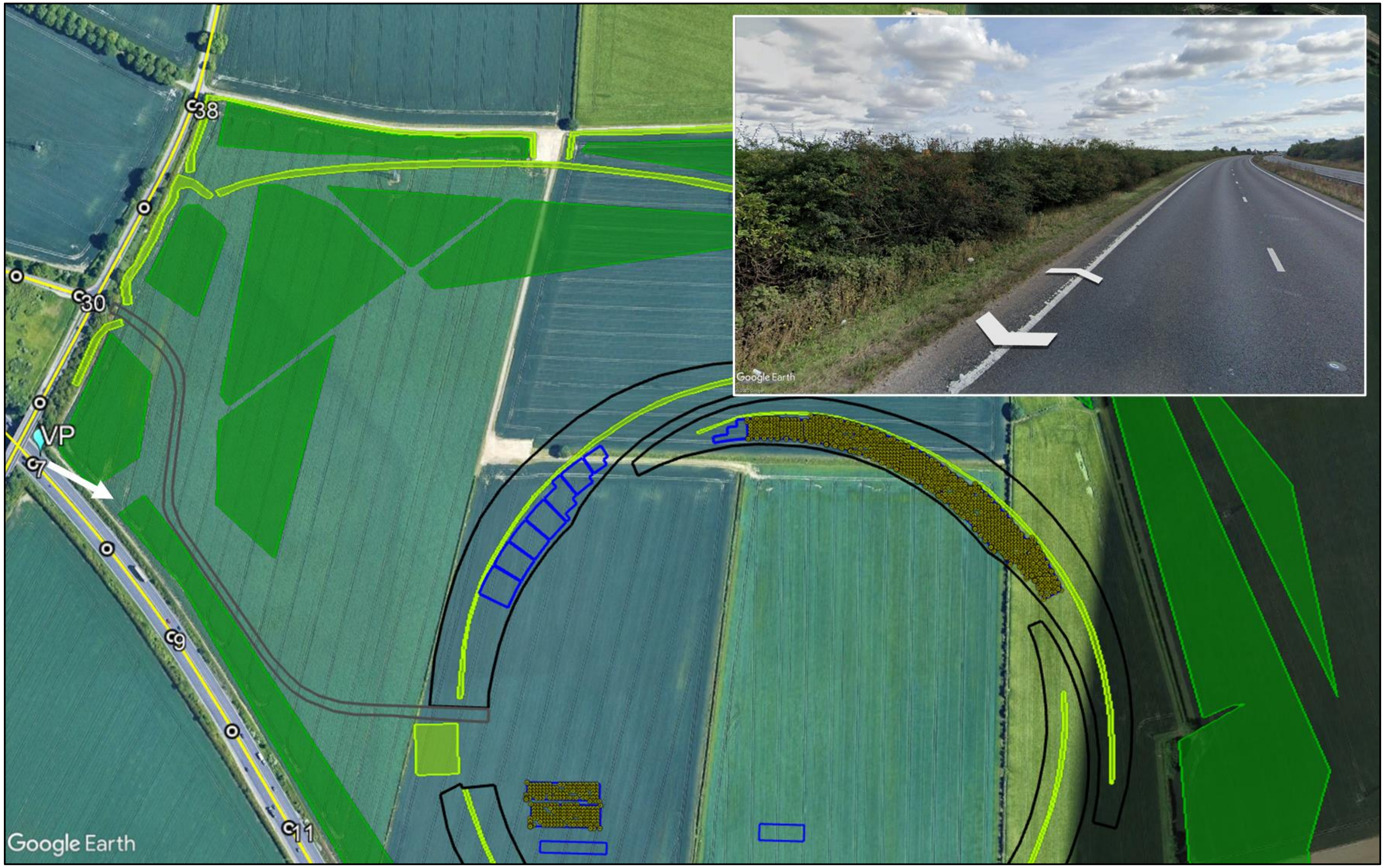


Figure 26 *Viewpoint and reflecting areas - adjacent to road receptor 7*

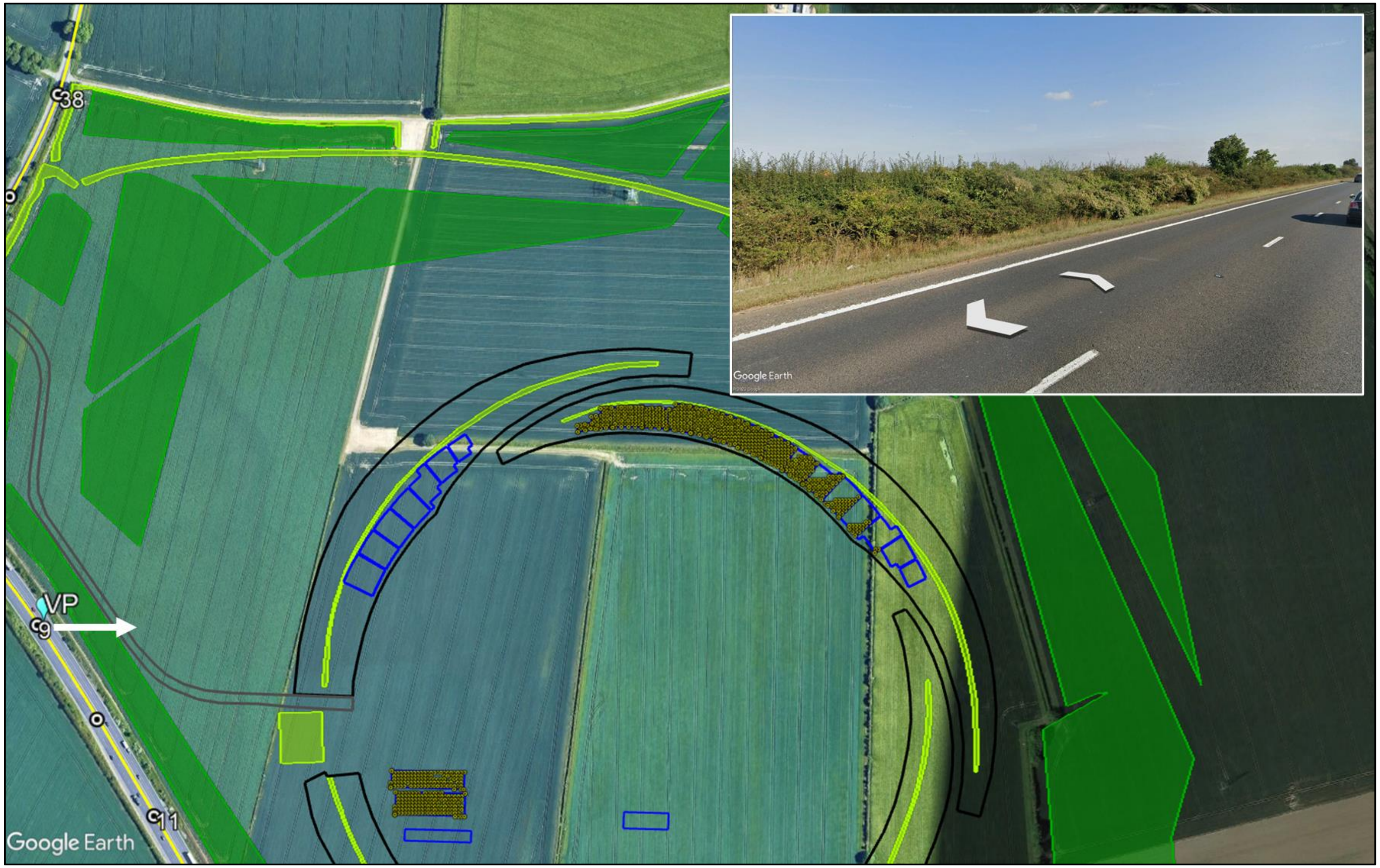


Figure 27 *Viewpoint and reflecting areas - adjacent to road receptor 9*

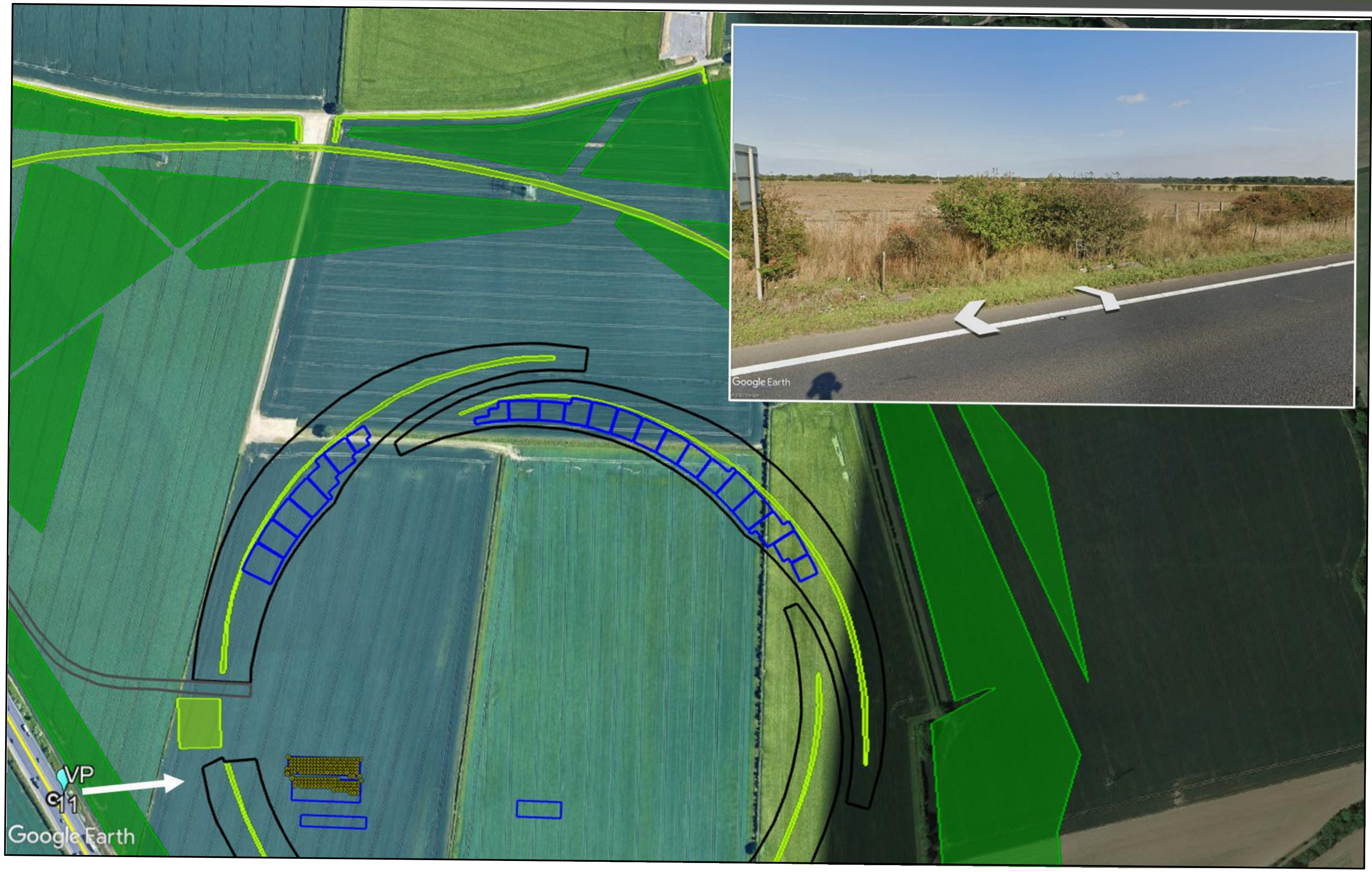


Figure 28 *Viewpoint and reflecting areas - adjacent to road receptor 11*

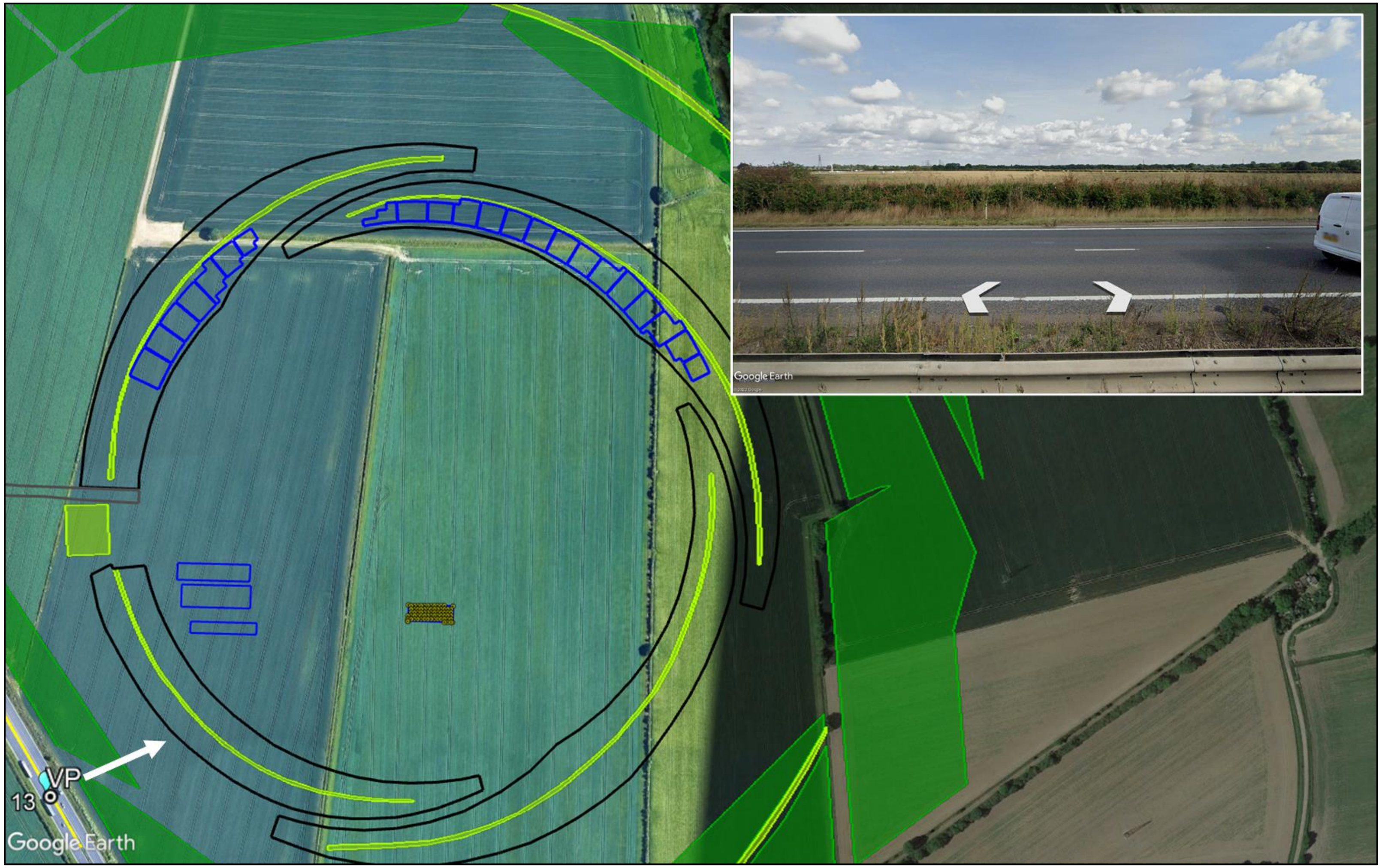


Figure 29 *Viewpoint and reflecting areas - adjacent to road receptor 13*

Figure 30 *Viewpoint and reflecting areas - adjacent to road receptor 26*

Figure 31 *Viewpoint and reflecting areas - adjacent to road receptor 30*

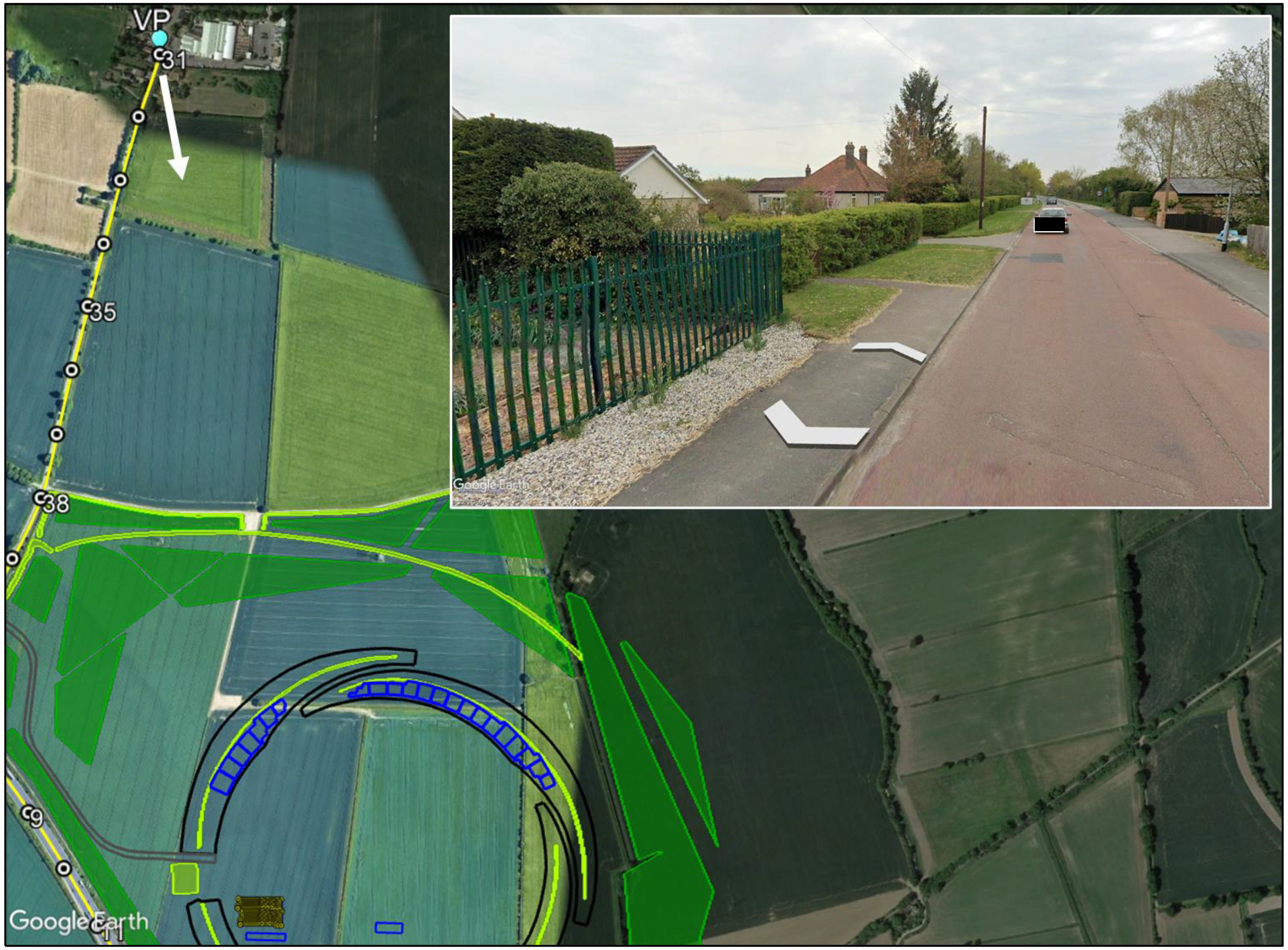


Figure 32 *Viewpoint and reflecting areas - adjacent to road receptor 31*

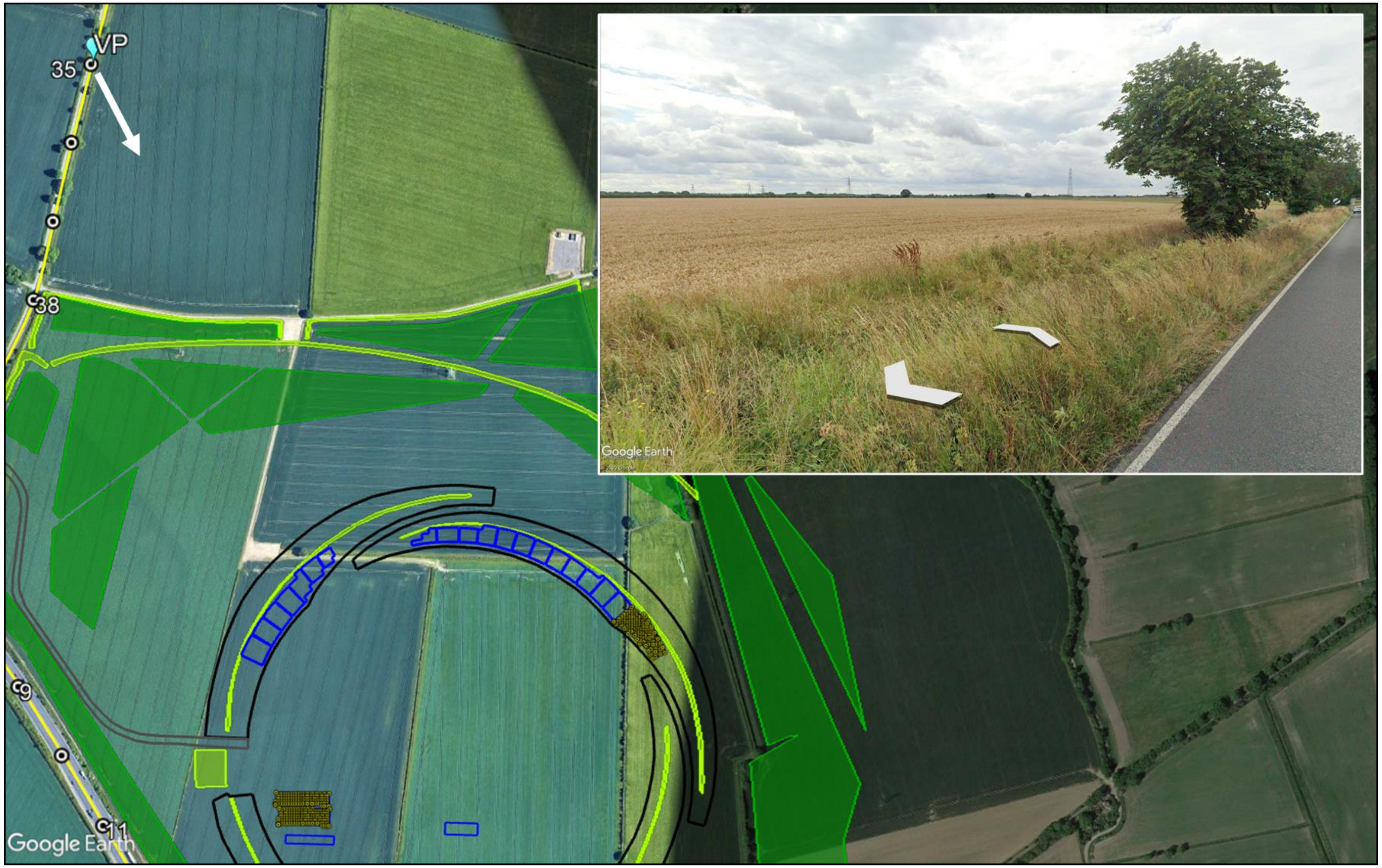


Figure 33 *Viewpoint and reflecting areas - adjacent to road receptor 35*

Figure 34 *Viewpoint and reflecting areas - adjacent to road receptor 38*

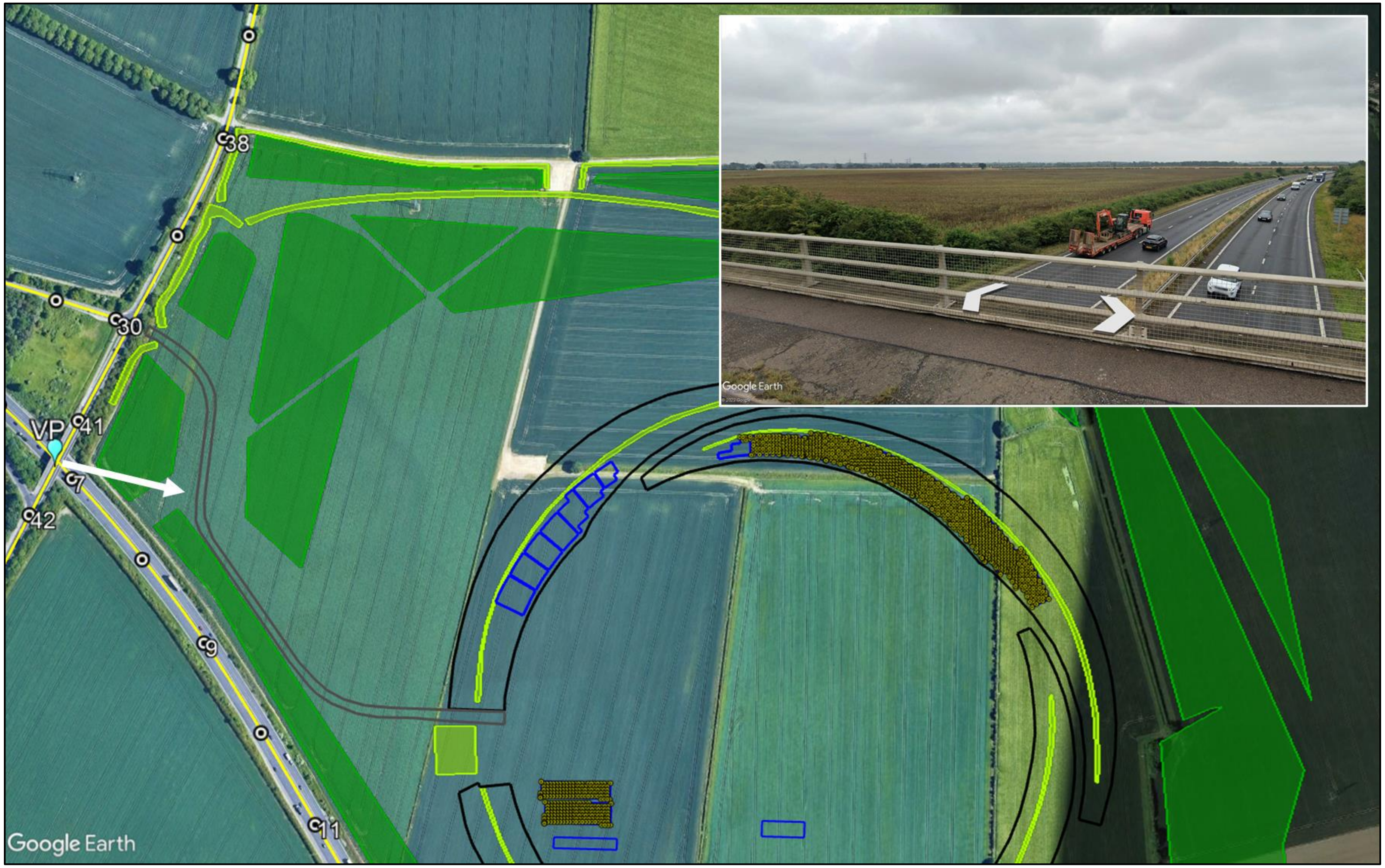


Figure 35 *Viewpoint and reflecting areas - adjacent to road receptor 41 and 42*

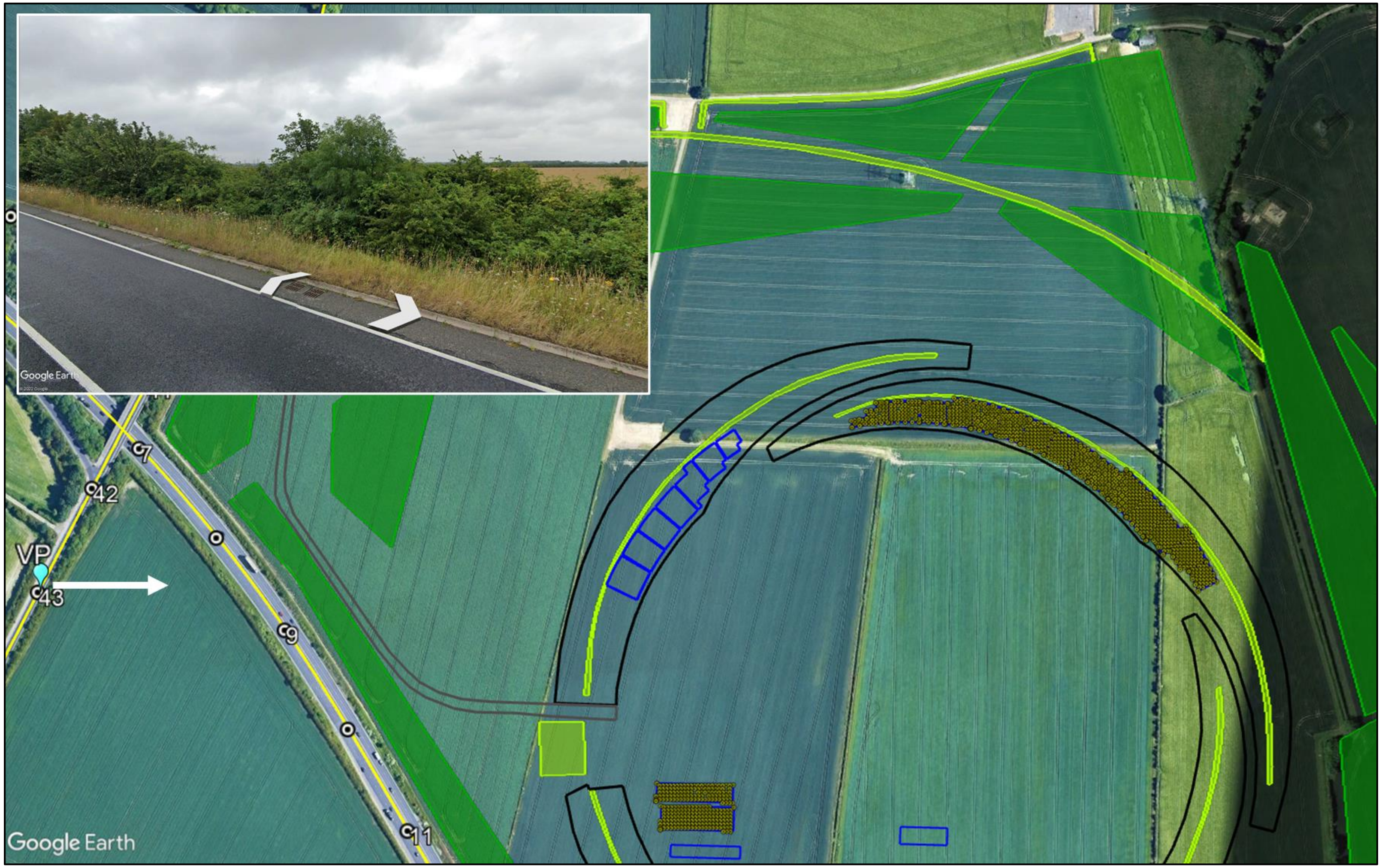


Figure 36 *Viewpoint and reflecting areas - adjacent to road receptor 43*

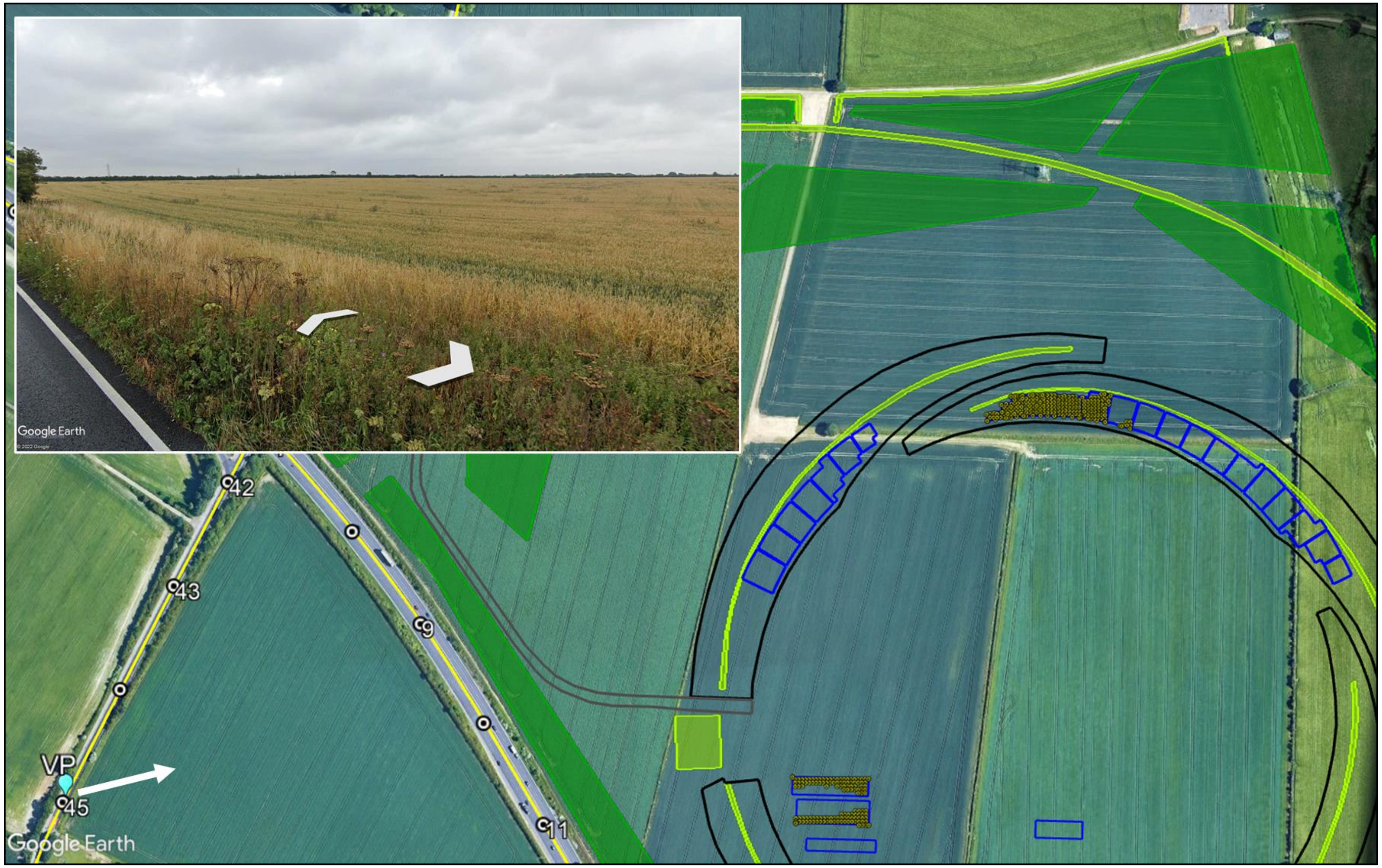


Figure 37 *Viewpoint and reflecting areas - adjacent to road receptor 45*

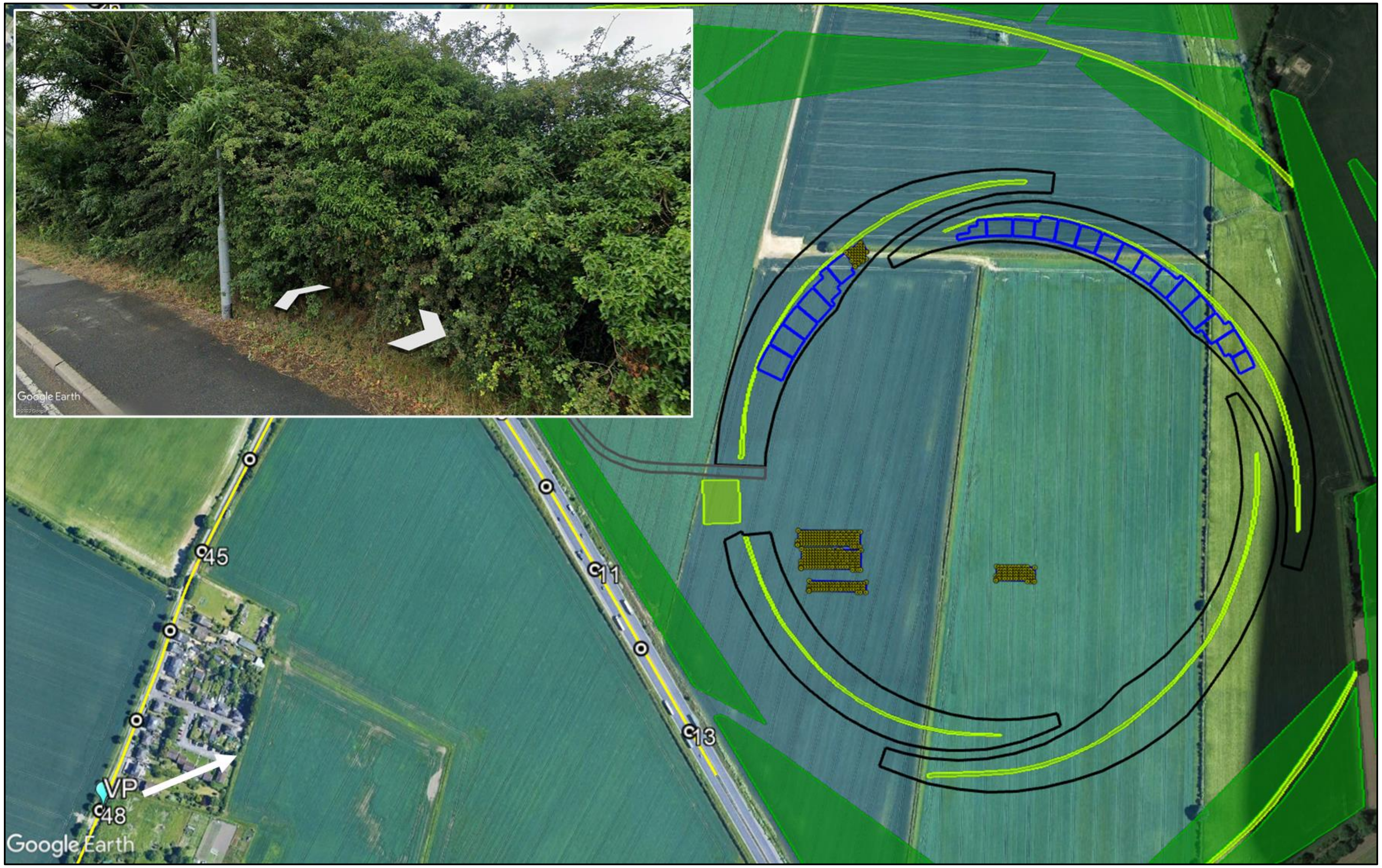


Figure 38 *Viewpoint and reflecting areas - adjacent to road receptor 48*

Figure 39 *Viewpoint and reflecting areas - adjacent to road receptor 51*

8.7 Dwelling Receptors

The results of the modelling indicate that solar reflections are geometrically possible towards 42 out of the 60 assessed dwelling receptors (1 to 6 and 25 to 60). The dwellings where solar reflections are geometrically possible are shown in Figure 40 below.

Figure 40 *Dwellings where reflections are geometrically possible*

The process for quantifying impact significance is defined in the report appendices. For dwelling receptors, the key considerations are:

- Whether a reflection is predicted to be experienced in practice.
- The duration of the predicted effects, relative to thresholds of:
    - 3 months per year.
    - 60 minutes per day.

Where effects are predicted to be experienced for less than 3 months per year and less than 60 minutes per day, or where the separation distance to the nearest visible reflecting panel is over 1km, the impact significance is low, and mitigation is not required.

Where effects are predicted to be experienced for more than 3 months per year or for more than 60 minutes per day, the impact significance is moderate and expert assessment of the following mitigating factors is required to determine the mitigation requirement:

- The separation distance to the panel area. Larger separation distances reduce the proportion of an observer's field of view that is affected by glare.
- The position of the Sun. Effects that coincide with direct sunlight appear less prominent than those that do not. The Sun is a far more significant source of light.

