Tritax Symmetry (Hinckley) Limited

# HINCKLEY NATIONAL RAIL FREIGHT INTERCHANGE

---

## The Hinckley National Rail Freight Interchange Development Consent Order

**Project reference TR050007**

# Applicant's response to ExA Written Questions [Appendix D - Glint and Glare Assessment]

**Document reference: 20.1.4**

**Revision: 01**

9 January 2024

---

**Planning Act 2008**

**The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009**
**Regulation 5(2)(q)**

PAGERPOWER
Urban & Renewables

# Solar Photovoltaic Glint and Glare Study

## Tritax Symmetry Management Ltd

## Hinckley National Rail Freight Interchange

January 2024

**PLANNING SOLUTIONS FOR:**

- Solar
- Telecoms
- Railways
- Defence
- Buildings
- Wind
- Airports
- Radar
- Mitigation

www.pagerpower.com

# ADMINISTRATION PAGE

| | |
|---|---|
| **Job Reference:** | 13044A |
| **Author:** | Abdul Wadud |
| **Telephone:** | [redacted] |
| **Email:** | [redacted]@pagerpower.com |

| | |
|---|---|
| **Reviewed By:** | Phillip Charhill; Aaron Williams |
| **Email:** | [redacted]agerpower.[redacted]pagerpower.com |

| Issue | Date | Detail of Changes |
|---|---|---|
| 1 | 8th January 2024 | Initial issue |
| 2 | 9th January 2024 | Administrative revisions |

*Stour Valley Business Centre, Brundon Lane, Sudbury, CO10 7GB*

[redacted]

# EXECUTIVE SUMMARY

## Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a roof-mounted solar photovoltaic development located in Elmesthorpe, Leicestershire, United Kingdom. This assessment pertains to the potential impacts upon road safety, residential amenity, railway operations and infrastructure, and aviation activity associated with Stoke Golding Airfield, Moxon's Farm Airfield, Viner's Airfield and Claybrooke Farm Airfield.

## Overall Conclusions

No significant impacts are predicted upon residential amenity, railway operations and infrastructure, and aviation activity associated with Stoke Golding Airfield, Moxon's Farm Airfield, Viner's Airfield and Claybrooke Farm Airfield. Mitigation is not recommended.

Mitigation is recommended for a 700m-section of the M69.

## 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. There is railway guidance with respect to signal sighting; however, no guidance with respect to glint and glare from solar developments upon , road safety, residential amenity and railway operations and infrastructure has been specifically produced. Pager Power has, however, produced guidance for glint and glare and solar photovoltaic developments which was published in early 2017, with the fourth edition published in 2022[1]. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, railway infrastructure and operations, and aviation activity.

Pager Power's approach is to identify receptors, 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, whilst comparing the results against available solar reflection studies. For aviation activity, where a solar reflection is predicted, solar intensity calculations are undertaken where appropriate in line with the Sandia National Laboratories' FAA methodology[2]. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact. Previous consultation with Network Rail and completing glint and glare assessment for railway infrastructure has been used to produce an overall methodology.

---

[1] Pager Power Glint and Glare Guidance, Fourth Edition, September 2022

[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.

Studies have measured the intensity of solar reflections from various naturally occurring and man-made surfaces. The results show that the intensity of solar reflections from solar panels are slightly higher than those from still water but significantly less than those from steel[3].

## Assessment Conclusions – Road Safety

Solar reflections are geometrically possible towards a 1.8km-section of the M69. For separate 700m and 400m sections, screening in the form of existing and proposed vegetation, and proposed units with non-reflecting panel areas are predicted to significantly obstruct views of reflecting panels, such that solar reflections will not be experienced by road users.

For the remaining 700m-section of the M69, solar reflections occur inside a road user's primary horizontal field-of-view (50 degrees horizontally either side relative to the direction of travel). No significant screening and a lack of sufficient mitigating factors (Section 6.3.3) have been identified for this section of road. Therefore, mitigation is recommended for this section (Section 6.3.4).

## Assessment Conclusions – Residential Amenity

Solar reflections are geometrically possible towards 76 of the assessed 118 dwellings. Screening in the form of existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels, such that solar reflections will not be experienced by residents at 60 dwellings.

For 16 dwellings, views of the reflecting panels may be possible despite partial screening in the form of existing and proposed vegetation and terrain. Solar reflections are predicted for less than 60 minutes on any given day and for more than three months of the year. A low impact is predicted, and mitigation is not recommended due to the following mitigating factors:

- The separation distance between an observer and the nearest reflecting panel is significant;
- Any effects are likely to be limited to an observer above the ground floor (if the dwelling is not a ground floor property only); and/or
- Effects would mostly coincide with direct sunlight.

## Assessment Conclusions – Railway Operations and Infrastructure

Solar reflections are geometrically possible towards separate 1.7km and 100m sections of railway. For the 100m section, screening in the form of existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels, such that solar reflections will not be experienced by train drivers.

For 300m of the 1.7km-section, views of the reflecting panels may be possible despite partial screening in the form of existing and proposed vegetation. Solar reflections occur outside a train driver's primary horizontal field-of-view (30 degrees horizontally either side of the direction of travel). A low impact is predicted, and mitigation is not recommended.

---

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

For the remaining 1.4km-section, solar reflections occur inside a train driver's primary horizontal field-of-view. Views of reflecting panels are considered to be unobstructed; however, the following mitigating factors (Section 6.2.2) are predicted to decrease the level of impact:

- Solar reflections do not occur in directly in front of a train driver and occur between 19°-30° within a train driver's horizontal field-of-view;
- Views of the reflecting panels are expected to be limited due to the height (21m agl) of the buildings relative to the eye line of a train driver (at 2.75m agl). Therefore, for much of this section of railway line, a train driver will need to look significantly vertically upwards to see most of the potentially visible reflecting panels;
- The workload of a train driver is expected to be relatively low as no switch points are identified along this section of railway or approaching a train station;
- A train driver will not have exited a tunnel or heavily shadowed area when solar reflections are geometrically possible, therefore disability glare is not considered possible;
- Solar reflections will mostly coincide with the Sun, which will be a more prominent source of light.

An overall low impact is predicted upon train driver's, and mitigation is not recommended.

Solar reflections are geometrically possible towards two trackside signals, of which a low impact is predicted.

## High-Level Assessment Conclusions – Aviation Activity

Solar reflections towards the approach paths and final sections of visual circuits for runway thresholds at Stoke Golding Airfield, Moxon's Farm Airfield, Viner's Airfield and Claybrooke Farm Airfield are predicted to occur outside a pilot's field-of-view (50 degrees either side relative to the runway threshold bearing) or have glare intensities no greater than 'low potential for temporary after image' (Section 7). Both glare scenarios are not considered significant in accordance with the associated guidance (Appendix D) and industry best practice. Mitigation is not required.

# LIST OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

# ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, United Kingdom. The company has undertaken projects in 59 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 roof-mounted solar photovoltaic development located in Elmesthorpe, Leicestershire, United Kingdom. This assessment pertains to the potential impacts upon road safety, residential amenity, railway operations and infrastructure, and aviation activity associated with Stoke Golding Airfield, Moxon's Farm Airfield, Viner's Airfield and Claybrooke Farm Airfield.

This report contains the following:

- Solar development details;
- Explanation of glint and glare;
- Overview of relevant guidance and studies;
- Overview of Sun movement;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- Results discussion;
- High-level overview of aviation considerations;
- Overall conclusions and recommendations.

## 1.2 Pager Power's Experience

Pager Power has undertaken over 1,200 Glint and Glare assessments in the UK and internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

## 1.3 Glint and Glare Definition

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

- 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 presented within the Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) – published by the Department for Energy Security and Net Zero in March 2023 and the Federal Aviation Administration in the USA.

# 2 SOLAR DEVELOPMENT LOCATION AND DETAILS

## 2.1 Overview

The following sections present key details pertaining to the proposed development and this assessment.

## 2.2 Proposed Development Site Layout

Figure 1 below shows the site layout[5] for the proposed development.

Figure 1 *Site layout*

---

[5] Source: Tritax Symmetry, January 2024, 'TR050007-001036-2.9 Hinckley NRFI Illustrative Context Masterplan'

The building elevations[6] are shown in Figure 2 below.

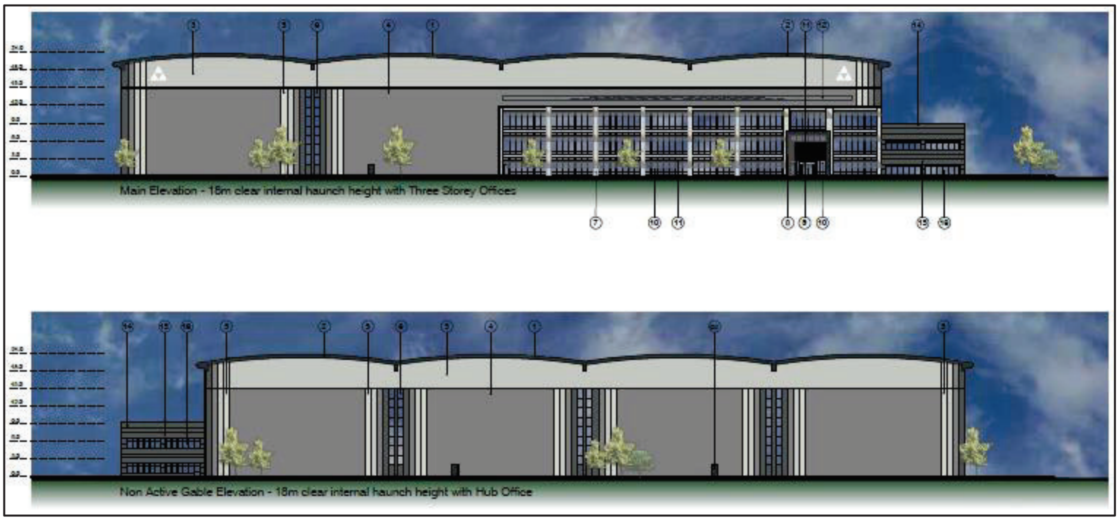
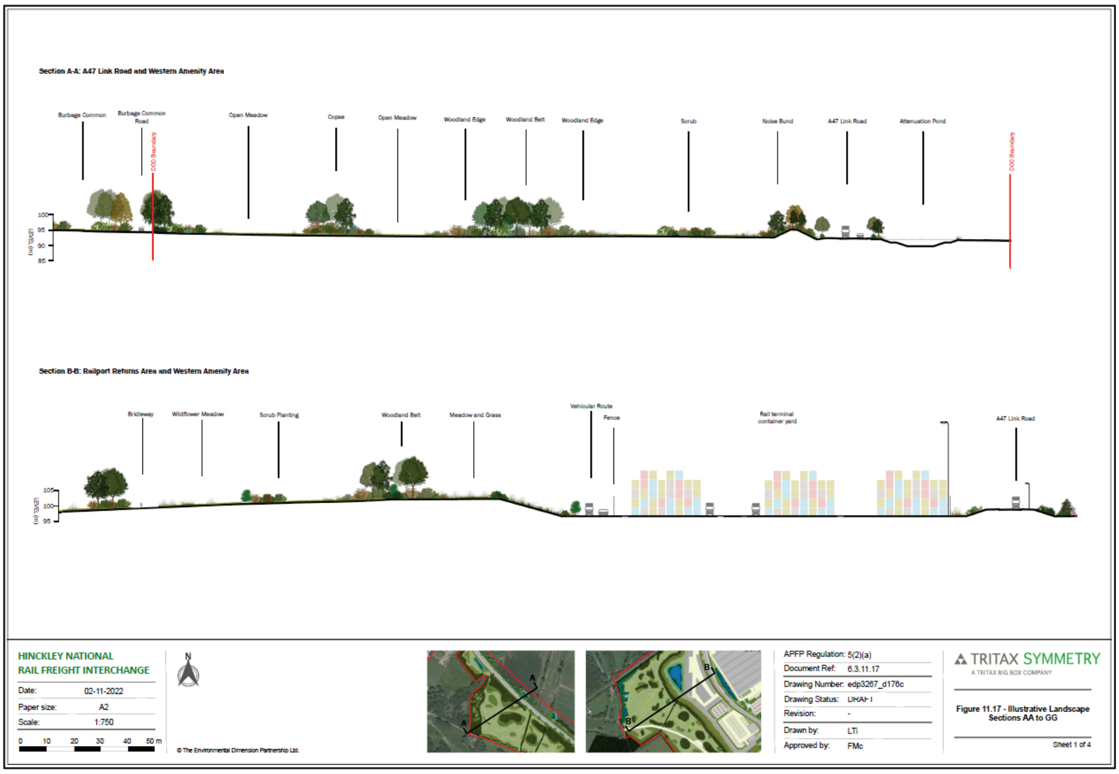


Figure 2 *Building elevations*

Proposed vegetation[7] as part of the development is shown in Figure 3 below.



HINCKLEY NATIONAL
RAIL FREIGHT INTERCHANGE
Date: 02-11-2022
Paper size: A2
Scale: 1:750

© The Environmental Dimension Partnership Ltd.

APFP Regulation: 5(2)(a)
Document Ref: 6.3.11.17
Drawing Number: edp3267_d176c
Drawing Status: DRAFT
Revision: -
Drawn by: LTi
Approved by: FMc

Figure 11.17 - Illustrative Landscape Sections AA to GG

Sheet 1 of 4

Figure 3 *Proposed vegetation*

---

[6] Source: AJA Architects LLP, January 2024, 'BLUEPRINT-1 Typical Design Application & Branding' (cropped)

[7] Source: Tritax Symmetry, January 2024, 'TR050007-000945-6.3.11.17 Hinckley NRFI ES Figure 11.17 - Illustrative Landscape Sections AA to GG'

## 2.3 Reflector Areas

The bounding coordinates for the proposed development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 4 below shows the assessed reflector areas (in blue) that have been used for modelling purposes.

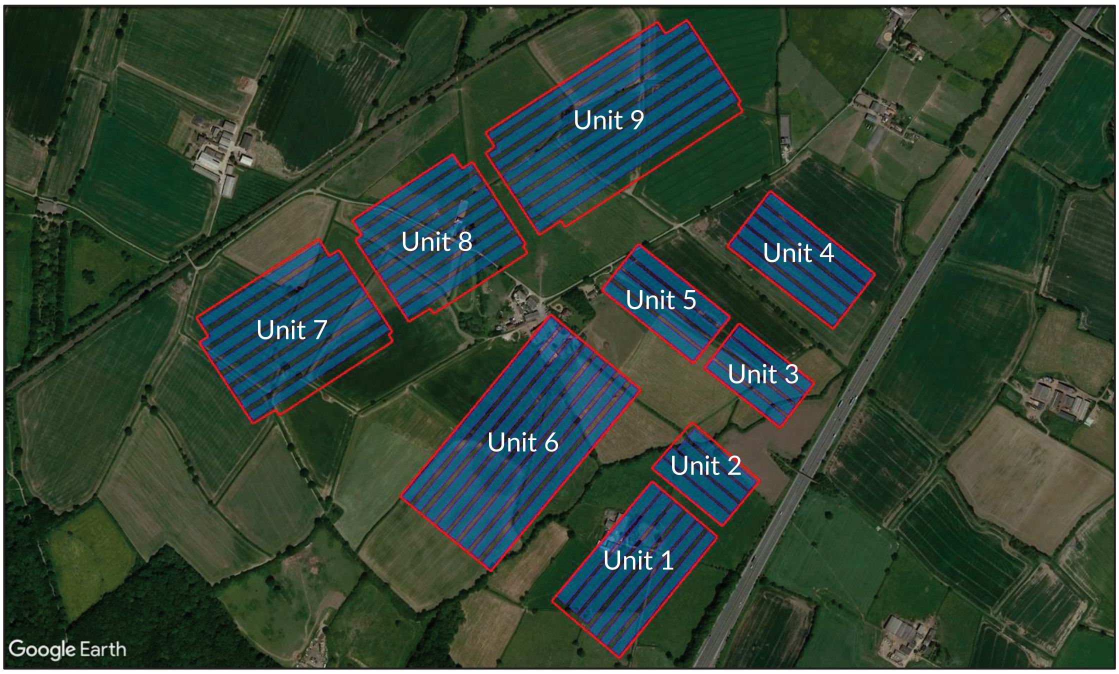


Figure 4 *Assessed reflector areas*

A resolution of 10m has been chosen for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 10m 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. If a reflection is experienced from an assessed panel location, then it is likely that a reflection will be viewable from similarly located panels within the proposed solar development.

## 2.4 Solar Panel Technical Information

The technical information of the modelled solar panels used in this assessment is summarised in Table 1 below.

| Unit | Azimuth Angles[8] (°) | Elevation Angle[9] (°) | Assessed Centre Height (m above ground level) |
|---|---|---|---|
| 1 | 130/310 | 5 | 21 |
| 2 | 40/220 | | |
| 3 | 40/220 | | |
| 4 | 40/220 | | |
| 5 | 40/220 | | |
| 6 | 130/310 | | |
| 7 | 145/325 | | |
| 8 | 145/325 | | |
| 9 | 145/325 | | |

Table 1 *Modelled panel information*

Panels are understood to be coated with an anti-reflective coating. The geometric assessment has considered whether a geometric reflection is solely possible and the impact when considering the glare scenario and mitigating factors as required.

---

[8] Direction the panels are facing relative to True North (0°)

[9] Roof pitch angle. Solar panels will be parallel to the roof pitch.

# 3 RAILWAYS ASSESSMENT METHODOLOGY

## 3.1 Overview

A railway stakeholder (such as Network Rail) may request further information regarding the potential effects of glint and glare from reflective surfaces when a development is located adjacent to a railway line (typically 50-100m from its infrastructure). The request may depend on the scale, percentage of reflective surfaces and the complexity of the nearby railway, for example. The following section presents details regarding the most common concerns relating to glint and glare.

## 3.2 Disability Glare

As well as the glint and glare definition presented in Section 1.3, glare can also be categorised as causing visual discomfort whereby an observer would instinctively look away, or cause disability whereby objects become difficult to see. The guidance produced by the Commission Internationale de L'Eclairage (CIE)[10] describes disability glare as:

*'Disability glare is glare that impairs vision. It is caused by scattering of light inside the eye…The veiling luminance of scattered light will have a significant effect on visibility when intense light sources are present in the peripheral visual field and contrast of objects is seen to be low.'*

*'Disability glare is most often of importance at night when contrast sensitivity is low and there may well be one or more bright light sources near to the line of sight, such as car headlights, streetlights or floodlights. But even in daylight conditions disability glare may be of practical significance: think of traffic lights when the sun is close to them, or the difficulty viewing paintings hanging next to windows.'*

These types of glare are of particular importance in the context of railway operations as they may cause a distraction to a train driver (discomfort) or may cause railway signals to be difficult to see (disability).

## 3.3 Common Concerns and Signal Overview

Typical reasons stated by a railway stakeholder for requesting a glint and glare assessment often relate to the following:

1. The development producing solar reflections towards train drivers.
2. The development producing solar reflections, which causes a train driver to take action.
3. The development producing solar reflections that affect railway signals.

With respect to point 1, a reflective panel could produce solar reflections towards a train driver. If this reflection occurs where a railway signal, crossing etc., is present, or where the driver's

---

[10] CIE 146:2002 & CIE 147:2002 Collection on glare (2002).

workload is particularly high, the solar reflection may affect operations. This is deemed to be the most concern with respect to solar reflections.

Following from point 1, point 2 identifies whether a modelled solar reflection could be significant by determining its intensity. Only where a solar reflection occurs under certain conditions and is of a particular intensity may it cause a reaction from a train driver and thus potentially affect safe operations. Therefore intensity calculations are undertaken where a solar reflection is identified and where its presence could potentially affect the safety of operations. Points 1 and 2 are completed in a 2-step approach.

With respect to all points, railway lines use light signals to manage trains on approach towards particular sections of track. If a signal is passed when not permitted, a SPAD (Signal Passed At Danger) is issued. The concerns will relate specifically to the possibility of the reflections appearing to illuminate signals that are not switched on (known as a phantom aspect illusion) or a distraction caused by the glare itself, both of which could lead to a SPAD. The definition is presented below:

*'Light emitted from a Signal lens assembly that has originated from an external source (usually the sun) and has been internally reflected within the Signal Head in such a way that the lens assembly gives the appearance of being lit.*[11]'

---

[11] Source: Glossary of Signalling Terms, Railway Group Guidance Note GK/GN0802. Issue One. Date April 2004.

# 4 GLINT AND GLARE ASSESSMENT METHODOLOGY

## 4.1 Overview

The following sub-sections provide a general overview with respect to the guidance studies and methodology which informs this report. Pager Power has also produced its own Glint and Glare Guidance which draws on assessment experience, consultation and industry expertise.

## 4.2 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.

## 4.3 Background

Details of the Sun's movements and solar reflections are presented in Appendix C. Details of the Sun's movements at the development location are presented in Appendix C, and details of the modelling approach itself are presented in Appendix E.

## 4.4 Methodology and Consultation

The railway glint and glare assessment methodology has been based on Pager Power's experience within the UK following previous consultation with Network Rail.

The general methodology for this glint and glare assessment is as follows:

- Identify the receptors of concern. In this instance the concern is reflections of the Sun from the reflecting panels towards surrounding railway receptors (potential signal and train driver locations) within 500 metres of the development, and roads and dwellings within 1,000 metres of the development.
- Define the reflectors for the development and choose an appropriate assessment resolution;
- Undertake geometric calculations[12] to determine whether a solar reflection may occur from a defined reflector area, and if so, when it will occur;

---

[12] Within the model, the development reflector area is defined, as well as the relevant receptor locations. The result is a chart that states whether a reflection can occur considering the location of the Sun throughout a given year and the duration of the solar reflection towards the receptor.

- If a reflection can occur, determine whether the modelled reflectors will be visible from the identified receptor locations;
- Consider the above together with the solar reflection's location of origin with respect to the location of the Sun in the sky, its angle above the horizontal and the time of day at which a solar reflection could occur;
- Determine whether the solar reflection is likely to be a significant hazard or nuisance factoring in all of the above in accordance with Appendix D;
- Consider mitigation, if appropriate.

## 4.5 Railway Specific Criteria

The specific parameters for a railway glint and glare assessment are presented below:

- Whether the solar reflection originates within a train driver's main field-of-view, defined as 30 degrees either side of the railway line with respect to the direction of travel;
- The contrast of sensitivity, considering a low sensitivity is where disability glare is more likely to occur;
- The reflecting area compared to the façade as a whole, with a significant area considered more than 50%;
- Solar reflections occurring towards a significant section of railway line where, for example:
    - A point of multiple lines with switch points;
    - At a station;
    - Signals being present;
    - Road or pedestrian crossings being present.
- The duration of the solar reflection;
- If the development in keeping with those around it and near to the assessed railway line.

## 4.6 Assumptions 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 sections present the relevant receptors assessed within this report. Terrain data has been interpolated based on Ordnance Survey (OS) 50 Digital Terrain Model (DTM) data. The receptor details for all receptors are presented in Appendix G.