- Whether solar reflections will be experienced from all storeys. The ground floor is typically considered the main living space and therefore has a greater significance with respect to residential amenity.
- Whether the dwelling appears to have windows facing the reflecting areas. An observer may need to look at an acute angle to observe the reflecting areas.

Where effects are predicted to be experienced for more than 3 months per year and more than 60 minutes per day, the impact significance is high, and mitigation is required.

The desk-based review is shown in Figures 41 to 49 on the following pages. Representative visual points ('VP' blue icons) indicating the location and direction of more detailed imagery are marked on aerial imagery, where appropriate. The yellow radial icons shown within the figures represent the location of the cumulative reflecting areas associated with the receptors. The green outlined areas within the figures represent the location of proposed vegetation screening adjacent to the proposed development. The black outlined areas within the figures represent the location of the proposed earth bund providing terrain screening adjacent to the proposed development (see Section 2.3 for further details). Specifically, each figure shows representative viewpoints.

For most of the surrounding dwellings where solar reflections are geometrically possible, screening in the form of existing vegetation will significantly obstruct the views of the reflecting panels. This means that observers will not experience solar reflections in practice. Furthermore, where there are gaps in existing screening, there is further screening in the form of proposed vegetation and/or terrain (proposed earth bund). Further to the proposed screening removing views of the reflecting panels, no impact is predicted. No further mitigation is recommended.

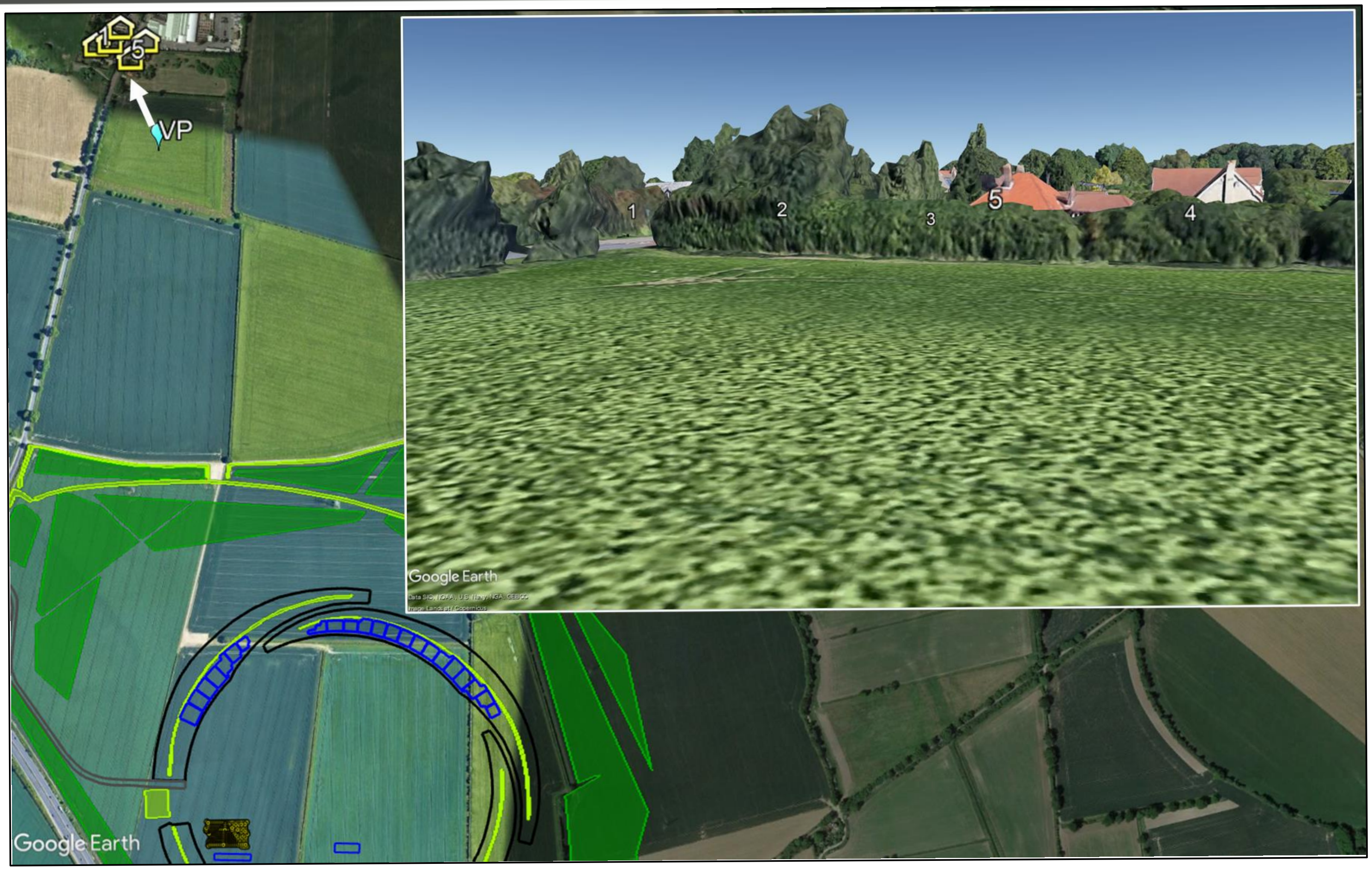


Figure 41 *Viewpoint and reflecting areas - dwelling receptors 1 to 5*

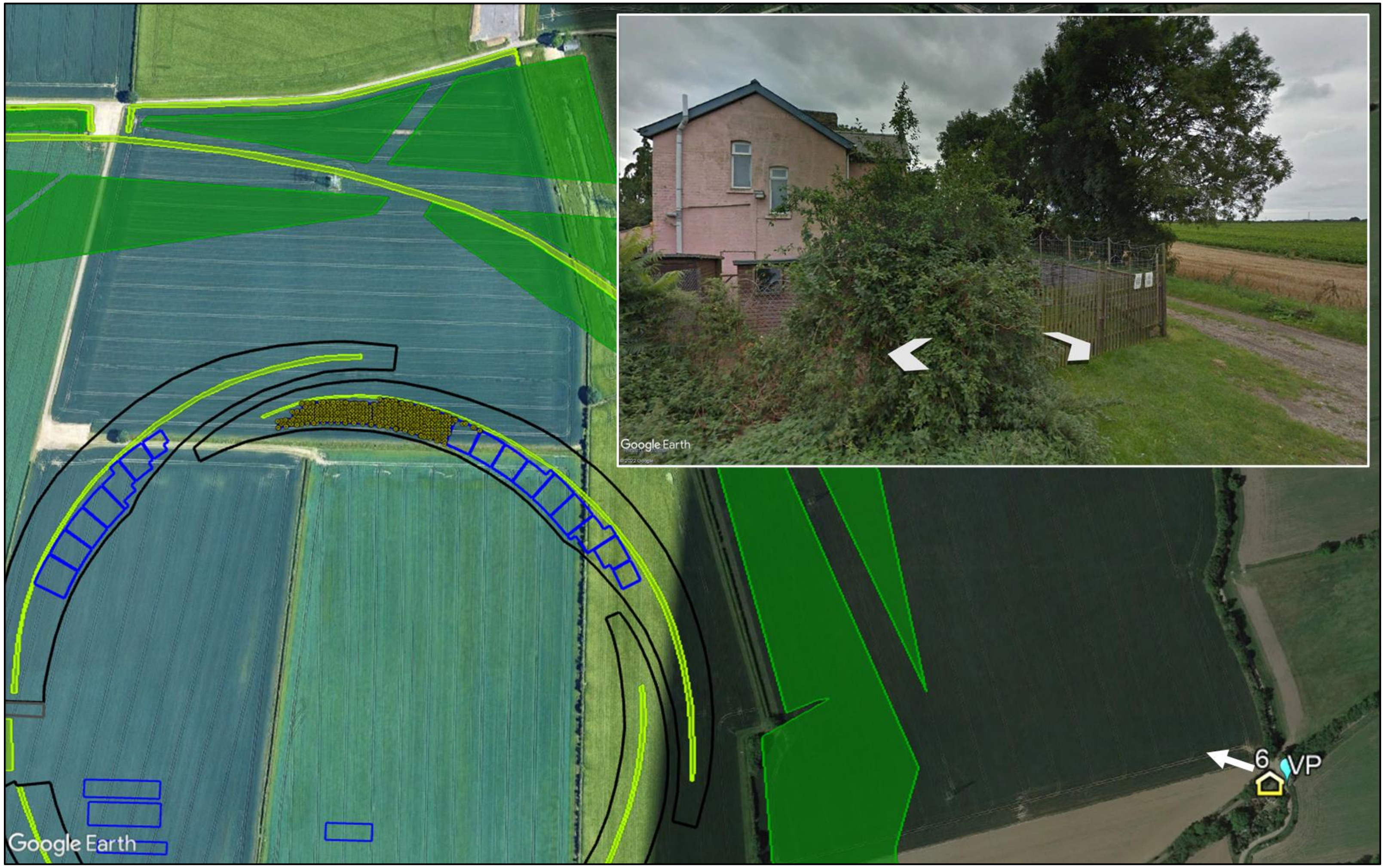


Figure 42 *Viewpoint and reflecting areas - dwelling receptor 6*

Figure 43 *Viewpoint and reflecting areas - dwelling receptors 25 to 27*

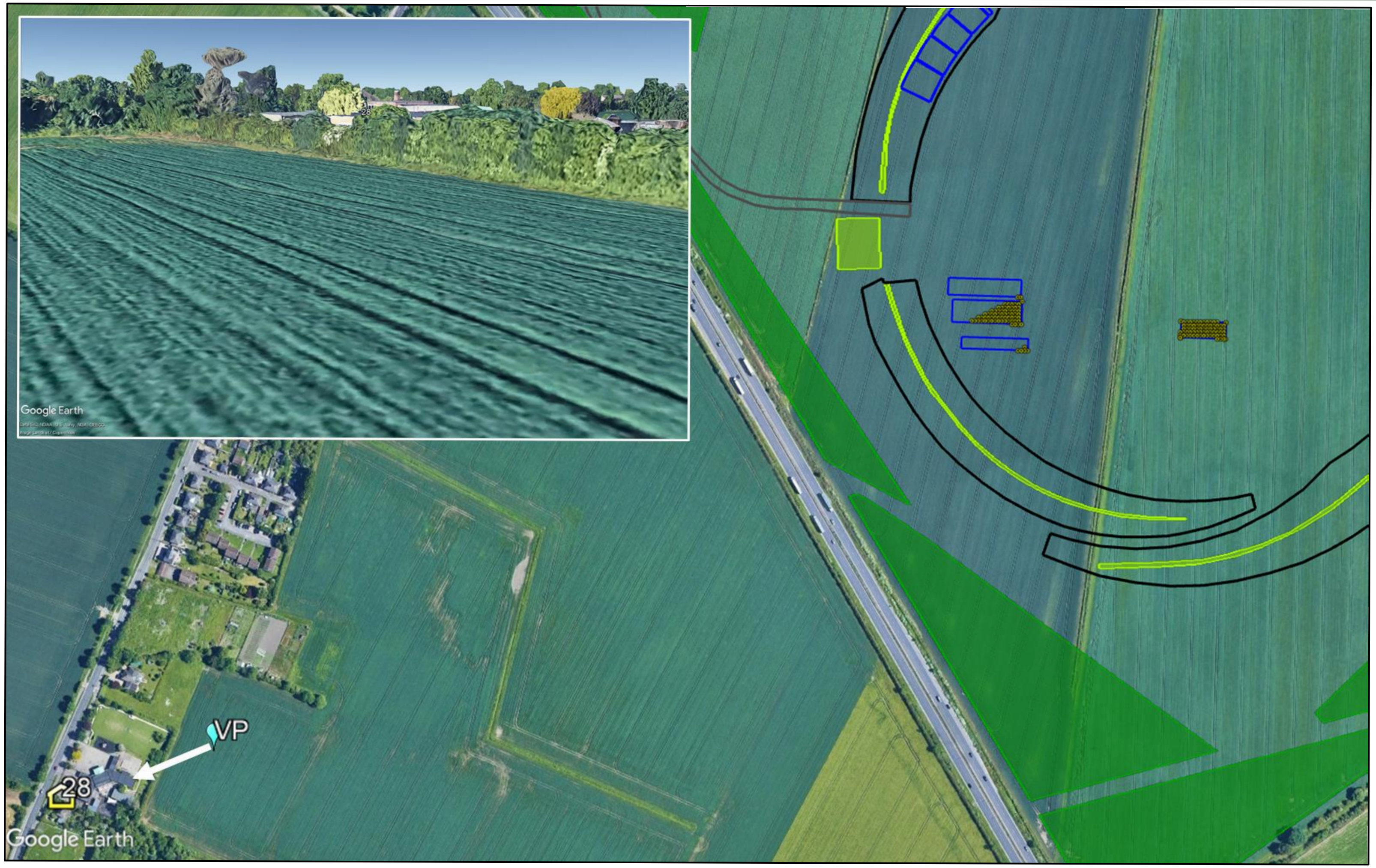


Figure 44 *Viewpoint and reflecting areas - dwelling receptor 28*

Figure 45 *Viewpoint and reflecting areas - dwelling receptor 29*

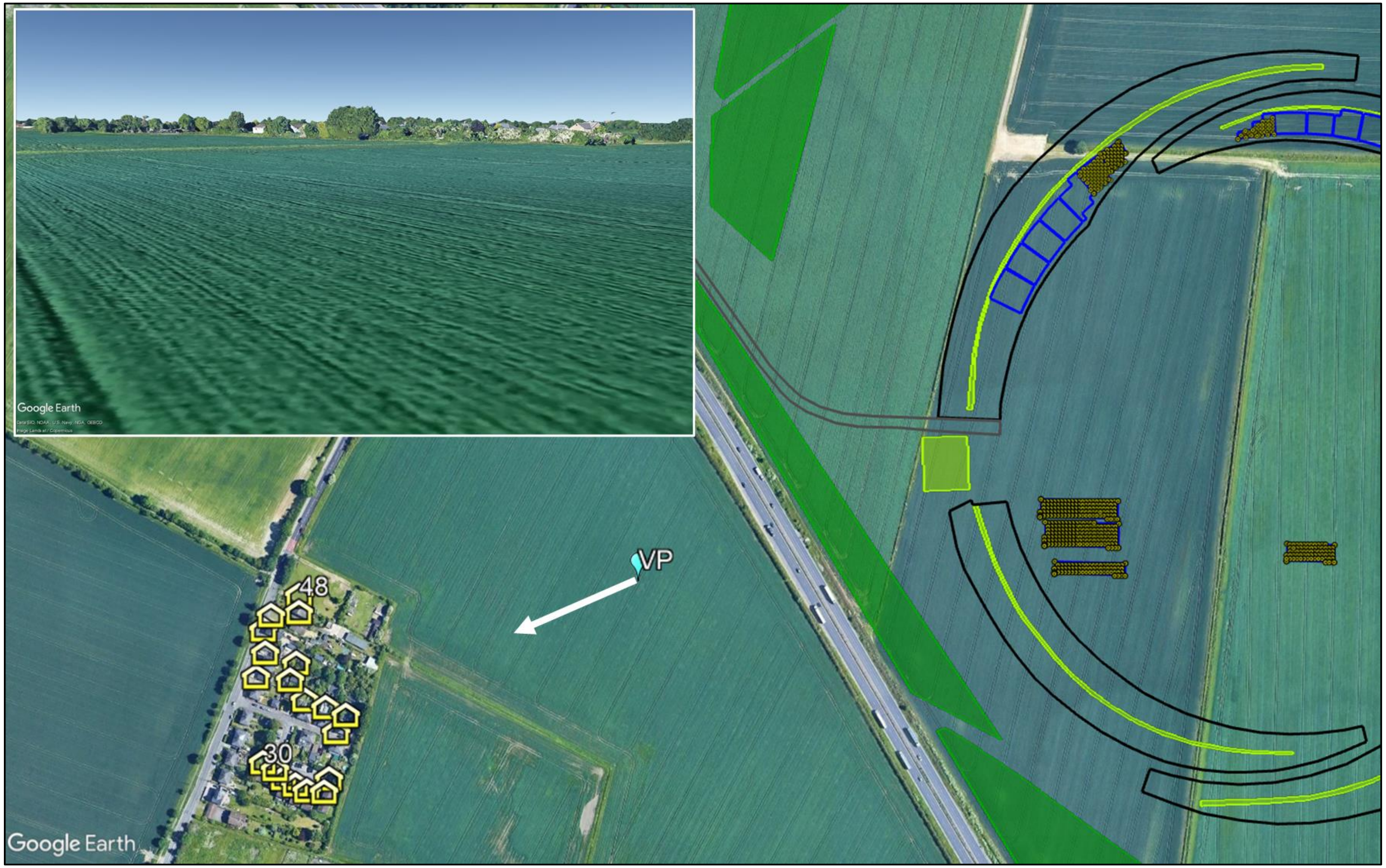


Figure 46 *Viewpoint and reflecting areas - dwelling receptors 30 to 48*

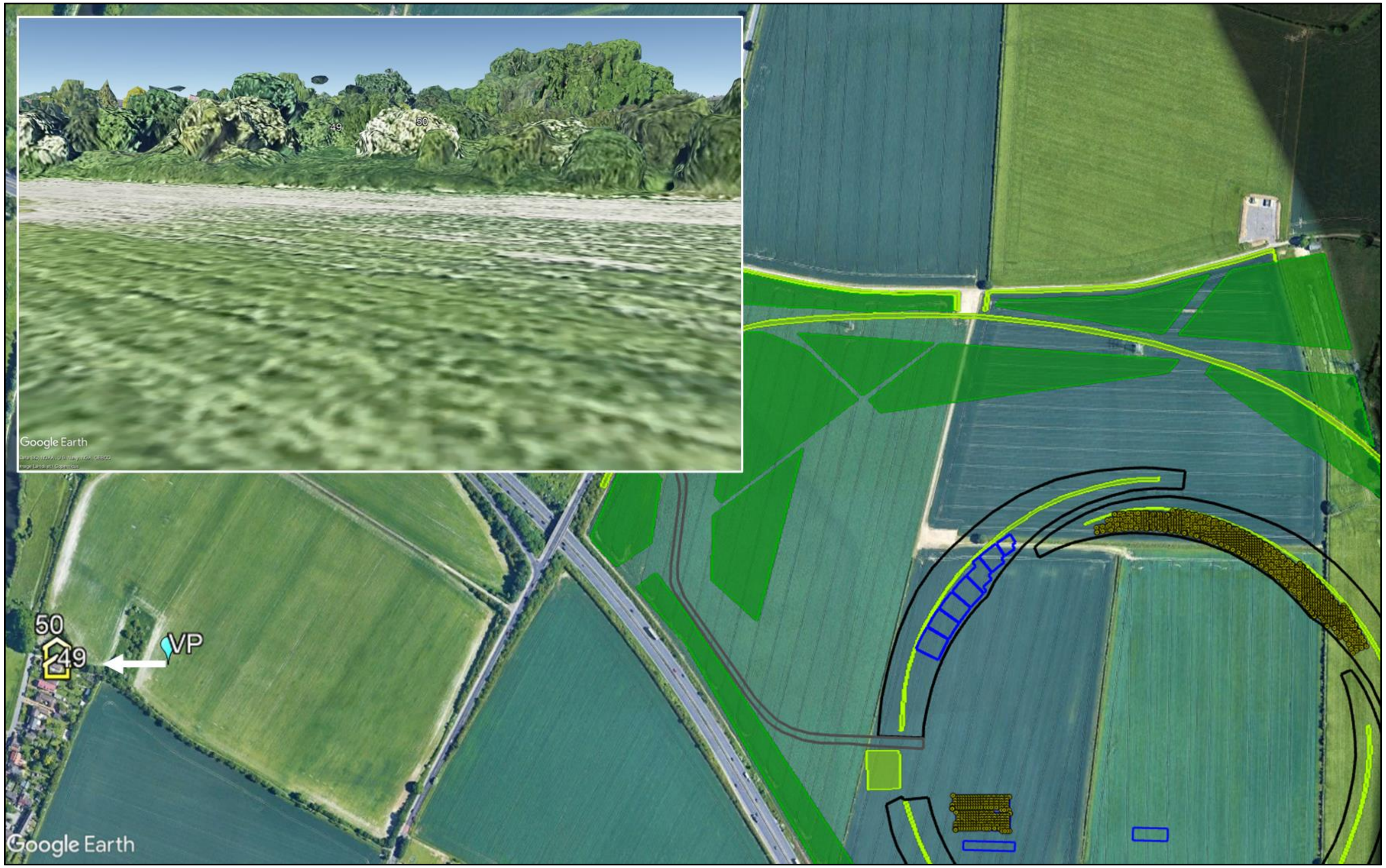


Figure 47 *Viewpoint and reflecting areas - dwelling receptors 49 and 50*

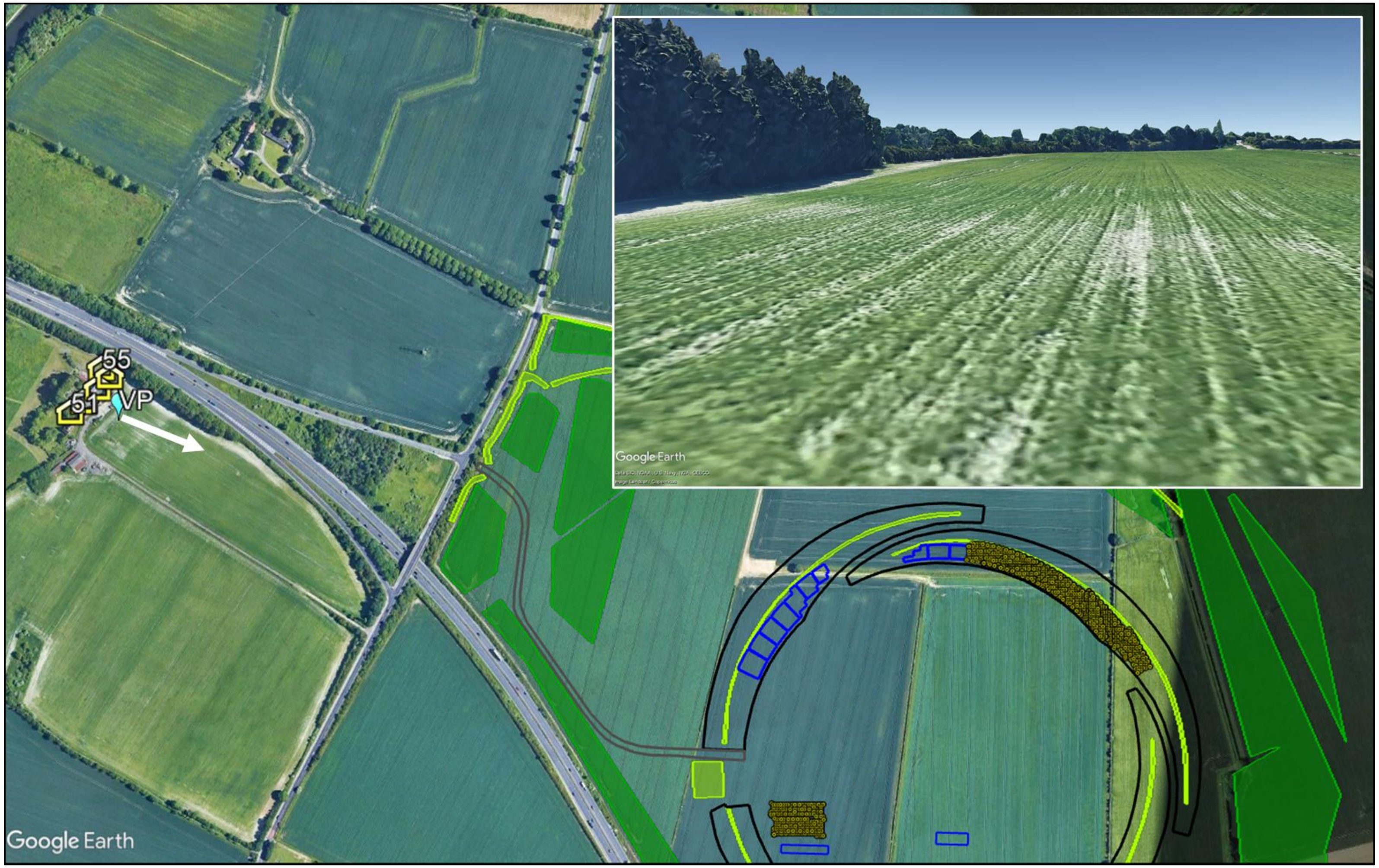


Figure 48 *Viewpoint and reflecting areas - dwelling receptors 51 to 55*

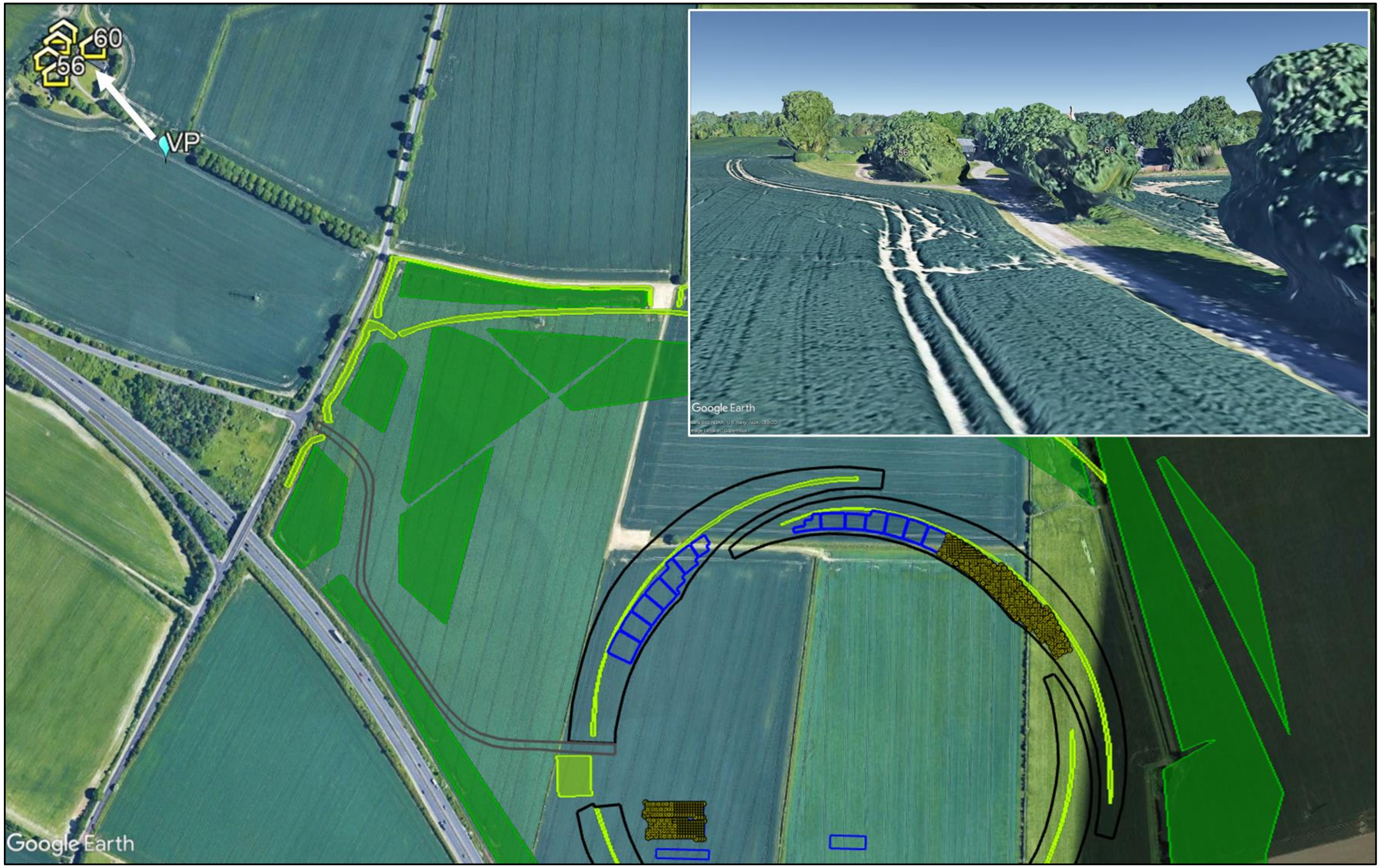


Figure 49 *Viewpoint and reflecting areas - dwelling receptors 56 to 60*

9 OVERALL CONCLUSIONS

9.1 ATC Tower

No solar reflection is geometrically possible towards the ATC Tower.

No impact is predicted, and no mitigation is required.

9.2 Runway Approaches 05 and 05G

No solar reflection is geometrically possible towards the runway approach paths 05 and 05G.

No impact is predicted, and no mitigation is required.

9.3 Runway Approach 23

The analysis has shown that solar reflections are predicted towards the 2-mile runway approach path 23.

From the threshold to 1.2 miles from the threshold no solar reflection is geometrically possible.

From 1.2 to 1.4 miles from the threshold solar reflections are geometrically possible. Solar reflections are predicted to occur outside of a pilot's primary field of view (50 degrees either side of the approach bearing), which is acceptable considering the associated guidance (Appendix D).

From 1.4 miles to 2 miles from the threshold solar reflections are geometrically possible. All glare intensities are no greater than 'low potential for temporary after-image', which is acceptable considering the associated guidance (Appendix D).

A low impact is predicted, and no mitigation is required.

9.4 Runway Approach 23G

The analysis has shown that solar reflections are predicted towards the 2-mile runway approach path 23G.

From the threshold to 1.3 miles from the threshold no solar reflection is geometrically possible.

From 1.3 to 1.5 miles from the threshold solar reflections are geometrically possible. Solar reflections are predicted to occur outside of a pilot's primary field of view (50 degrees either side of the approach bearing), which is acceptable considering the associated guidance (Appendix D).

From 1.5 miles to 2 miles from the threshold solar reflections are geometrically possible. All glare intensities are no greater than 'low potential for temporary after-image', which is acceptable considering the associated guidance (Appendix D). A low impact is predicted, and no mitigation is required.

9.5 Roads

For most of the assessed sections of the A14, the B1047 and Horningsea Road, where solar reflections are geometrically possible, screening in the form of existing vegetation and/or buildings will significantly obstruct the views of the reflecting panels. This means that observers will not experience solar reflections in practice. Furthermore, where there are gaps in existing screening, there is further screening in the form of proposed vegetation and/or terrain (proposed earth bund). Further to the proposed screening removing views of the reflecting panels, no impact is predicted. No further mitigation is recommended.

9.6 Dwellings

For most of the surrounding dwellings where solar reflections are geometrically possible, screening in the form of existing vegetation will significantly obstruct the views of the reflecting panels. This means that observers will not experience solar reflections in practice. Furthermore, where there are gaps in existing screening, there is further screening in the form of proposed vegetation and/or terrain (proposed earth bund). Further to the proposed screening removing views of the reflecting panels, no impact is predicted. No further mitigation is recommended.

9.7 Overall Conclusions

No significant impacts are predicted upon aviation activity at Cambridge Airport.

Further to proposed screening removing views of the reflecting panels, no impacts upon road safety or residential amenity are predicted. No further mitigation is recommended.

APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'.

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

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[20] (specifically regarding the consideration of solar farms, paragraph 013) states:

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

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

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

…

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

…

The approach to assessing cumulative landscape and visual impact of large scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero.'

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[20] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 01/11/2021

Draft National Policy Statement for Renewable Energy Infrastructure

The Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)[21] sets out the primary policy for decisions by the Secretary of State for nationally significant renewable energy infrastructure. Section 2.52 states:

'2.52.1 Solar panels may reflect the sun's rays, causing glint and glare. Glint is defined as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.

2.52.2 In some instances, it may be necessary to seek a glint and glare assessment as part of the application. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts. The potential for solar PV panels, frames and supports to have a combined reflective quality should be assessed. This assessment needs to consider the likely reflective capacity of all of the materials used[22] in the construction of the solar PV farm.

2.52.3 Applicants should consider using, and in some cases the Secretary of State may require, solar panels to be of a non-glare/ non-reflective type and the front face of the panels to comprise of (or be covered) with a non-reflective coating for the lifetime of the permission.

2.52.4 Solar PV panels are designed to absorb, not reflect, irradiation. However, the Secretary of State should assess the potential impact of glint and glare on nearby homes and motorists.

2.52.5 There is no evidence that glint and glare from solar farms interferes in any way with aviation navigation or pilot and aircraft visibility or safety. Therefore, the Secretary of State is unlikely to have to give any weight to claims of aviation interference as a result of glint and glare from solar farms.'

Consultation to determine whether EN-3 provides a suitable framework to support decision making for nationally significant energy infrastructure ended in November 2021. Pager Power is

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[21] Draft National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Business, Energy & Industrial Strategy, date: September 2021, accessed on: 01/11/2021.

[22] In Pager Power's experience, the solar panels themselves are the overriding source of specular reflections which have the potential to cause significant impacts upon safety or amenity.

aware that aviation stakeholders were not consulted prior to the publication of the draft policy and understands that they will still request a glint and glare assessment on the basis that glare may lead to impact upon aviation safety. It is possible that the draft policy will change in light of the consultation responses from aviation stakeholders.

Finally, it should be noted that the EN-3 relates solely to nationally significant renewable energy infrastructure and therefore does not apply to all planning applications for solar farms.

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare has been determined when assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

The Pager Power approach has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[23] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

Aviation Assessment Guidance

The UK Civil Aviation Authority (CAA) issued interim guidance relating to Solar Photovoltaic Systems (SPV) on 17 December 2010 and was subject to a CAA information alert 2010/53. The formal policy was cancelled on September 7th, 2012[24] however the advice is still applicable[25] until a formal policy is developed. The relevant aviation guidance from the CAA is presented in the section below.

CAA Interim Guidance

This interim guidance makes the following recommendations (p.2-3):

'8. It is recommended that, as part of a planning application, the SPV developer provide safety assurance documentation (including risk assessment) regarding the full potential impact of the SPV installation on aviation interests.

9. Guidance on safeguarding procedures at CAA licensed aerodromes is published within CAP 738 Safeguarding of Aerodromes and advice for unlicensed aerodromes is contained within CAP 793 Safe Operating Practices at Unlicensed Aerodromes.

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[23] Solar Photovoltaic Development Glint and Glare Guidance, Third Edition V3.1, May 2021. Pager Power.

[24] Archived at Pager Power

[25] Reference email from the CAA dated 19/05/2014.

10. Where proposed developments in the vicinity of aerodromes require an application for planning permission the relevant LPA normally consults aerodrome operators or NATS when aeronautical interests might be affected. This consultation procedure is a statutory obligation in the case of certain major airports, and may include military establishments and certain air traffic surveillance technical sites. These arrangements are explained in Department for Transport Circular 1/2003 and for Scotland, Scottish Government Circular 2/2003.

11. In the event of SPV developments proposed under the Electricity Act, the relevant government department should routinely consult with the CAA. There is therefore no requirement for the CAA to be separately consulted for such proposed SPV installations or developments.

12. If an installation of SPV systems is planned on-aerodrome (i.e. within its licensed boundary) then it is recommended that data on the reflectivity of the solar panel material should be included in any assessment before installation approval can be granted. Although approval for installation is the responsibility of the ALH[26]*, as part of a condition of a CAA Aerodrome Licence, the ALH is required to obtain prior consent from CAA Aerodrome Standards Department before any work is begun or approval to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Aerodrome Infrastructure.*

13. During the installation and associated construction of SPV systems there may also be a need to liaise with nearby aerodromes if cranes are to be used; CAA notification and permission is not required.

14. The CAA aims to replace this informal guidance with formal policy in due course and reserves the right to cancel, amend or alter the guidance provided in this document at its discretion upon receipt of new information.

15. Further guidance may be obtained from CAA's Aerodrome Standards Department via aerodromes@caa.co.uk.'

FAA Guidance

The most comprehensive guidelines available for the assessment of solar developments near aerodromes has been produced by the United States Federal Aviation Administration (FAA). The first guidelines were produced initially in November 2010 and updated in 2013. A final policy was released in 2021, which superseded the interim guidance.

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'[27], the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects*

[26] Aerodrome Licence Holder.

[27] Archived at Pager Power

on Federally Obligated Airports'[28], and the 2021 final policy is entitled '*Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'*[29].

Key excerpts from the final policy are presented below:

Initially, FAA believed that solar energy systems could introduce a novel glint and glare effect to pilots on final approach. FAA has subsequently concluded that in most cases, the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features. However, FAA has continued to receive reports of potential glint and glare from on-airport solar energy systems on personnel working in ATCT cabs. Therefore, FAA has determined the scope of agency policy should be focused on the impact of on-airport solar energy systems to federally-obligated towered airports, specifically the airport's ATCT cab.

The policy in this document updates and replaces the previous policy by encouraging airport sponsors to conduct an ocular analysis of potential impacts to ATCT cabs prior to submittal of a Notice of Proposed Construction or Alteration Form 7460-1 (hereinafter Form 7460-1). Airport sponsors are no longer required to submit the results of an ocular analysis to FAA. Instead, to demonstrate compliance with 14 CFR 77.5(c), FAA will rely on the submittal of Form 7460-1 in which the sponsor confirms that it has analyzed the potential for glint and glare and determined there is no potential for ocular impact to the airport's ATCT cab. This process will enable FAA to evaluate the solar energy system project, with assurance that the system will not impact the ATCT cab.

FAA encourages airport sponsors of federally-obligated towered airports to conduct a sufficient analysis to support their assertion that a proposed solar energy system will not result in ocular impacts. There are several tools available on the open market to airport sponsors that can analyze potential glint and glare to an ATCT cab. For proposed systems that will clearly not impact ATCT cabs (e.g., on-airport solar energy systems that are blocked from the ATCT cab's view by another structure), the use of such tools may not be necessary to support the assertion that a proposed solar energy system will not result in ocular impacts.

The excerpt above states where a solar PV development is to be located on a federally obligated aerodrome with an ATC Tower, it will require a glint and glare assessment to accompany its application. It states that pilots on approach are no longer a specific assessment requirement due to effects from solar energy systems being similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features.

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[28] [redacted] Department of Transportation, Federal Aviation Administration (FAA), date: 10/2013, accessed on: 08/12/2021.

[29] [redacted] Federal Aviation Administration, date: May 2021, accessed on: 08/12/2021.

Ultimately it comes down to the specific aerodrome to ensure it is adequately safeguarded, and it is on this basis that glint and glare assessments are routinely still requested.

The policy also states that several different tools and methodologies can be used to assess the impacts of glint and glare, which was previously required to be undertaken by the Solar Glare Hazard Analysis Tool (SGHAT) using the Sandia National Laboratories methodology.

In 2018, the FAA released the latest version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports'*[30]. Whilst the 2021 final policy also supersedes this guidance, many of the points are still relevant because aerodromes are still safeguarding against glint and glare irrespective of the FAA guidance. The key points are presented below for reference:

- *Reflectivity refers to light that is reflected off surfaces. The potential effects of reflectivity are glint (a momentary flash of bright light) and glare (a continuous source of bright light). These two effects are referred to hereinafter as "glare," which can cause a brief loss of vision, also known as flash blindness*[31].
- *The amount of light reflected off a solar panel surface depends on the amount of sunlight hitting the surface, its surface reflectivity, geographic location, time of year, cloud cover, and solar panel orientation.*
- *As illustrated on Figure 16*[32]*, flat, smooth surfaces reflect a more concentrated amount of sunlight back to the receiver, which is referred to as specular reflection. The more a surface is polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.*
- *Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:*
    - *A qualitative analysis of potential impact in consultation with the Control Tower, pilots and airport officials;*
    - *A demonstration field test with solar panels at the proposed site in coordination with FAA Tower personnel;*
    - *A geometric analysis to determine days and times when an impact is predicted.*

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[30] [redacted] Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

[31] Flash Blindness, as described in the FAA guidelines, can be described as a temporary visual interference effect that persists after the source of illumination has ceased. This occurs from many reflective materials in the ambient environment.

[32] First figure in Appendix B.

- *The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and system design.*
- ***1. Assessing Baseline Reflectivity Conditions*** *– Reflection in the form of glare is present in current aviation operations. The existing sources of glare come from glass windows, auto surface parking, rooftops, and water bodies. At airports, existing reflecting surfaces may include hangar roofs, surface parking, and glassy office buildings. To minimize unexpected glare, windows of air traffic control towers and airplane cockpits are coated with anti-reflective glazing. Operators also wear polarized eye wear. Potential glare from solar panels should be viewed in this context. Any airport considering a solar PV project should first review existing sources of glare at the airport and the effectiveness of measures used to mitigate that glare.*
- ***2. Tests in the Field*** *– Potential glare from solar panels can easily be viewed at the airport through a field test. A few airports have coordinated these tests with FAA Air Traffic Controllers to assess the significance of glare impacts. To conduct such a test, a sponsor can take a solar panel out to proposed location of the solar project, and tilt the panel in different directions to evaluate the potential for glare onto the air traffic control tower. For the two known cases where a field test was conducted, tower personnel determined the glare was not significant. If there is a significant glare impact, the project can be modified by ensuring panels are not directed in that direction.*
- ***3. Geometric Analysis*** *– Geometric studies are the most technical approach for reflectivity issues. They are conducted when glare is difficult to assess through other methods. Studies of glare can employ geometry and the known path of the sun to predict when sunlight will reflect off of a fixed surface (like a solar panel) and contact a fixed receptor (e.g., control tower). At any given site, the sun moves across the sky every day and its path in the sky changes throughout year. This in turn alters the destination of the resultant reflections since the angle of reflection for the solar panels will be the same as the angle at which the sun hits the panels. The larger the reflective surface, the greater the likelihood of glare impacts.*
- *Facilities placed in remote locations, like the desert, will be far from receptors and therefore potential impacts are limited to passing aircraft. Because the intensity of the light reflected from the solar panel decreases with increasing distance, an appropriate question is how far you need to be from a solar reflected surface to avoid flash blindness. It is known that this distance is directly proportional to the size of the array in question*[33] *but still requires further research to definitively answer.*

[33] Ho, Clifford, Cheryl Ghanbari, and Richard Diver. 2009. Hazard Analysis of Glint and Glare From Concentrating Solar Power Plants. SolarPACES 2009, Berlin Germany. Sandia National Laboratories.

- ***Experiences of Existing Airport Solar Projects*** *– Solar installations are presently operating at a number of airports, including megawatt-sized solar facilities covering multiple acres. Air traffic control towers have expressed concern about glint and glare from a small number of solar installations. These were often instances when solar installations were sited between the tower and airfield, or for installations with inadequate or no reflectivity analysis. Adequate reflectivity analysis and alternative siting addressed initial issues at those installations.*

Air Navigation Order (ANO) 2016

In some instances, an aviation stakeholder can refer to the ANO 2016[34] with regard to safeguarding. Key points from the document are presented below.

Lights liable to endanger

224. (1) A person must not exhibit in the United Kingdom any light which—

(a) by reason of its glare is liable to endanger aircraft taking off from or landing at an aerodrome; or

(b) by reason of its liability to be mistaken for an aeronautical ground light is liable to endanger aircraft.

(2) If any light which appears to the CAA to be a light described in paragraph (1) is exhibited, the CAA may direct the person who is the occupier of the place where the light is exhibited or who has charge of the light, to take such steps within a reasonable time as are specified in the direction—

(a) to extinguish or screen the light; and

(b) to prevent in the future the exhibition of any other light which may similarly endanger aircraft.

(3) The direction may be served either personally or by post, or by affixing it in some conspicuous place near to the light to which it relates.

(4) In the case of a light which is or may be visible from any waters within the area of a general lighthouse authority, the power of the CAA under this article must not be exercised except with the consent of that authority.

Lights which dazzle or distract

225. A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft.'

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[34] The Air Navigation Order 2016. [online] Available at: <https://www.legislation.gov.uk/uksi/2016/765/contents/made> [Accessed 4 February 2022].

The document states that no 'light', 'dazzle' or 'glare' should be produced which will create a detrimental impact upon aircraft safety.

Endangering safety of an aircraft

240. A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft.

Endangering safety of any person or property

241. A person must not recklessly or negligently cause or permit an aircraft to endanger any person or property.

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

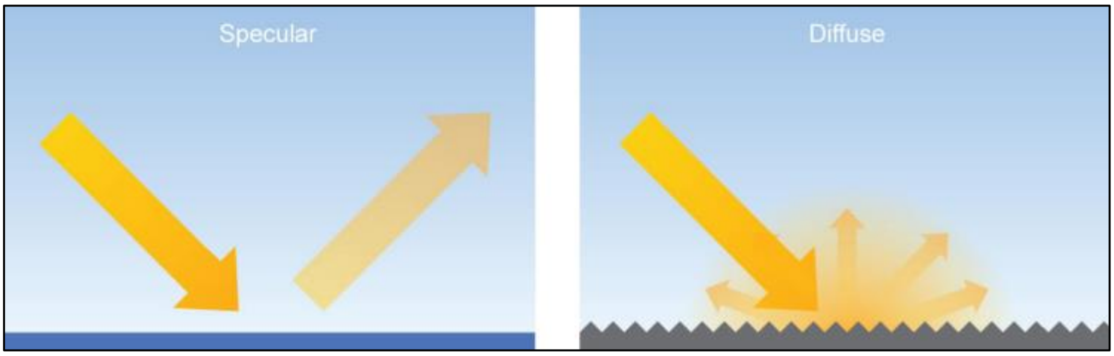
Overview

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

The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[35], illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

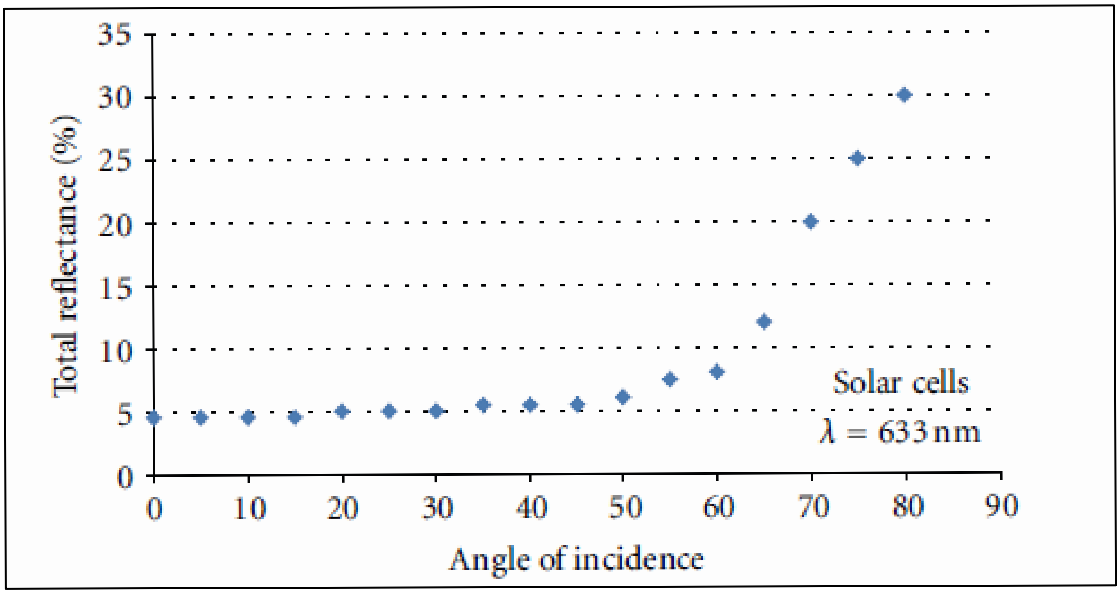
35 [redacted] Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

Solar Reflection Studies

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

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

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[36]". They researched the potential glare that a pilot could experience from a 25-degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

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

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

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

FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[37]

The 2018 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected[38]
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

Relative reflectivity of various surfaces

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

An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by

[37] [redacted] Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

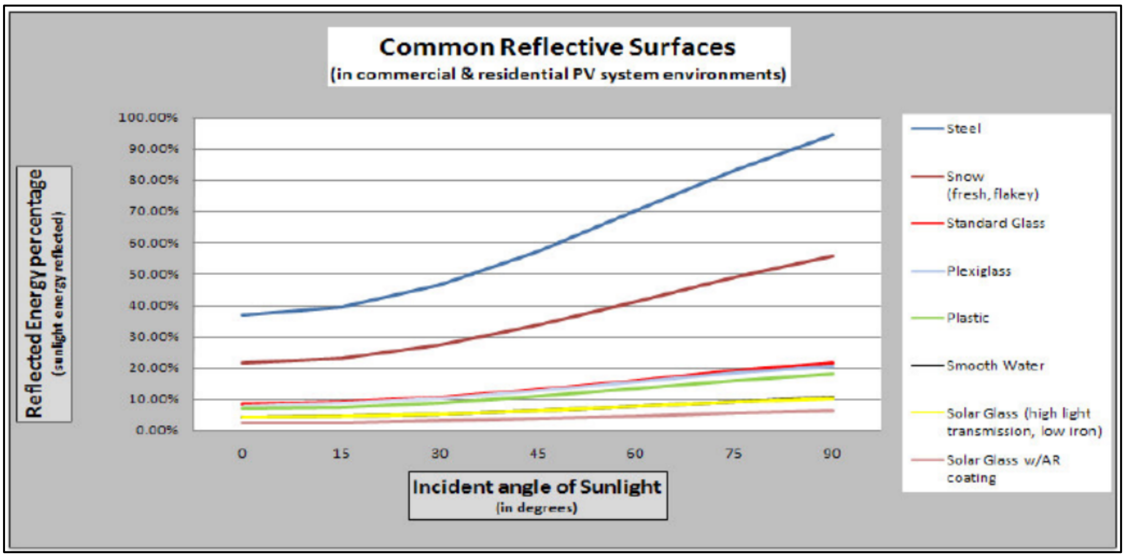
[38] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

SunPower Technical Notification (2009)

SunPower published a technical notification[39] to '*increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment*'.

The figure presented below shows the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel.



Common reflective surfaces

The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those of '*standard glass and other common reflective surfaces*'.

With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

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

Urban & Renewables

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

The Sun's position in the sky can be accurately described by its azimuth and elevation. Azimuth is a direction relative to true north (horizontal angle i.e. from left to right) and elevation describes the Sun's angle relative to the horizon (vertical angle i.e. up and down).

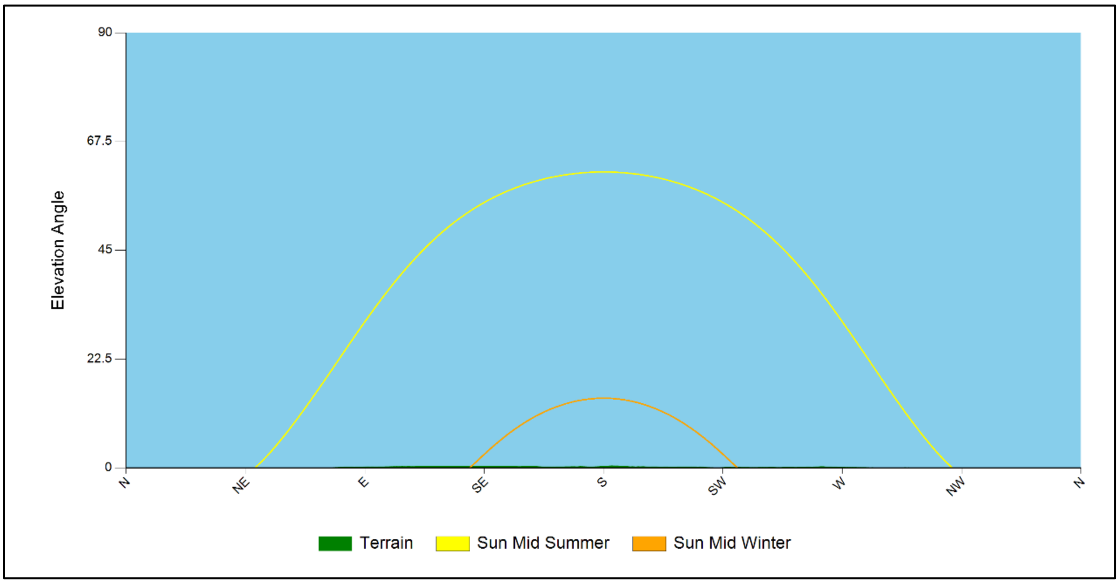
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- Time.
- Date.
- Latitude.
- Longitude.

The following is true at the location of the solar development:

- The Sun is at its highest around midday and is to the south at this time.
- The Sun rises highest on 21 June (longest day).
- On 21 December, the maximum elevation reached by the Sun is at its lowest (shortest day).

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector. The figure below shows terrain at the horizon as well as the sunrise and sunset curves throughout the year from the development location.



APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

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

Impact Significance Definition

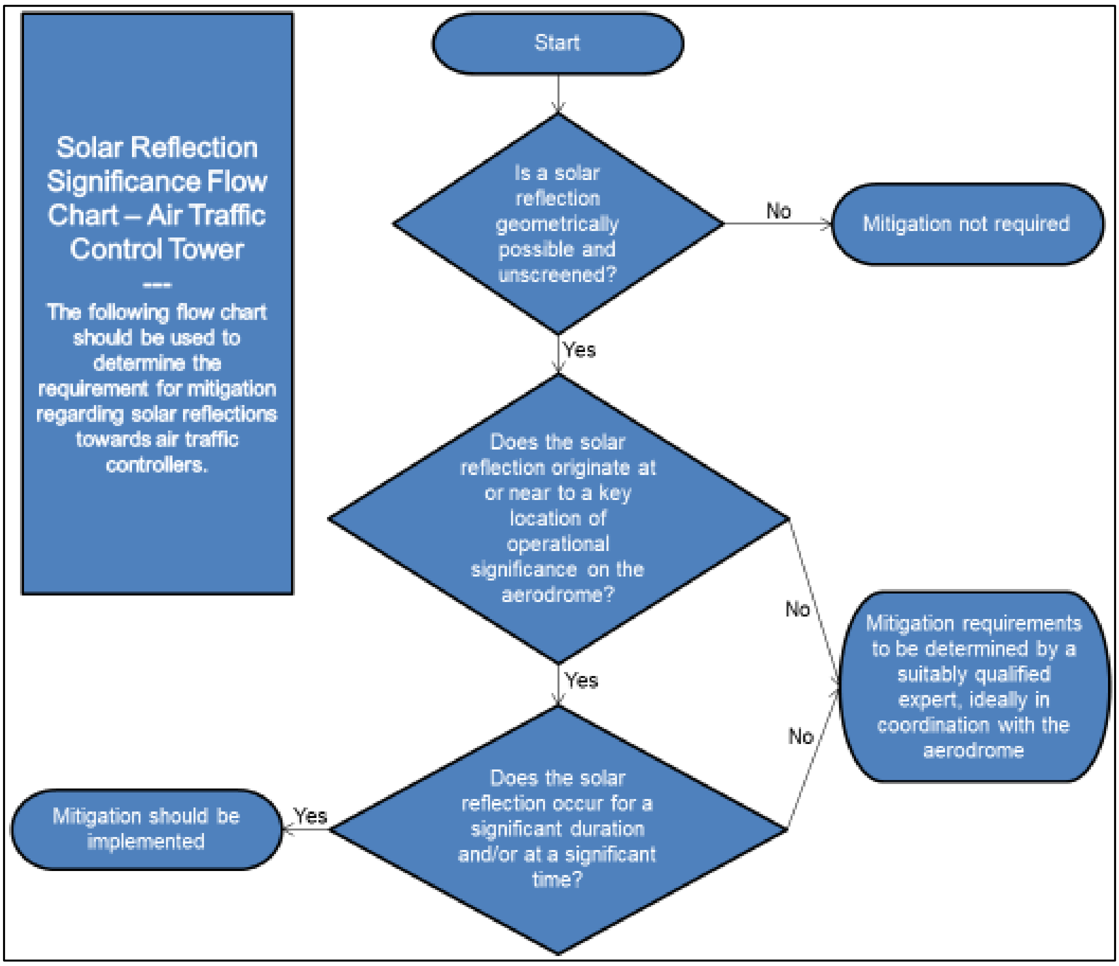
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

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

Impact significance definition

Assessment Process – ATC Tower

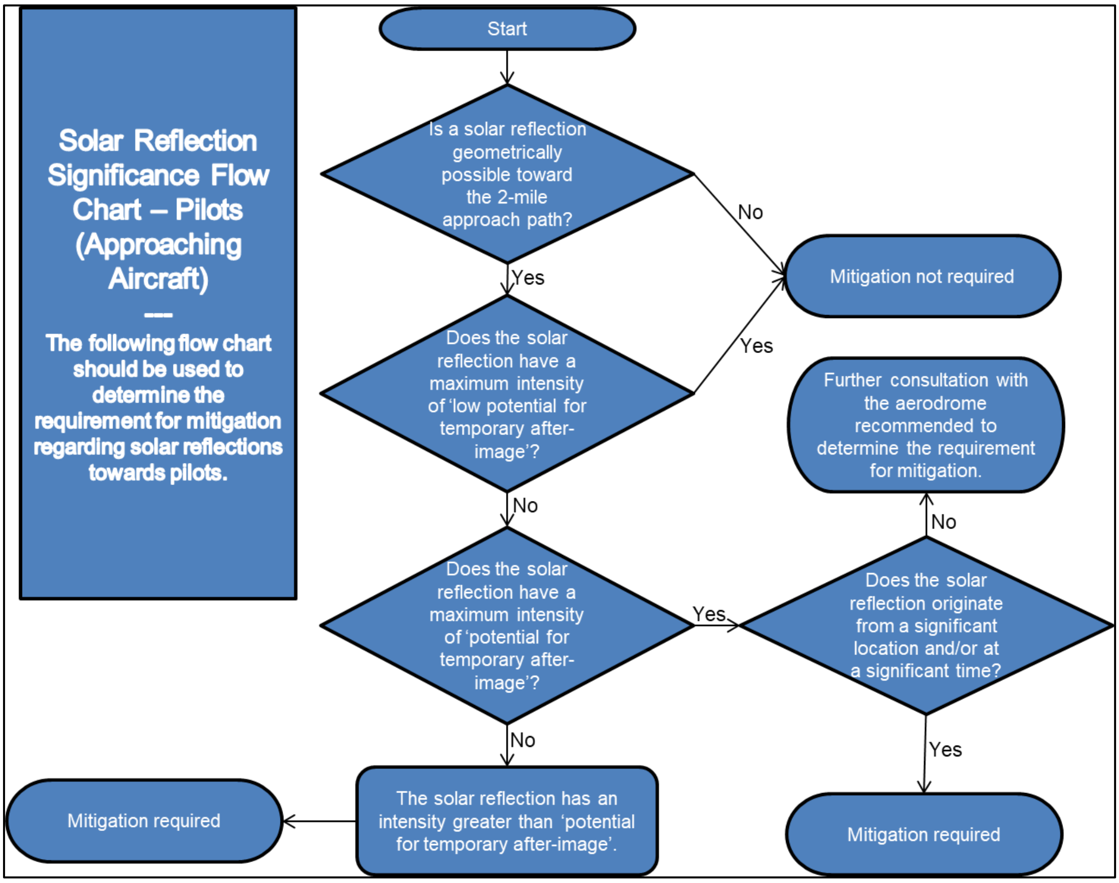
The charts relate to the determining the potential impact upon the ATC Tower.