## 5.2 Railway Operations and Infrastructure Overview

Railway receptors within close proximity (typically within 100m) to a solar development are often required for assessment. When required, a 500m assessment area is considered appropriate and has been designed accordingly.

Receptors within the 500m assessment area are identified based on mapping and aerial photography of the region. A more detailed assessment is made if the modelling reveals that a reflection would be geometrically possible. The significance of a reflection 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.

## 5.3 Train Driver Receptors

### 5.3.1 Train Driver Receptors Overview

The analysis has considered train driver receptors that:

- Are within the 500-metre assessment area;
- Have a potential view of the development.

An additional height of 2.75m above rail level is used to model the eye-level[13] of train drivers, based on previous consultation[14].

### 5.3.2 Identified Train Driver Receptors

A 2.20km-section of railway track is located northwest of the proposed development. In total, 23 receptors have been assessed. The distance between train driver receptors is circa 100m positioned along the orange line, as shown in Figure 5 on the following page.

---

[13] This fixed height for the train driver receptors is for modelling purposes. Small changes to the modelling height by a few metres is not expected to significantly change the modelling results.

[14] Consultation undertaken with Network Rail in the UK.

Figure 5 *Assessed train driver receptors*

## 5.4 Railway Signal Receptors

### 5.4.1 Railway Signal Overview

Railway signals, including assets of Network Rail, are identified from the available imagery. This report can be updated following further signals and assets identified by Network Rail.

The assessment has considered both gantry and trackside signals within 500m of the development and a line-of-sight of the development. The typical heights above ground level of each signal have been provided by Network Rail[15]. The heights[16] used for the assessment are:

- Gantry signal – 3.35m agl;
- Trackside signal – 2.25m agl.

### 5.4.2 Identified Railway Signals

The locations of the assessed trackside signal receptors are shown in Figure 6 on the following page. A total of two trackside signals have been assessed.

This report can be updated to consider any signals or assets later identified by Network Rail.

---

[15] Consultation undertaken with Network Rail in the UK

[16] These fixed heights are for signal receptors for modelling purposes. Small changes to the modelling height by a few metres is not expected to significantly change the modelling results.

Figure 6 *Assessed trackside signals*

## 5.5 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 (white outlined area in Figure 7 on page 26) has been designed accordingly as 1km from the proposed development.

Potential receptors within the associated assessment area 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.

## 5.6 Road Receptors

### 5.6.1 Road Receptors Overview

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 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.

### 5.6.2 Identified Road Receptors

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

- Are within the one-kilometre assessment area;
- Have a potential view of the panels.

A 3.10km section of the M69 has been identified within the assessment area with potential views of the proposed development. Receptors 1 to 32 are placed approximately 100m apart along the identified road section, as shown in Figure 7 on the following page. An additional height of 1.5m is added to account for the eye-level of a typical road user.

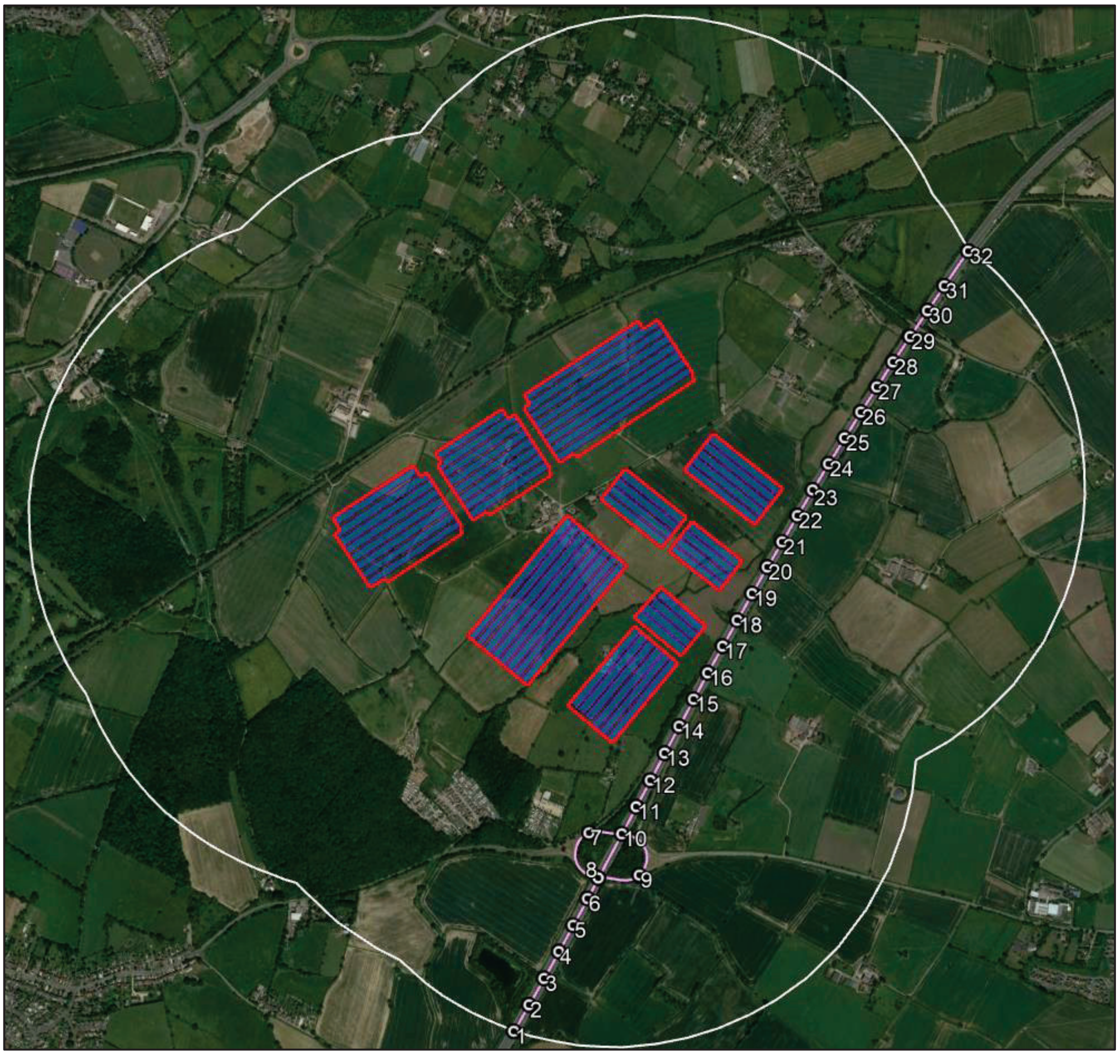


Figure 7 *Road receptors*

## 5.7 Dwelling Receptors

### 5.7.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

- Are within the one-kilometre assessment area; and
- Have a potential view of the panels.

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.

Additionally, in some cases, a single receptor point may be used to represent a small number of separate addresses. In such cases, the results for the receptor will be representative of the adjacent observer locations, such that the overall level of effect in each area is captured reliably.

### 5.7.2 Identified Dwelling Receptors

The assessed dwelling receptors are shown in Figure 8 below. In total, 118 dwellings have been assessed. An additional 1.8m height above ground is used in the modelling to simulate the typical viewing height of an observer on the ground floor[17].

Figure 8 *Overview of all dwellings*

---

[17] Small changes to this height are not significant, and views above the ground floor considered are considered where appropriate

# 6 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

## 6.1 Overview

The following sub-sections summarise the results of the assessment:

- The key considerations for each receptor type. The criteria are determined by the assessment process for each receptor, which are set out in Appendix D;
- Geometric modelling results of the assessment based solely on bare-earth terrain i.e., without consideration of screening in the form of buildings, dwellings, (existing or proposed) vegetation, and/or terrain. The modelling output for receptors, shown in Appendix H, presents the precise predicted times and the reflecting panel areas;
- Results discussion, considering whether a reflection will be experienced in practice and a desk-based review of imagery. When determining the visibility of the reflecting panels for an observer, a conservative review of the available imagery, landscape strategy plan, google earth viewshed (high-level terrain analysis), and/or site photography (if available) is undertaken, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing screening will remove effects;
- The overall impact significance and any mitigation recommendations/requirements;

Appendix H presents the results charts showing specific times and dates.

## 6.2 Train Driver Receptors

### 6.2.1 Key Considerations

The key considerations for quantifying impact significance for train driver receptors are:

- Whether a reflection is predicted to be experienced in practice;
- The location of the reflecting panel relative to a train driver's direction of travel;
- The workload of a train driver experiencing a solar reflection.

Where no solar reflections are geometrically possible or where solar reflections are predicted to be significantly screened, no impact is predicted, and mitigation is not required.

Where reflections originate from outside of a train driver's primary horizontal field-of-view (30 degrees either side of the direction of travel), or where the separation distance to the nearest visible reflecting panel is over 500m, the impact significance is low, and mitigation is not recommended.

Where reflections originate from inside of a train driver's primary horizontal field-of-view, expert assessment of the following mitigating factors is required to determine the impact significance:

- Whether the solar reflection originates from directly in front of a train driver. Solar reflections that are directly in front of a road user are more hazardous.
- Whether a solar reflection is fleeting in nature. Small gap/s in screening, e.g. an access point to the site, may not result in a sustained reflection for a train driver.

- 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 workload of a train driver experiencing a solar reflection. Is there visibility of a railway signal or level crossing when solar reflections are predicted to be received? Is there a switch in the railway line when solar reflections are predicted to be received?
- 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.

Following consideration of these mitigating factors, where the solar reflection does not remain significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection remains significant, the impact significance is moderate, and mitigation is recommended.

Where reflections originate from directly in front of a train driver and there are no mitigating factors, the impact significance is high, and mitigation is required.

### 6.2.2 Geometric Calculation Results and Discussion

The results of the geometric calculations for the train driver receptors and overall predicted impact are presented in Table 2 on the following page.

| Train Driver Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 1 – 14 | Solar reflections are geometrically possible **inside** a train driver's primary horizontal field-of-view | Existing vegetation to be retained, and proposed vegetation predicted to obstruct views, with marginal views considered possible | Reflecting panels occur between 19°-30° within a train driver's field-of-view<br>Views of the reflecting panels are expected to be limited due to the height (21m agl) of the buildings relative to the eye line of a train driver (at 2.75m agl). Therefore, for much of this section of railway line, a train driver will need to look significantly vertically upwards to see most of the potentially visible reflecting panels<br>No switch points or signals are identified along this section of railway<br>A train driver will not have exited a tunnel when solar reflections are | Low impact |

| Train Driver Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| | | | geometrically possible, therefore disability glare is not considered possible<br>The separation distance between the closest point of the railway and reflecting panel area is approximately 140m, exceeding to 500m<br>Solar reflections will coincide with the Sun, which will be a more prominent source of light | |
| 15 – 18 | Solar reflections are geometrically possible **outside** a train driver's primary horizontal field-of-view | Existing vegetation to be retained, and proposed vegetation predicted to obstruct views, with marginal views considered possible | N/A | Low impact |
| 19 – 22 | Solar reflections are not geometrically possible | N/A | N/A | No impact |

| Train Driver Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 23 | Solar reflections are geometrically possible **outside** a train driver's primary horizontal field-of-view | Existing vegetation to be retained, and proposed vegetation predicted to significantly obstruct views | N/A | No impact |
| Trackside Signal 1 | Solar reflections are geometrically possible | Existing vegetation and terrain; solar reflections predicted to partially reach signal | Reflections do not occur directly 180° to the signal<br>Signal will be orientated the opposite direction to solar reflection | Low impact |
| Trackside Signal 2 | Solar reflections are geometrically possible | Existing vegetation and terrain predicted to significantly obstruct reflections towards signal | Reflections do not occur directly 180° to the signal | Low impact |

Table 2 *Geometric modelling results and predicted impact – train driver receptors*

### 6.2.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in Figures 9 to 14 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing vegetation is outlined in green.

Figure 9 Partial vegetation *screening for train driver receptors 1 to 14*

Figure 10 *Section of railway between train driver receptors 1 to 14*

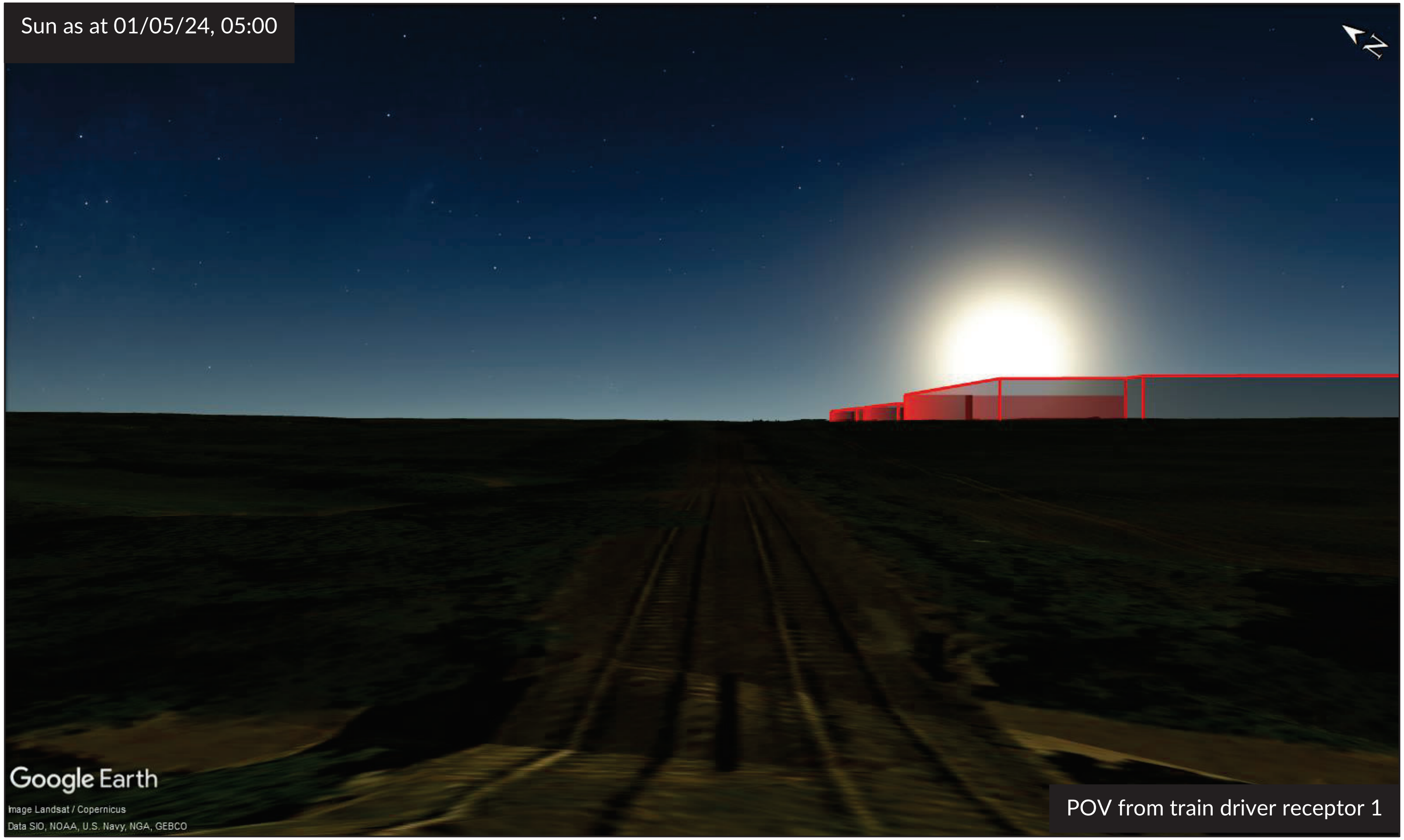


Figure 11 *Solar reflections coinciding with the Sun between train driver receptors 1 to 14*

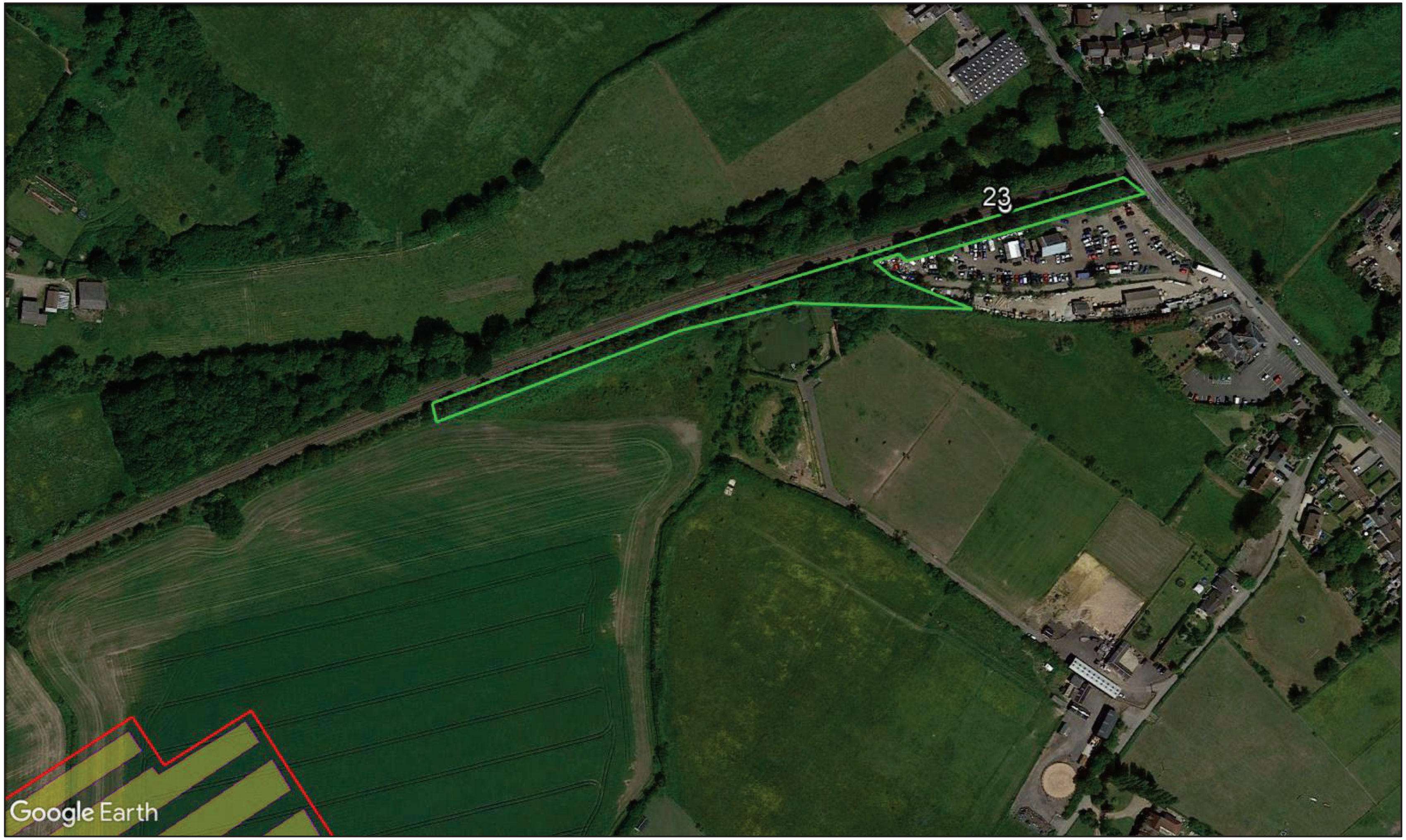


Figure 12 *Screening for train driver receptor 23*

Figure 13 *Trackside signal 1*

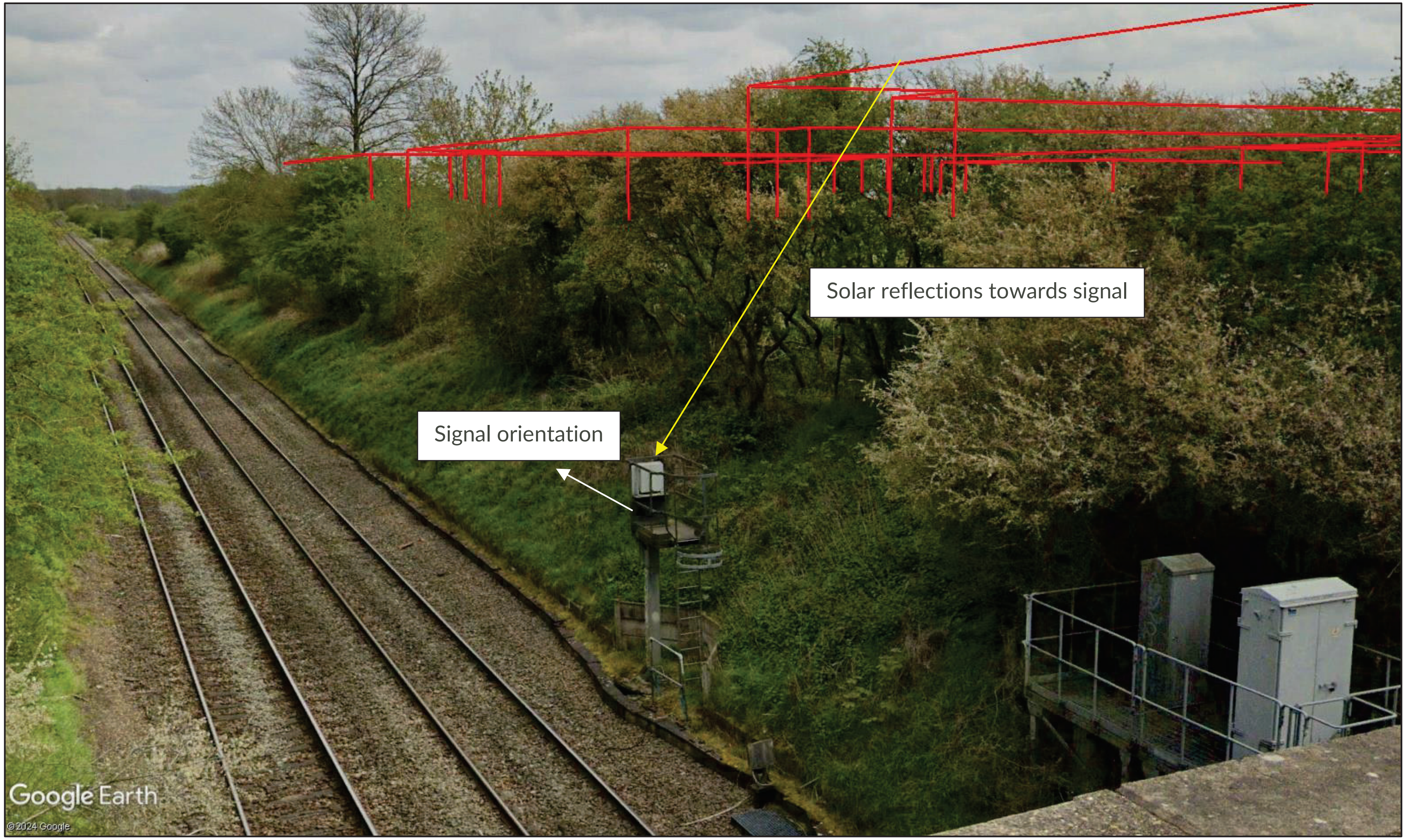


Figure 14 *Trackside signal 2*

## 6.3 Assessment Results – Road Receptors

### 6.3.1 Key Considerations

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

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

Where solar reflections are not geometrically possible, or the reflecting panels are predicted to be significantly obstructed from view, no impact is predicted, and mitigation is not required.

Where solar reflections originate from outside of a road user's primary horizontal field-of-view (50 degrees either side relative to the direction of travel), or the closest reflecting panel is over 1km from the road user, the impact significance is low, and mitigation is not recommended.

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

- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side;
- Whether visibility is likely for elevated drivers (relevant to dual carriageways and motorways[18]);
- 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;
- Whether a solar reflection is fleeting in nature. Small gap/s in screening, e.g. an access point to the site, may not result in a sustained reflection for a road user;
- 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.

Following consideration of these relevant factors, where the solar reflection is not deemed significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

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

### 6.3.2 Geometric Modelling Results and Discussion

The results of the geometric calculations for the road receptors and overall predicted impact are presented in Table 3 on the following page.

---

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

| Road Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 1 – 12 | Solar reflections are not geometrically possible | N/A | N/A | No impact |
| 13 – 15 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 16 – 19 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | Buildings (non-reflecting panels) predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 20 - 27 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | No significant screening identified | Reflecting panels occur between 20°-50° within a road user's field-of-view<br>Solar reflections will coincide with the Sun, which will be a more prominent source of light | Moderate |
| 28 – 32 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |

Table 3 *Geometric modelling results and predicted impact - road receptors*

### 6.3.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in the following Figures 15 to 19 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing vegetation is outlined in green. Streetview images are used to show the point-of-view of a road user at specific locations, with blue cones to illustrate the field-of-view / viewing direction.

| Road Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 1 – 12 | Solar reflections are not geometrically possible | N/A | N/A | No impact |
| 13 – 15 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 16 – 19 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | Buildings (non-reflecting panels) predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 20 - 27 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | No significant screening identified | Reflecting panels occur between 20°-50° within a road user's field-of-view<br>Solar reflections will coincide with the Sun, which will be a more prominent source of light | Moderate |
| 28 – 32 | Solar reflections are geometrically possible **inside** a road user's primary horizontal field-of-view | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |

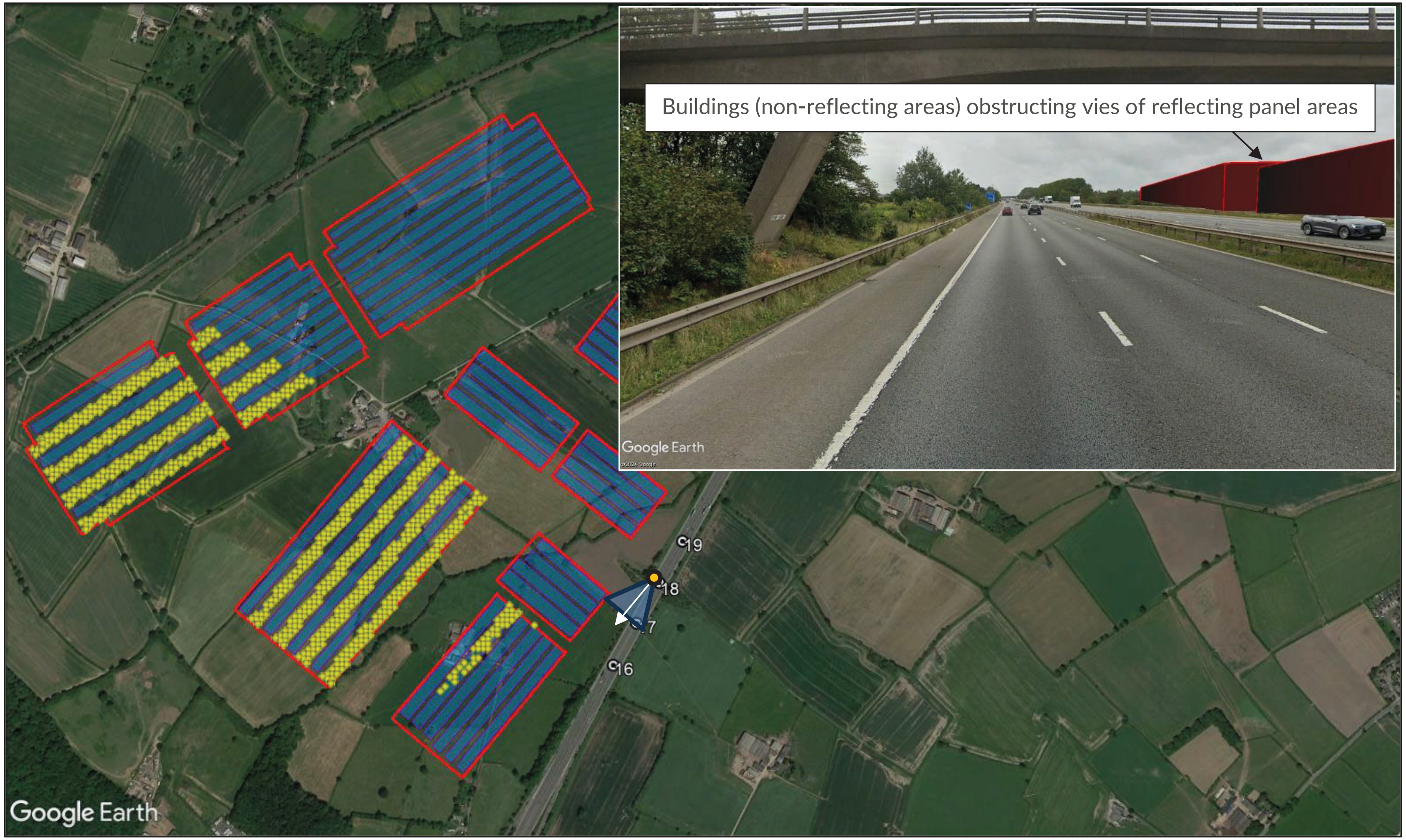
Table 3 *Geometric modelling results and predicted impact - road receptors*

### 6.3.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in the following Figures 15 to 19 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing vegetation is outlined in green. Streetview images are used to show the point-of-view of a road user at specific locations, with blue cones to illustrate the field-of-view / viewing direction.

Figure 15 *Screening for road receptors 13 to 15*

Figure 15 *Screening for road receptors 13 to 15*



Buildings (non-reflecting areas) obstructing vies of reflecting panel areas

Figure 16 *Screening for road receptors 16 to 19*

Figure 17 *Reflecting area relative to field-of-view for road receptors 20 to 27*

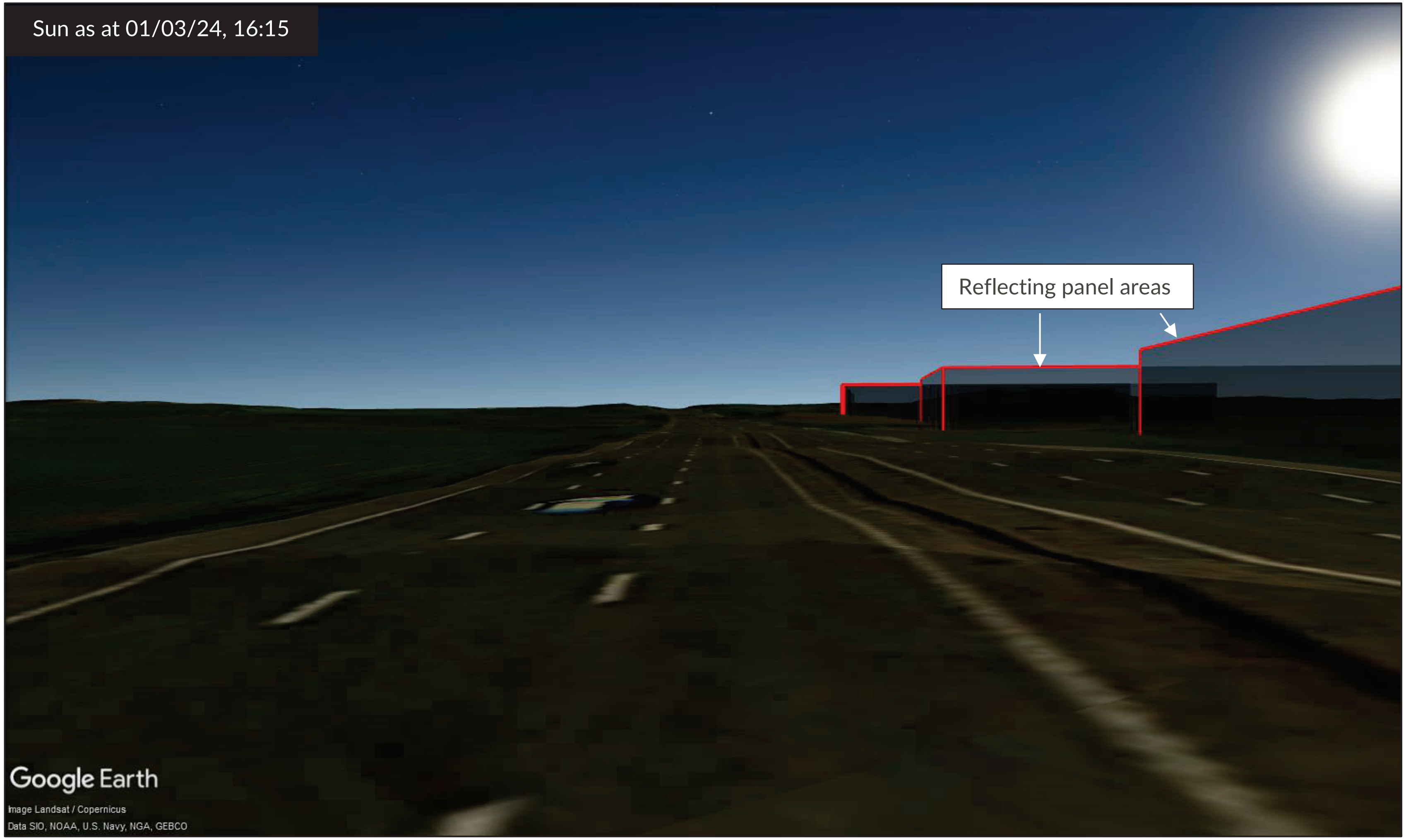


Figure 18 *Solar reflections coinciding with the Sun between road receptors 20 to 27*

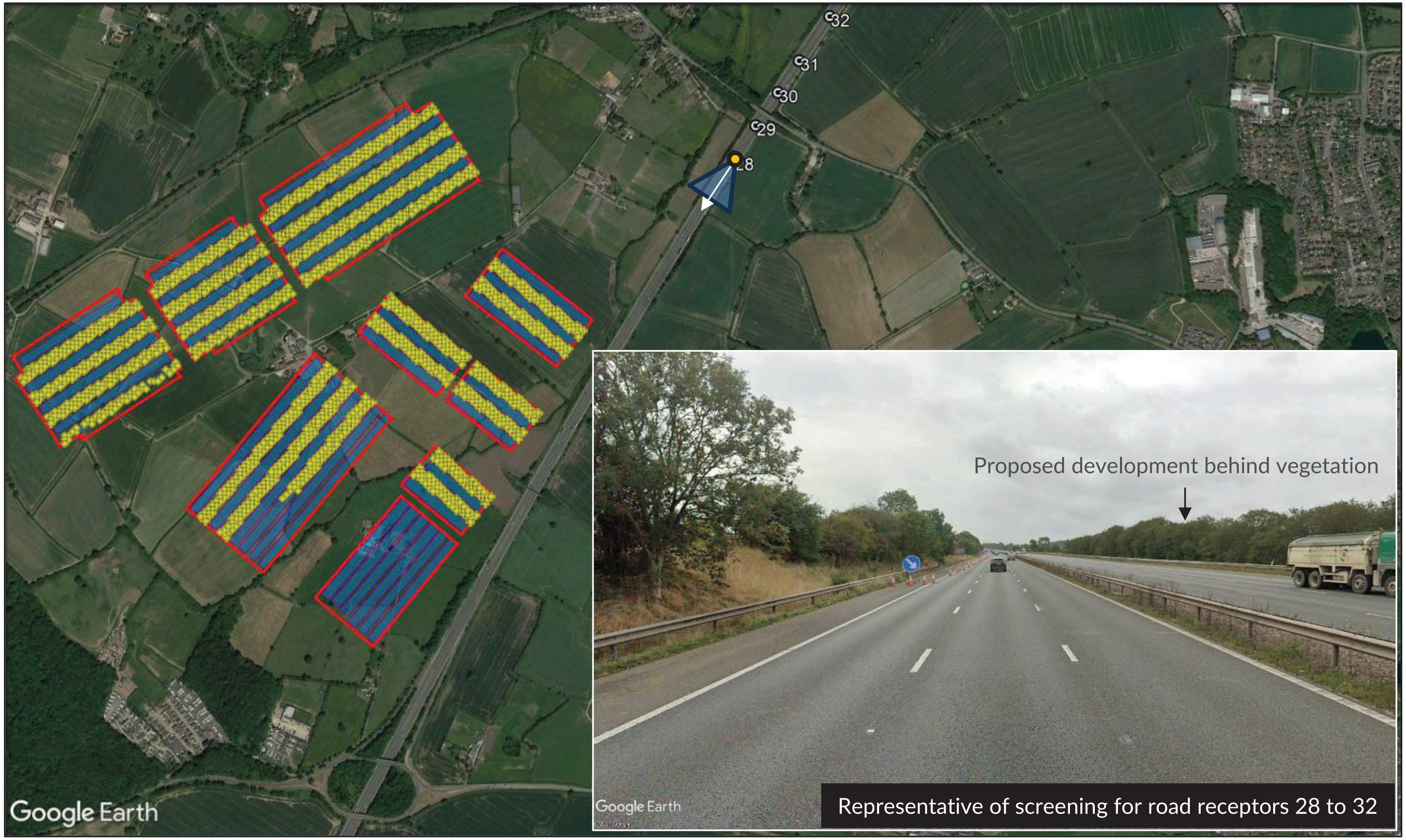


Figure 19 *Screening for road receptors 28 to 32*

### 6.3.4 Road Section and Panel Areas to Mitigate

Based on the results of the assessment, mitigation is recommended for a 700m-section of the M69, between receptors 20 and 27. The areas that require mitigation are indicated by the pink lines in Figure 20 below.

Figure 20 *Panel areas to mitigate for road users*

The mitigation strategy and optimal solution may include:

- Provision of building specific Glint & Glare assessments when detailed building design is submitted;
- Detailed design of PV alignment on building roofs to adequately reduce the effects of glint and glare on the affected receptors identified;
- Additional screening incorporated as part of detailed building design, where appropriate.

It is possible that a site survey or detailed screening analysis would reveal that some of the reflecting areas are already significantly obscured from view relative to the identified receptors. It is recommended that the mitigation in the form of a site configuration adequately reducing the reflecting panel areas towards the identified section of road.

## 6.4 Assessment Results – Dwelling Receptors

### 6.4.1 Key Considerations

The key considerations for residential dwellings are:

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

Where solar reflections are not geometrically possible, or the reflecting panels are predicted to be significantly obstructed from view, no impact is predicted, and mitigation is not required.

Where effects occur for **less** than three months per year and **less** than 60 minutes on any given day, or the closest reflecting panel is over 1km from the dwelling, the impact significance is low, and mitigation is not recommended.

Where reflections are predicted to be experienced for **more** than three months per year and/or for **more** than 60 minutes on any given day, expert assessment of the following factors is required to determine the impact significance and 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;
- Whether visibility is likely from all storeys – the ground floor is typically considered the main living space and has a greater significance with respect to residential amenity;
- Whether the dwelling appears to have windows facing the reflecting area – factors that restrict potential views of a reflecting area reduce the level of impact.

Following consideration of these mitigating factors, where the solar reflection is not deemed significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

If effects last for **more** than 3 months per year and for **more** than 60 minutes on any given day, and there are no mitigating factors, the impact significance is high, and mitigation is required.

### 6.4.2 Geometric Modelling Results and Discussion

Table 4 on the following page presents the geometric modelling results and predicted impact significance for the assessed dwelling receptors.

| Dwelling Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 1 – 5 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation, buildings and intervening terrain predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 6 – 17 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation and intervening terrain predicted to partially obstruct views of reflecting panels with marginal views considered possible | Views limited to above ground floor levels<br>Separation distance greater than 495m<br>Solar reflections will coincide with the Sun | Low impact |
| 18 – 22 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation, buildings and intervening terrain predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 23 – 27 | Solar reflections geometrically possible for **less** than 3 months per year and **less** than 60 minutes on any given day | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |

| Dwelling Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 28 – 33 | Solar reflections are not geometrically possible | N/A | N/A | No impact |
| 34 – 40 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation and buildings predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 41 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation and intervening terrain predicted to partially obstruct views of reflecting panels with marginal views considered possible | Views limited to above ground floor levels<br>Separation distance greater than 395m<br>Solar reflections will coincide with the Sun | Low impact |
| 42 – 50 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |

| Dwelling Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 51 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation and buildings predicted to obstruct views of reflecting panels with marginal views considered possible | Views limited to above ground floor levels<br>Separation distance greater than 550m<br>Solar reflections will coincide with the Sun | Low impact |
| 52 – 54 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation and buildings predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 55 – 57 | Solar reflections geometrically possible for **less** than 3 months per year and **less** than 60 minutes on any given day | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 58 – 93 | Solar reflections are not geometrically possible | N/A | N/A | No impact |

| Dwelling Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 94 – 107 | Solar reflections geometrically possible for **less** than 3 months per year and **less** than 60 minutes on any given day | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 108 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 109 – 110 | Solar reflections geometrically possible for **less** than 3 months per year and **less** than 60 minutes on any given day | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |
| 111 – 116 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation predicted to significantly obstruct views of reflecting panels | N/A | No impact |

| Dwelling Receptor | Geometric Modelling Results (screening not considered) | Identified Screening and Predicted Visibility (desk-based review) | Mitigating Factors | Predicted Impact Classification |
|---|---|---|---|---|
| 117 – 118 | Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day | Existing vegetation predicted to obstruct views of reflecting panels with marginal views considered possible | Views limited to above ground levels<br>Separation distance greater than 595m<br>Solar reflections will coincide with the Sun | Low impact |

Table 4 *Geometric modelling results and predicted impact - dwelling receptors*

### 6.4.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in Figures 21 to 32 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing vegetation and buildings is outlined in orange and pink respectively. Zones of Theoretical Visibility[19] (ZTV) indicate the visible terrain in green from a point to illustrate the intervening terrain.

---

[19] Generated by Google Earth at 2m above ground level

Figure 21 *Screening for dwellings 1 to 4*

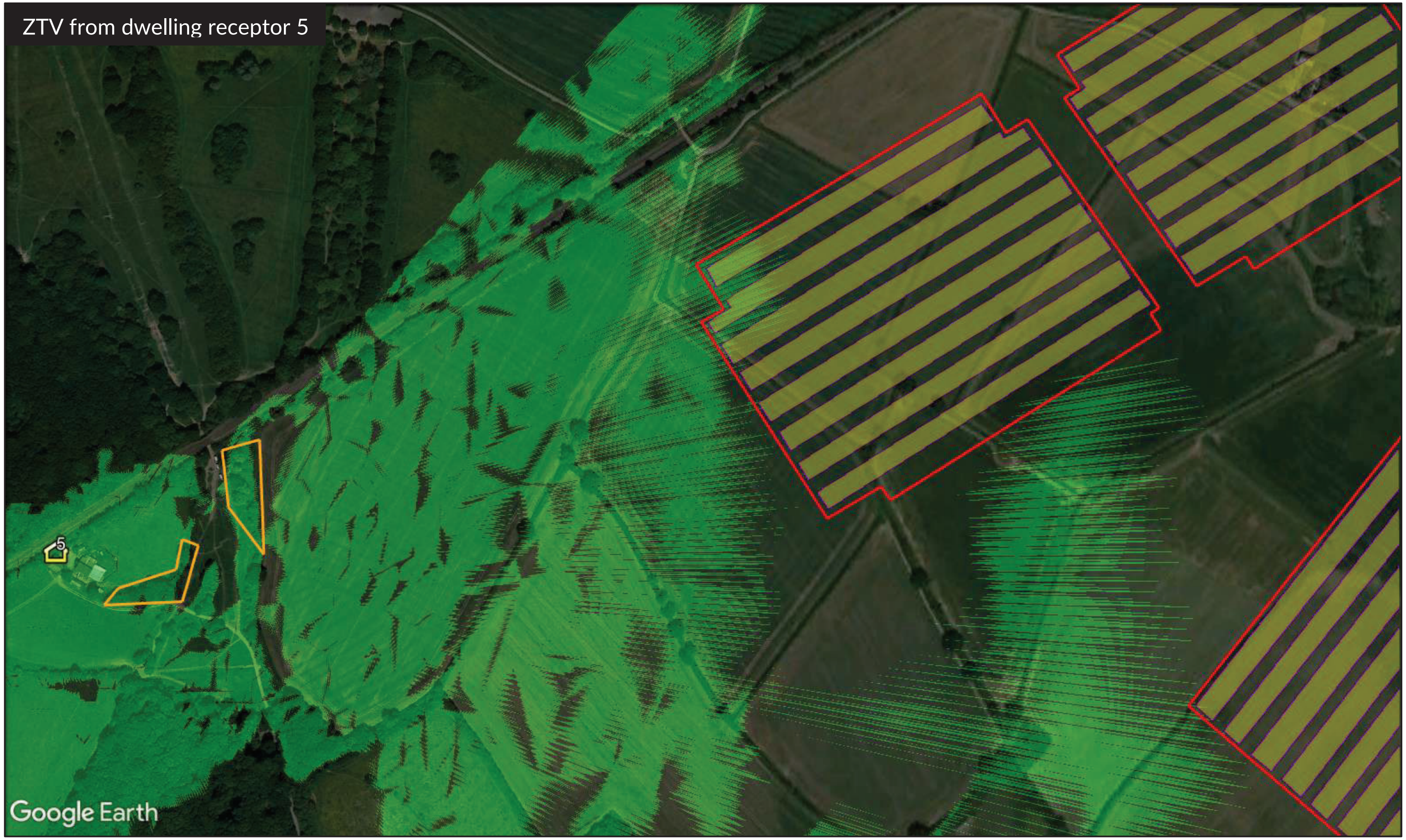


Figure 22 *Screening for dwelling 5*

Figure 23 *Screening for dwellings 6 to 27*

Figure 24 *Screening for dwellings 34 to 35*

Figure 25 *Screening for dwellings 36 to 39*

Figure 26 *Screening for dwelling 40*

Figure 27 *Screening for dwellings 41 to 42*

Figure 28 *Screening for dwellings 43 to 54*

Figure 29 *Screening for dwellings 55 to 57*

Figure 30 *Screening for dwellings 94 to 106*

Figure 31 *Screening for dwellings 107 to 113*

Figure 32 *Screening for dwellings 114 to 118*

# 7 HIGH-LEVEL AVIATION ASSESSMENTS

## 7.1 Overview

Glint and glare assessment for aviation receptors are typically undertaken for licensed aerodromes within 10km of a proposed solar development. Geometric modelling for general aviation unlicensed aerodromes is typically required within 5km of a proposed development. At ranges of 10-20km, the requirement for assessment is much less common for unlicensed aerodromes, with typically assessment only being undertaken for licensed aerodromes at these ranges. Assessment of any aviation effects for developments over 20km is not a usual requirement.