ATC tower impact significance flow chart

Assessment Process – Approaching Aircraft

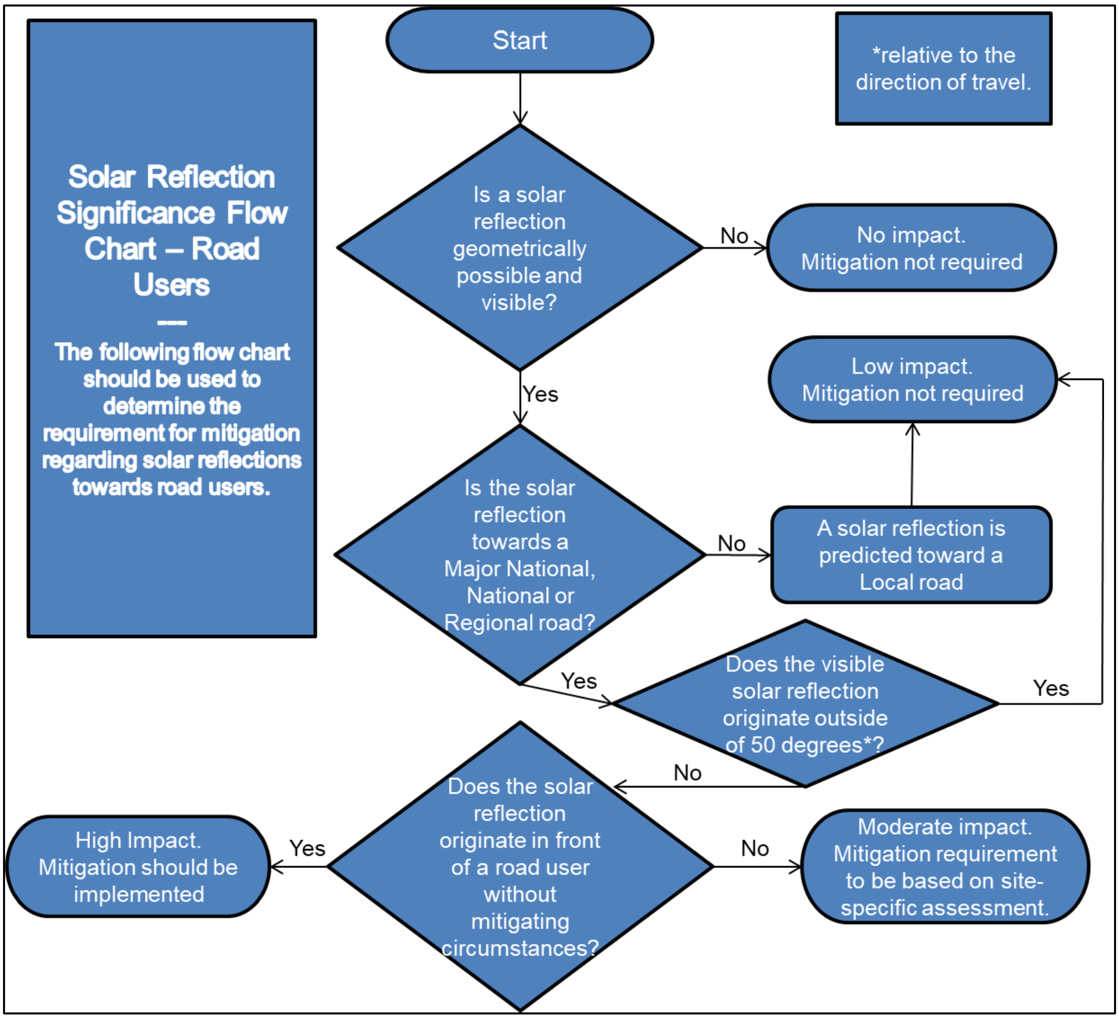
The charts relate to the determining the potential impact upon approaching aircraft.



Pilots (approaching aircraft) impact significance flow chart

Assessment Process for Road Receptors

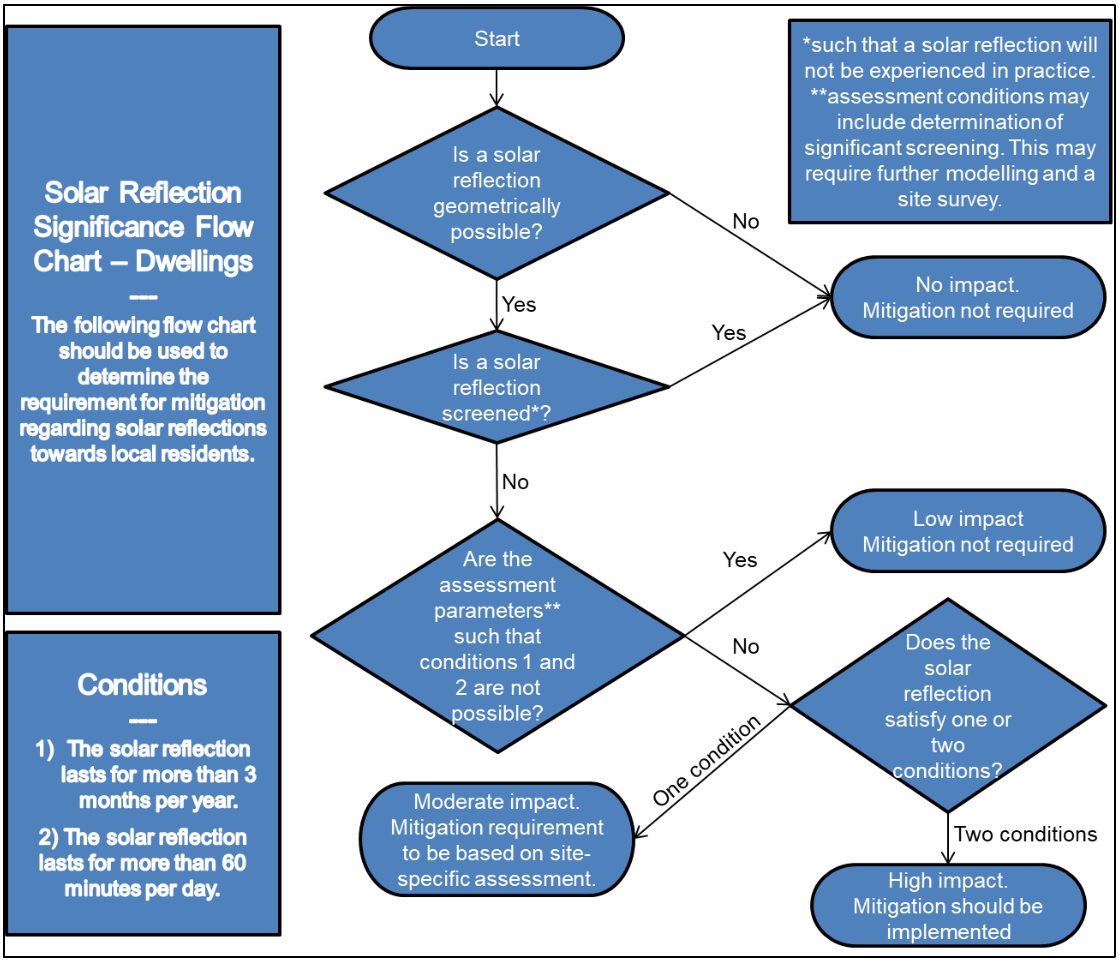
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road user impact significance flow chart

Assessment Process for Dwelling Receptors

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



Dwelling impact significance flow chart

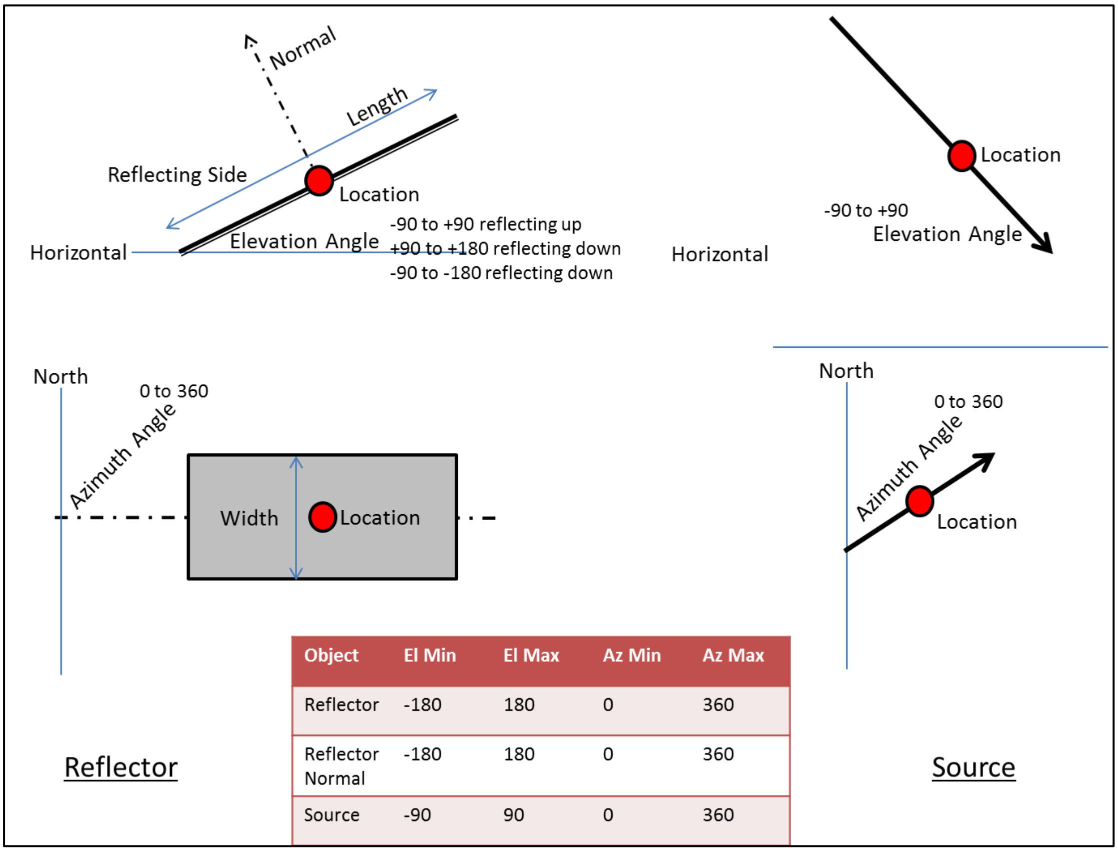
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

- The Earth's orbit around the Sun;
- The Earth's rotation;
- The Earth's orientation;
- The reflector's location;
- The reflector's 3D Orientation.

Reflections from a flat reflector are calculated by considering the normal which is an imaginary line that is perpendicular to the reflective surface and originates from it. The diagram below may be used to aid understanding of the reflection calculation process.



Object	El Min	El Max	Az Min	Az Max
Reflector	-180	180	0	360
Reflector Normal	-180	180	0	360
Source	-90	90	0	360

The following process is used to determine the 3D Azimuth and Elevation of a reflection:

- Use the Latitude and Longitude of reflector as the reference for calculation purposes;
- Calculate the Azimuth and Elevation of the normal to the reflector;
- Calculate the 3D angle between the source and the normal;
- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
    - The angle between source and normal is equal to angle between normal and reflection;

Source, Normal and Reflection are in the same plane.

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Pager Power's Model

The model considers 100% sunlight during daylight hours which is highly conservative.

The model does not account for terrain between the reflecting solar panels and the assessed receptor where a solar reflection is geometrically possible.

The model considers terrain between the reflecting solar panels and the visible horizon (where the sun may be obstructed from view of the panels)[40].

It is assumed that the panel elevation angle assessed represents the elevation angle for all of the panels within each solar panel area defined.

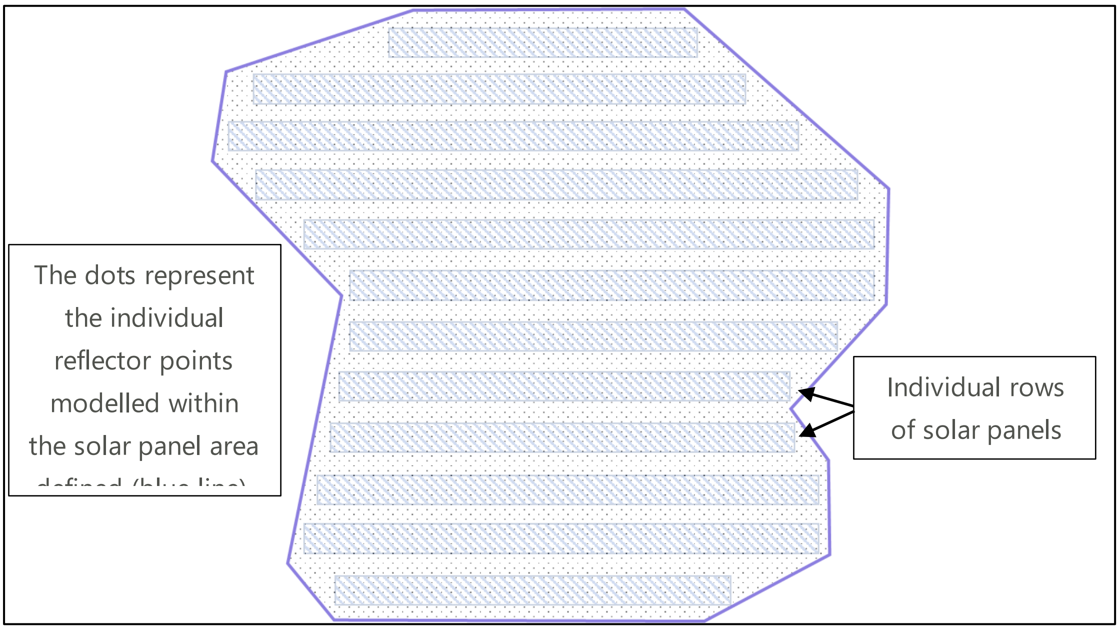
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

Only a reflection from the face of the panel has been considered. The frame or the reverse of the frame of the solar panel has not been considered.

The model assumes that a receptor can view the face of every panel (point, defined in the following paragraph) within the development area whilst in reality this, in the majority of cases, will not occur. Therefore any predicted solar reflection from the face of a solar panel that is not visible to a receptor will not occur in practice.

A finite number of points within each solar panel area defined is chosen based on an assessment resolution so that a comprehensive understanding of the entire development can be formed. This determines whether a solar reflection could ever occur at a chosen receptor. The model does not consider the specific panel rows or the entire face of the solar panel within the development outline, rather a single point is defined every 'x' metres (based on the assessment resolution) with the geometric characteristics of the panel. A panel area is however defined to encapsulate all possible panel locations. See the figure below which illustrates this process.

[40] UK only.



Solar panel area modelling overview

A single reflection point is chosen for the geometric calculations. This suitably determines whether a solar reflection can be experienced at a receptor location and the time of year and duration of the solar reflection. Increased accuracy could be achieved by increasing the number of heights assessed however this would only marginally change the results and is not considered significant.

The available street view imagery, satellite mapping, terrain and any site imagery provided by the developer has been used to assess line of sight from the assessed receptors to the modelled solar panel area, unless stated otherwise. In some cases, this imagery may not be up to date and may not give the full perspective of the installation from the location of the assessed receptor.

Any screening in the form of trees, buildings etc. that may obstruct the Sun from view of the solar panels is not within the modelling unless stated otherwise. The terrain profile at the horizon is considered if stated.

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

ATC Receptor Details

The co-ordinates and overall altitude of the ATC Tower has been extrapolated from available maps and imagery. The ground height has been taken from Pager Power's database[41] based on the co-ordinates of the ATC Tower. The details are presented in the table below.

Longitude (°)	Latitude (°)	Ground Height (m) (amsl)	ATC Tower Height (m) (agl)	Overall Assessed Altitude (m) (amsl)
0.17277	52.20807	15.39	24	39.39

ATC Tower receptor details

The Approach Path for Aircraft Landing on Runway 05

The table below presents the data for the assessed locations for aircraft on approach to runway 05. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.24m) above the runway threshold (10.88m/35.7ft[42] amsl).

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
Threshold	0.16646	52.20059	26.12
Receptor 02	0.16465	52.19966	34.56
Receptor 03	0.16285	52.19872	42.99
Receptor 04	0.16104	52.19779	51.42
Receptor 05	0.15923	52.19686	59.86
Receptor 06	0.15743	52.19592	68.29
Receptor 07	0.15562	52.19499	76.73
Receptor 08	0.15381	52.19405	85.16

[41] Based on OS Panorama 50m DTM

[42] Source: NATS AIP.

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
Receptor 09	0.15201	52.19312	93.60
Receptor 10	0.15020	52.19219	102.03
Receptor 11 – 1 mile	0.14839	52.19125	110.46
Receptor 12	0.14659	52.19032	118.90
Receptor 13	0.14478	52.18939	127.33
Receptor 14	0.14297	52.18845	135.77
Receptor 15	0.14117	52.18752	144.20
Receptor 16	0.13936	52.18659	152.63
Receptor 17	0.13755	52.18565	161.07
Receptor 18	0.13575	52.18472	169.50
Receptor 19	0.13394	52.18379	177.94
Receptor 20	0.13213	52.18285	186.37
Receptor 21 – 2 miles	0.13033	52.18192	194.81

Assessed receptor (aircraft) locations on the approach path for runway 05

The Approach Path for Aircraft Landing on Runway 23

The table below presents the data for the assessed locations for aircraft on approach to runway 23. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.24m) above the runway threshold (14.48m/47.5ft amsl).

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
Threshold	0.18440	52.20988	29.72
Receptor 02	0.18620	52.21081	38.15
Receptor 03	0.18801	52.21174	46.59
Receptor 04	0.18982	52.21267	55.02

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
Receptor 05	0.19163	52.21361	63.45
Receptor 06	0.19344	52.21454	71.89
Receptor 07	0.19524	52.21547	80.32
Receptor 08	0.19705	52.21641	88.76
Receptor 09	0.19886	52.21734	97.19
Receptor 10	0.20067	52.21827	105.63
Receptor 11 – 1 mile	0.20247	52.21921	114.06
Receptor 12	0.20428	52.22014	122.49
Receptor 13	0.20609	52.22107	130.93
Receptor 14	0.20790	52.22200	139.36
Receptor 15	0.20970	52.22294	147.80
Receptor 16	0.21151	52.22387	156.23
Receptor 17	0.21332	52.22480	164.67
Receptor 18	0.21513	52.22574	173.10
Receptor 19	0.21693	52.22667	181.53
Receptor 20	0.21874	52.22760	189.97
Receptor 21 – 2 miles	0.22055	52.22854	198.40

Assessed receptor (aircraft) locations on the approach path for runway 23

The Approach Path for Aircraft Landing on Runway 05G

The table below presents the data for the assessed locations for aircraft on approach to runway 05G. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.24m) above the runway threshold (10.85m/35.6ft amsl).

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
Threshold	0.17559	52.20309	26.09
Receptor 02	0.17379	52.20216	34.53
Receptor 03	0.17198	52.20122	42.96
Receptor 04	0.17017	52.20029	51.39
Receptor 05	0.16836	52.19936	59.83
Receptor 06	0.16655	52.19843	68.26
Receptor 07	0.16475	52.19749	76.70
Receptor 08	0.16294	52.19656	85.13
Receptor 09	0.16113	52.19563	93.56
Receptor 10	0.15932	52.19469	102.00
Receptor 11 – 1 mile	0.15752	52.19376	110.43
Receptor 12	0.15571	52.19283	118.87
Receptor 13	0.15390	52.19190	127.30
Receptor 14	0.15209	52.19096	135.74
Receptor 15	0.15028	52.19003	144.17
Receptor 16	0.14848	52.18910	152.60
Receptor 17	0.14667	52.18817	161.04
Receptor 18	0.14486	52.18723	169.47
Receptor 19	0.14305	52.18630	177.91
Receptor 20	0.14124	52.18537	186.34
Receptor 21 – 2 miles	0.13944	52.18444	194.78

Assessed receptor (aircraft) locations on the approach path for runway 05G

The Approach Path for Aircraft Landing on Runway 23G

The table below presents the data for the assessed locations for aircraft on approach to runway 23G. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.24m) above the runway threshold (10.82m/47.5ft amsl).

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
Threshold	0.18567	52.20830	26.06
Receptor 02	0.18748	52.20923	34.49
Receptor 03	0.18928	52.21016	42.93
Receptor 04	0.19109	52.21109	51.36
Receptor 05	0.19290	52.21203	59.80
Receptor 06	0.19471	52.21296	68.23
Receptor 07	0.19652	52.21389	76.67
Receptor 08	0.19833	52.21482	85.10
Receptor 09	0.20013	52.21576	93.53
Receptor 10	0.20194	52.21669	101.97
Receptor 11 – 1 mile	0.20375	52.21762	110.40
Receptor 12	0.20556	52.21855	118.84
Receptor 13	0.20737	52.21949	127.27
Receptor 14	0.20918	52.22042	135.71
Receptor 15	0.21098	52.22135	144.14
Receptor 16	0.21279	52.22228	152.57
Receptor 17	0.21460	52.22322	161.01
Receptor 18	0.21641	52.22415	169.44
Receptor 19	0.21822	52.22508	177.88
Receptor 20	0.22003	52.22601	186.31

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
Receptor 21 – 2 miles	0.22183	52.22695	194.74

Assessed receptor (aircraft) locations on the approach path for runway 23G

Terrain Height

Ground heights are interpolated based on OSGB36 data.

Road Receptor Data

An additional height of 1.5m has been added to the ground height, this has been taken as typical eye level for a road user.

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	0.17275	52.23196	27	0.17682	52.23094
2	0.17407	52.23157	28	0.17821	52.23064
3	0.17535	52.23112	29	0.17961	52.23037
4	0.17656	52.23063	30	0.18043	52.23021
5	0.17773	52.23008	31	0.18460	52.23782
6	0.17883	52.22948	32	0.18412	52.23697
7	0.17984	52.22885	33	0.18370	52.23610
8	0.18080	52.22816	34	0.18332	52.23523
9	0.18167	52.22745	35	0.18297	52.23438
10	0.18246	52.22669	36	0.18261	52.23350
11	0.18321	52.22591	37	0.18228	52.23263
12	0.18392	52.22517	38	0.18191	52.23176
13	0.18467	52.22439	39	0.18128	52.23092
14	0.18546	52.22355	40	0.18061	52.23014
15	0.18618	52.22281	41	0.17993	52.22934
16	0.18693	52.22203	42	0.17925	52.22854

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
17	0.18765	52.22129	43	0.17857	52.22775
18	0.18853	52.22046	44	0.17790	52.22695
19	0.18937	52.21979	45	0.17717	52.22608
20	0.19036	52.21910	46	0.17667	52.22533
21	0.19131	52.21851	47	0.17616	52.22449
22	0.19250	52.21788	48	0.17559	52.22364
23	0.19409	52.21717	49	0.17498	52.22276
24	0.17281	52.23204	50	0.17443	52.22202
25	0.17415	52.23166	51	0.17392	52.22114
26	0.17548	52.23129			

Road Receptor Data

Dwelling Receptor Data

An additional height of 1.8m has been added to the ground height, this has been taken as typical eye level for an observer on the ground floor.

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	0.52030	51.05443	31	0.17684	52.22411
2	0.52047	51.05400	32	0.17695	52.22404
3	0.51985	51.05432	33	0.17710	52.22399
4	0.51977	51.05441	34	0.17724	52.22394
5	0.51965	51.05456	35	0.17745	52.22394
6	0.51929	51.05442	36	0.17751	52.22404
7	0.51958	51.05423	37	0.17760	52.22439
8	0.51944	51.05405	38	0.17772	52.22452
9	0.51922	51.05404	39	0.17747	52.22458
10	0.51927	51.05421	40	0.17721	52.22463

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
11	0.51892	51.05444	41	0.17703	52.22478
12	0.51886	51.05386	42	0.17710	52.22491
13	0.51860	51.05411	43	0.17661	52.22481
14	0.51838	51.05388	44	0.17672	52.22499
15	0.51837	51.05507	45	0.17669	52.22516
16	0.51840	51.05521	46	0.17679	52.22527
17	0.51746	51.05515	47	0.17713	52.22529
18	0.51674	51.05335	48	0.17714	52.22542
19	0.51667	51.05322	49	0.17108	52.22744
20	0.51290	51.05403	50	0.17108	52.22762
21	0.51260	51.05436	51	0.17326	52.23055
22	0.51240	51.05443	52	0.17351	52.23067
23	0.51124	51.05514	53	0.17378	52.23082
24	0.51067	51.05521	54	0.17399	52.23095
25	0.51168	51.05712	55	0.17385	52.23105
26	0.51132	51.05710	56	0.17651	52.23353
27	0.51072	51.05742	57	0.17637	52.23369
28	0.51018	51.05717	58	0.17653	52.23385
29	0.50674	51.05737	59	0.17662	52.23397
30	0.50648	51.05723	60	0.17712	52.23382

Dwelling Receptor Data

Modelled Reflector Data

An additional height (approximate mid-point of the solar panels) has been added to the existing ground height at each point. The additional height for the ground mounted panels 'G' is 2.7m, car port panels 'C' is 3.5m, and rooftop panels 'R' is 8m.

Area G1

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18570	52.22780	5	0.18625	52.22789
2	0.18575	52.22787	6	0.18620	52.22783
3	0.18582	52.22795	7	0.18614	52.22776
4	0.18589	52.22802	8	0.18608	52.22768

Modelled Reflector Data – Area G1

Area G2

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18590	52.22803	5	0.18643	52.22806
2	0.18597	52.22811	6	0.18636	52.22801
3	0.18601	52.22815	7	0.18632	52.22796
4	0.18609	52.22822	8	0.18626	52.22790

Modelled Reflector Data – Area G2

Area G3

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18610	52.22822	5	0.18663	52.22822
2	0.18616	52.22828	6	0.18655	52.22817
3	0.18622	52.22833	7	0.18650	52.22812
4	0.18631	52.22839	8	0.18643	52.22807

Modelled Reflector Data – Area G3

Area G4

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18631	52.22839	5	0.18685	52.22837
2	0.18640	52.22846	6	0.18677	52.22832
3	0.18647	52.22851	7	0.18670	52.22828
4	0.18655	52.22856	8	0.18663	52.22823

Modelled Reflector Data – Area G4

Area G5

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18656	52.22856	7	0.18693	52.22856
2	0.18665	52.22862	8	0.18699	52.22852
3	0.18672	52.22865	9	0.18691	52.22848
4	0.18666	52.22870	10	0.18684	52.22844
5	0.18676	52.22875	11	0.18690	52.22840
6	0.18698	52.22859	12	0.18685	52.22838

Modelled Reflector Data – Area G5

Area G6

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18677	52.22876	6	0.18715	52.22874
2	0.18687	52.22880	7	0.18720	52.22870
3	0.18697	52.22885	8	0.18714	52.22867
4	0.18706	52.22889	9	0.18707	52.22864
5	0.18720	52.22876	10	0.18699	52.22859

Modelled Reflector Data – Area G6

Area G7

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18707	52.22890	5	0.18738	52.22884
2	0.18730	52.22899	6	0.18732	52.22881
3	0.18739	52.22890	7	0.18727	52.22879
4	0.18734	52.22888	8	0.18721	52.22877

Modelled Reflector Data – Area G7

Area G8

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18878	52.22906	8	0.18916	52.22920
2	0.18888	52.22907	9	0.18923	52.22921
3	0.18898	52.22908	10	0.18924	52.22905
4	0.18897	52.22914	11	0.18916	52.22904
5	0.18903	52.22914	12	0.18903	52.22903
6	0.18910	52.22914	13	0.18889	52.22902
7	0.18909	52.22920	14	0.18879	52.22901

Modelled Reflector Data – Area G8

Area G9

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18924	52.22921	6	0.18955	52.22905

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
2	0.18936	52.22921	7	0.18946	52.22905
3	0.18949	52.22921	8	0.18936	52.22905
4	0.18964	52.22921	9	0.18925	52.22905
5	0.18963	52.22905			

Modelled Reflector Data – Area G9

Area G10

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18965	52.22921	5	0.18996	52.22904
2	0.18976	52.22921	6	0.18986	52.22904
3	0.18987	52.22920	7	0.18975	52.22905
4	0.18999	52.22919	8	0.18964	52.22905

Modelled Reflector Data – Area G10

Area G11

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19000	52.22919	6	0.19035	52.22921
2	0.19007	52.22919	7	0.19028	52.22900
3	0.19008	52.22924	8	0.19017	52.22902
4	0.19017	52.22923	9	0.19008	52.22903
5	0.19027	52.22922	10	0.18997	52.22904

Modelled Reflector Data – Area G11

Area G12

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19036	52.22921	5	0.19059	52.22895
2	0.19048	52.22919	6	0.19049	52.22897
3	0.19056	52.22918	7	0.19040	52.22899

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
4	0.19070	52.22915	8	0.19029	52.22900

Modelled Reflector Data – Area G12

Area G13

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19071	52.22915	5	0.19090	52.22889
2	0.19081	52.22913	6	0.19080	52.22891
3	0.19091	52.22911	7	0.19072	52.22893
4	0.19103	52.22908	8	0.19060	52.22895

Modelled Reflector Data – Area G13

Area G14

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19104	52.22908	5	0.19121	52.22880
2	0.19116	52.22905	6	0.19111	52.22883
3	0.19128	52.22901	7	0.19101	52.22886
4	0.19136	52.22899	8	0.19091	52.22888

Modelled Reflector Data – Area G14

Area G15

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19136	52.22899	5	0.19149	52.22870
2	0.19147	52.22896	6	0.19138	52.22874
3	0.19157	52.22892	7	0.19130	52.22877
4	0.19167	52.22888	8	0.19121	52.22880

Modelled Reflector Data – Area G15

Area G16

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19167	52.22888	5	0.19176	52.22859
2	0.19176	52.22884	6	0.19167	52.22863
3	0.19186	52.22880	7	0.19159	52.22866
4	0.19196	52.22876	8	0.19150	52.22870

Modelled Reflector Data – Area G16

Area G17

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19196	52.22875	6	0.19229	52.22865
2	0.19205	52.22872	7	0.19201	52.22846
3	0.19212	52.22868	8	0.19194	52.22850
4	0.19219	52.22864	9	0.19185	52.22855
5	0.19225	52.22868	10	0.19176	52.22859

Modelled Reflector Data – Area G17

Area G18

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19230	52.22865	5	0.19224	52.22832
2	0.19239	52.22860	6	0.19217	52.22837
3	0.19247	52.22855	7	0.19210	52.22841
4	0.19255	52.22850	8	0.19202	52.22846

Modelled Reflector Data – Area G18

Area G19

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19255	52.22850	5	0.19246	52.22817
2	0.19264	52.22844	6	0.19239	52.22822
3	0.19271	52.22839	7	0.19232	52.22827

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
4	0.19279	52.22833	8	0.19225	52.22832

Modelled Reflector Data – Area G19

Area G20

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19279	52.22833	7	0.19266	52.22809
2	0.19287	52.22827	8	0.19261	52.22813
3	0.19292	52.22822	9	0.19256	52.22816
4	0.19300	52.22825	10	0.19250	52.22814
5	0.19308	52.22817	11	0.19246	52.22817
6	0.19272	52.22803			

Modelled Reflector Data – Area G20

Area G21

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19308	52.22817	6	0.19300	52.22794
2	0.19314	52.22811	7	0.19293	52.22791
3	0.19320	52.22805	8	0.19288	52.22797
4	0.19326	52.22798	9	0.19284	52.22801
5	0.19304	52.22790	10	0.19280	52.22806

Modelled Reflector Data – Area G21

Area G22

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.19326	52.22797	5	0.19316	52.22775
2	0.19331	52.22792	6	0.19313	52.22780

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
3	0.19335	52.22788	7	0.19309	52.22784
4	0.19339	52.22782	8	0.19304	52.22790

Modelled Reflector Data – Area G22

Area C1

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18634	52.22627	3	0.18729	52.22612
2	0.18729	52.22626	4	0.18632	52.22614

Modelled Reflector Data – Area C1

Area C2

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18639	52.22610	3	0.18729	52.22590
2	0.18730	52.22608	4	0.18638	52.22592

Modelled Reflector Data – Area C2

Area R1

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18651	52.22580	3	0.18738	52.22569
2	0.18738	52.22578	4	0.18650	52.22570

Modelled Reflector Data – Area R1

Area R2

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.18940	52.22593	3	0.18998	52.22579

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
2	0.18999	52.22592	4	0.18939	52.22580

Modelled Reflector Data – Area R2

APPENDIX H – DETAILLED MODELLING RESULTS

Overview

The Pager Power charts for the receptors are shown below and on the following pages for completeness. Each chart shows:

- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of the report;
- The reflecting panels – bottom right image. The reflecting area is shown in yellow. If the yellow panels are not visible from the observer location, no issues will occur in practice. Additional obstructions which may obscure the panels from view are considered separately within the analysis;
- The reflection date/time graph – left hand side of the page. The blue line indicates the dates and times at which geometric reflections are possible. This relates to reflections from the yellow areas.
- The sunrise and sunset curves throughout the year (red and yellow lines).