The proposed development size, distance between the aerodrome and proposed development and industry experience are considered to determine the potential impact.

The following sections present high-level assessments and conclusions of aviation concerns for Stoke Golding Airfield, Moxon's Farm Airfield, Viner's Airfield and Claybrooke Farm Airfield.

## 7.2 High-Level Assessment of Stoke Golding Airfield

Stoke Golding Airfield is an unlicensed aerodrome approximately 7.7km northwest of the proposed development with one operational runway and is understood not to have an Air Traffic Control (ATC) Tower. The runway details[20] are presented below:

- 08/26 measuring 470 metres by 17 metres (grass).

The location of Stoke Golding Airfield and 1-mile splayed approach paths for each runway threshold relative to the proposed development is shown in Figure 33 on the following page.

---

[20] As determined from aerial imagery

Figure 33 *Stoke Golding Airfield relative to proposed development*

### 7.2.1 Assessment

The following can be concluded for Stoke Golding Airfield with regards to the proposed development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 08 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable;
- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 26 will be outside a pilot's primary field-of-view (50 degrees either side relative to the runway threshold bearing), and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice
- Solar reflections towards the final sections of circuits / joins for runway thresholds 08/26 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable.

### 7.2.2 Conclusions

No significant impacts upon aviation activity associated with Stoke Golding Airfield are predicted, and mitigation is not required. Detailed modelling is not recommended.

## 7.3 High-Level Assessment of Moxon's Farm Airfield

Moxon's Farm Airfield is an unlicensed aerodrome approximately 5.6km southwest of the proposed development with one operational runway and is understood not to have an ATC Tower. The runway details[21] are presented below:

- 07/25 measuring 140 metres by 14 metres (grass).

The location of Moxon's Farm Airfield and 1-mile splayed approach paths for each runway threshold relative to the proposed development is shown in Figure 34 below.

Figure 34 *Moxon's Farm Airfield relative to proposed development*

### 7.3.1 Assessment

The following can be concluded for Moxon's Farm Airfield with regards to the proposed development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 07 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable;
- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 25 will be outside a pilot's primary field-of-view, and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice;
- Solar reflections towards the final sections of circuits / joins for runway thresholds 07/25 will have glare intensities no greater than 'low potential for temporary after-

---

[21] As determined from aerial imagery

image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable.

### 7.3.2 Conclusions

No significant impacts upon aviation activity associated with Moxon's Farm Airfield are predicted, and mitigation is not required. Detailed modelling is not recommended.

## 7.4 High-Level Assessment of Viner's Airfield

Viner's Airfield is an unlicensed aerodrome approximately 7.5km south of the proposed development with one operational runway and is understood not to have an ATC Tower. The runway details[22] are presented below:

- 08/26 measuring 300 metres by 14 metres (grass).

The location of Viner's Airfield and 1-mile splayed approach paths for each runway threshold relative to the proposed development is shown in Figure 35 below.

Figure 35 *Viner's Airfield relative to proposed development*

### 7.4.1 Assessment

The following can be concluded for Viner's Airfield with regards to the proposed development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 08 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable;

---

[22] As determined from aerial imagery

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 26 will be outside a pilot's primary field-of-view, and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice;
- Solar reflections towards the final sections of circuits / joins for runway thresholds 08/26 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable.

### 7.4.2 Conclusions

No significant impacts upon aviation activity associated with Viner's Airfield are predicted, and mitigation is not required. Detailed modelling is not recommended.

## 7.5 High-Level Assessment of Claybrooke Farm Airfield

Claybrooke Farm Airfield is an unlicensed aerodrome approximately 5.0km southeast of the proposed development with one operational runway and is understood not to have an ATC Tower. The runway details[23] are presented below:

- 02/20 measuring 320 metres by 15 metres (grass).

The location of Claybrooke Farm Airfield and 1-mile splayed approach paths for each runway threshold relative to the proposed development is shown in Figure 36 below.

Figure 36 *Claybrooke Farm Airfield relative to proposed development*

---

[23] As determined from aerial imagery

### 7.5.1 Assessment

The following can be concluded for Claybrooke Farm Airfield with regards to the proposed development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 02 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable;
- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 20 will be outside a pilot's primary field-of-view, and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice;
- Solar reflections towards the final sections of circuits / joins for runway thresholds 02/20 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice, the glare intensity is considered acceptable.

### 7.5.2 Conclusions

No significant impacts upon aviation activity associated with Claybrooke Farm Airfield are predicted, and mitigation is not required. Detailed modelling is not recommended.

# 8 OVERALL CONCLUSIONS

## 8.1 Assessment Conclusions – Road Safety

Solar reflections are geometrically possible towards a 1.8km-section of the M69. For separate 700m and 400m sections, screening in the form of existing and proposed vegetation, and proposed units with non-reflecting panel areas are predicted to significantly obstruct views of reflecting panels, such that solar reflections will not be experienced by road users.

For the remaining 700m-section of the M69, solar reflections occur inside a road user's primary horizontal field-of-view (50 degrees horizontally either side relative to the direction of travel). No significant screening and a lack of sufficient mitigating factors (Section 6.3.3) have been identified for this section of road. Therefore, mitigation is recommended for this section (Section 6.3.4).

## 8.2 Assessment Conclusions – Residential Amenity

Solar reflections are geometrically possible towards 76 of the assessed 118 dwellings. Screening in the form of existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels, such that solar reflections will not be experienced by residents at 60 dwellings.

For 16 dwellings, views of the reflecting panels may be possible despite partial screening in the form of existing and proposed vegetation and terrain. Solar reflections are predicted for less than 60 minutes on any given day and for more than three months of the year. A low impact is predicted, and mitigation is not recommended due to the following mitigating factors:

- The separation distance between an observer and the nearest reflecting panel is significant;
- Any effects are likely to be limited to an observer above the ground floor (if the dwelling is not a ground floor property only); and/or
- Effects would mostly coincide with direct sunlight.

## 8.3 Assessment Conclusions – Railway Operations and Infrastructure

Solar reflections are geometrically possible towards separate 1.7km and 100m sections of railway. For the 100m section, screening in the form of existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels, such that solar reflections will not be experienced by train drivers.

For 300m of the 1.7km-section, solar reflections occur outside a train driver's primary horizontal field-of-view (30 degrees either side of the direction of travel). Screening in the form of existing and proposed vegetation is predicted to obstruct views of reflecting panels, with marginal views considered possible.

For the remaining 1.4km-section, solar reflections occur inside a train driver's primary horizontal field-of-view. Views of reflecting panels are considered to be unobstructed; however, the following mitigating factors (Section 6.2.2) are predicted to decrease the level of impact:

- Solar reflections do not occur in directly in front of a train driver and occur between 19°-30° within a train driver's horizontal field-of-view;
- Views of the reflecting panels are expected to be  limited due to the height (21m agl) of the buildings relative to the eye line of a train driver (at 2.75m agl). Therefore, for much of this section of railway line, a train driver will need to look significantly vertically upwards to see most of the potentially visible reflecting panels;
- The workload of a train driver is expected to be relatively low as no switch points are identified along this section of railway or approaching a train station;
- A train driver will not have exited a tunnel or heavily shadowed area when solar reflections are geometrically possible, therefore disability glare is not considered possible;
- Solar reflections will mostly coincide with the Sun, which will be a more prominent source of light.

An overall low impact is predicted upon train driver's, and mitigation is not recommended.

Solar reflections are geometrically possible towards two trackside signals, of which a low impact is predicted.

## 8.4 High-Level Assessment Conclusions – Aviation Activity

Solar reflections towards the approach paths and final sections of visual circuits for runway thresholds at Stoke Golding Airfield, Moxon's Farm Airfield, Viner's Airfield and Claybrooke Farm Airfield are predicted to occur outside a pilot's field-of-view (50 degrees either side relative to the runway threshold bearing) or have glare intensities no greater than 'low potential for temporary after image' (Section 7). Both glare scenarios are not considered significant in accordance with the associated guidance (Appendix D) and industry best practice. Mitigation is not required.

## 8.5 Overall Conclusions

No significant impacts are predicted upon residential amenity, railway operations and infrastructure, and aviation activity associated with Stoke Golding Airfield, Moxon's Farm Airfield, Viner's Airfield and Claybrooke Farm Airfield. Mitigation is not recommended.

Mitigation is recommended for a 700m-section of the M69.

# 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[24] (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.'*

---

[24] 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 National Policy Statement for Renewable Energy Infrastructure (EN-3)[25] sets out the primary policy for decisions by the Secretary of State for nationally significant renewable energy infrastructure. Sections 2.10.102-106 state:

*'2.10.102 Solar panels are specifically designed to absorb, not reflect, irradiation.[26] However, solar panels may reflect the sun's rays at certain angles, 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.*

*2.10.103 Applicants should map receptors to qualitatively identify potential glint and glare issues and determine if a glint and glare assessment is necessary as part of the application.*

*2.10.104 When a quantitative glint and glare assessment is necessary, applicants are expected to consider the geometric possibility of glint and glare affecting nearby receptors and provide an assessment of potential impact and impairment based on the angle and duration of incidence and the intensity of the reflection.*

*2.10.105 The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and design. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts.*

*2.10.106 When a glint and glare assessment is undertaken, the potential for solar PV panels, frames and supports to have a combined reflective quality may need to be assessed, although the glint and glare of the frames and supports is likely to be significantly less than the panels.'*

The EN-3 does not state which receptors should be considered as part of a quantitative glint and glare assessment. Based on Pager Power's extensive project experience, typical receptors include residential dwellings, road users, aviation infrastructure, and railway infrastructure.

Sections 2.10.134-136 state:

*'2.10.134 Applicants should consider using, and in some cases the Secretary of State may require, solar panels to comprise of (or be covered with) anti-glare/anti-reflective coating with a specified angle of maximum reflection attenuation for the lifetime of the permission.*

*2.10.135 Applicants may consider using screening between potentially affected receptors and the reflecting panels to mitigate the effects.*

*2.10.136 Applicants may consider adjusting the azimuth alignment of or changing the elevation tilt angle of a solar panel, within the economically viable range, to alter the angle of incidence.*

---

[25] National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: November 2023, accessed on: 21/12/2023.

[26] *'Most commercially available solar panels are designed with anti-reflective glass or are produced with anti-reflective coating and have a reflective capacity that is generally equal to or less hazardous than other objects typically found in the outdoor environment, such as bodies of water or glass buildings.'*

> *In practice this is unlikely to remove the potential impact altogether but in marginal cases may contribute to a mitigation strategy.'*

The mitigation strategies listed within the EN-3 are relevant strategies that are frequently utilised to eliminate or reduce glint and glare effects towards surrounding observers. The most common form of mitigation is the implementation of screening along the site boundary.

Sections 2.10.158-159 state:

*2.10.158 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, motorists, public rights of way, and aviation infrastructure (including aircraft departure and arrival flight paths).*

*2.10.159 Whilst there is some evidence that glint and glare from solar farms can be experienced by pilots and air traffic controllers in certain conditions, there is no evidence that glint and glare from solar farms results in significant impairment on aircraft safety. Therefore, unless a significant impairment can be demonstrated, the Secretary of State is unlikely to give any more than limited weight to claims of aviation interference because of glint and glare from solar farms.*

The EN-3 goes some way in acknowledging that the issue is more complex than presented in the early draft issues; though, this is still unlikely to be welcomed by aviation stakeholders, who will still request a glint and glare assessment on the basis that glare may lead to a potentially significant impact upon aviation safety.

Finally, 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

Railway operations is not mentioned specifically within this guidance however it is stated that a developer will need to consider '*the proposal's visual impact, the effect on landscape of glint and glare and on neighbouring uses…'*. Network Rail is a statutory consultee when a development is located in close proximity to its infrastructure.

No process for determining and contextualising the effects of glint and glare are, however, provided. Therefore, the Pager Power approach is to determine whether a reflection from a development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

## Railway Assessment Guidelines

The following section provides an overview of the relevant railway guidance with respect to the siting of signals on railway lines. Network Rail is the stakeholder of the UK's railway infrastructure. Whilst the guidance is not strictly applicable in Ireland, the general principles within the guidance is expected to apply.

A railway operator's concerns would likely to relate to the following:

1. The development producing solar glare that affects train drivers; and

2. The development producing solar reflections that affect railway signals and create a risk of a phantom aspect signal.

Railway guidelines are presented below. These relate specifically to the sighting distance for railway signals.

**Reflections and Glare**

The extract below is taken from Section A5 – Reflections and glare (pages 64-65) of the 'Signal Sighting Assessment Requirements'27 which details the requirement for assessing glare towards railway signals.

***Reflections and glare***

*Rationale*

*Reflections can alter the appearance of a display so that it appears to be something else.*

*Guidance*

*A5 is present if direct glare or reflected light is directed into the eyes or into the lineside signalling asset that could make the asset appear to show a different aspect or indication to the one presented.*
*A5 is relevant to any lineside signalling asset that is capable of presenting a lit signal aspect or indication.*

*The extent to which excessive illumination could make an asset appear to show a different signal aspect or indication to the one being presented can be influenced by the product being used. Requirements for assessing the phantom display performance of signalling products are set out in GKRT0057 section 4.1.*

*Problems arising from reflection and glare occur when there is a very large range of luminance, that is, where there are some objects that are far brighter than others. The following types of glare are relevant:*

*a) Disability glare, caused by scattering of light in the eye, can make it difficult to read a lit display.*

*b) Discomfort glare, which is often associated with disability glare. While being unpleasant, it does not affect the signal reading time directly, but may lead to distraction and fatigue.*

*Examples of the adverse effect of disability glare include:*

*a) When a colour light signal presenting a lit yellow aspect is viewed at night but the driver is unable to determine whether the aspect is a single yellow or a double yellow.*

*b) Where a colour light signal is positioned beneath a platform roof painted white and the light reflecting off the roof can make the signal difficult to read.*

*Options for militating against A5 include:*

*a) Using a product that is specified to achieve high light source: phantom ratio values.*

*b) Alteration to the features causing the glare or reflection.*

---

[27] Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 18.10.2016.

c) *Provision of screening.*

Glare is possible and should be assessed when the luminance is much brighter than other light sources. Glare may be unpleasant and therefore cause distraction and fatigue, or may make the signal difficult to read and increase the reading time.

**Determining the Field of Focus**

The extract below is taken from Appendix F - Guidance on Field of Vision (pages 98-101) of the 'Signal Sighting Assessment Requirements'[28] which details the visibility of signals, train drivers' field of vision and the implications with regard to signal positioning.

***Asset visibility***

*The effectiveness of an observer's visual system in detecting the existence of a target asset will depend upon its:*

a) *Position in the observer's visual field.*

b) *Contrast with its background.*

c) *Luminance properties.*

d) *The observer's adaptation to the illumination level of the environment.*

*It is also influenced by the processes relating to colour vision, visual accommodation, and visual acuity. Each of these issues is described in the following sections.*

*Field of vision*

*The field of vision, or visual field, is the area of the visual environment that is registered by the eyes when both eyes and head are held still. The normal extent of the visual field is approximately 135o in the vertical plane and 200o in the horizontal plane.*

*The visual field is usually described in terms of central and peripheral regions: the central field being the area that provides detailed information. This extends from the central point ($0^{o}$) to approximately $30^{o}$ at each eye. The peripheral field extends from 30o out to the edge of the visual field.*

*F.6.3 Objects positioned towards the centre of the observer's field of vision are seen more quickly and identified more accurately because this is where our sensitivity to contrast is the highest. Peripheral vision is particularly sensitive to movement and light.*

---

[28] Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 28.08.2020.

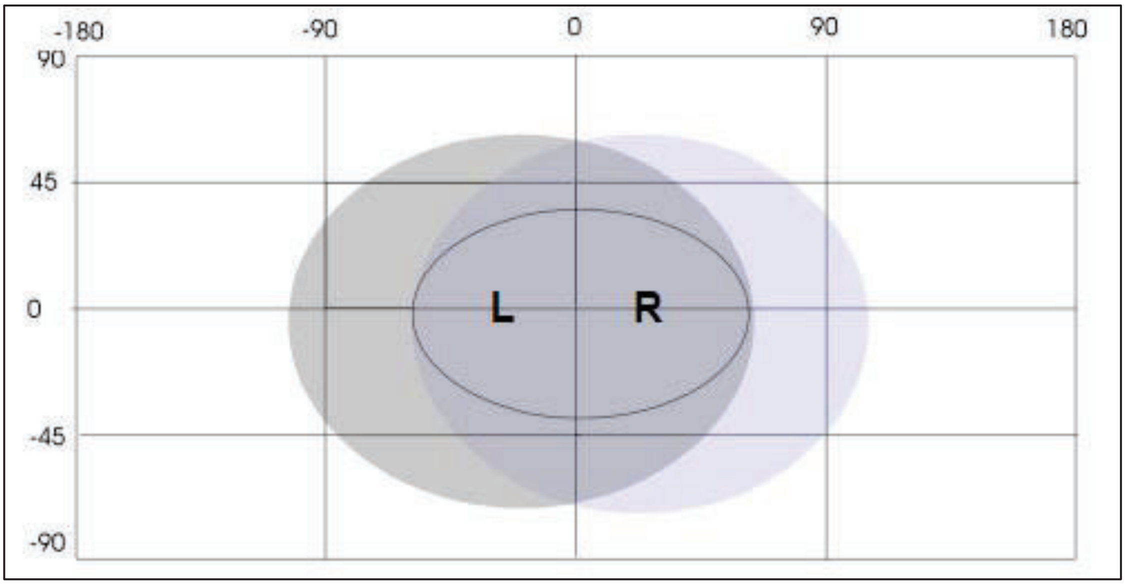


*Figure G 21 - Field of view*

*In Figure G 21, the two shaded regions represent the view from the left eye (L) and the right eye (R) respectively. The darker shaded region represents the region of binocular overlap. The oval in the centre represents the central field of vision.*

*Research has shown that drivers search for signs or signals towards the centre of the field of vision. Signals, indicators and signs should be positioned at a height and distance from the running line that permits them to be viewed towards the centre of the field of vision. This is because:*

a) *As train speed increases, drivers become increasingly dependent on central vision for asset detection. At high speeds, drivers demonstrate a tunnel vision effect and focus only on objects in a field of + 8$^{o}$ from the direction of travel.*

b) *Sensitivity to movement in the peripheral field, even minor distractions can reduce the visibility of the asset if it is viewed towards the peripheral field of vision. The presence of clutter to the sides of the running line can be highly distracting (for example, fence posts, lamp-posts, traffic, or non-signal lights, such as house, compatibility factors or security lights).*

*Figure G 22 and Table G 5 identify the radius of an 8o cone at a range of close-up viewing distances from the driver's eye. This shows that, depending on the lateral position of a stop signal, the optimal (normal) train stopping point could be as far as 25 m back from the signal to ensure that it is sufficiently prominent.*

*The dimensions quoted in Table G 5 assume that the driver is looking straight ahead. Where driver-only operation (DOO) applies, the drivers' line of sight at the time of starting the train is influenced by the location of DOO monitors and mirrors. In this case it may be appropriate to provide supplementary information alongside the monitors or mirrors using one of the following:*

a) *A co-acting signal.*
b) *A miniature banner repeater indicator.*
c) *A right away indicator.*
d) *A sign to remind the driver to check the signal aspect.*

*In order to prevent misreading by trains on adjacent lines, the co-acting signal or miniature banner repeater may be configured so that the aspect or indication is presented only when a train is at the platform to which it applies.*

*'Car stop' signs should be positioned so that the relevant platform starting signals and / or indicators can be seen in the driver's central field of vision.*

*If possible, clutter and non-signal lights in a driver's field of view should be screened off or removed so that they do not cause distraction.*

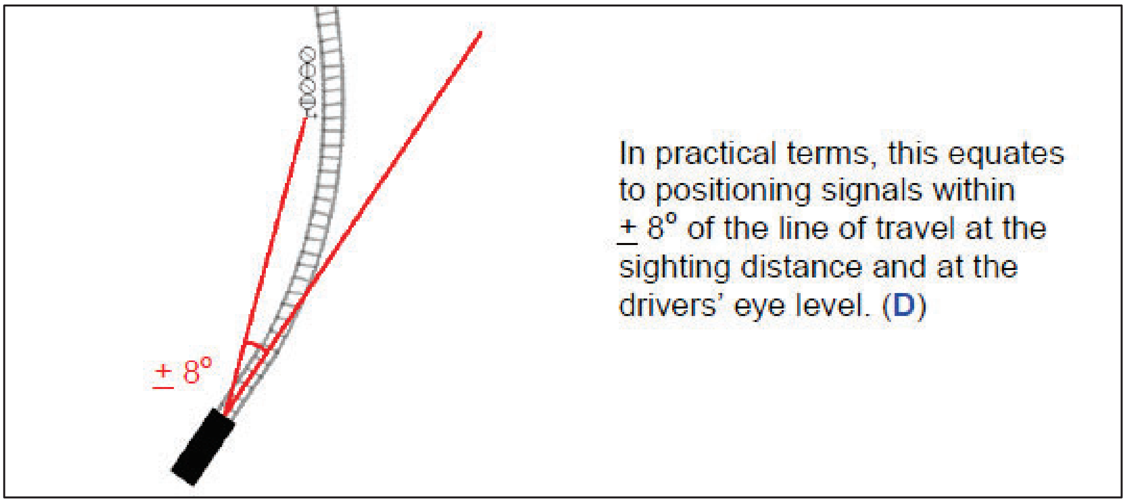


*Figure G 22 - Signal positioning*

| 'A' (m) | 'B' (m) | Typical display positions |
|---|---|---|
| *5* | *0.70* | - |
| *6* | *0.84* | - |
| *7* | *0.98* | - |
| *8* | *1.12* | - |
| *9* | *1.26* | - |
| *10* | *1.41* | - |
| *11* | *1.55* | - |
| *12* | *1.69* | - |
| *13* | *1.83* | - |
| *14* | *1.97* | - |
| *15* | *2.11* | *A stop aspect positioned 3.3 m above rail level and 2.1 m from the left hand rail is within the 8° cone at 15.44 m in front of the driver* |
| *16* | *2.25* | - |
| *17* | *2.39* | - |
| *18* | *2.53* | *A stop aspect positioned 5.1 m above rail level and 0.9 m from the left hand rail is within the 8° cone at 17.93 m in front of the driver* |
| *19* | *2.67* | - |
| *20* | *2.81* | - |
| *21* | *2.95* | - |
| *22* | *3.09* | - |
| *23* | *3.23* | - |
| *24* | *3.37* | - |
| *25* | *3.51* | *A stop aspect positioned 3.3 m above rail level and 2.1 m from the right hand rail is within the 8° cone at 25.46 m in front of the driver* |

*Table G 5 – 8° cone angle co-ordinates for close-up viewing*

The distance at which the 8° cone along the track is initiated is dependent on the minimum reading time and distance which is associated to the speed of trains along the track. This is discussed below.