The Forge charts for the receptors are shown on the following pages. Each chart shows:

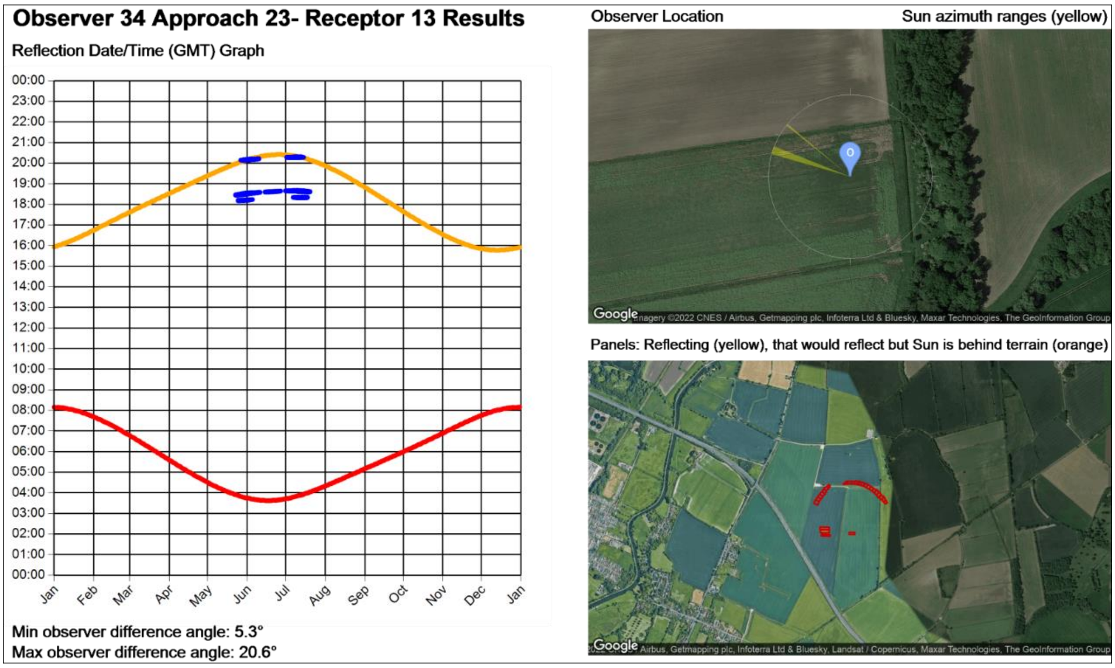
- The annual predicted solar reflections.
- The daily duration of the solar reflections.
- The location of the proposed development where glare will originate.
- The calculated intensity of the predicted solar reflections.

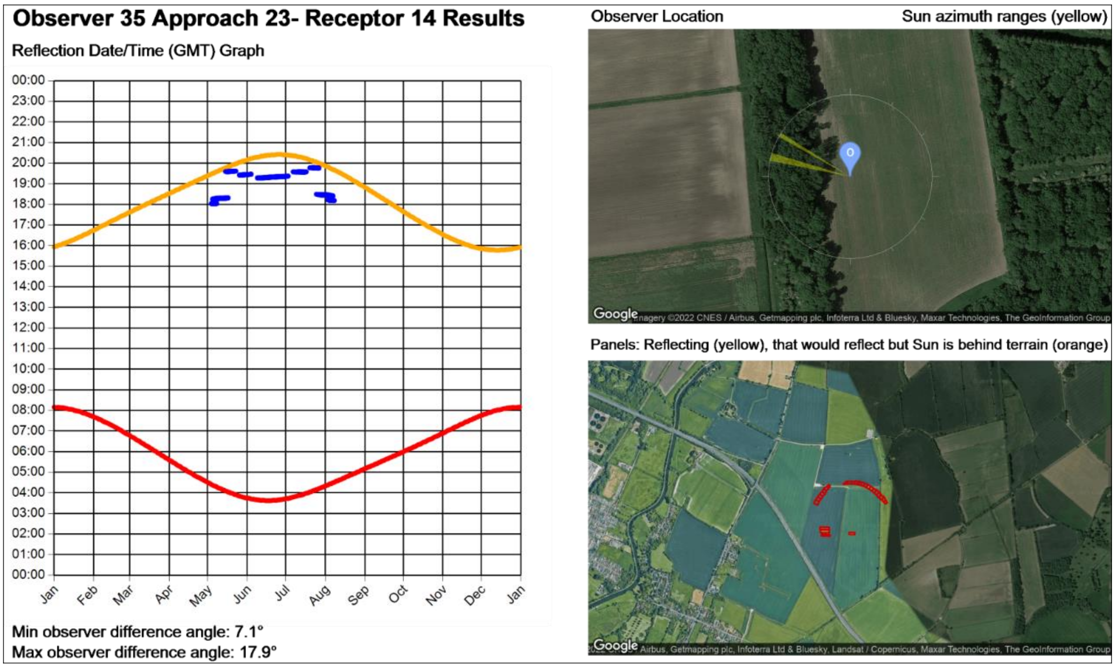
For approach paths, two further charts are shown within the Forge modelling results:

- Locations along the approach path receiving glare.
- The dates when glare would occur at each location along the approach.

Runway Approach 23

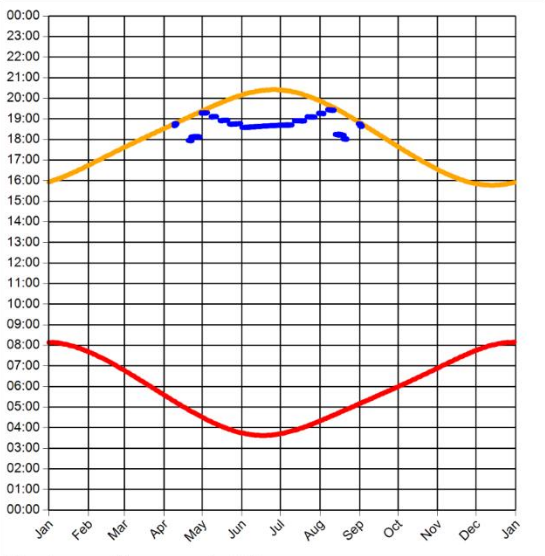
Pager Power


Observer 34 Approach 23- Receptor 13 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 5.3°
Max observer difference angle: 20.6°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 35 Approach 23- Receptor 14 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 7.1°
Max observer difference angle: 17.9°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 36 Approach 23- Receptor 15 Results

Reflection Date/Time (GMT) Graph



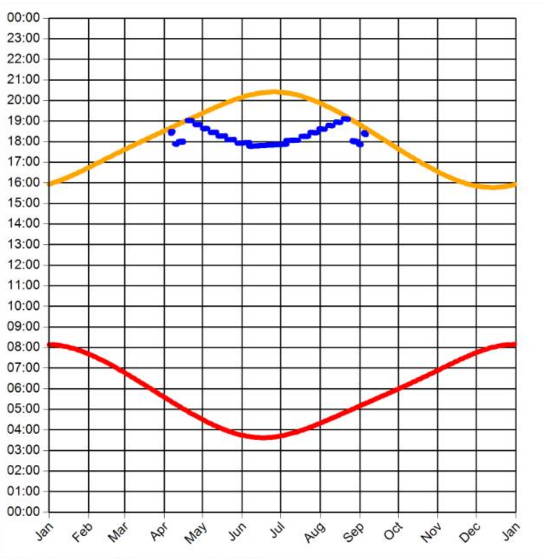
Min observer difference angle: 4.5°
Max observer difference angle: 19.1°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 37 Approach 23- Receptor 16 Results

Reflection Date/Time (GMT) Graph



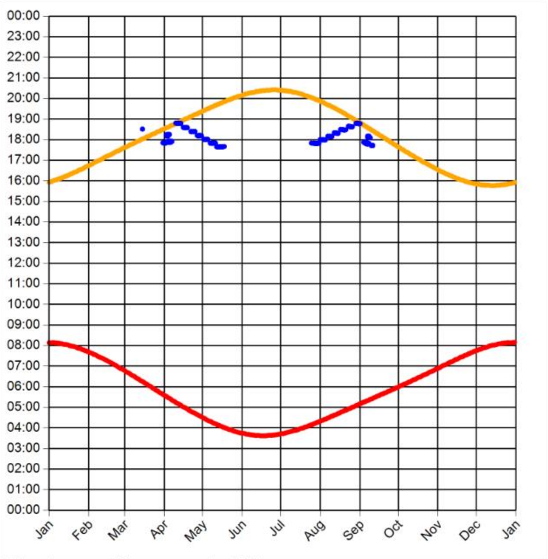
Min observer difference angle: 5.8°
Max observer difference angle: 26.3°

Observer Location — Sun azimuth range is 273.4° - 290.5° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 38 Approach 23- Receptor 17 Results

Reflection Date/Time (GMT) Graph



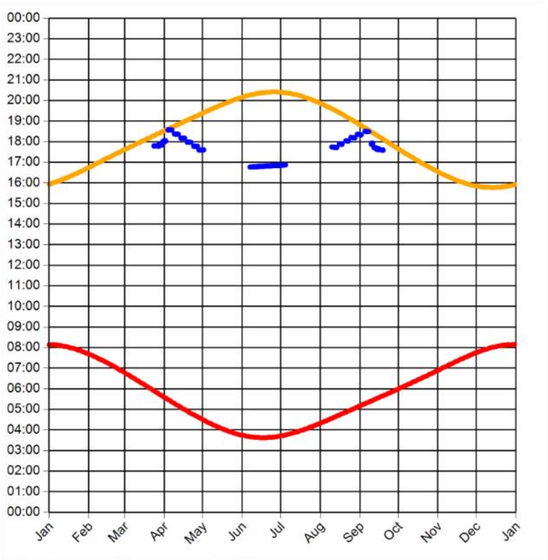
Min observer difference angle: 5.6°
Max observer difference angle: 23.9°

Observer Location Sun azimuth range is 270.1° - 285.4° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 39 Approach 23- Receptor 18 Results

Reflection Date/Time (GMT) Graph



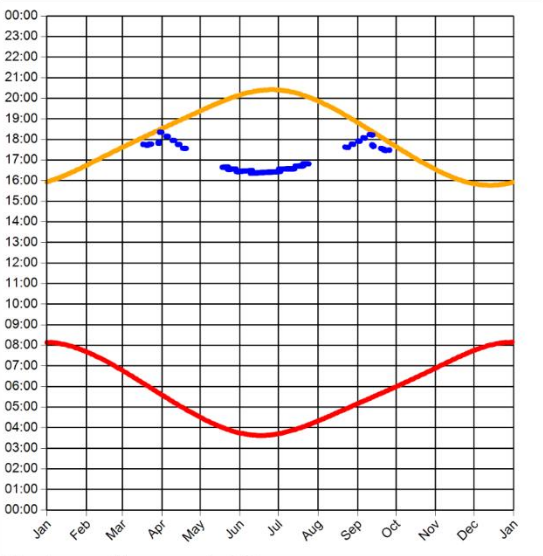
Min observer difference angle: 5.8°
Max observer difference angle: 35.1°

Observer Location Sun azimuth range is 267.3° - 280.8° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 40 Approach 23- Receptor 19 Results

Reflection Date/Time (GMT) Graph



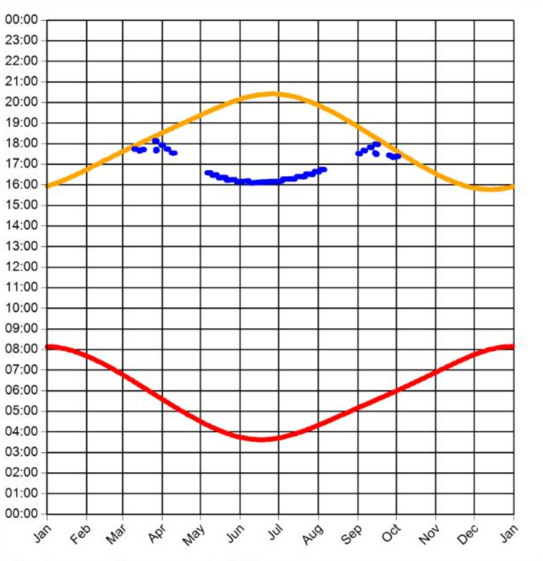
Min observer difference angle: 6.2°
Max observer difference angle: 38.6°

Observer Location Sun azimuth range is 264.8° - 276.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 41 Approach 23- Receptor 20 Results

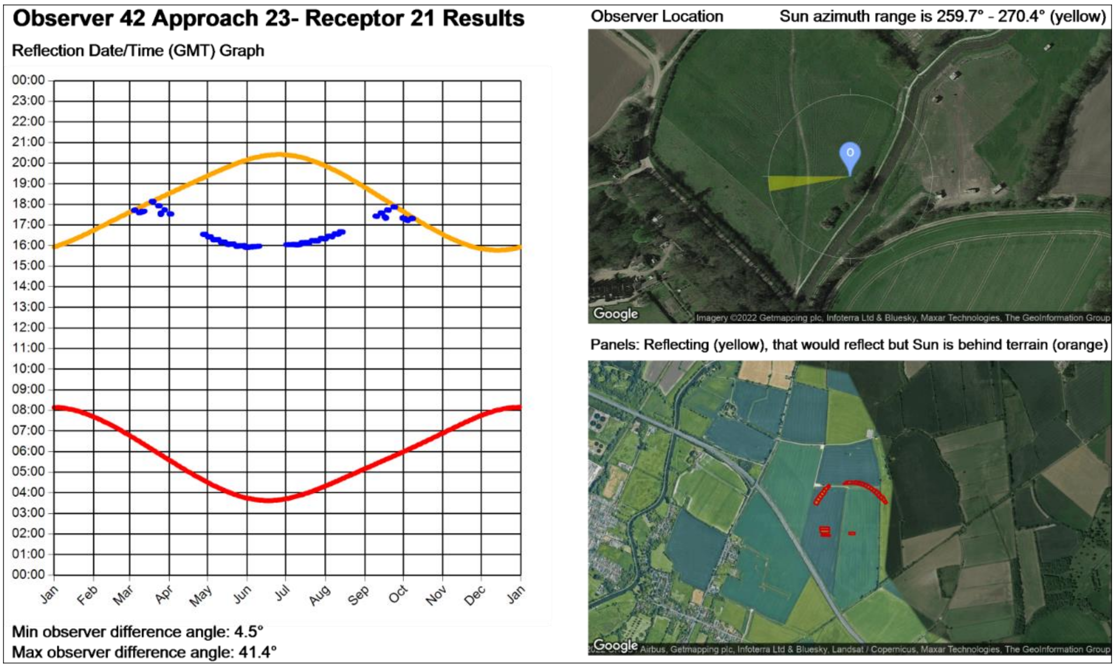
Reflection Date/Time (GMT) Graph



Min observer difference angle: 5.7°
Max observer difference angle: 40.8°

Observer Location Sun azimuth range is 262.5° - 273° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



Observer 42 Approach 23- Receptor 21 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 4.5°
Max observer difference angle: 41.4°
Observer Location
Sun azimuth range is 259.7° - 270.4° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

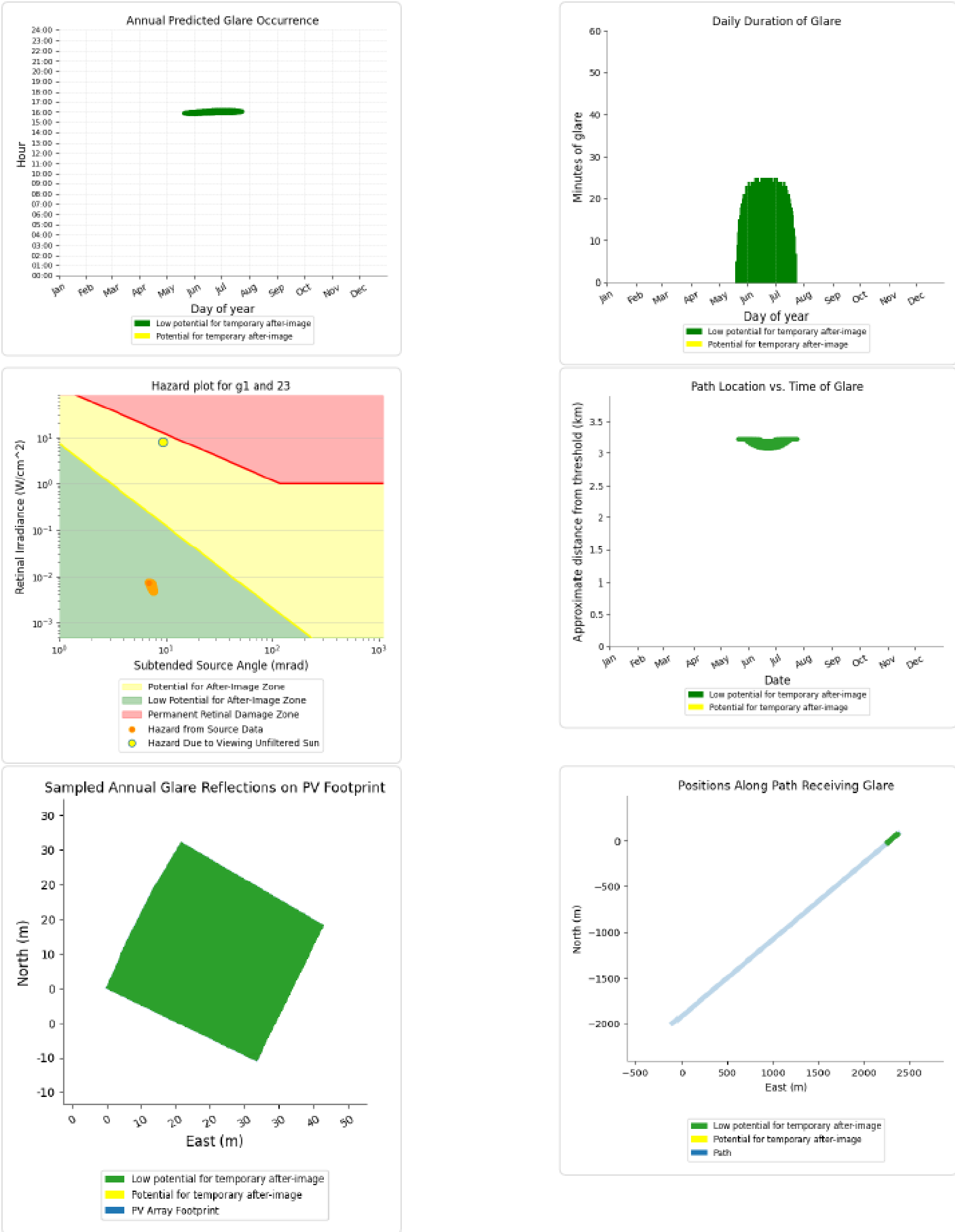
Forge

Modelling result for panel area G1 and runway approach 23. Further forge modelling results can be provided upon request.

G1 - Receptor (23)

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

- 1,458 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

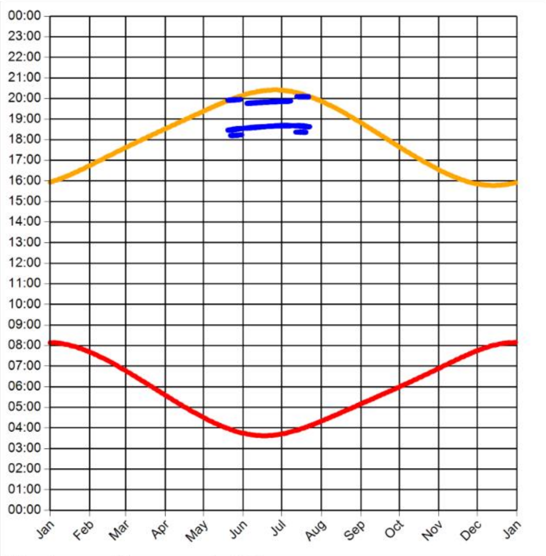


Runway Approach 23G

Pager Power

Observer 77 Approach 23G- Receptor 14 Results

Reflection Date/Time (GMT) Graph



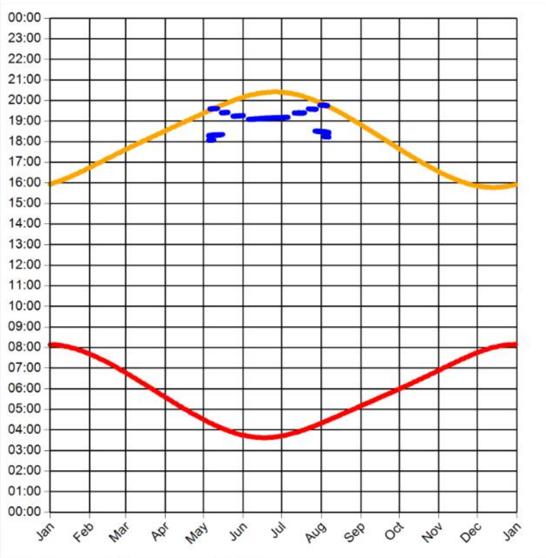
Min observer difference angle: 4.9°
Max observer difference angle: 19.4°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

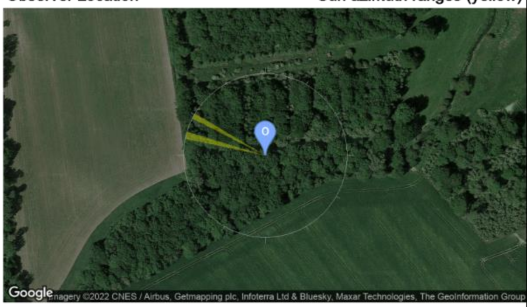
Observer 78 Approach 23G- Receptor 15 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 4.6°
Max observer difference angle: 17.2°

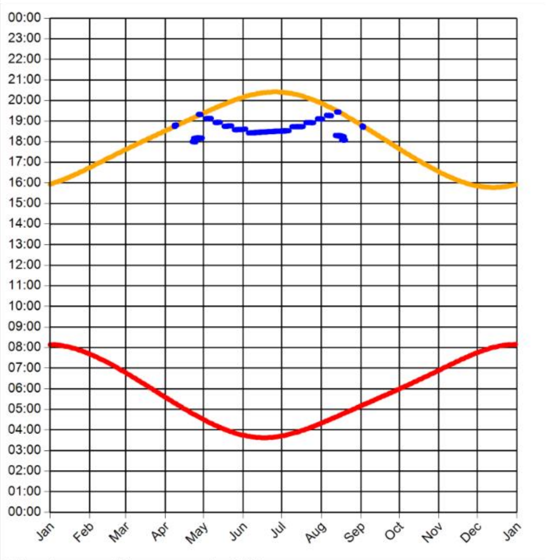
Observer Location | Sun azimuth ranges (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 79 Approach 23G- Receptor 16 Results

Reflection Date/Time (GMT) Graph



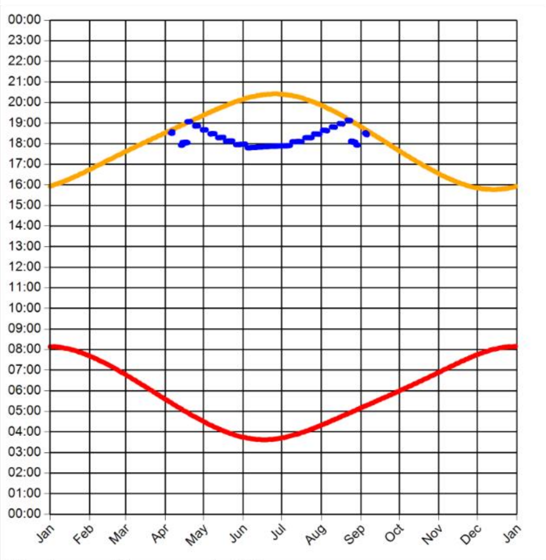
Min observer difference angle: 3.6°
Max observer difference angle: 20°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 80 Approach 23G- Receptor 17 Results

Reflection Date/Time (GMT) Graph



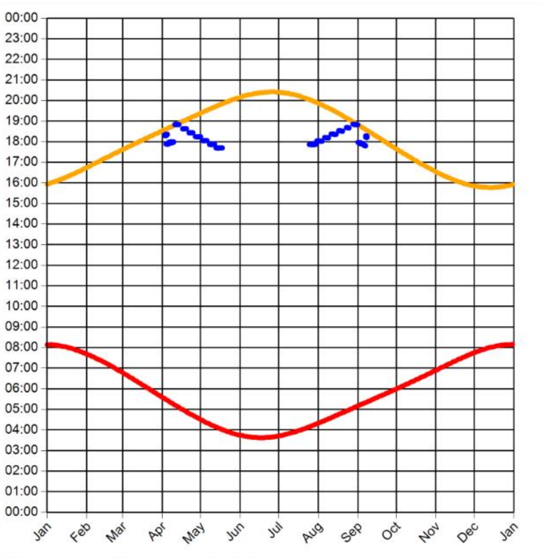
Min observer difference angle: 4.8°
Max observer difference angle: 25.5°

Observer Location | Sun azimuth range is 274.8° - 290.5° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 81 Approach 23G- Receptor 18 Results

Reflection Date/Time (GMT) Graph



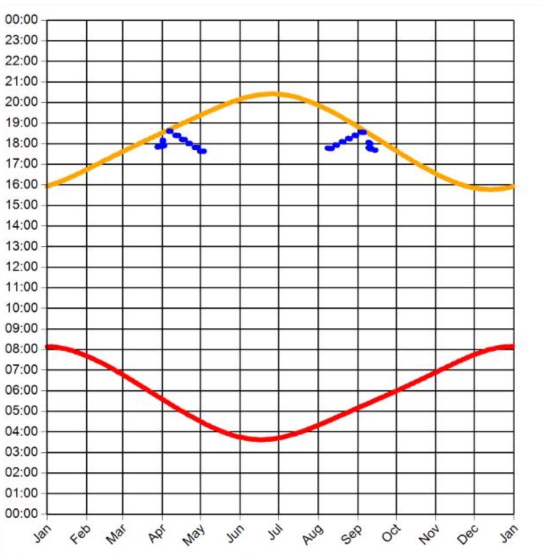
Min observer difference angle: 4.9°
Max observer difference angle: 23.2°

Observer Location — Sun azimuth range is 271.8° - 286° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 82 Approach 23G- Receptor 19 Results

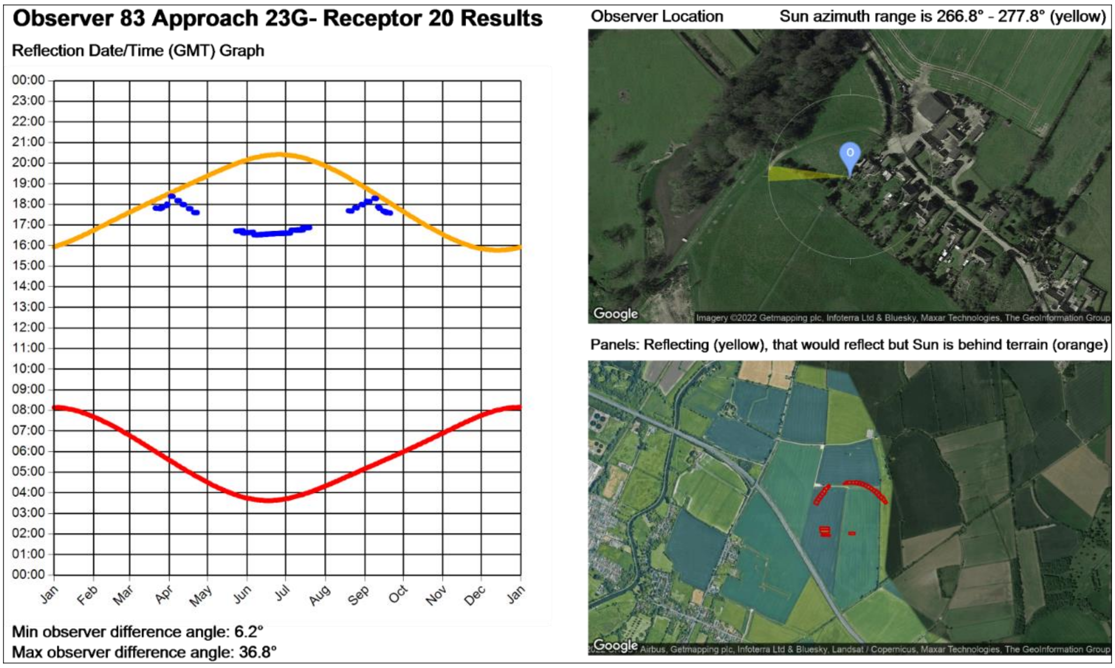
Reflection Date/Time (GMT) Graph

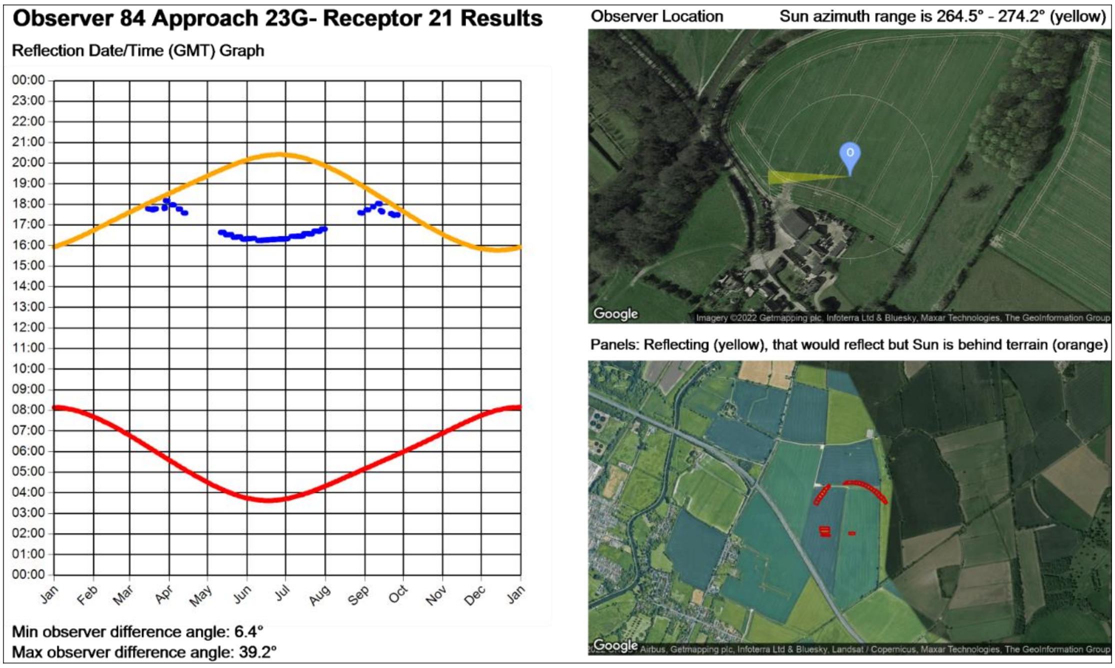


Min observer difference angle: 5.4°
Max observer difference angle: 21°

Observer Location — Sun azimuth range is 269.2° - 281.6° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 83 Approach 23G- Receptor 20 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 6.2°
Max observer difference angle: 36.8°
Observer Location
Sun azimuth range is 266.8° - 277.8° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 84 Approach 23G- Receptor 21 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 6.4°
Max observer difference angle: 39.2°
Observer Location
Sun azimuth range is 264.5° - 274.2° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

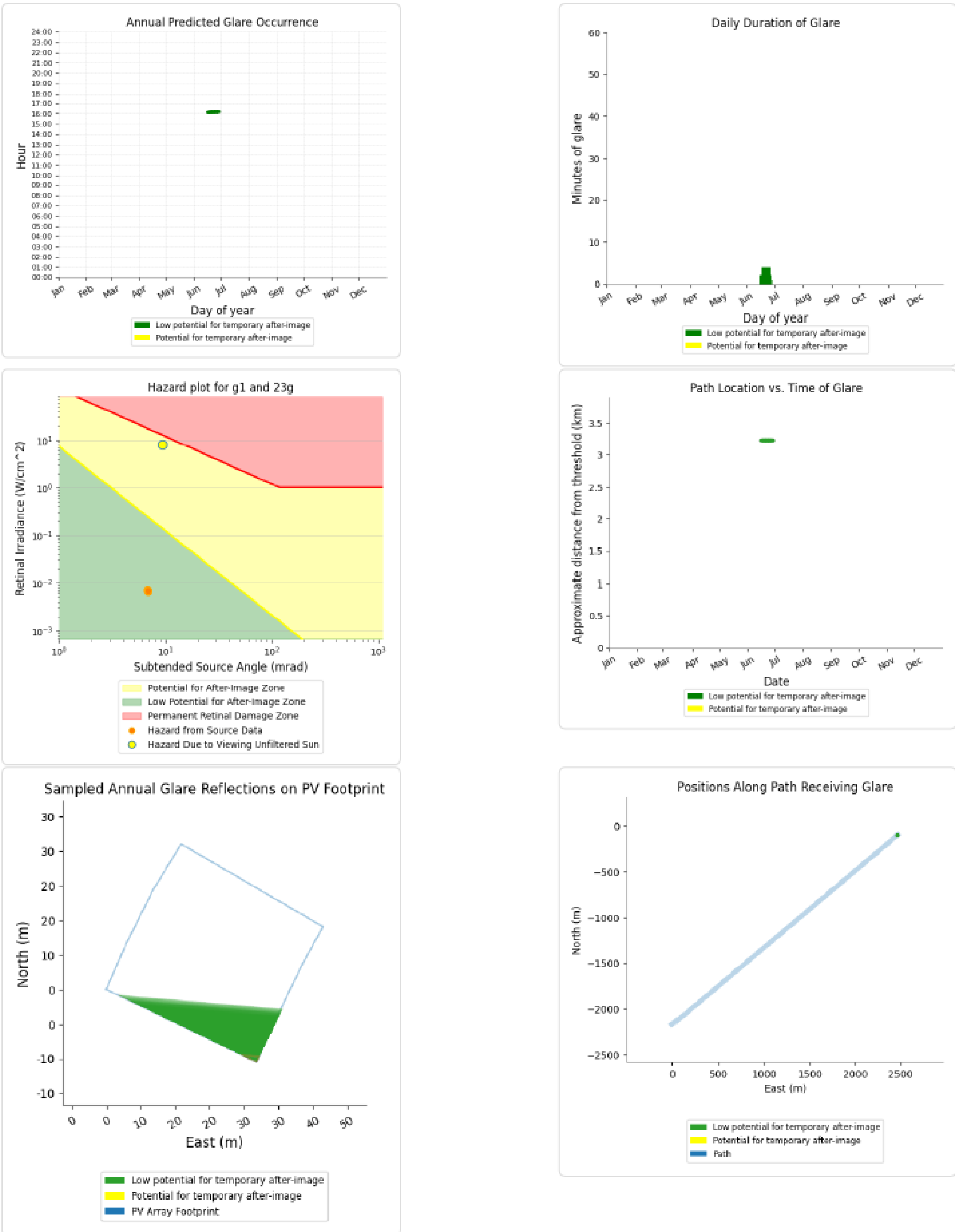
Forge

Modelling result for panel area G1 and runway approach 23G. Further forge modelling results can be provided upon request.