### Determining the Assessed Minimum Reading Time

The extracts below are taken from the RIS-0737-CCS-1 of the 'Signal Sighting Assessment Requirements' which details the required minimum reading time for a train driver when approaching a signal.

The following abbreviations are defined within the 'Definitions and Abbreviations':

***'Baseline response time***

*The minimum time value that can be used by the SSC to specify the MRT for a particular signalling asset type.*

***Supplementary response time***

*The assessed amount of extra time that the SSC adds to the BRT to determine the MRT value for a specific lineside signalling asset.'*

The following extract is taken from page 114 of the RIS-0737-CCS-1:

***'Minimum response time (MRT)***

*The assessed minimum time needed by a driver (or other authorised user) to respond to the information presented by a specific lineside signalling asset, taking account of the following human tasks:*

*a) Read the display or display combination.*

*a) Interpret the display or display combination*

*b) Assimilate all of the available information*

*c) Decide what action to take (if any), and when it needs to be taken*

*d) Take the action, where necessary, before the train passes the asset.*

*MRT = BRT + SRT'*

The distance at which a signal should be clearly viewable is determined by the maximum speed of the trains along the track. If there are multiple signals present at a location then an additional 0.2 seconds reading time is added to the overall viewing time.

### Signal Design and Lighting System

Many railway signals are now LED lights and not filament (incandescent) bulbs. The benefits of an LED signal over a filament bulb signal with respect to possible phantom aspect illuminations are as follows:

- An LED railway signal produces a more intense light making them more visible to approaching trains when compared to the traditional filament bulb technology[29];

---

[29] Source: Wayside LED Signals – Why it's Harder than it Looks, Bill Petit.

- No reflective mirror is present within the LED signal itself unlike a filament bulb. The presence of the reflective surfaces greatly increases the likelihood of incoming light being reflecting out making the signal appear illuminated.

Many LED signal manufacturers[30,31,32] claim that LED signal lights significantly reduce or completely remove the likelihood of a phantom aspect illumination occurring.

## 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[33] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

---

[30] Source: http://www.unipartdorman.co.uk/assets/unipart_dorman_rail_brochure.pdf. (Last accessed 21.02.18).

[31] Source: http://www.vmstech.co.uk/downloads/Rail.pdf. (Last accessed 21.02.18).

[32] Source: Siemens, Sigmaguard LED Tri-Colour L Signal – LED Signal Technology at Incandescent Prices. Datasheet 1A-23. (Last accessed 22.02.18).

[33] Solar Photovoltaic Development Glint and Glare Guidance, Fourth Edition, September 2022. Pager Power.

# APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

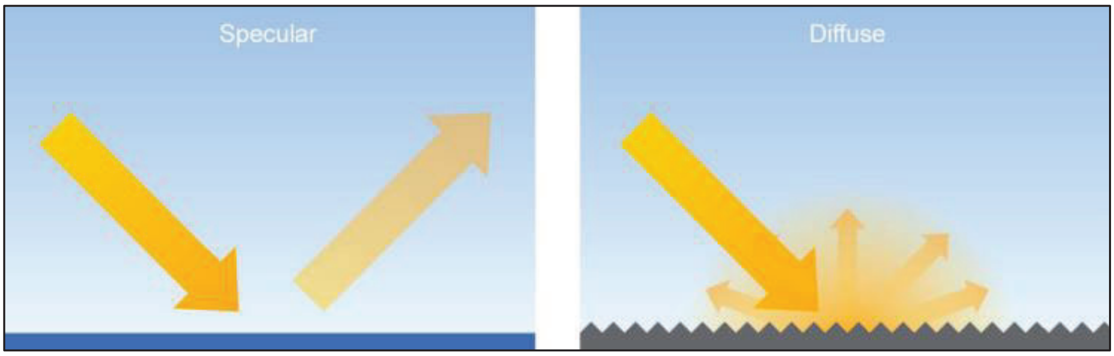
## Overview

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[34], 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*

---

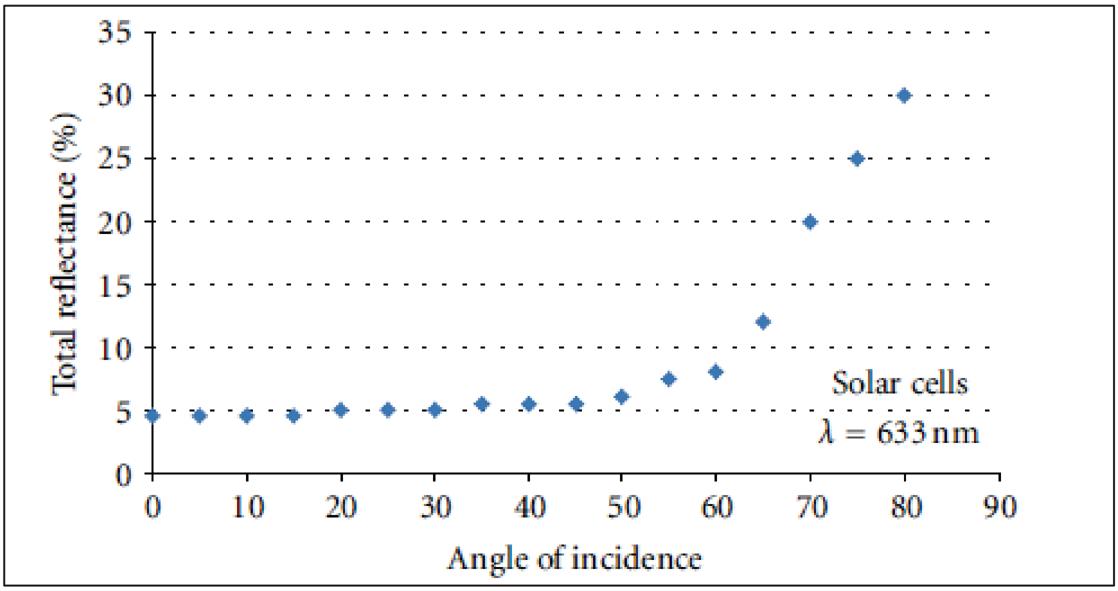
[34] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

## 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*[35]”. 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;
- 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.

---

[35] 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

**FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[36]**

The 2010 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[37] |
|---|---|
| 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 Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

---

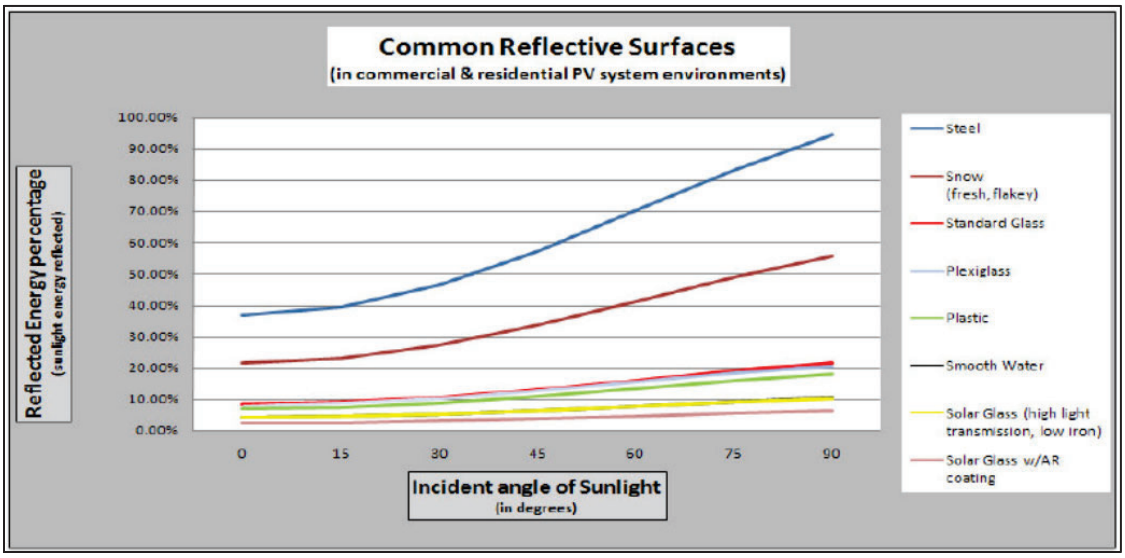
[36] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

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

**SunPower Technical Notification (2009)**

SunPower published a technical notification[38] 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.

---

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

# 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).

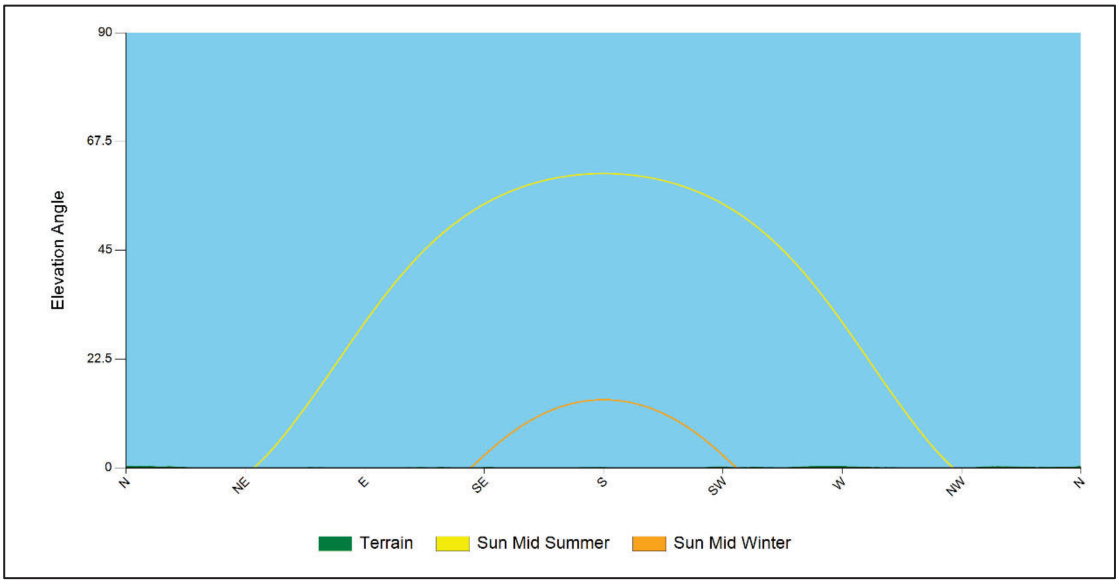
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- 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 lon:-1.319022 lat:52.549797.



*Terrain at the visible horizon and sun paths*

# 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

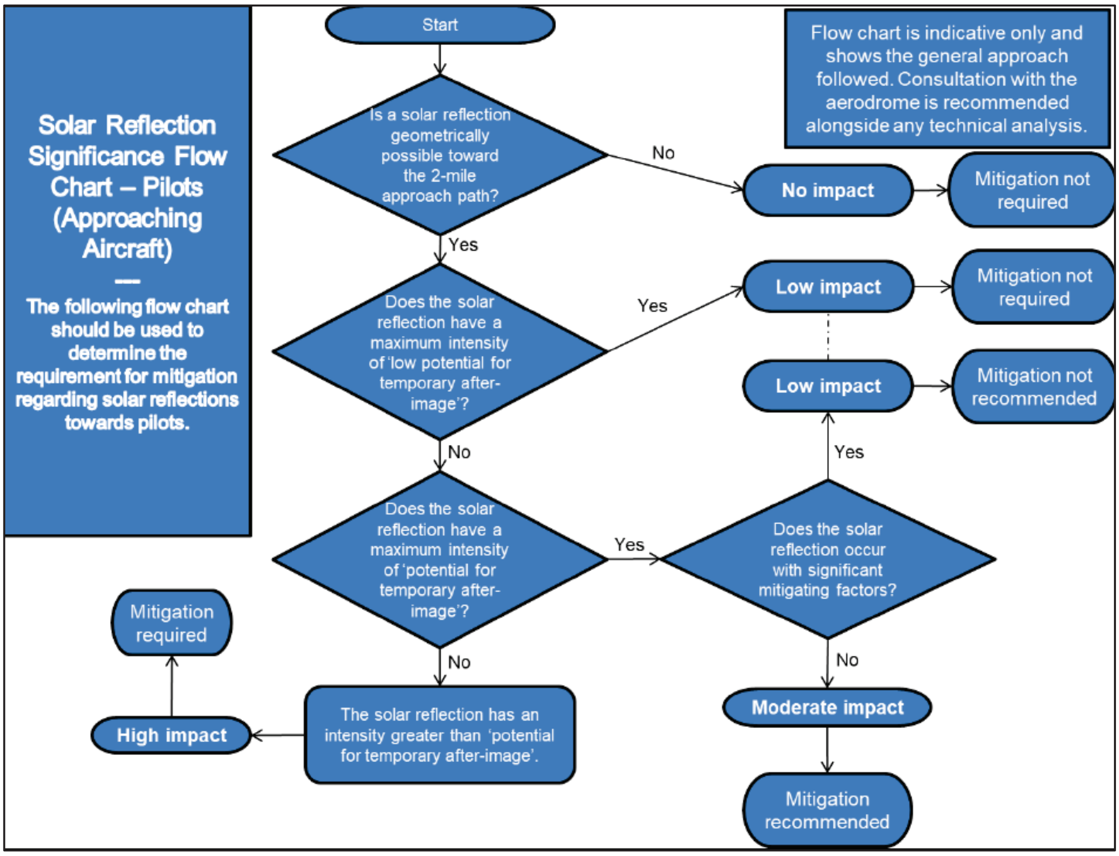
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

| 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 significantly. | No mitigation recommended. |
| Moderate | A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case given individual receptor criteria. | Mitigation recommended. |
| Major | A solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria. | Mitigation will be required if the proposed development is to proceed. |

*Impact significance definition*

## Impact Significance Determination for Approaching Aircraft

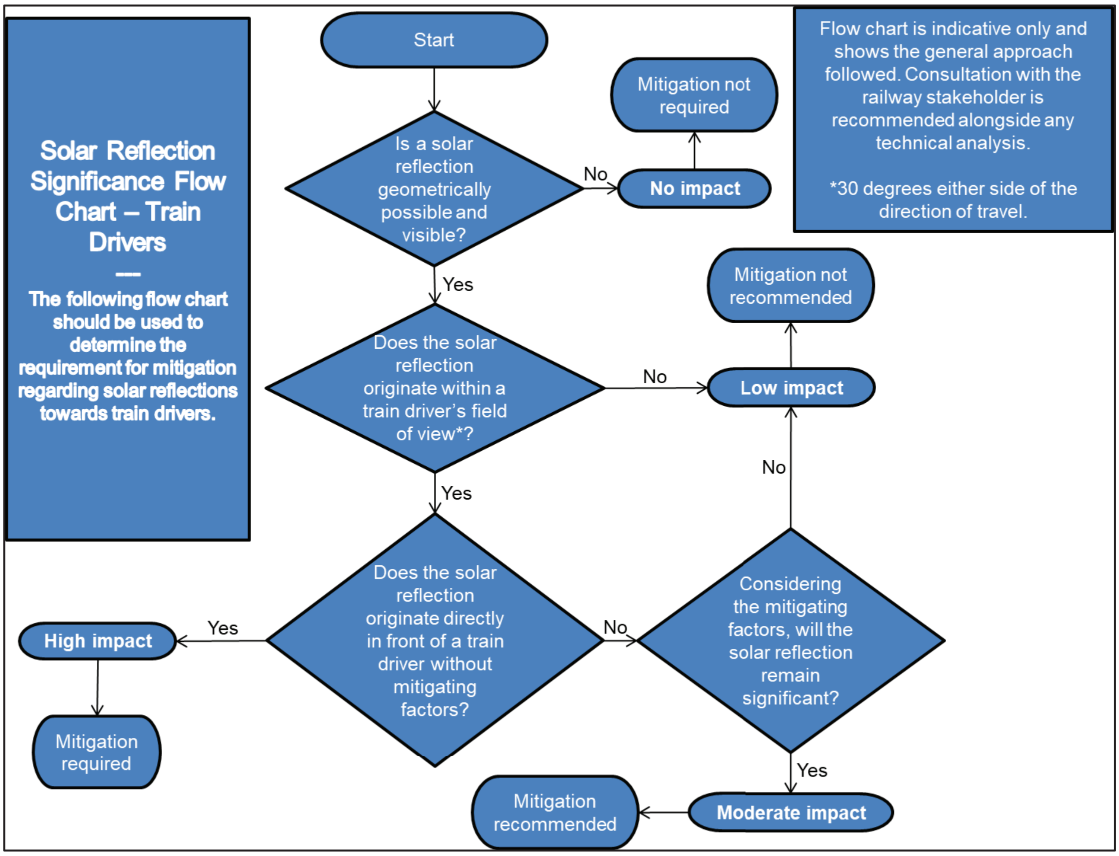
The flow chart presented below has been followed when determining the impact significance for approaching aircraft.



*Approach path receptor impact significance flow chart*

## Impact Significance Determination for Train Drivers

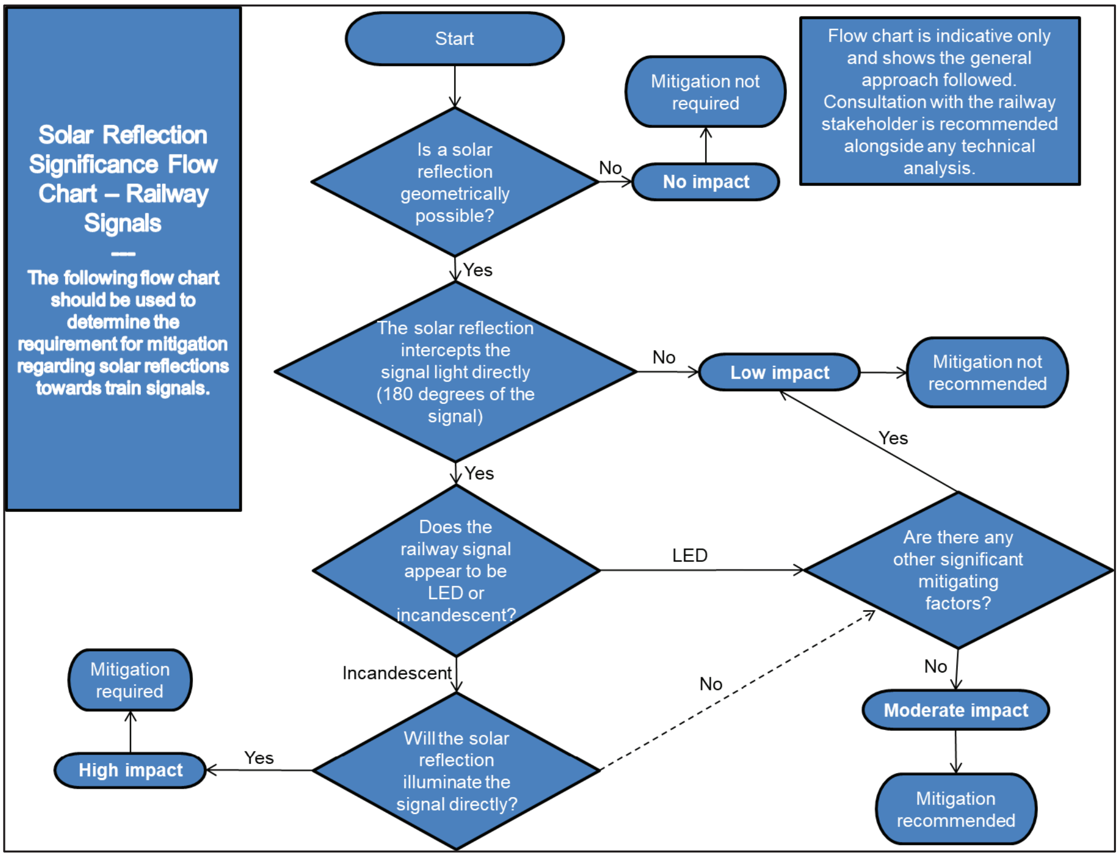
The flow chart presented below has been followed when determining the impact significance and mitigation requirement for train drivers.



*Train Driver impact significance flow chart*

## Impact Significance Determination for Railway Signals

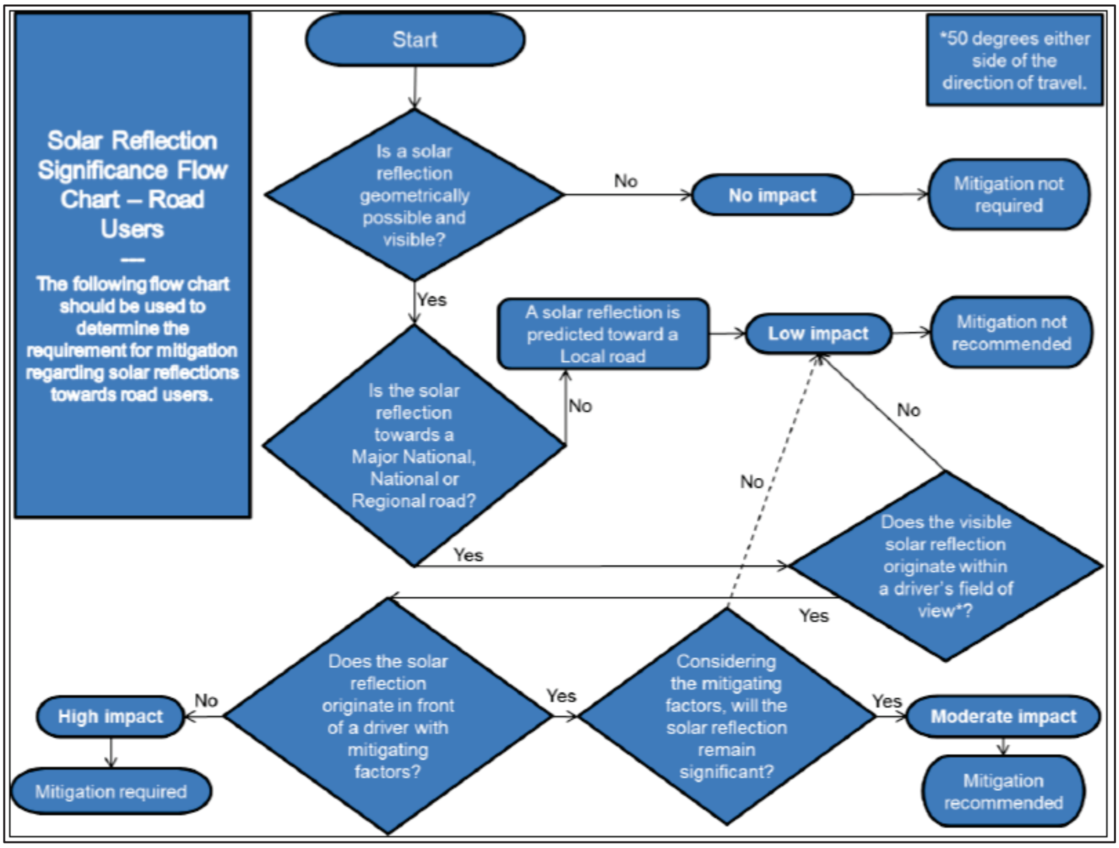
The flow chart presented below has been followed when determining the impact significance mitigation requirement for railway signals.