G1 - Receptor (23G)

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

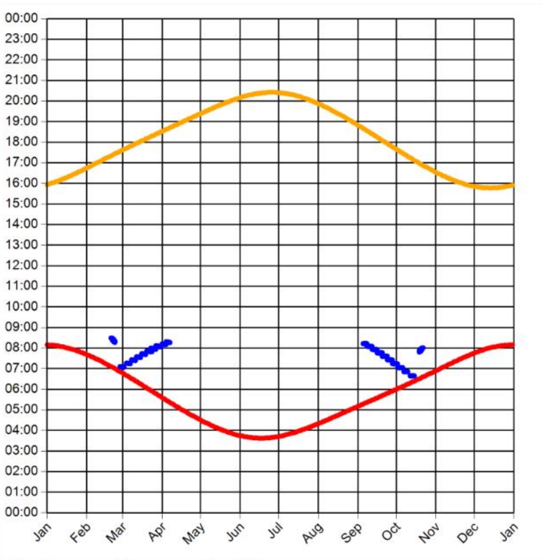
- 47 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



Road Receptors

Observer 1 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 1.6°
Max observer difference angle: 26.2°

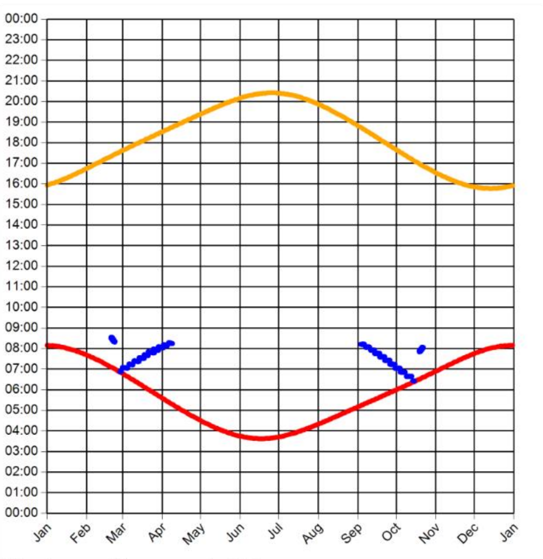
Observer Location

Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 2 Results

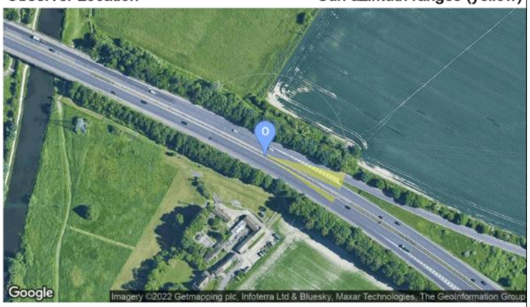
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 26.7°

Observer Location

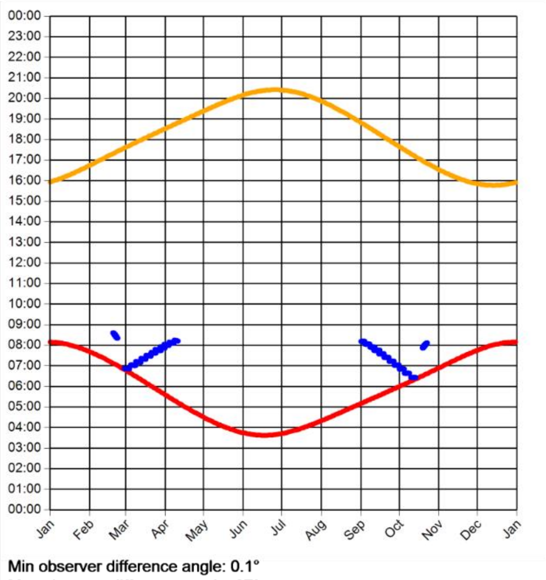
Sun azimuth ranges (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 3 Results

Reflection Date/Time (GMT) Graph



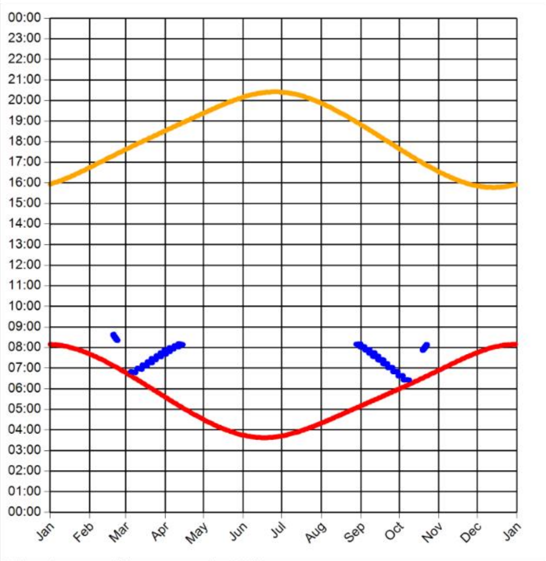
Min observer difference angle: 0.1°
Max observer difference angle: 27°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 4 Results

Reflection Date/Time (GMT) Graph



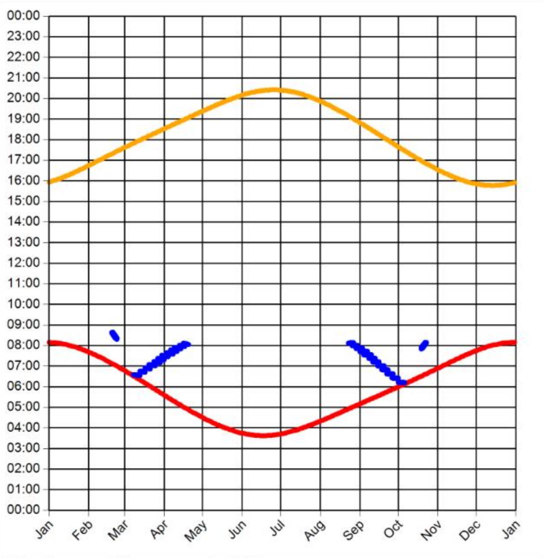
Min observer difference angle: 1.4°
Max observer difference angle: 27.8°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 5 Results

Reflection Date/Time (GMT) Graph



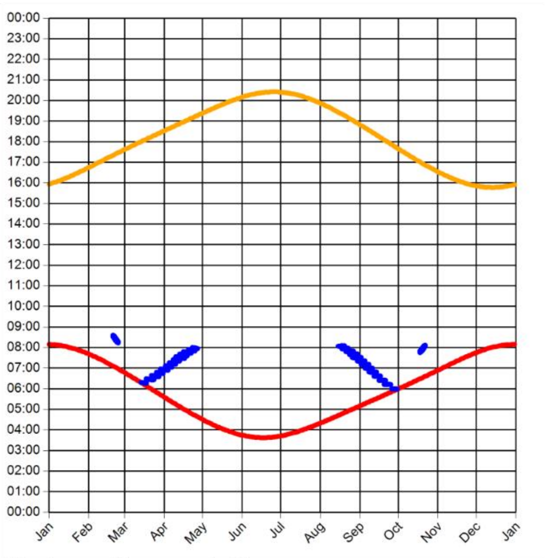
Min observer difference angle: 0.3°
Max observer difference angle: 28.6°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 6 Results

Reflection Date/Time (GMT) Graph



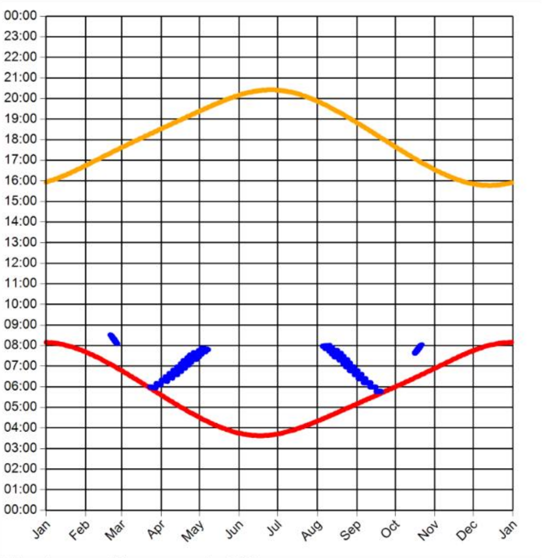
Min observer difference angle: 0°
Max observer difference angle: 30°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 7 Results

Reflection Date/Time (GMT) Graph



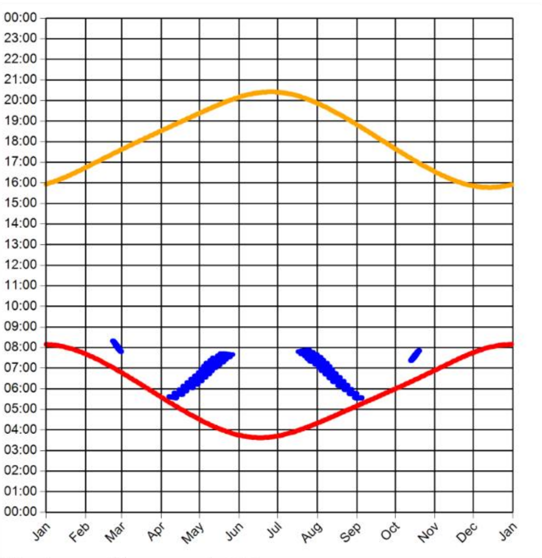
Min observer difference angle: 0.3°
Max observer difference angle: 31.2°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 8 Results

Reflection Date/Time (GMT) Graph



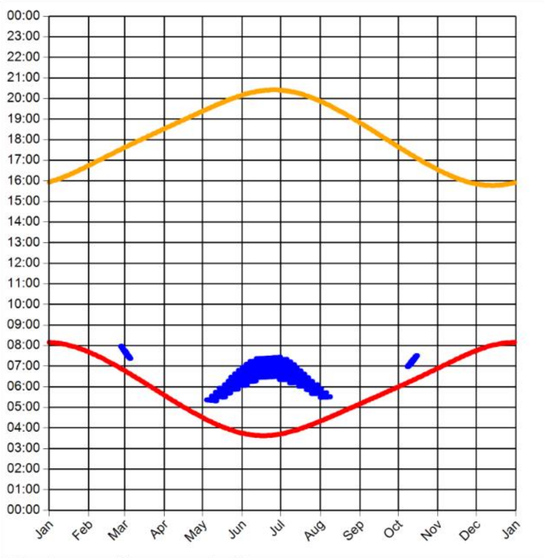
Min observer difference angle: 2.1°
Max observer difference angle: 32.9°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 9 Results

Reflection Date/Time (GMT) Graph



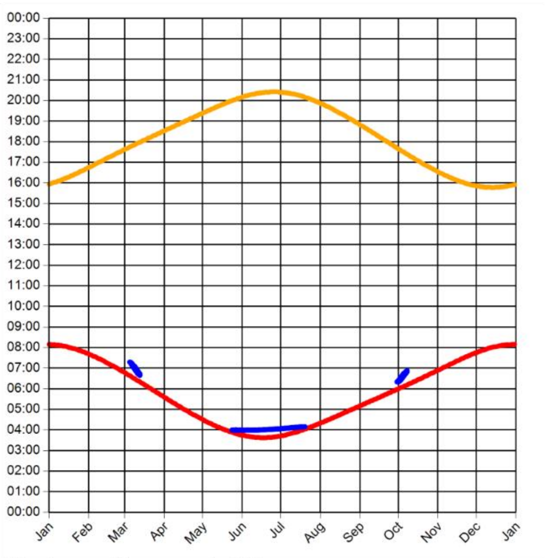
Min observer difference angle: 6°
Max observer difference angle: 31.6°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 10 Results

Reflection Date/Time (GMT) Graph



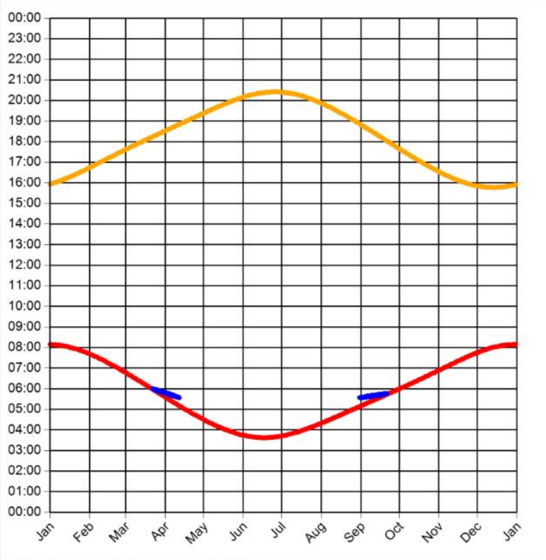
Min observer difference angle: 0.6°
Max observer difference angle: 5.4°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 11 Results

Reflection Date/Time (GMT) Graph



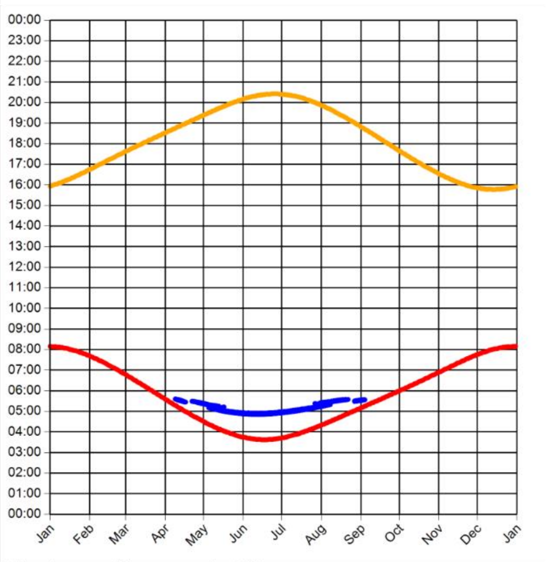
Min observer difference angle: 0°
Max observer difference angle: 2.8°

Observer Location | Sun azimuth range is 79.6° - 88.5° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 12 Results

Reflection Date/Time (GMT) Graph



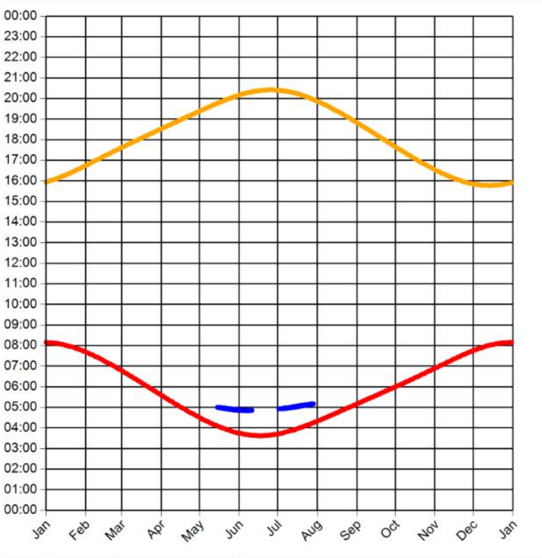
Min observer difference angle: 1.6°
Max observer difference angle: 9°

Observer Location | Sun azimuth range is 62.5° - 80.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 13 Results

Reflection Date/Time (GMT) Graph



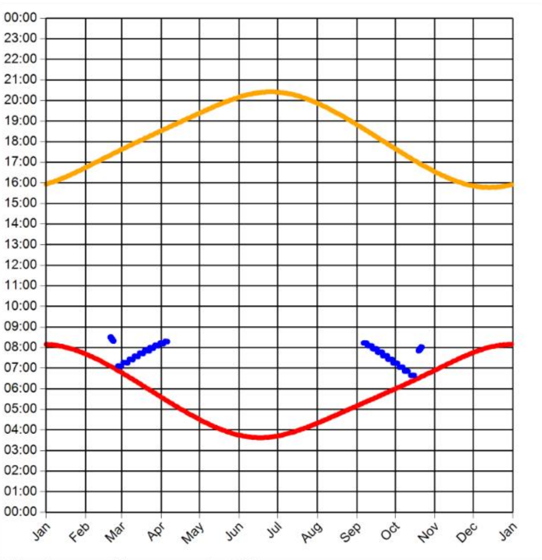
Min observer difference angle: 6°
Max observer difference angle: 7.7°

Observer Location — Sun azimuth range is 62.9° - 67.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 24 Results

Reflection Date/Time (GMT) Graph



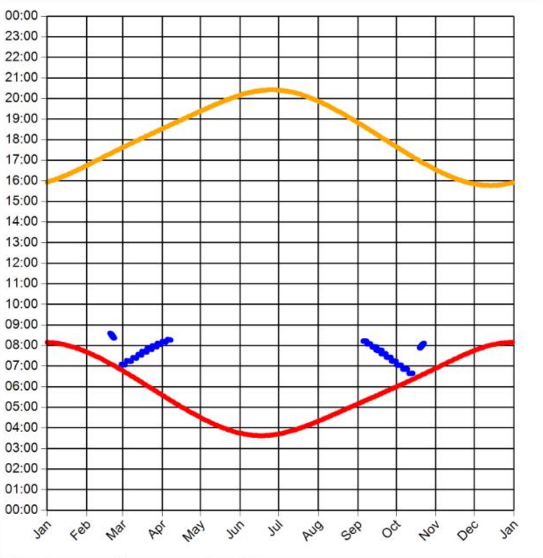
Min observer difference angle: 1.3°
Max observer difference angle: 26°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 25 Results

Reflection Date/Time (GMT) Graph



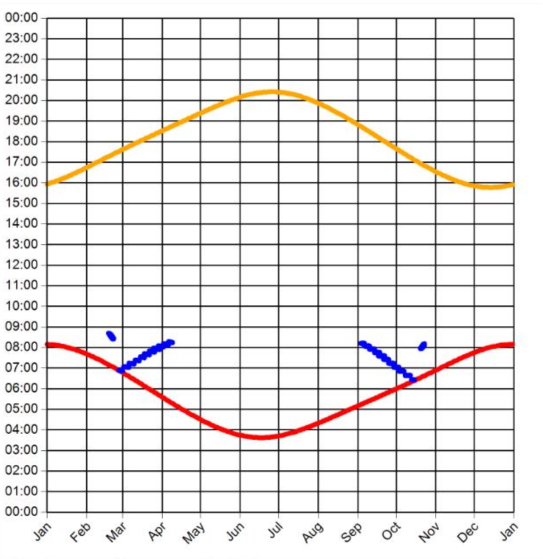
Min observer difference angle: 1.9°
Max observer difference angle: 26.4°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 26 Results

Reflection Date/Time (GMT) Graph



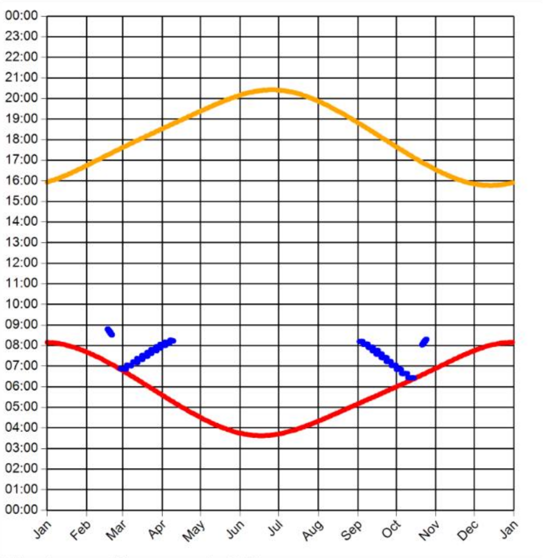
Min observer difference angle: 0.1°
Max observer difference angle: 26.7°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 27 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 26.9°

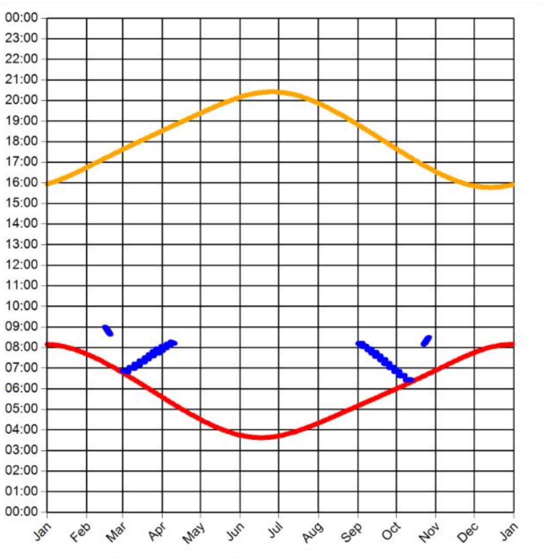
Observer Location

Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 28 Results

Reflection Date/Time (GMT) Graph

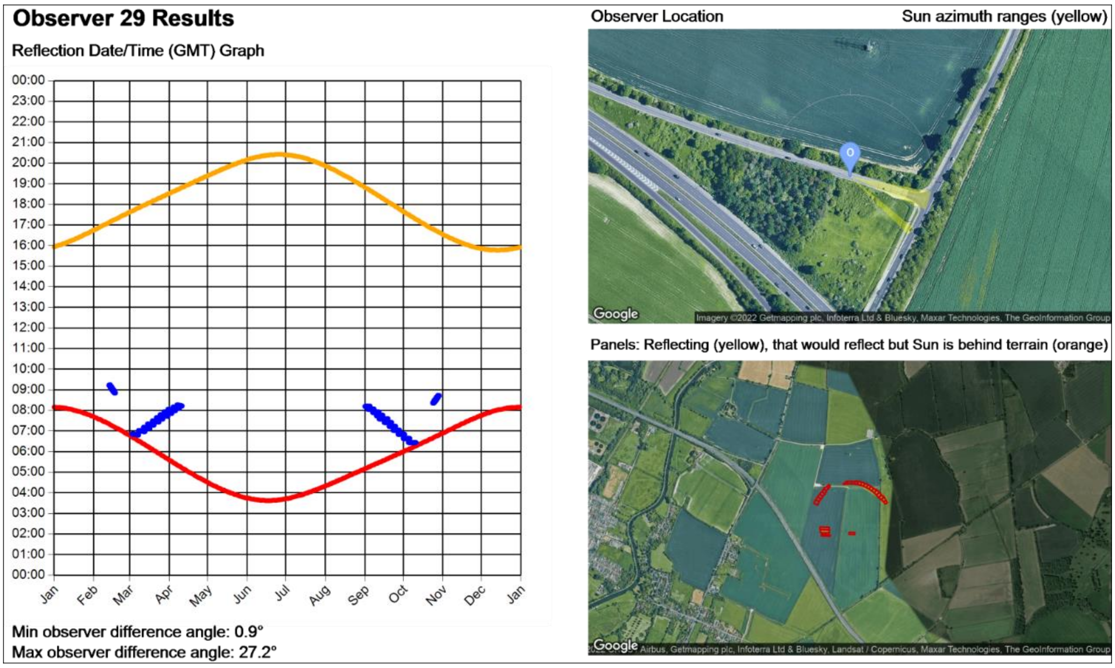


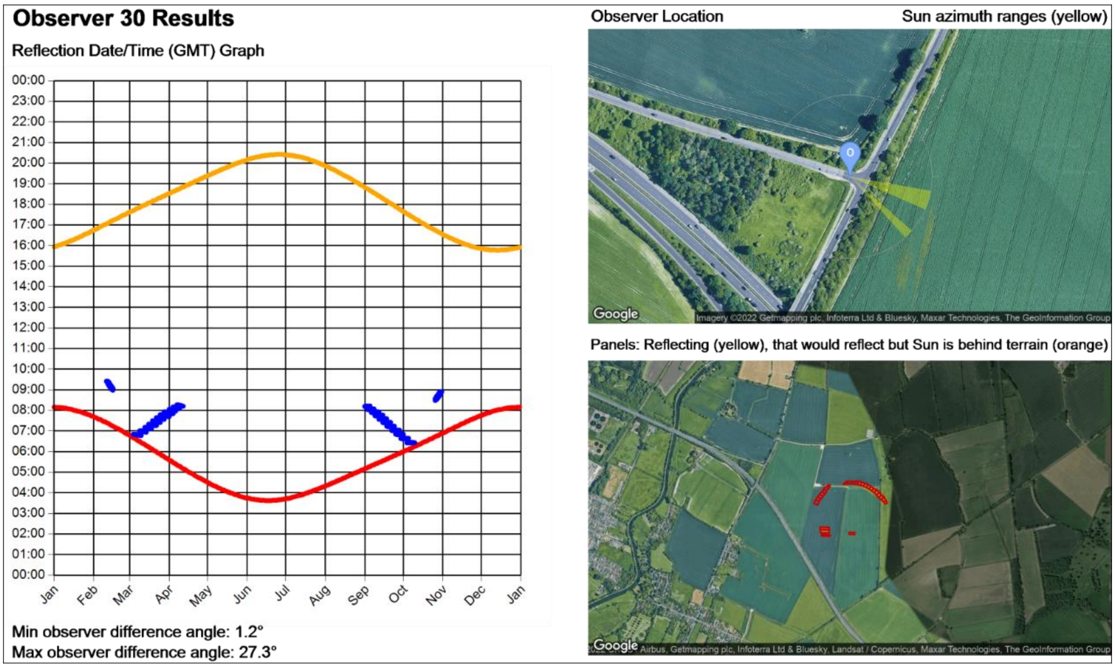
Min observer difference angle: 0.4°
Max observer difference angle: 27.1°

Observer Location

Sun azimuth ranges (yellow)

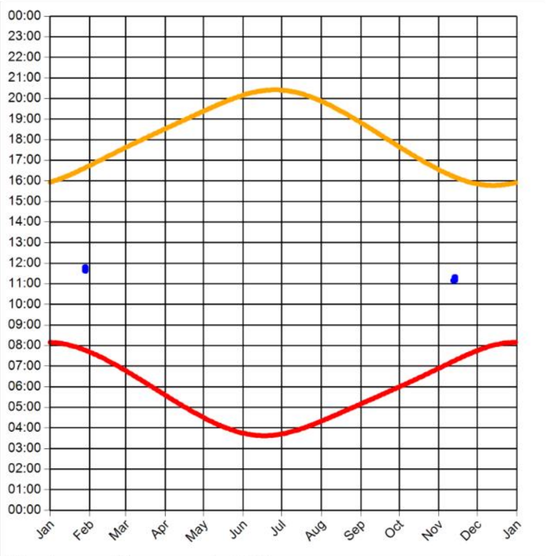
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 29 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 0.9°
Max observer difference angle: 27.2°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 30 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 1.2°
Max observer difference angle: 27.3°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Observer 31 Results

Reflection Date/Time (GMT) Graph



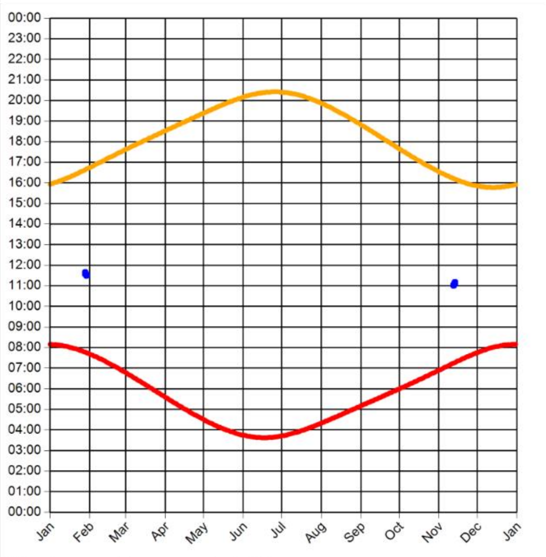
Min observer difference angle: 18.9°
Max observer difference angle: 19.5°

Observer Location Sun azimuth range is 171.1° - 174.3° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 32 Results

Reflection Date/Time (GMT) Graph



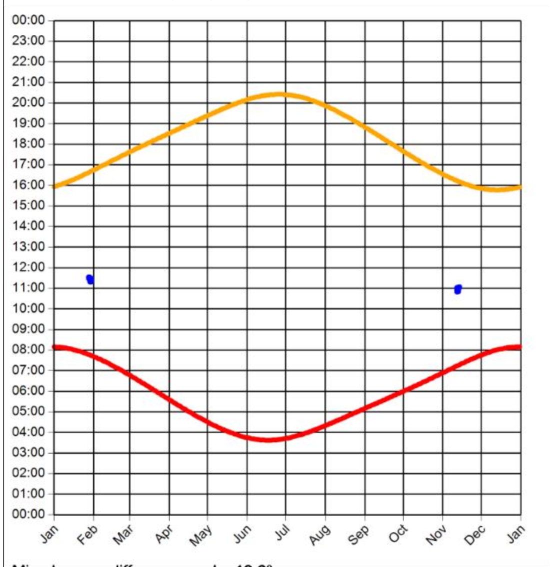
Min observer difference angle: 18.7°
Max observer difference angle: 19.3°

Observer Location Sun azimuth range is 168.8° - 172.2° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 33 Results

Reflection Date/Time (GMT) Graph



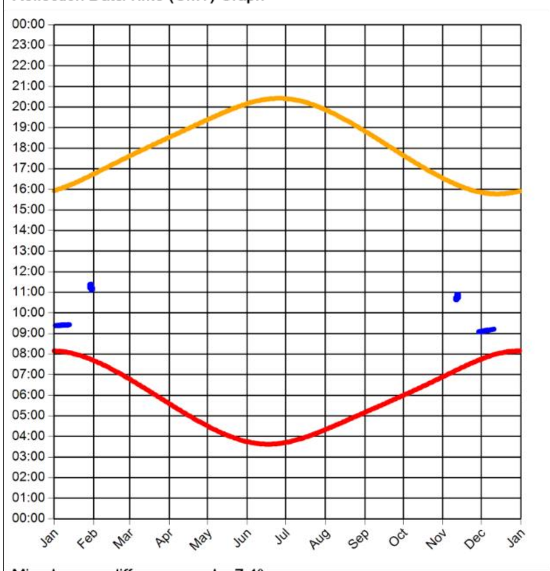
Min observer difference angle: 18.6°
Max observer difference angle: 19.2°

Observer Location Sun azimuth range is 166.3° - 170.2° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 34 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 7.4°
Max observer difference angle: 18.9°

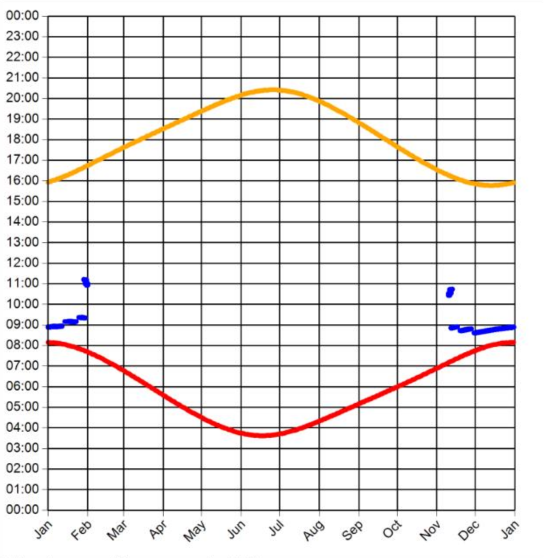
Observer Location Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

PAGERPOWER
Urban & Renewables

Observer 35 Results

Reflection Date/Time (GMT) Graph



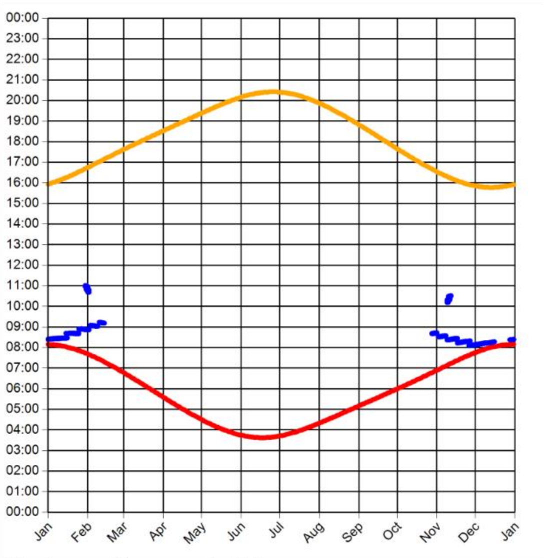
Min observer difference angle: 4.1°
Max observer difference angle: 18.8°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

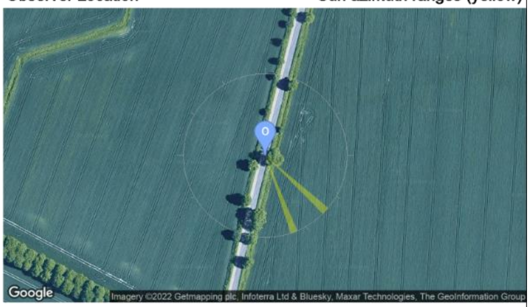
Observer 36 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 1.1°
Max observer difference angle: 18.5°

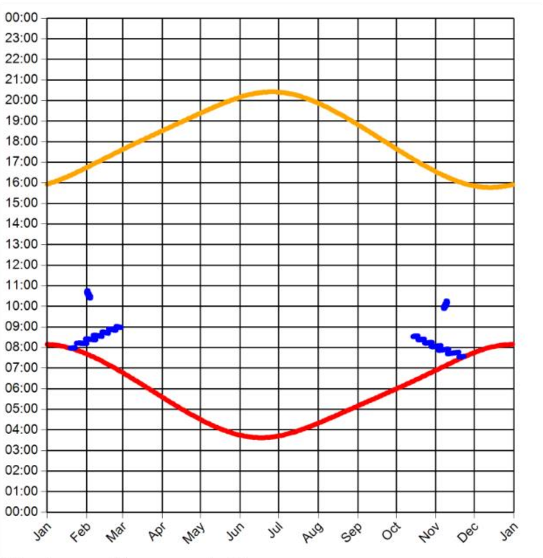
Observer Location | Sun azimuth ranges (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 37 Results

Reflection Date/Time (GMT) Graph



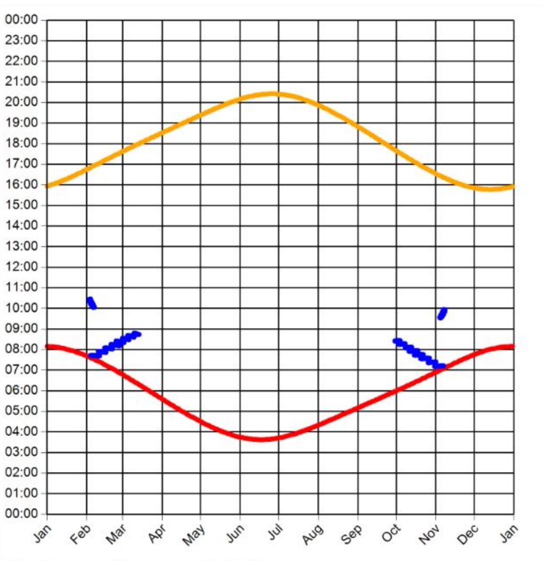
Min observer difference angle: 0°
Max observer difference angle: 18.1°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 38 Results

Reflection Date/Time (GMT) Graph



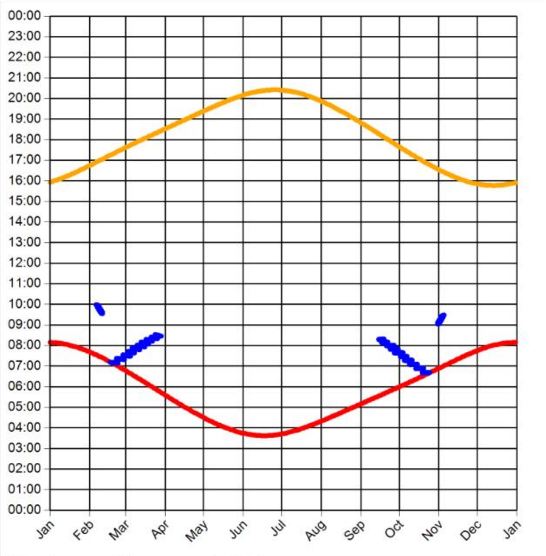
Min observer difference angle: 0.5°
Max observer difference angle: 21.1°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 39 Results

Reflection Date/Time (GMT) Graph



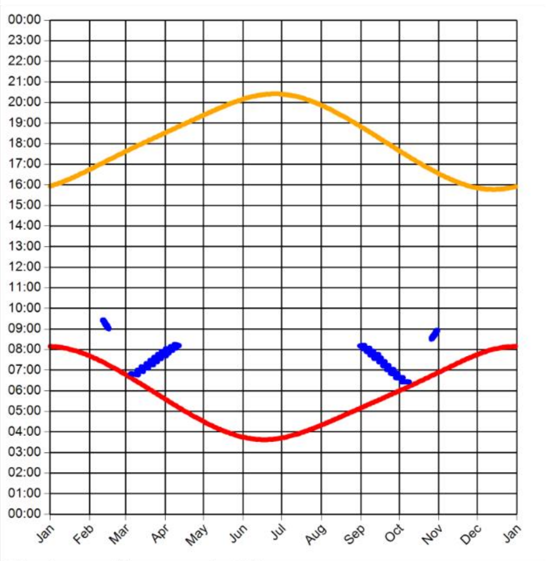
Min observer difference angle: 0.1°
Max observer difference angle: 24.6°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

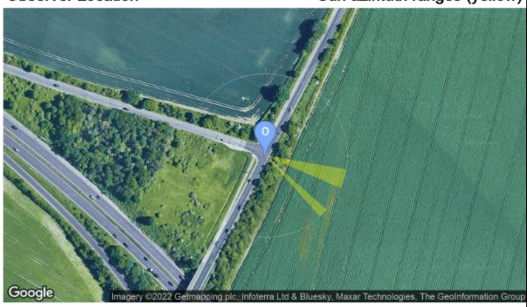
Observer 40 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 1.5°
Max observer difference angle: 27.4°

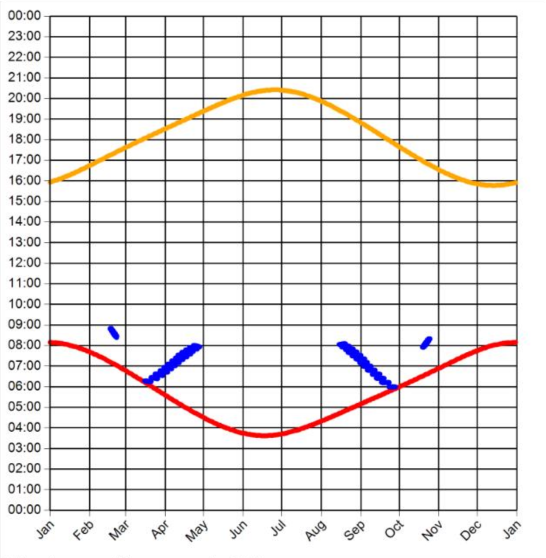
Observer Location | Sun azimuth ranges (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 41 Results

Reflection Date/Time (GMT) Graph



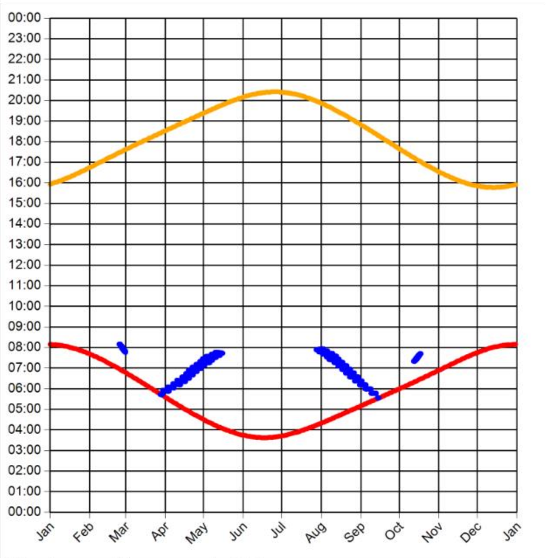
Min observer difference angle: 0.4°
Max observer difference angle: 29.9°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 42 Results

Reflection Date/Time (GMT) Graph



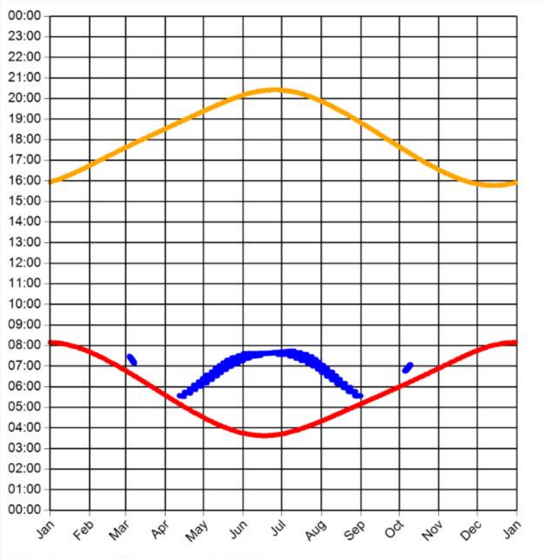
Min observer difference angle: 0.1°
Max observer difference angle: 32°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 43 Results

Reflection Date/Time (GMT) Graph



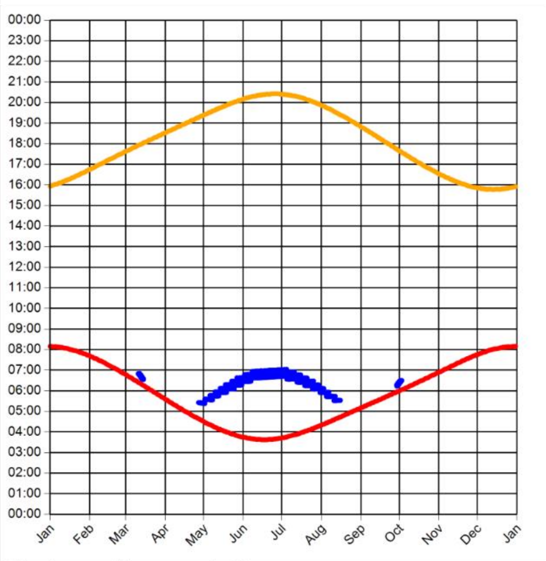
Min observer difference angle: 3.2°
Max observer difference angle: 33.7°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 44 Results

Reflection Date/Time (GMT) Graph



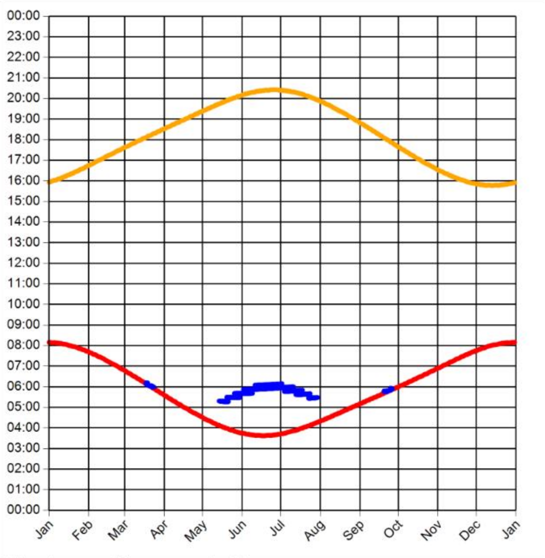
Min observer difference angle: 2°
Max observer difference angle: 28.1°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 45 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 20°

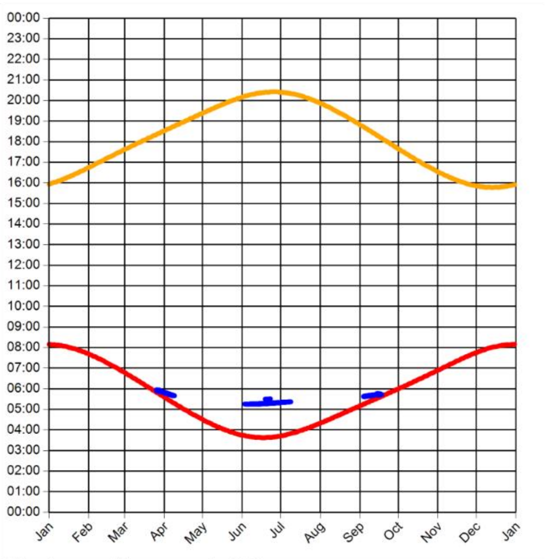
Observer Location

Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 46 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 14.6°

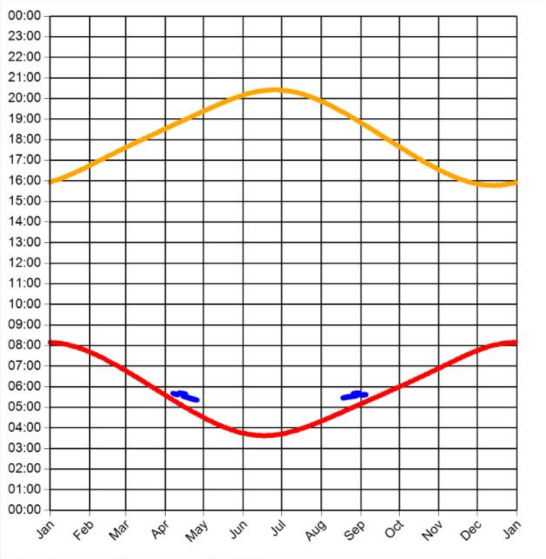
Observer Location

Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 47 Results

Reflection Date/Time (GMT) Graph



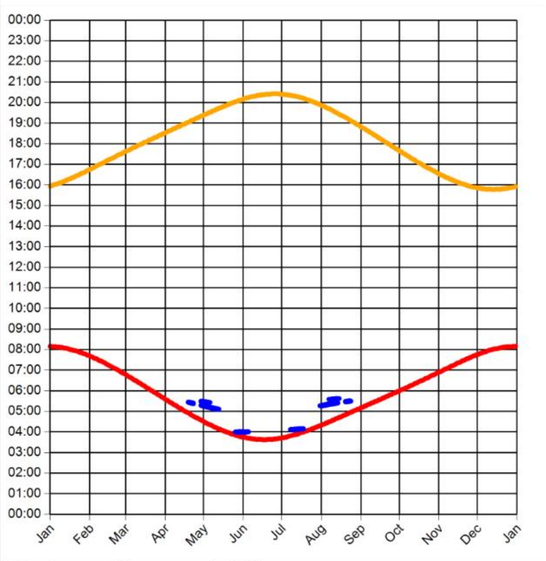
Min observer difference angle: 2.2°
Max observer difference angle: 5.3°

Observer Location Sun azimuth range is 74.7° - 81.8° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 48 Results

Reflection Date/Time (GMT) Graph



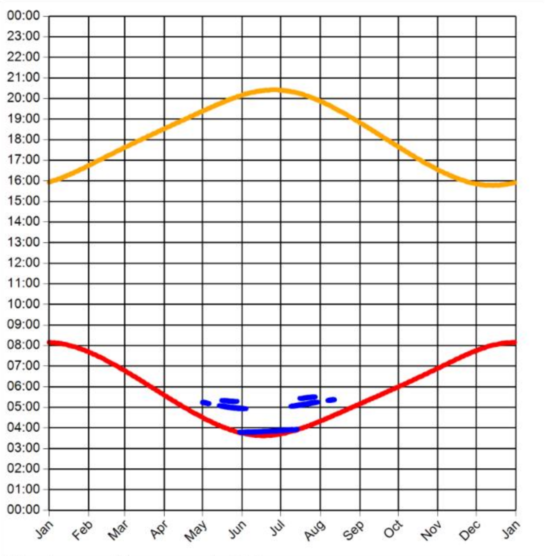
Min observer difference angle: 0.9°
Max observer difference angle: 8.4°

Observer Location Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 49 Results

Reflection Date/Time (GMT) Graph



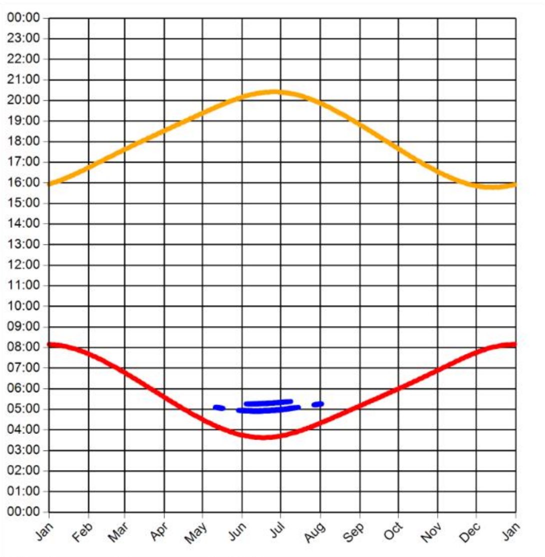
Min observer difference angle: 0.1°
Max observer difference angle: 11.1°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 50 Results

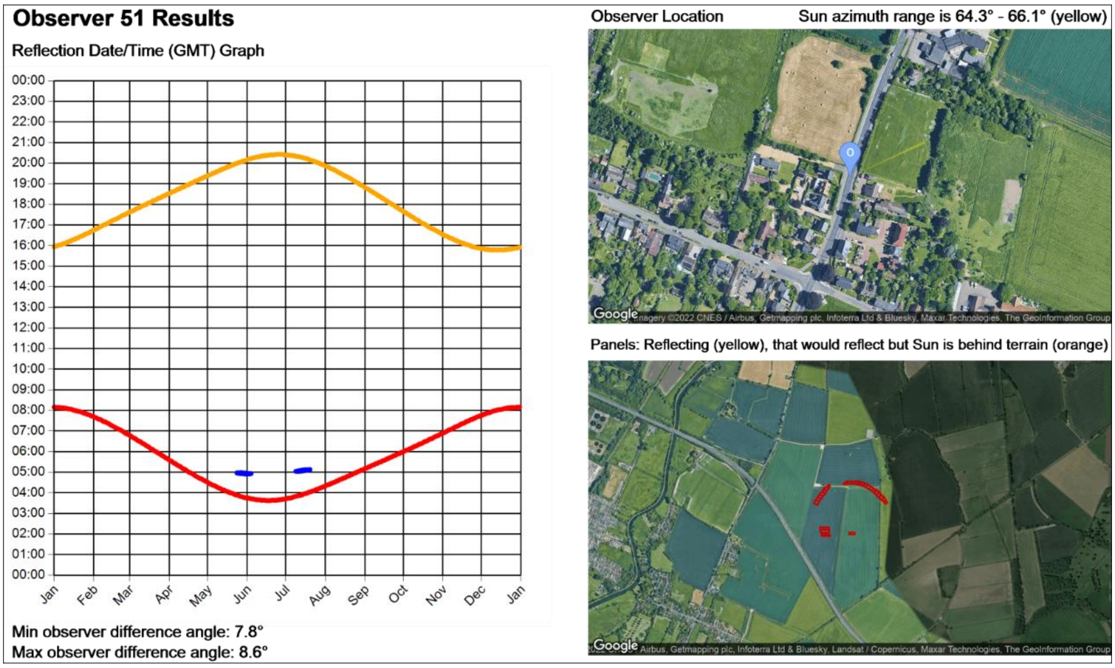
Reflection Date/Time (GMT) Graph



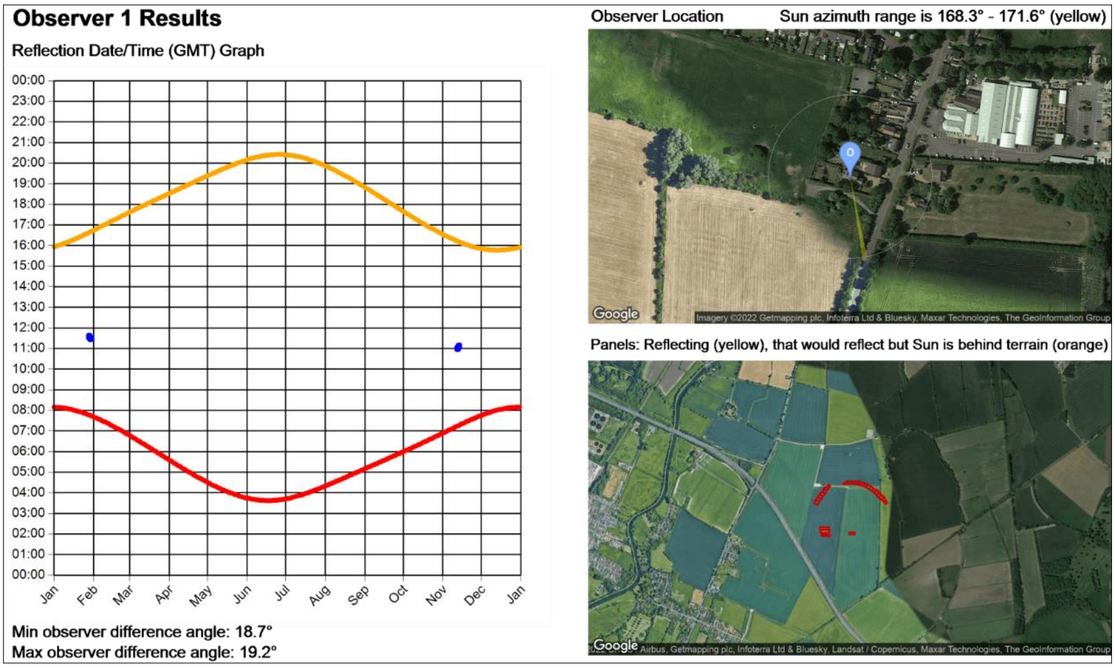
Min observer difference angle: 6.6°
Max observer difference angle: 12.3°

Observer Location | Sun azimuth range is 63° - 69.4° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

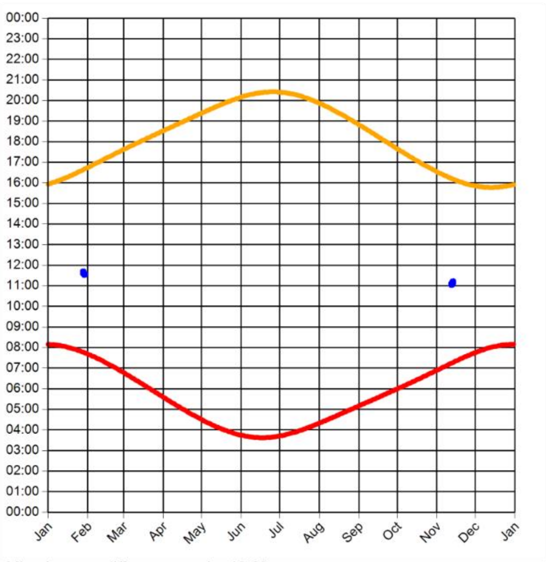


Dwelling Receptors



Observer 2 Results

Reflection Date/Time (GMT) Graph



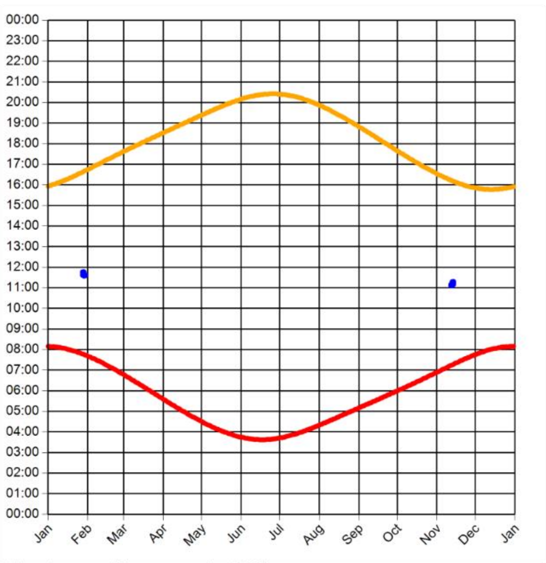
Min observer difference angle: 18.8°
Max observer difference angle: 19.4°

Observer Location Sun azimuth range is 169.4° - 172.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 3 Results

Reflection Date/Time (GMT) Graph



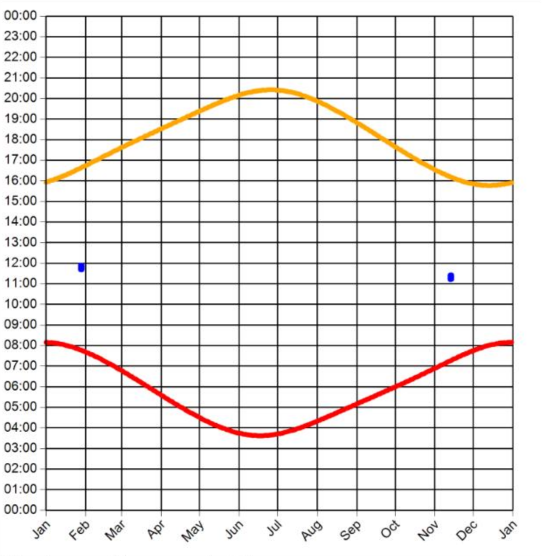
Min observer difference angle: 18.9°
Max observer difference angle: 19.5°

Observer Location Sun azimuth range is 170.4° - 173.6° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 4 Results

Reflection Date/Time (GMT) Graph



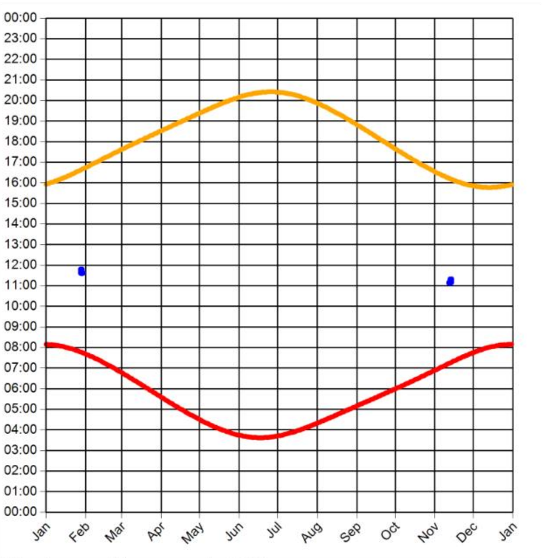
Min observer difference angle: 19°
Max observer difference angle: 19.4°

Observer Location Sun azimuth range is 172.2° - 175.5° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 5 Results

Reflection Date/Time (GMT) Graph



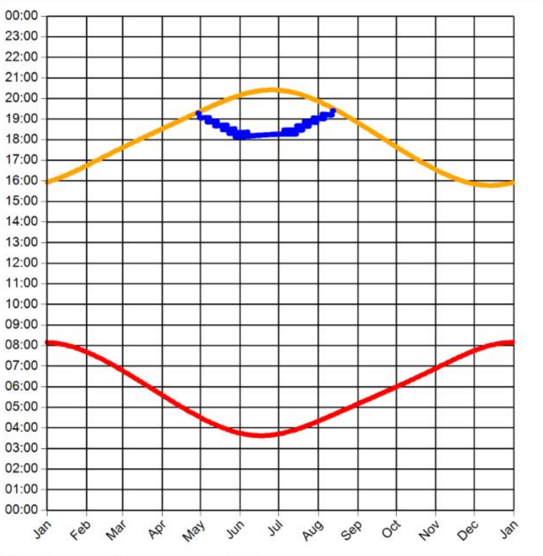
Min observer difference angle: 18.9°
Max observer difference angle: 19.5°

Observer Location Sun azimuth range is 170.8° - 174.1° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 6 Results

Reflection Date/Time (GMT) Graph



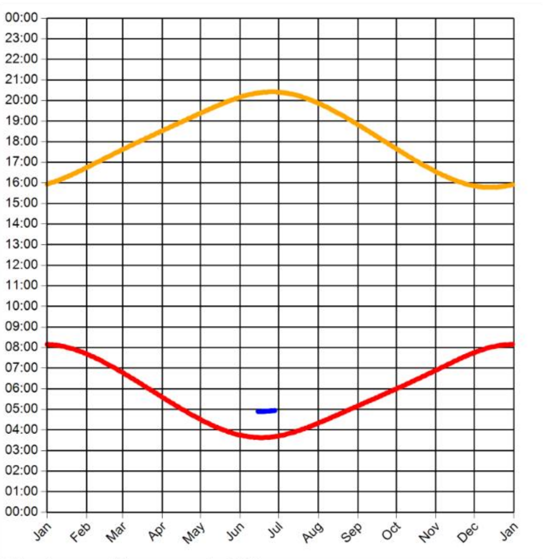
Min observer difference angle: 0.2°
Max observer difference angle: 16.9°

Observer Location Sun azimuth range is 285.7° - 294.8° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 25 Results

Reflection Date/Time (GMT) Graph



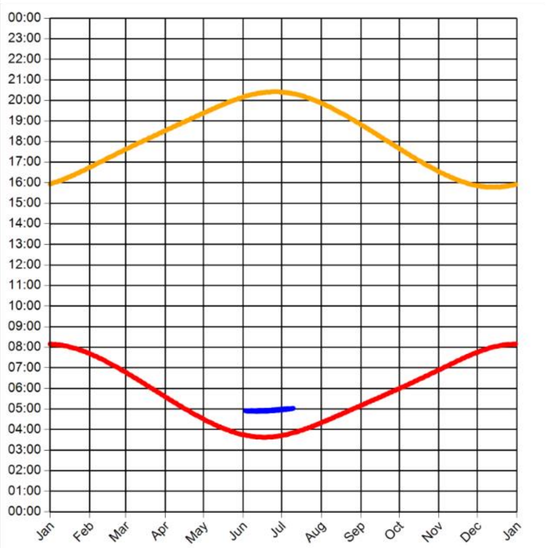
Min observer difference angle: 8.8°
Max observer difference angle: 8.9°

Observer Location Sun azimuth range is 62.8° - 63.1° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 26 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 8.4°
Max observer difference angle: 9.1°