*Railway signal impact significance flow chart*

## Impact Significance Determination for Road Receptors

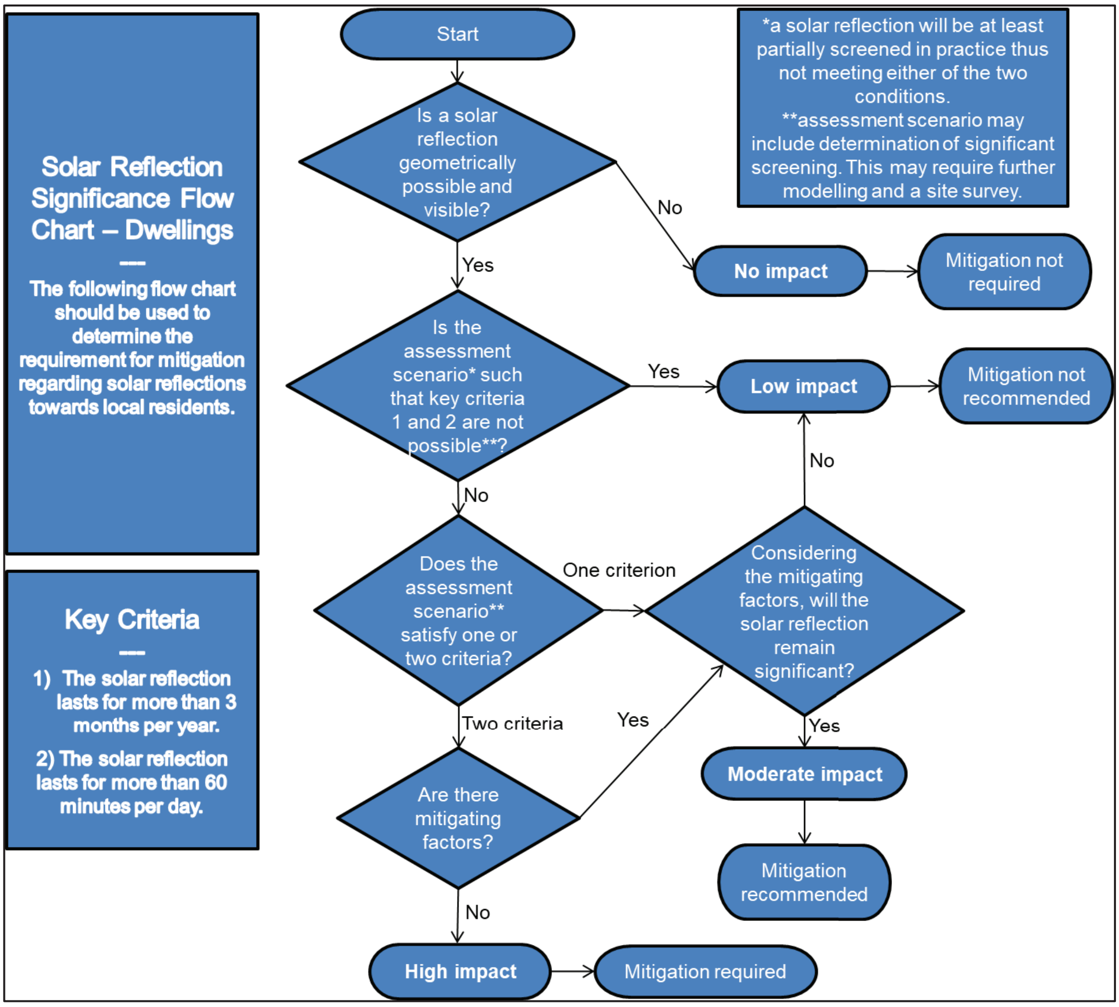
The flow chart presented below has been followed when determining the impact significance for road receptors.



*Road receptor impact significance flow chart*

## Impact Significance Determination for Dwelling Receptors

The flow chart presented below has been followed when determining the impact significance for dwelling receptors.



*Dwelling receptor impact significance flow chart*

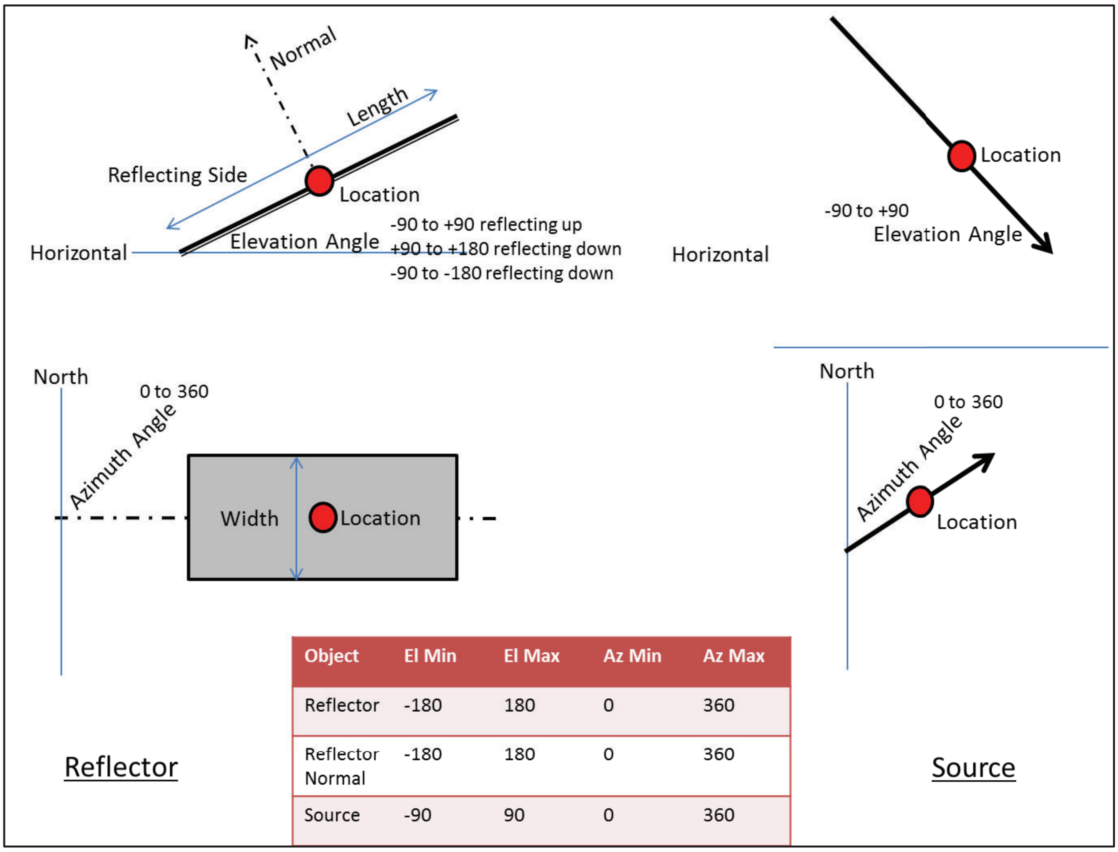
# APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

## 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 |

*Reflection calculation process*

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)[39].

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.

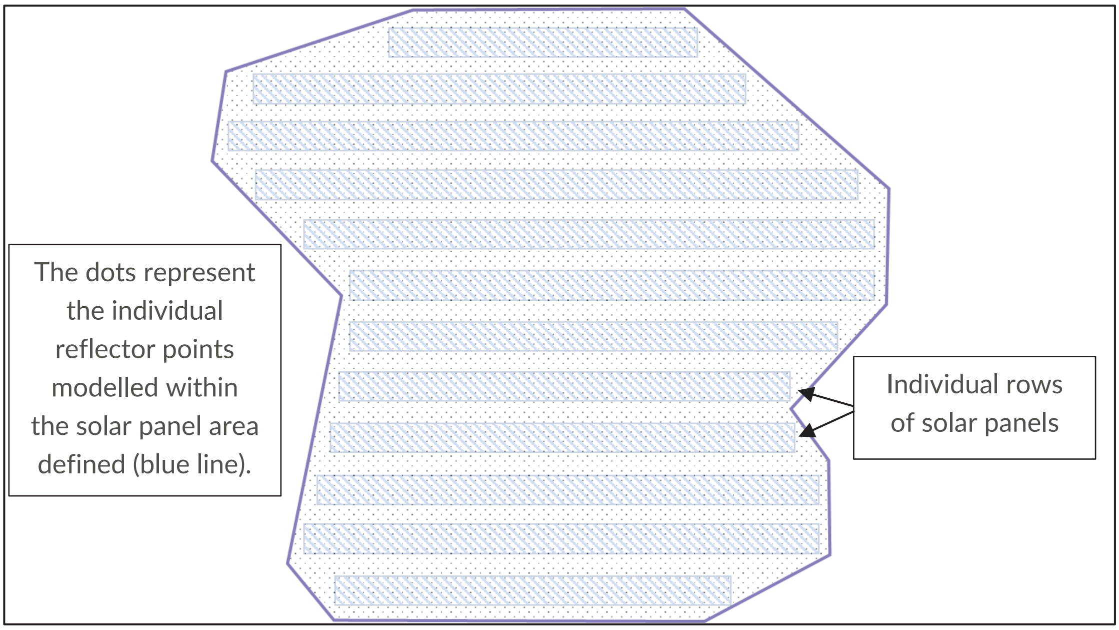
Only a reflection from the face of the panel has been considered. The frame or the reverse or frame of the solar panel has not been considered.

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.

---

[39] 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

## Overview

Coordinate data and terrain heights are ascertained from OSGB36 and OS 50 DTM data.

## Modelled Reflector Areas

In total, 55 panel areas have been defined to model the reflecting panel areas. Coordinates outlining each panel area can be made available upon request.

## Train Driver Receptors

An additional 2.75m height has been added to the elevation to account for the eye-level of a train driver.

| No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) | No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) |
|---|---|---|---|---|---|---|---|
| 1 | 52.54848 | -1.33729 | 97.75 | 13 | 52.55460 | -1.32271 | 92.45 |
| 2 | 52.54899 | -1.33608 | 96.75 | 14 | 52.55508 | -1.32150 | 92.75 |
| 3 | 52.54951 | -1.33484 | 97.75 | 15 | 52.55555 | -1.32021 | 93.40 |
| 4 | 52.55002 | -1.33364 | 100.93 | 16 | 52.55599 | -1.31890 | 92.31 |
| 5 | 52.55053 | -1.33243 | 101.60 | 17 | 52.55639 | -1.31763 | 91.41 |
| 6 | 52.55105 | -1.33120 | 101.53 | 18 | 52.55677 | -1.31633 | 88.66 |
| 7 | 52.55154 | -1.33002 | 99.04 | 19 | 52.55713 | -1.31496 | 88.68 |
| 8 | 52.55206 | -1.32878 | 97.22 | 20 | 52.55748 | -1.31357 | 87.75 |
| 9 | 52.55257 | -1.32757 | 96.75 | 21 | 52.55781 | -1.31217 | 87.24 |
| 10 | 52.55308 | -1.32637 | 95.01 | 22 | 52.55818 | -1.31037 | 86.75 |
| 11 | 52.55360 | -1.32513 | 92.75 | 23 | 52.55850 | -1.30855 | 86.09 |
| 12 | 52.55409 | -1.32395 | 92.55 |  |  |  |  |

*Train driver receptor data*

## Dwelling Receptor Data

An additional 1.5m height has been added to the elevation to account for the eye-level of road user.

| No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) | No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) |
|---|---|---|---|---|---|---|---|
| 1 | 52.55457 | -1.34262 | 99.62 | 60 | 52.56028 | -1.30935 | 89.18 |
| 2 | 52.55449 | -1.34234 | 98.80 | 61 | 52.56038 | -1.30955 | 89.39 |
| 3 | 52.55309 | -1.33891 | 96.99 | 62 | 52.56047 | -1.30959 | 89.93 |
| 4 | 52.55306 | -1.33868 | 96.80 | 63 | 52.56063 | -1.30960 | 90.73 |
| 5 | 52.54756 | -1.33886 | 96.80 | 64 | 52.56074 | -1.30976 | 90.93 |
| 6 | 52.54237 | -1.32668 | 111.72 | 65 | 52.56088 | -1.30974 | 91.23 |
| 7 | 52.54228 | -1.32650 | 111.65 | 66 | 52.56102 | -1.30988 | 91.49 |
| 8 | 52.54218 | -1.32629 | 111.80 | 67 | 52.56110 | -1.31006 | 91.50 |
| 9 | 52.54202 | -1.32612 | 111.80 | 68 | 52.56118 | -1.31041 | 91.90 |
| 10 | 52.54190 | -1.32601 | 111.74 | 69 | 52.56117 | -1.31068 | 91.93 |
| 11 | 52.54182 | -1.32591 | 111.58 | 70 | 52.56122 | -1.31084 | 91.80 |
| 12 | 52.54174 | -1.32577 | 111.37 | 71 | 52.56130 | -1.31101 | 91.80 |
| 13 | 52.54182 | -1.32542 | 111.68 | 72 | 52.56141 | -1.31132 | 91.80 |
| 14 | 52.54198 | -1.32514 | 111.80 | 73 | 52.56154 | -1.31149 | 92.39 |
| 15 | 52.54205 | -1.32500 | 111.80 | 74 | 52.56184 | -1.31145 | 93.31 |
| 16 | 52.54216 | -1.32480 | 111.80 | 75 | 52.56025 | -1.31060 | 89.16 |
| 17 | 52.54229 | -1.32457 | 111.80 | 76 | 52.56063 | -1.31129 | 90.73 |
| 18 | 52.54216 | -1.32437 | 111.80 | 77 | 52.56086 | -1.31165 | 91.80 |
| 19 | 52.54208 | -1.32425 | 111.80 | 78 | 52.56198 | -1.31251 | 96.49 |

| No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) | No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) |
|---|---|---|---|---|---|---|---|
| 20 | 52.54199 | -1.32414 | 111.80 | 79 | 52.56144 | -1.31313 | 95.41 |
| 21 | 52.54191 | -1.32402 | 111.80 | 80 | 52.56132 | -1.31360 | 95.77 |
| 22 | 52.54183 | -1.32391 | 111.80 | 81 | 52.56186 | -1.31413 | 98.87 |
| 23 | 52.54174 | -1.32378 | 111.80 | 82 | 52.56207 | -1.31504 | 100.05 |
| 24 | 52.54164 | -1.32365 | 111.80 | 83 | 52.56216 | -1.31546 | 100.88 |
| 25 | 52.54156 | -1.32352 | 111.80 | 84 | 52.56242 | -1.31589 | 101.48 |
| 26 | 52.54147 | -1.32343 | 111.67 | 85 | 52.56250 | -1.31623 | 101.79 |
| 27 | 52.54142 | -1.32315 | 111.79 | 86 | 52.56259 | -1.31666 | 101.80 |
| 28 | 52.54149 | -1.32079 | 111.80 | 87 | 52.56263 | -1.31695 | 101.80 |
| 29 | 52.54142 | -1.32025 | 111.80 | 88 | 52.56277 | -1.31711 | 101.80 |
| 30 | 52.54133 | -1.32009 | 111.80 | 89 | 52.56287 | -1.31747 | 101.80 |
| 31 | 52.54134 | -1.31987 | 111.80 | 90 | 52.56299 | -1.31792 | 101.80 |
| 32 | 52.54122 | -1.31958 | 111.80 | 91 | 52.56299 | -1.31859 | 103.80 |
| 33 | 52.54080 | -1.31324 | 103.49 | 92 | 52.56289 | -1.31955 | 101.50 |
| 34 | 52.54366 | -1.30705 | 101.80 | 93 | 52.56308 | -1.32002 | 101.98 |
| 35 | 52.54853 | -1.30086 | 96.75 | 94 | 52.56344 | -1.32113 | 105.92 |
| 36 | 52.55151 | -1.29418 | 89.80 | 95 | 52.56326 | -1.32122 | 104.38 |
| 37 | 52.55401 | -1.30066 | 94.28 | 96 | 52.56307 | -1.32133 | 102.94 |
| 38 | 52.55462 | -1.29998 | 93.80 | 97 | 52.56280 | -1.32149 | 102.29 |
| 39 | 52.55444 | -1.29666 | 95.52 | 98 | 52.56260 | -1.32163 | 102.23 |
| 40 | 52.55348 | -1.31153 | 90.52 | 99 | 52.56240 | -1.32145 | 101.05 |

| No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) | No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) |
|---|---|---|---|---|---|---|---|
| 41 | 52.55542 | -1.30744 | 91.01 | 100 | 52.56203 | -1.32208 | 99.71 |
| 42 | 52.55656 | -1.30689 | 91.80 | 101 | 52.56228 | -1.32287 | 100.37 |
| 43 | 52.55660 | -1.30518 | 88.77 | 102 | 52.56202 | -1.32310 | 99.55 |
| 44 | 52.55670 | -1.30529 | 88.56 | 103 | 52.56177 | -1.32326 | 98.56 |
| 45 | 52.55679 | -1.30540 | 88.12 | 104 | 52.56156 | -1.32335 | 97.24 |
| 46 | 52.55687 | -1.30547 | 87.72 | 105 | 52.56139 | -1.32260 | 97.34 |
| 47 | 52.55695 | -1.30557 | 89.45 | 106 | 52.56116 | -1.32277 | 96.72 |
| 48 | 52.55692 | -1.30610 | 91.80 | 107 | 52.55864 | -1.31793 | 89.12 |
| 49 | 52.55709 | -1.30573 | 91.15 | 108 | 52.55841 | -1.32007 | 89.62 |
| 50 | 52.55717 | -1.30583 | 91.20 | 109 | 52.55905 | -1.32006 | 91.80 |
| 51 | 52.55715 | -1.30651 | 91.64 | 110 | 52.55939 | -1.32047 | 91.80 |
| 52 | 52.55727 | -1.30635 | 90.71 | 111 | 52.55887 | -1.32100 | 91.32 |
| 53 | 52.55740 | -1.30626 | 89.92 | 112 | 52.55900 | -1.32114 | 91.93 |
| 54 | 52.55747 | -1.30620 | 88.57 | 113 | 52.55976 | -1.32229 | 93.57 |
| 55 | 52.55924 | -1.30782 | 84.80 | 114 | 52.56033 | -1.32320 | 94.35 |
| 56 | 52.55940 | -1.30791 | 85.21 | 115 | 52.56092 | -1.32436 | 95.02 |
| 57 | 52.55958 | -1.30823 | 85.95 | 116 | 52.56149 | -1.32571 | 96.04 |
| 58 | 52.56002 | -1.30858 | 87.85 | 117 | 52.55817 | -1.32615 | 90.50 |
| 59 | 52.56012 | -1.30875 | 88.49 | 118 | 52.55752 | -1.32669 | 91.80 |

*Dwelling Receptor Data*

## Train Signal Receptor Data

An additional 2.75m height has been added to the elevation to account for the signal height.

| No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) | No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) |
|---|---|---|---|---|---|---|---|
| 1 | 52.55119 | -1.33096 | 100.32 | 2 | 52.55127 | -1.33048 | 99.39 |

*Train Signal Receptor Data*

## Road Receptor Data

An additional 1.5m height has been added to the elevation to account for the eye-level of road user.

| No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) | No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) |
|---|---|---|---|---|---|---|---|
| 1 | 52.53500 | -1.32159 | 99.24 | 17 | 52.54637 | -1.31143 | 94.39 |
| 2 | 52.53578 | -1.32086 | 100.50 | 18 | 52.54714 | -1.31072 | 92.66 |
| 3 | 52.53656 | -1.32013 | 100.50 | 19 | 52.54793 | -1.30999 | 90.50 |
| 4 | 52.53735 | -1.31941 | 101.50 | 20 | 52.54872 | -1.30925 | 89.50 |
| 5 | 52.53813 | -1.31871 | 103.21 | 21 | 52.54946 | -1.30853 | 89.36 |
| 6 | 52.53892 | -1.31801 | 104.50 | 22 | 52.55024 | -1.30778 | 88.71 |
| 7 | 52.54087 | -1.31794 | 110.14 | 23 | 52.55100 | -1.30704 | 87.99 |
| 8 | 52.53953 | -1.31749 | 105.31 | 24 | 52.55177 | -1.30626 | 89.50 |
| 9 | 52.53962 | -1.31549 | 104.50 | 25 | 52.55254 | -1.30548 | 90.40 |
| 10 | 52.54084 | -1.31634 | 107.20 | 26 | 52.55331 | -1.30469 | 89.84 |
| 11 | 52.54163 | -1.31565 | 104.89 | 27 | 52.55405 | -1.30390 | 90.25 |
| 12 | 52.54241 | -1.31496 | 103.27 | 28 | 52.55480 | -1.30312 | 89.57 |
| 13 | 52.54321 | -1.31426 | 101.46 | 29 | 52.55555 | -1.30229 | 88.83 |

| No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) | No. | Longitude (°) | Latitude (°) | Assessed Height (m amsl) |
|---|---|---|---|---|---|---|---|
| 14 | 52.54401 | -1.31356 | 98.70 | 30 | 52.55631 | -1.30144 | 89.09 |
| 15 | 52.54481 | -1.31285 | 96.84 | 31 | 52.55705 | -1.30062 | 90.50 |
| 16 | 52.54558 | -1.31216 | 96.19 | 32 | 52.55807 | -1.29946 | 92.20 |

*Road Receptor Data*

# APPENDIX H – DETAILLED MODELLING RESULTS

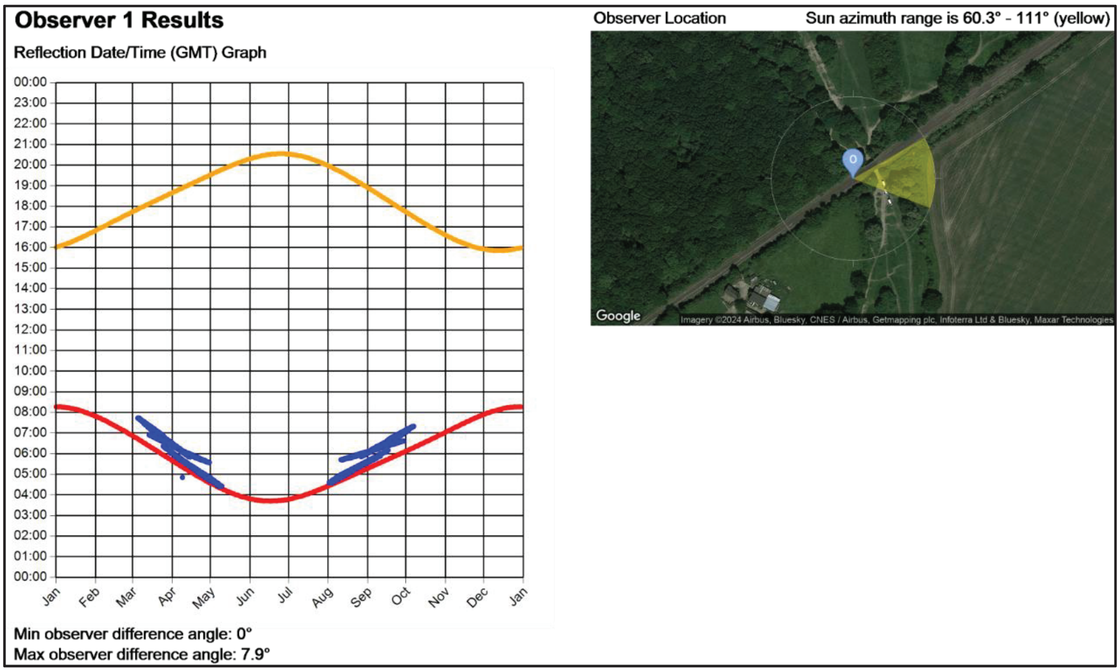
## Overview

The Pager Power charts for selected receptors are shown below and on the following pages. 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).

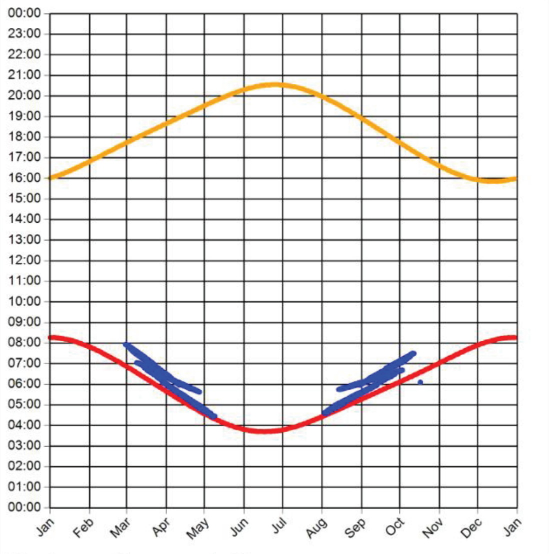
## Train Driver Receptors

Modelling results for receptors where a low impact is predicted are presented. Full modelling results are available upon request.



## Observer 2 Results

Reflection Date/Time (GMT) Graph



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

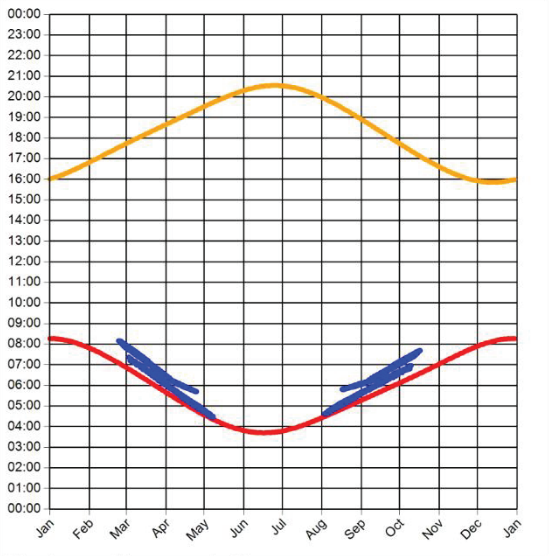
Observer Location

Sun azimuth range is 60.7° - 114.5° (yellow)

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

## Observer 3 Results

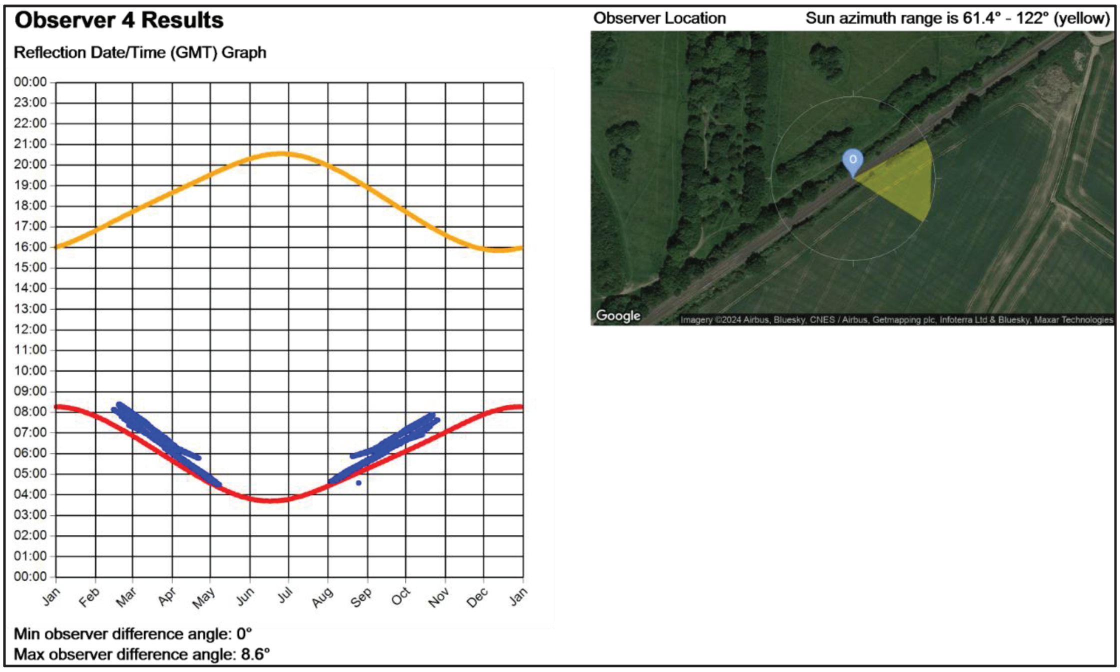
Reflection Date/Time (GMT) Graph



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

Observer Location

Sun azimuth range is 61° - 118.2° (yellow)



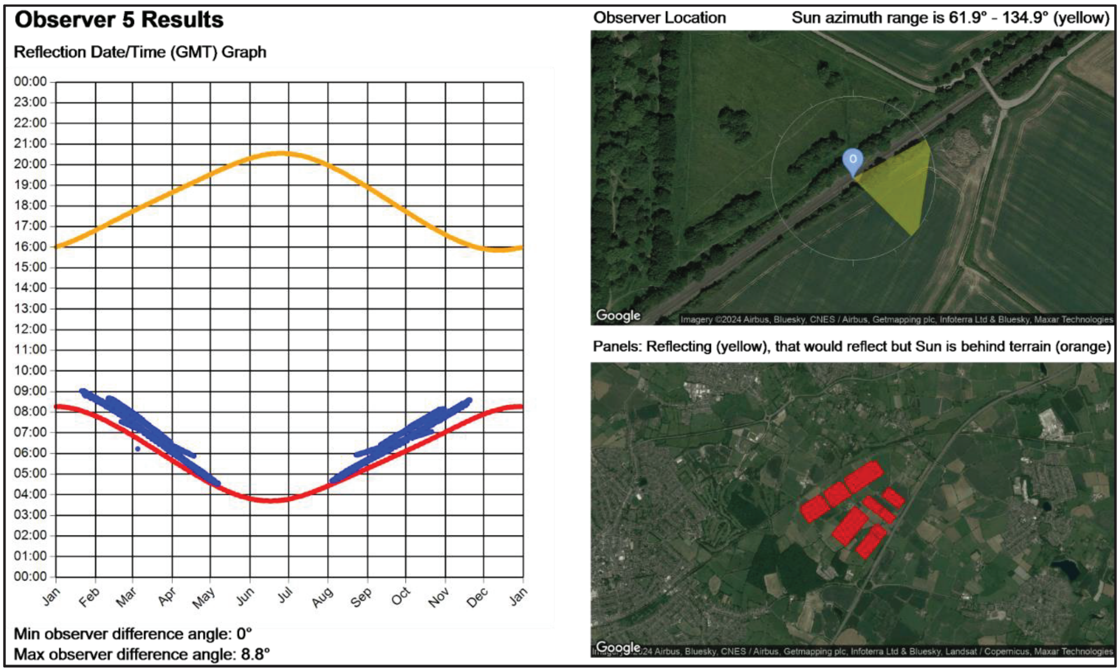
**Observer 4 Results**

Reflection Date/Time (GMT) Graph

Observer Location

Sun azimuth range is 61.4° - 122° (yellow)

Min observer difference angle: 0°
Max observer difference angle: 8.6°



**Observer 5 Results**

Reflection Date/Time (GMT) Graph

Observer Location

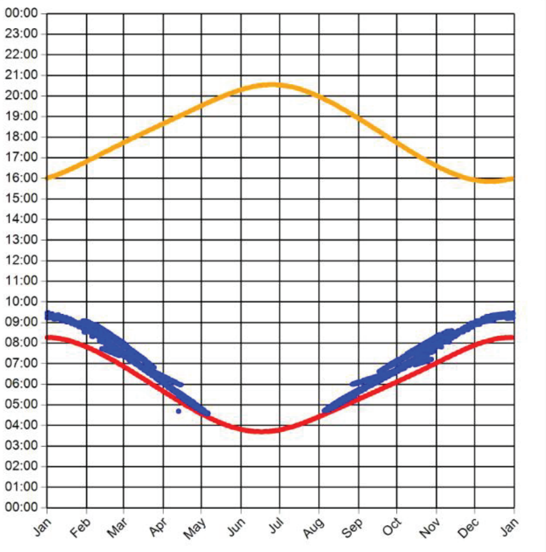
Sun azimuth range is 61.9° - 134.9° (yellow)

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

Min observer difference angle: 0°
Max observer difference angle: 8.8°

## Observer 6 Results

Reflection Date/Time (GMT) Graph



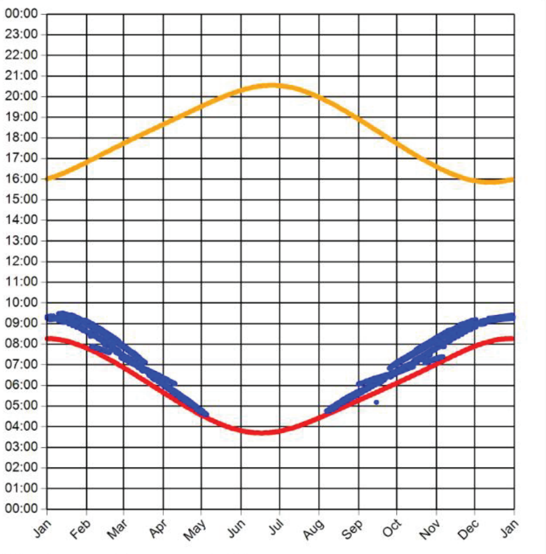
Min observer difference angle: 0°
Max observer difference angle: 9°

Observer Location

Sun azimuth range is 62.5° - 143.8° (yellow)

## Observer 7 Results

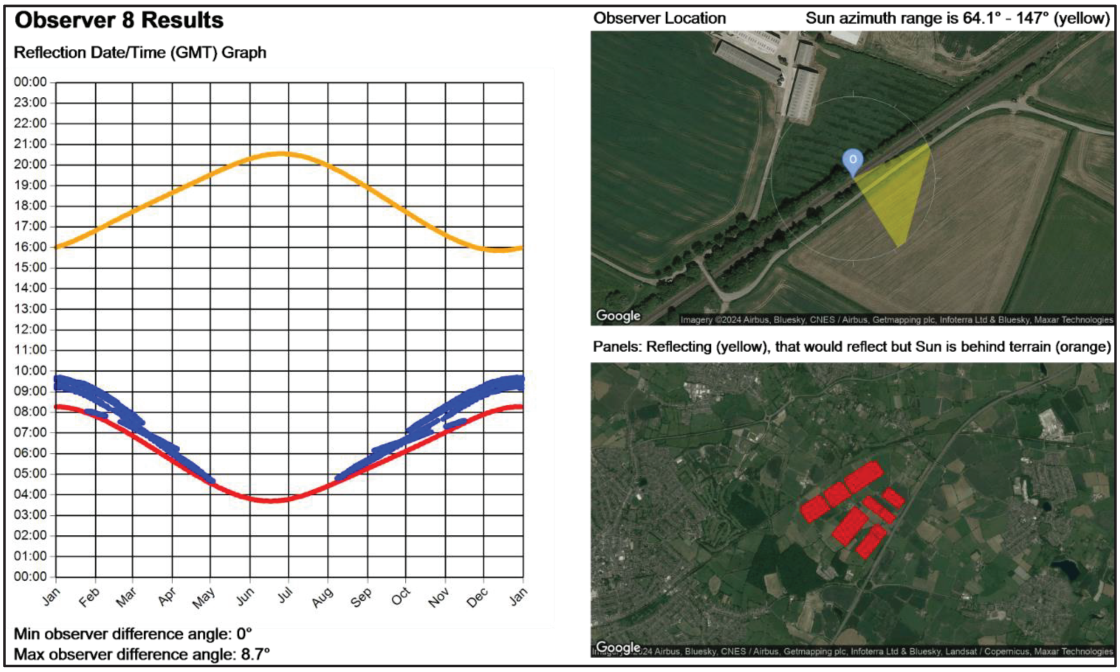
Reflection Date/Time (GMT) Graph

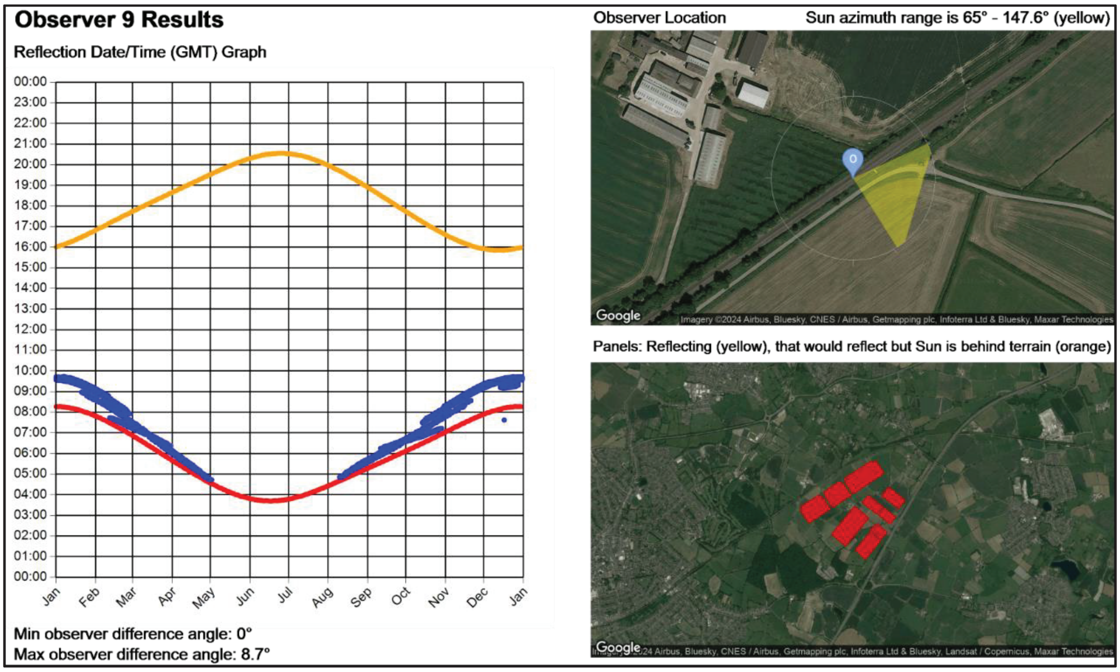


Min observer difference angle: 0°
Max observer difference angle: 8.8°

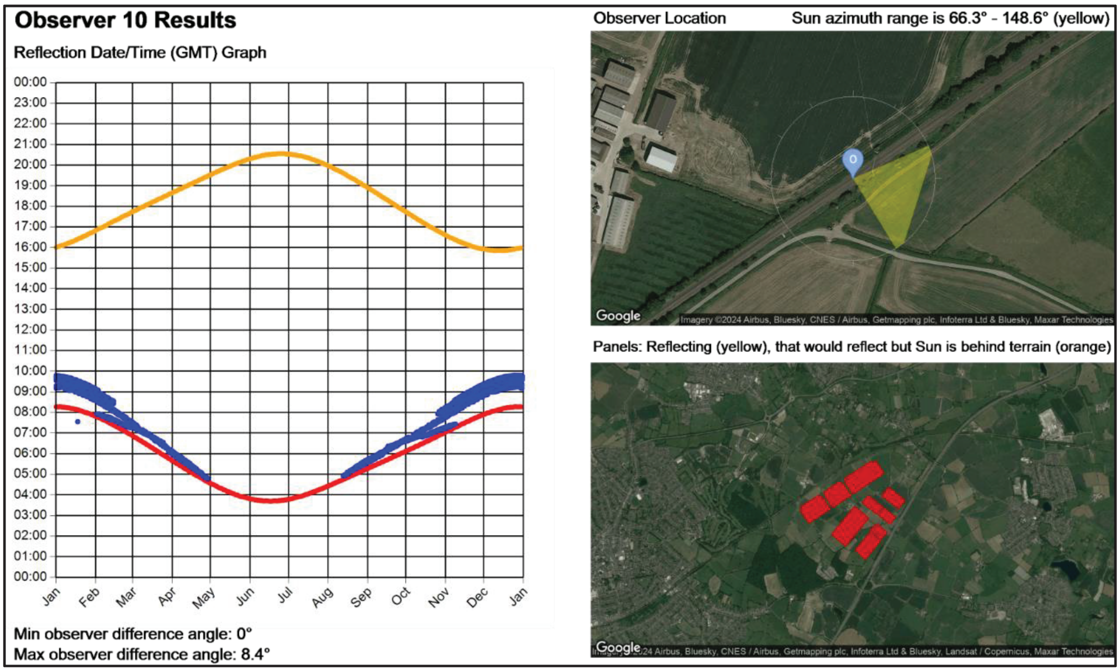
Observer Location

Sun azimuth range is 63.2° - 142.8° (yellow)


Observer 8 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°
Max observer difference angle: 8.7°
Observer Location
Sun azimuth range is 64.1° - 147° (yellow)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat / Copernicus, Maxar Technologies

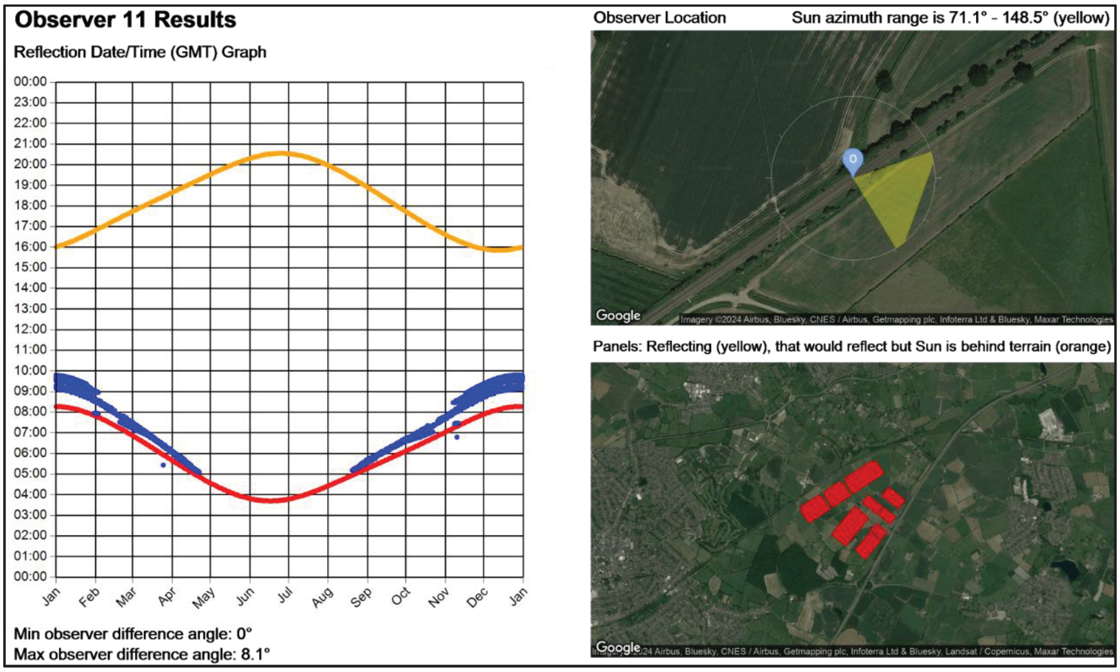

Observer 9 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 0°
Max observer difference angle: 8.7°
Observer Location
Sun azimuth range is 65° - 147.6° (yellow)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat / Copernicus, Maxar Technologies