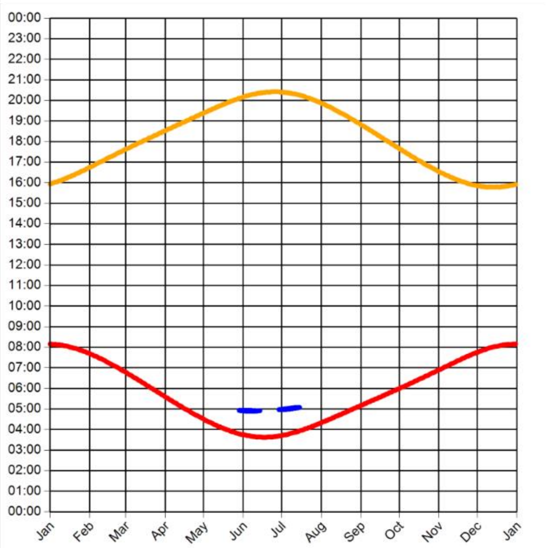
Observer Location

Sun azimuth range is 62.8° - 64.3° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 27 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 8.1°
Max observer difference angle: 8.9°

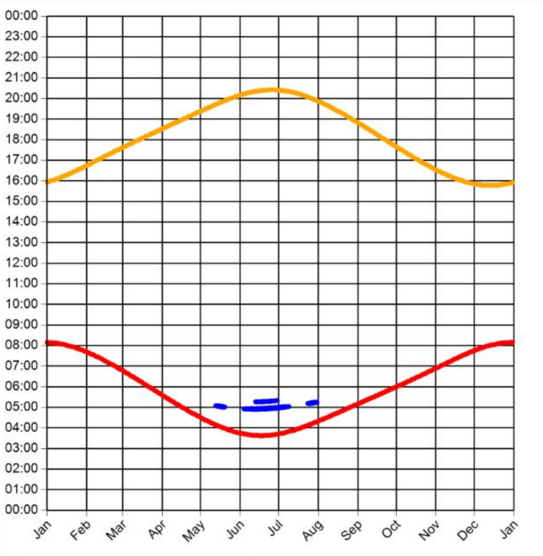
Observer Location

Sun azimuth range is 63.3° - 65.1° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 28 Results

Reflection Date/Time (GMT) Graph



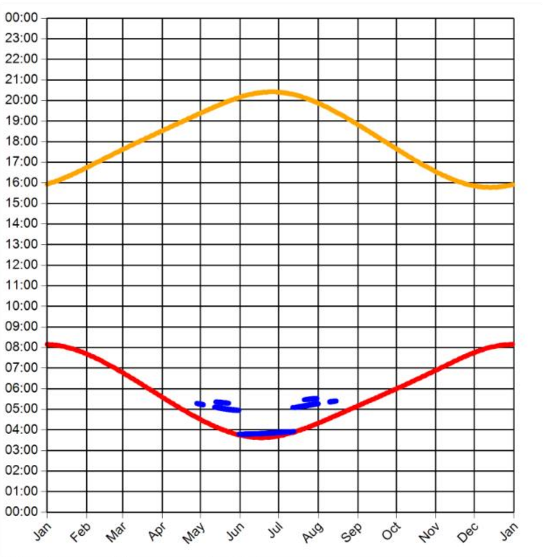
Min observer difference angle: 6.9°
Max observer difference angle: 12.2°

Observer Location | Sun azimuth range is 63° - 68.9° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 29 Results

Reflection Date/Time (GMT) Graph



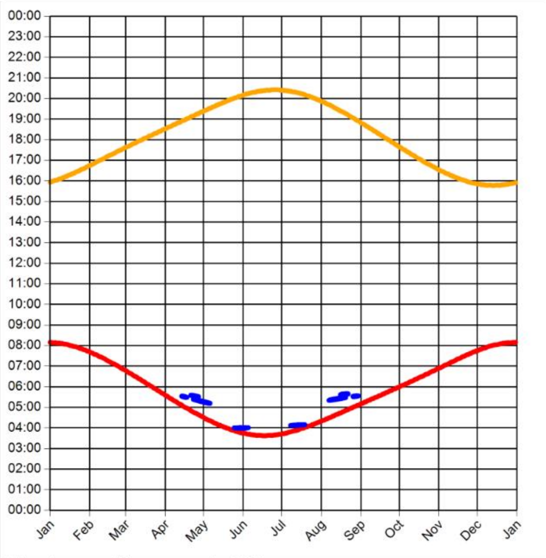
Min observer difference angle: 0.2°
Max observer difference angle: 10.5°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 30 Results

Reflection Date/Time (GMT) Graph



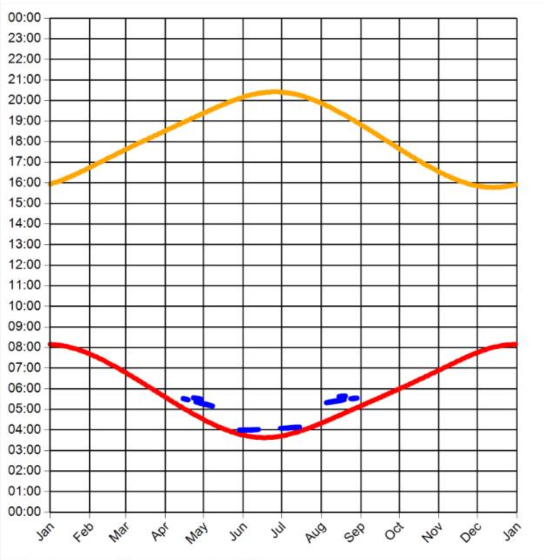
Min observer difference angle: 0.8°
Max observer difference angle: 6.9°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 31 Results

Reflection Date/Time (GMT) Graph



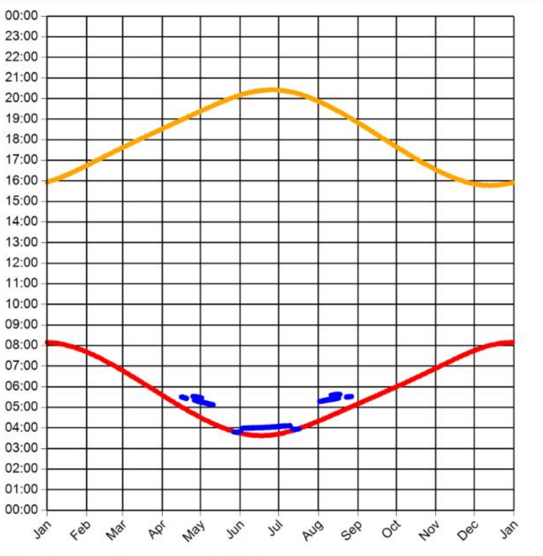
Min observer difference angle: 1.2°
Max observer difference angle: 7.2°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 32 Results

Reflection Date/Time (GMT) Graph



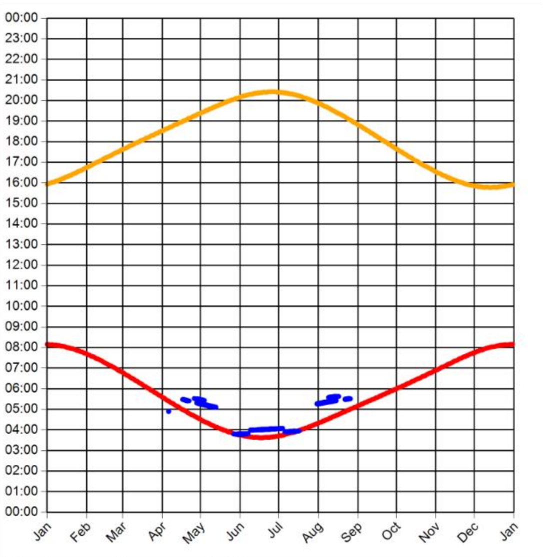
Min observer difference angle: 0.1°
Max observer difference angle: 7.7°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 33 Results

Reflection Date/Time (GMT) Graph



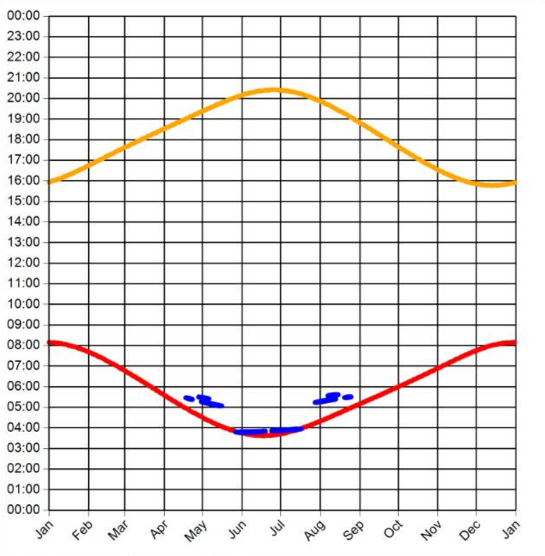
Min observer difference angle: 0°
Max observer difference angle: 7.9°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 34 Results

Reflection Date/Time (GMT) Graph



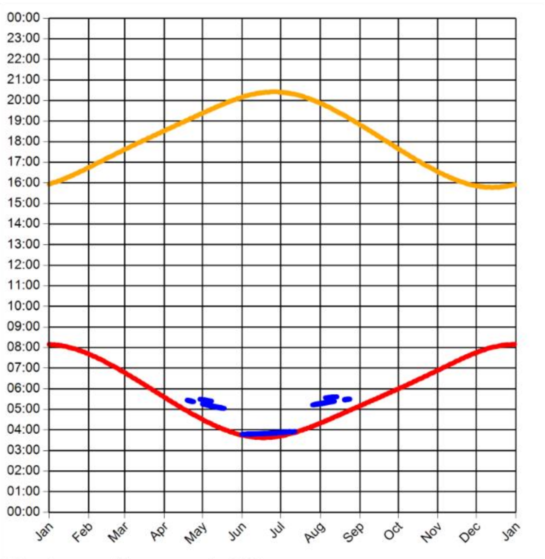
Min observer difference angle: 0°
Max observer difference angle: 8.2°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 35 Results

Reflection Date/Time (GMT) Graph



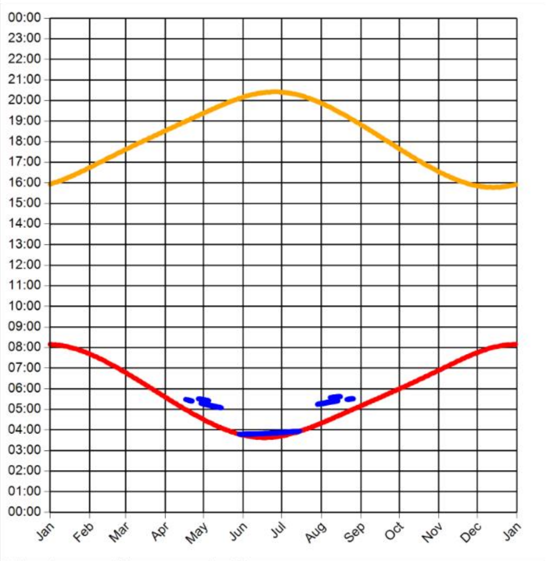
Min observer difference angle: 0.2°
Max observer difference angle: 8.6°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 36 Results

Reflection Date/Time (GMT) Graph



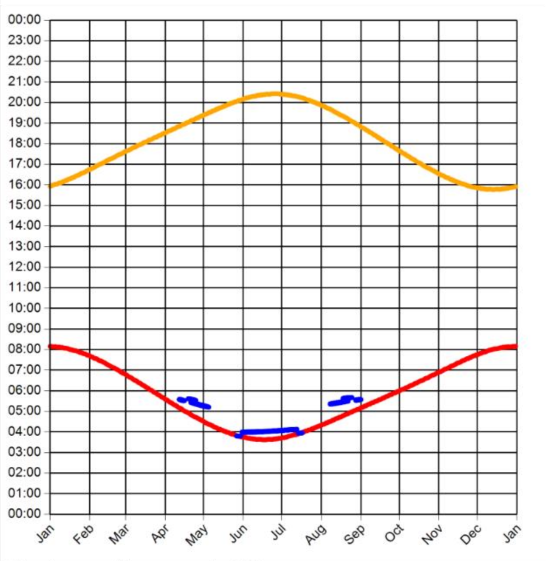
Min observer difference angle: 0°
Max observer difference angle: 8°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 37 Results

Reflection Date/Time (GMT) Graph



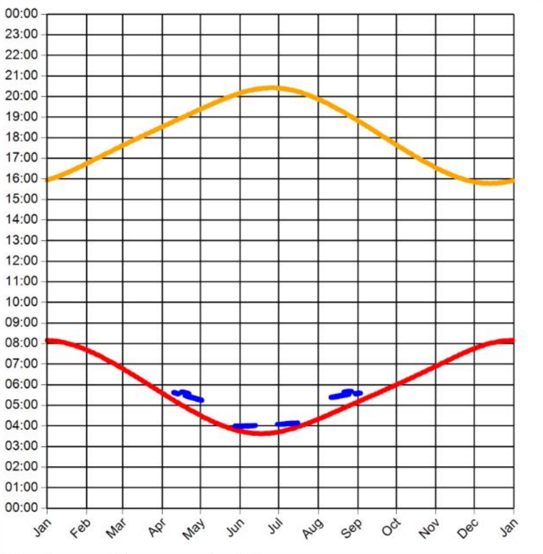
Min observer difference angle: 0.2°
Max observer difference angle: 6.5°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 38 Results

Reflection Date/Time (GMT) Graph



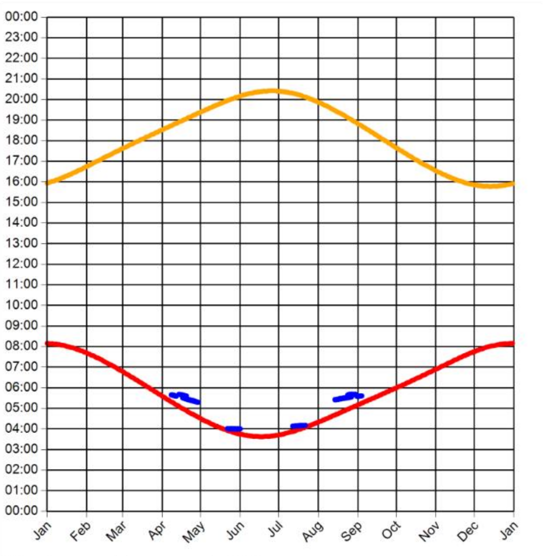
Min observer difference angle: 1.2°
Max observer difference angle: 6.2°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 39 Results

Reflection Date/Time (GMT) Graph



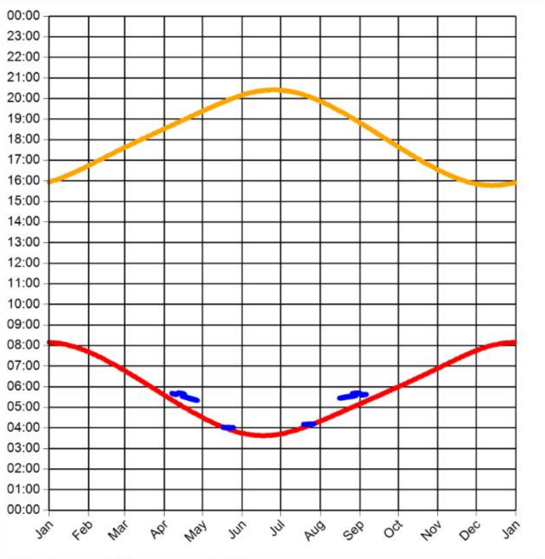
Min observer difference angle: 0.5°
Max observer difference angle: 5.9°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 40 Results

Reflection Date/Time (GMT) Graph



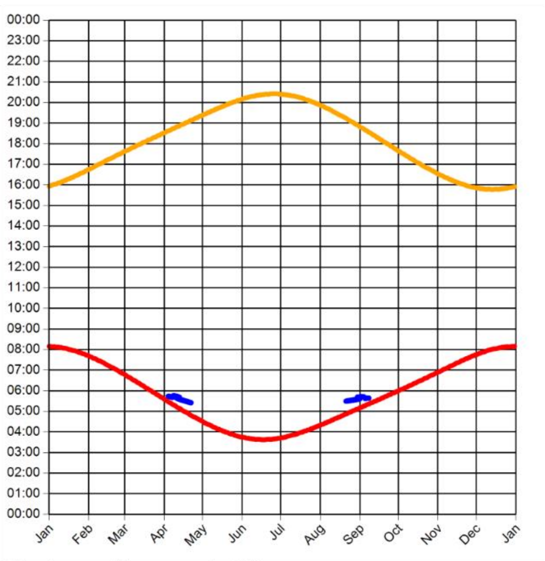
Min observer difference angle: 0°
Max observer difference angle: 5.5°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 41 Results

Reflection Date/Time (GMT) Graph



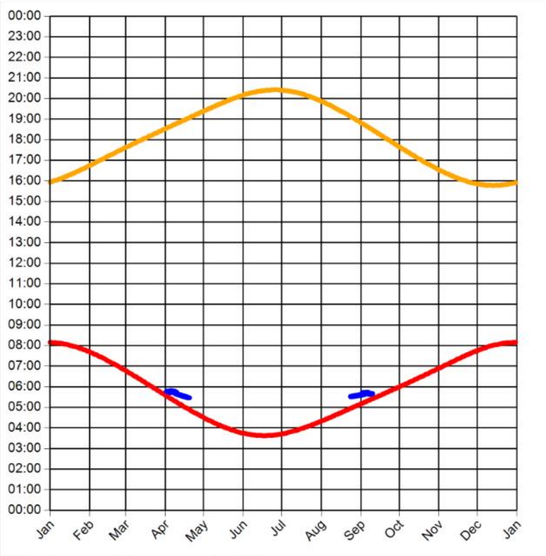
Min observer difference angle: 1.7°
Max observer difference angle: 4.9°

Observer Location | Sun azimuth range is 76° - 83° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 42 Results

Reflection Date/Time (GMT) Graph



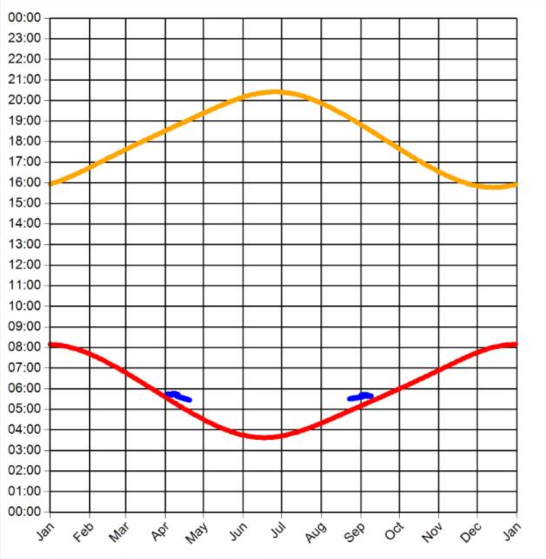
Min observer difference angle: 1.4°
Max observer difference angle: 4.6°

Observer Location — Sun azimuth range is 77° - 83.8° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 43 Results

Reflection Date/Time (GMT) Graph



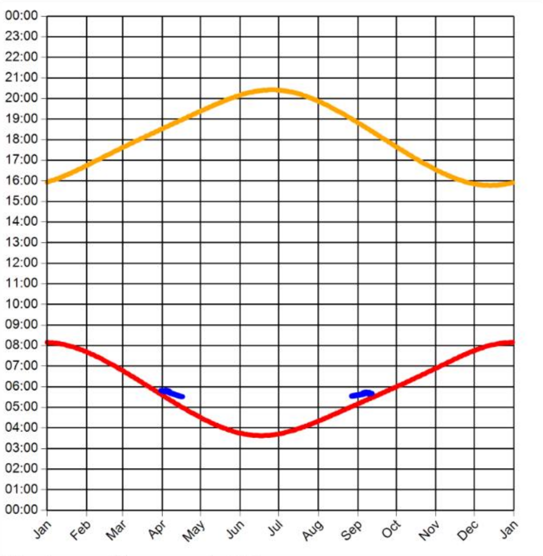
Min observer difference angle: 1.5°
Max observer difference angle: 4.5°

Observer Location — Sun azimuth range is 76.7° - 83.4° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 44 Results

Reflection Date/Time (GMT) Graph



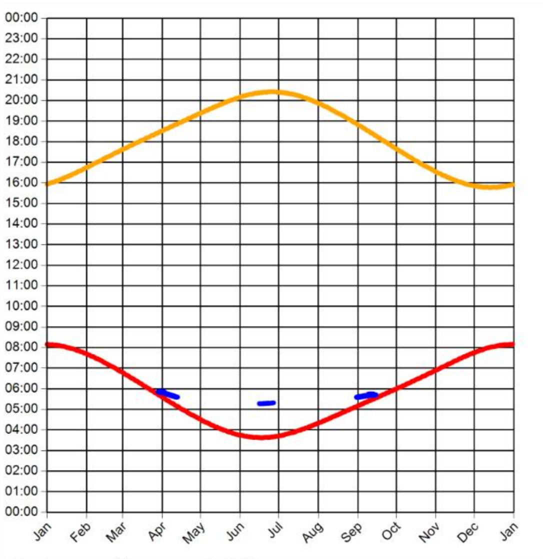
Min observer difference angle: 1.1°
Max observer difference angle: 4.1°

Observer Location — Sun azimuth range is 78.2° - 84.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 45 Results

Reflection Date/Time (GMT) Graph



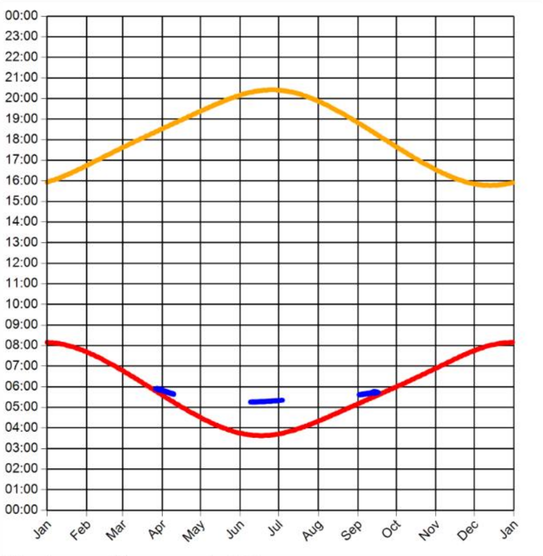
Min observer difference angle: 0.6°
Max observer difference angle: 12.9°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 46 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.3°
Max observer difference angle: 12.8°

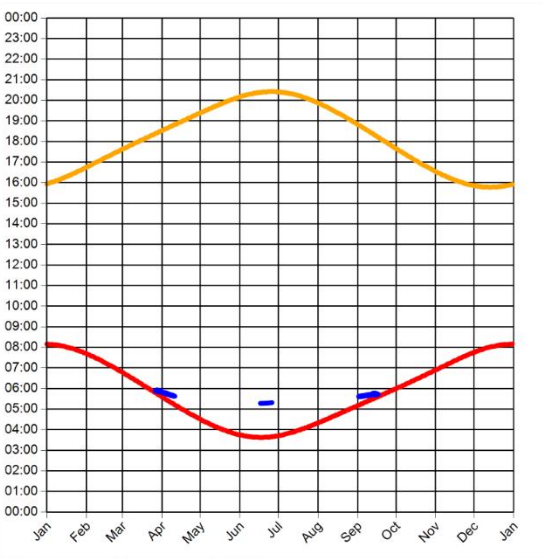
Observer Location

Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 47 Results

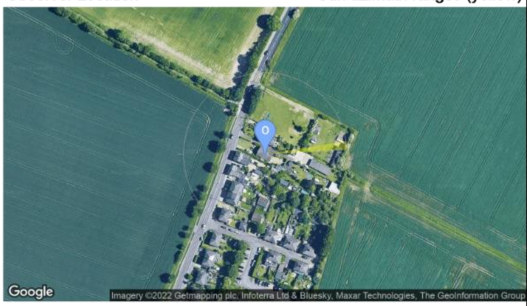
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.3°
Max observer difference angle: 12.8°

Observer Location

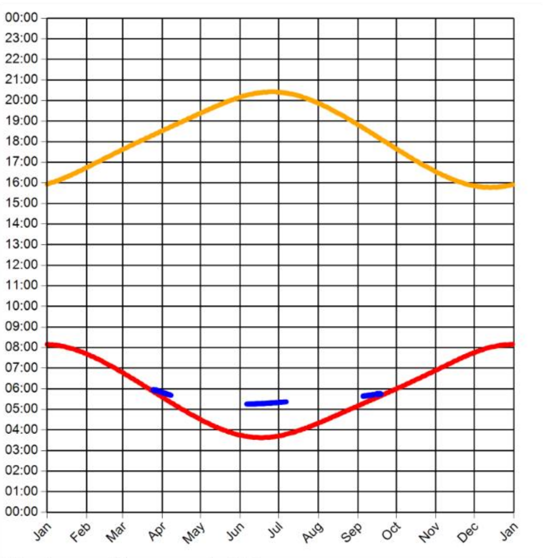
Sun azimuth ranges (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 48 Results

Reflection Date/Time (GMT) Graph



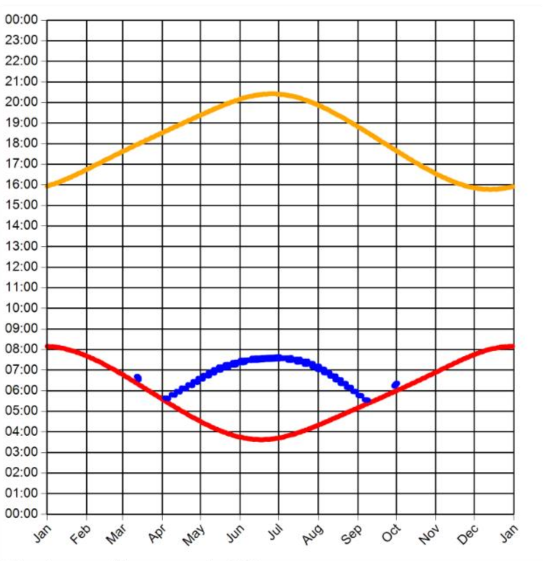
Min observer difference angle: 0.1°
Max observer difference angle: 12.9°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 49 Results

Reflection Date/Time (GMT) Graph



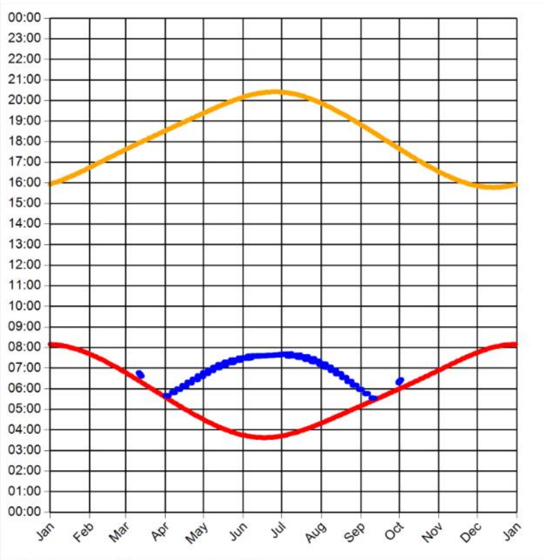
Min observer difference angle: 0.8°
Max observer difference angle: 33.3°

Observer Location — Sun azimuth range is 81.3° - 98.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 50 Results

Reflection Date/Time (GMT) Graph



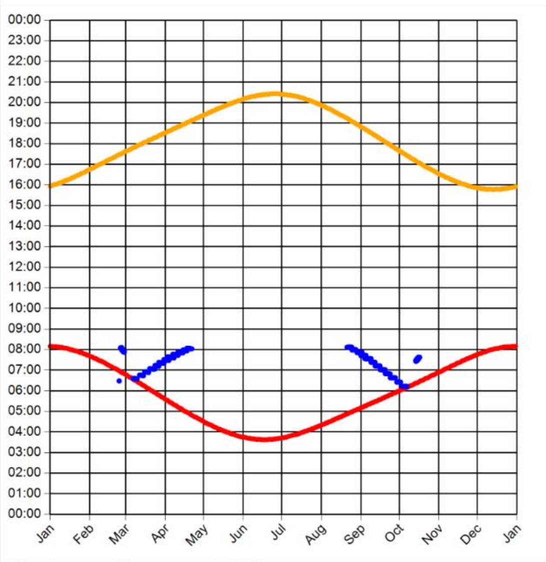
Min observer difference angle: 0.3°
Max observer difference angle: 33.3°

Observer Location | Sun azimuth range is 82° - 99.9° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 51 Results

Reflection Date/Time (GMT) Graph



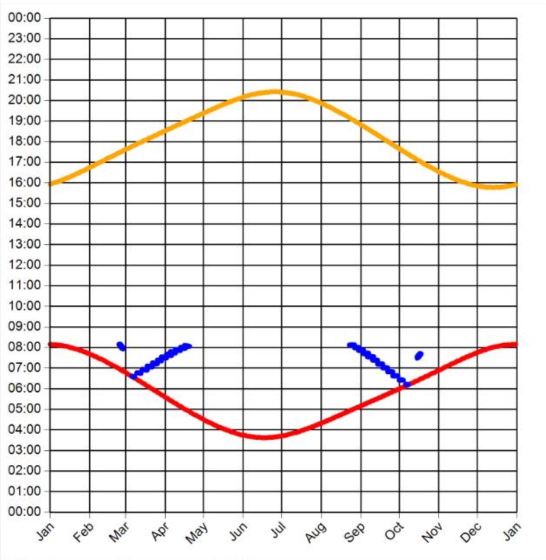
Min observer difference angle: 0.1°
Max observer difference angle: 29°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 52 Results

Reflection Date/Time (GMT) Graph



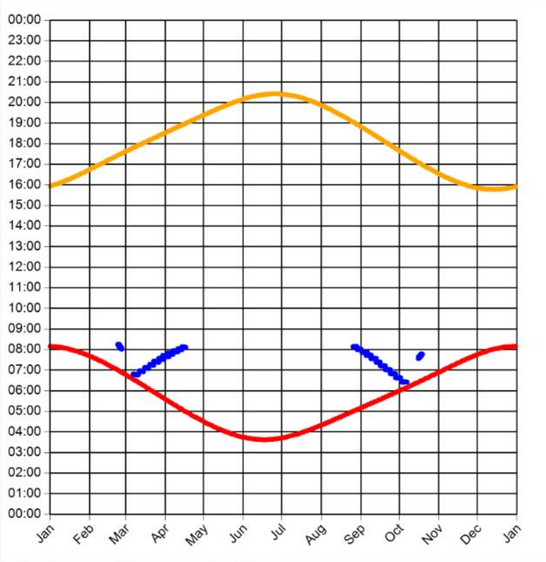
Min observer difference angle: 0°
Max observer difference angle: 28.6°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 53 Results

Reflection Date/Time (GMT) Graph



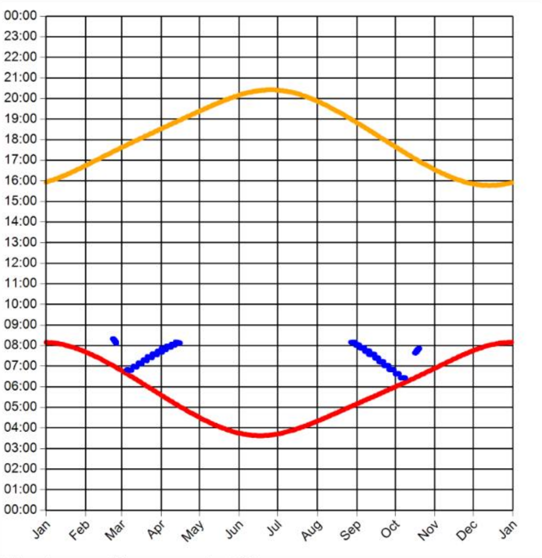
Min observer difference angle: 1.8°
Max observer difference angle: 28.1°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 54 Results

Reflection Date/Time (GMT) Graph



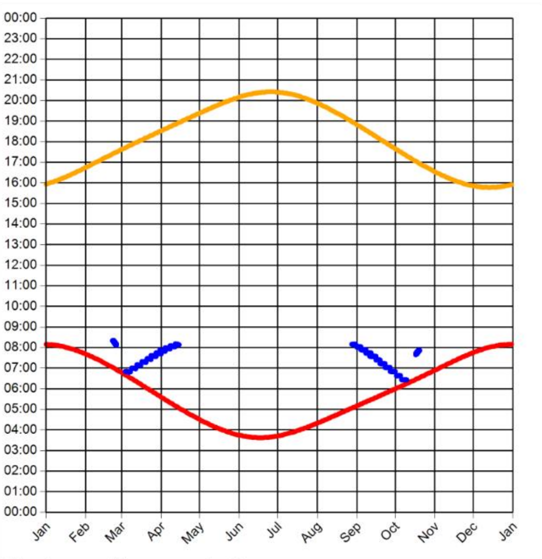
Min observer difference angle: 1.3°
Max observer difference angle: 28°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 55 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 1°
Max observer difference angle: 27.8°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)