## Observer 10 Results

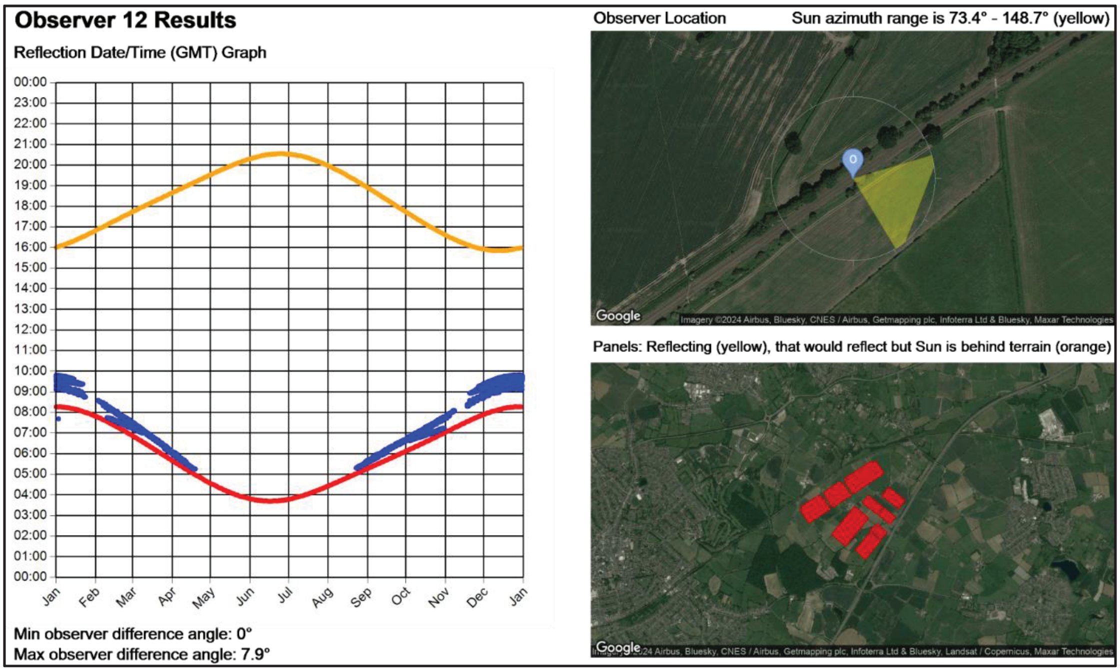


Min observer difference angle: 0°
Max observer difference angle: 8.4°

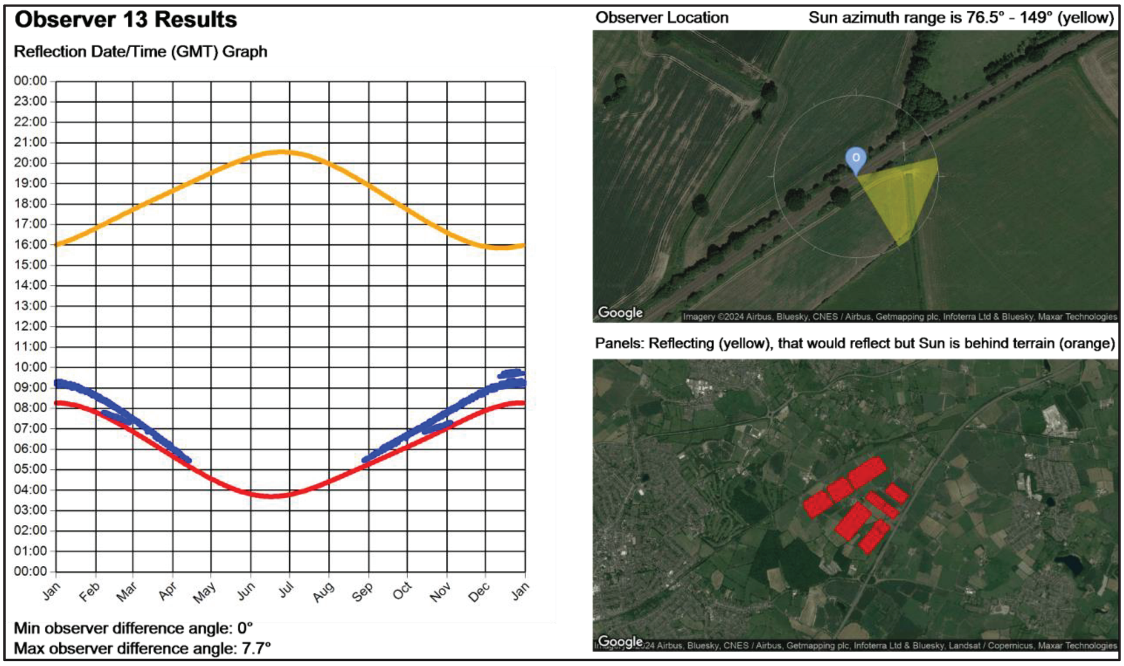
## Observer 11 Results



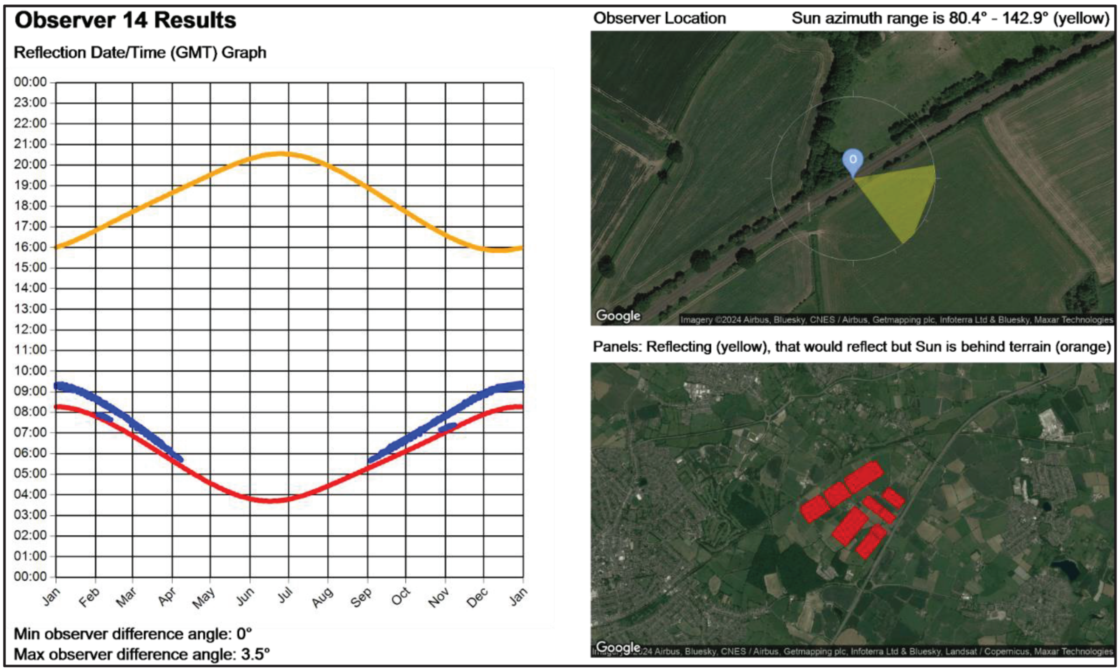
Min observer difference angle: 0°
Max observer difference angle: 8.1°



Observer 12 Results



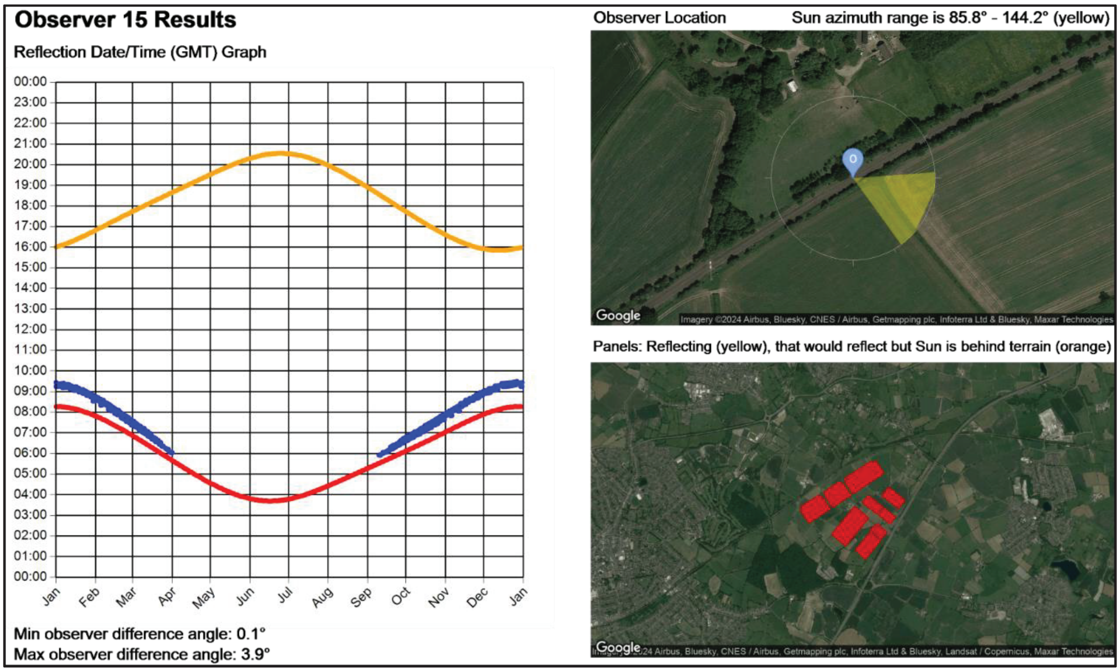
Observer 13 Results



**Observer 14 Results**

Reflection Date/Time (GMT) Graph

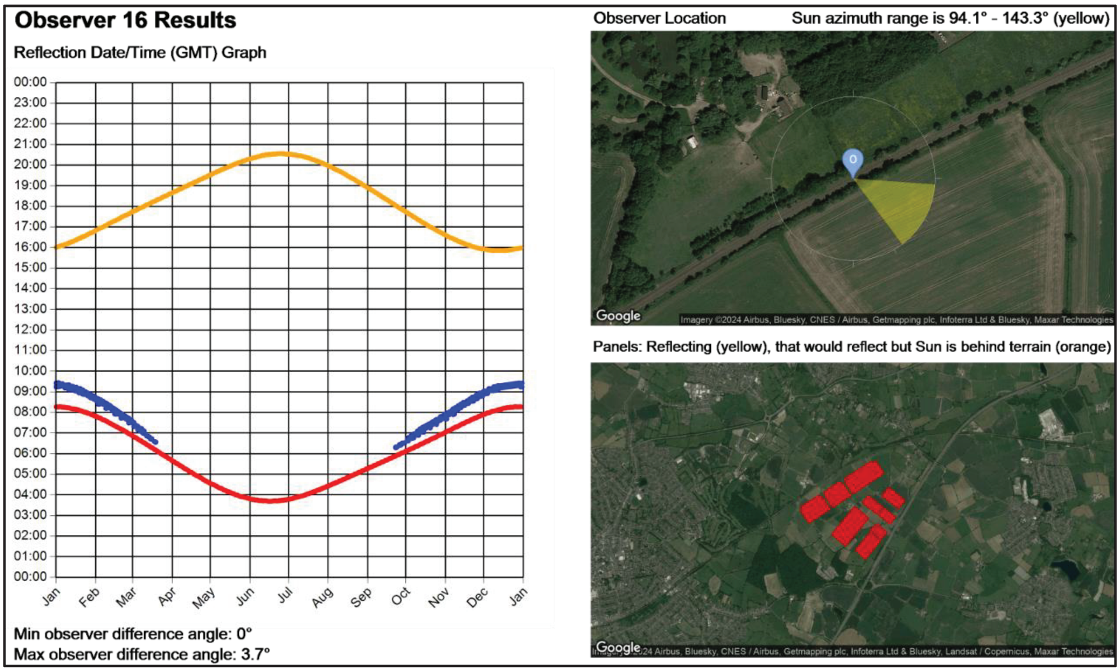
Min observer difference angle: 0°
Max observer difference angle: 3.5°



**Observer 15 Results**

Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.1°
Max observer difference angle: 3.9°



**Observer 16 Results**

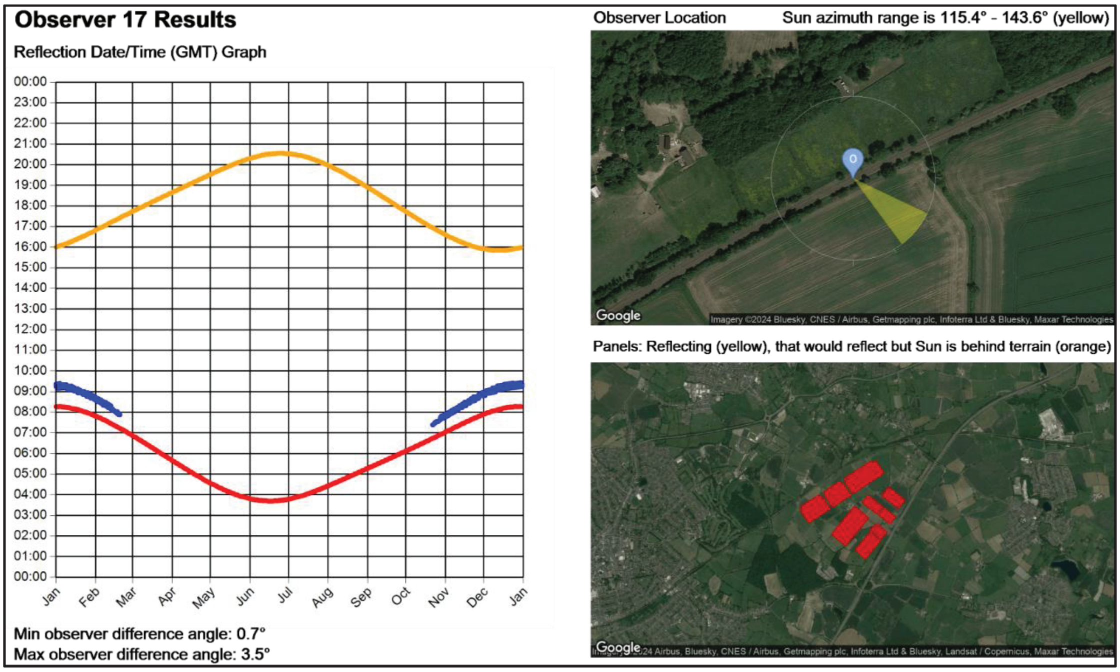
Reflection Date/Time (GMT) Graph

Min observer difference angle: 0°
Max observer difference angle: 3.7°

Observer Location

Sun azimuth range is 94.1° - 143.3° (yellow)

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



**Observer 17 Results**

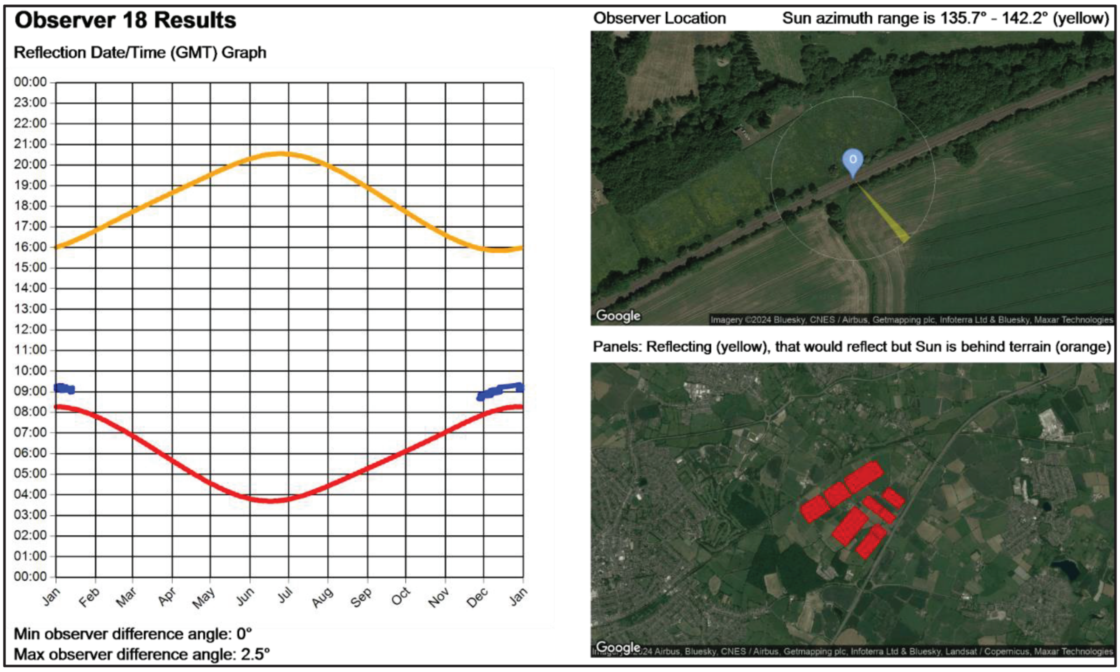
Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.7°
Max observer difference angle: 3.5°

Observer Location

Sun azimuth range is 115.4° - 143.6° (yellow)

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



**Observer 18 Results**

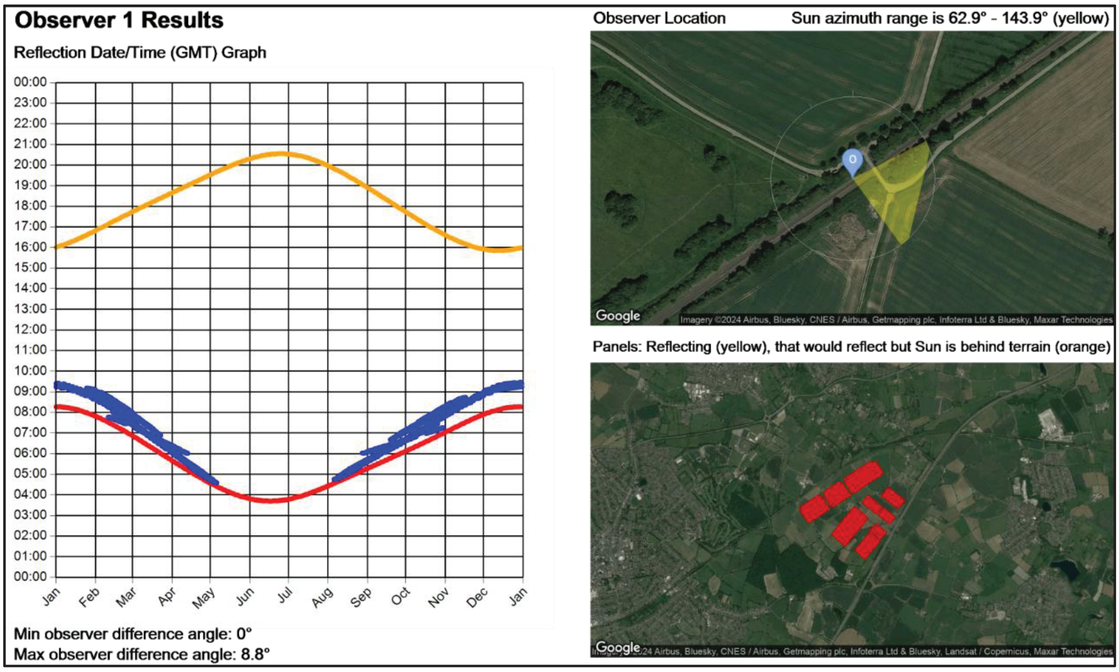
Reflection Date/Time (GMT) Graph

Min observer difference angle: 0°
Max observer difference angle: 2.5°

Observer Location — Sun azimuth range is 135.7° - 142.2° (yellow)

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

## Train Driver Receptors



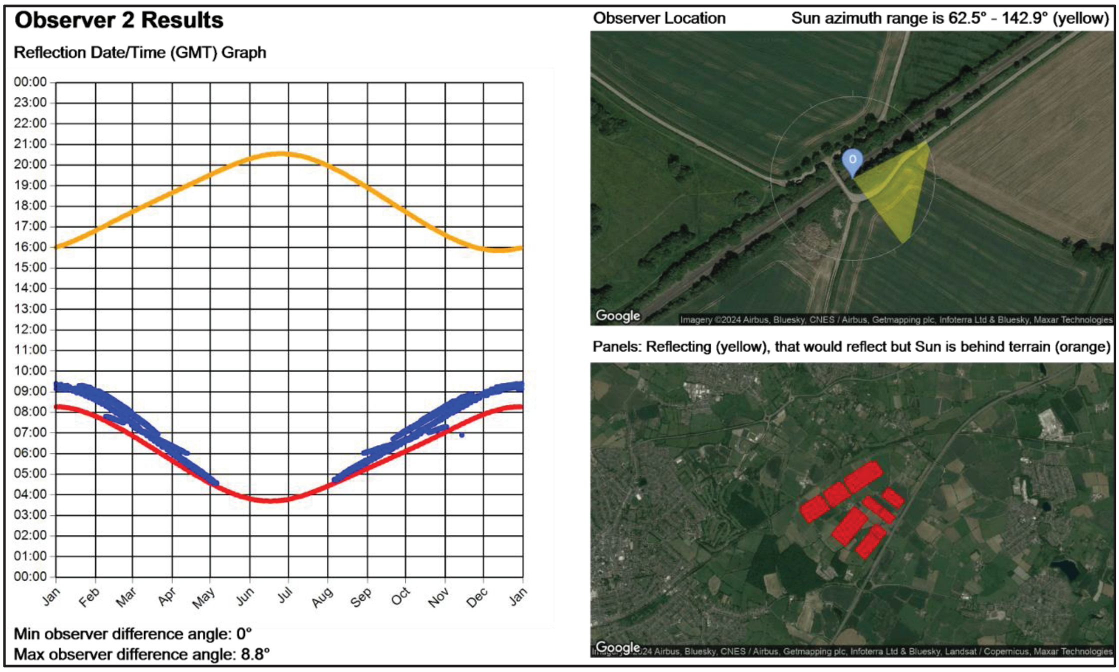
**Observer 1 Results**

Reflection Date/Time (GMT) Graph

Min observer difference angle: 0°
Max observer difference angle: 8.8°

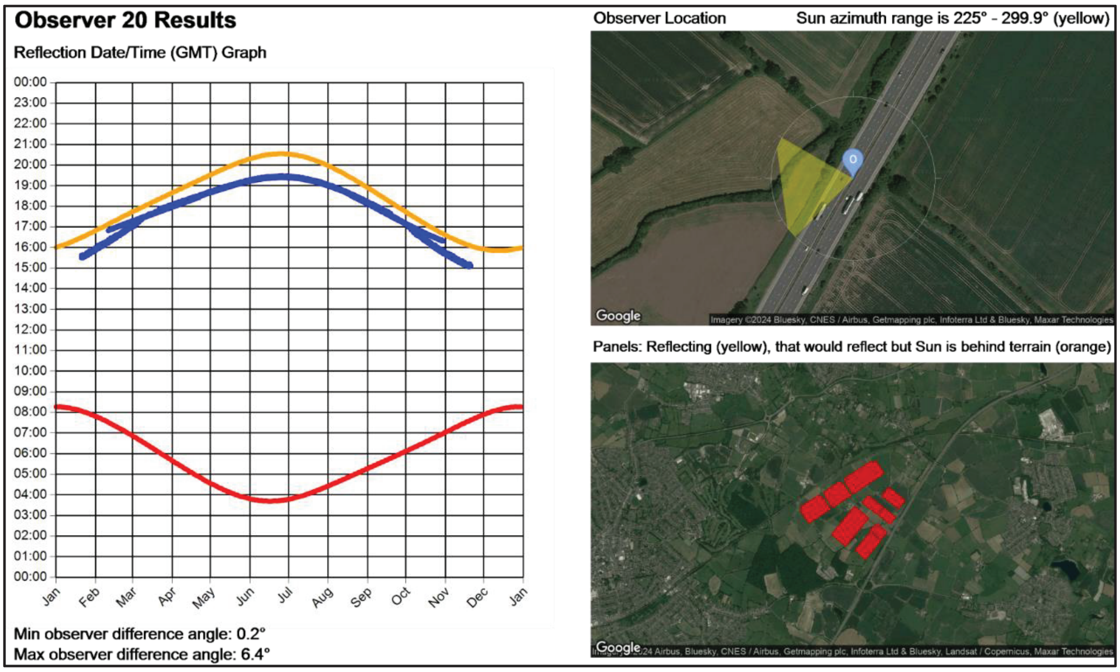
Observer Location — Sun azimuth range is 62.9° - 143.9° (yellow)

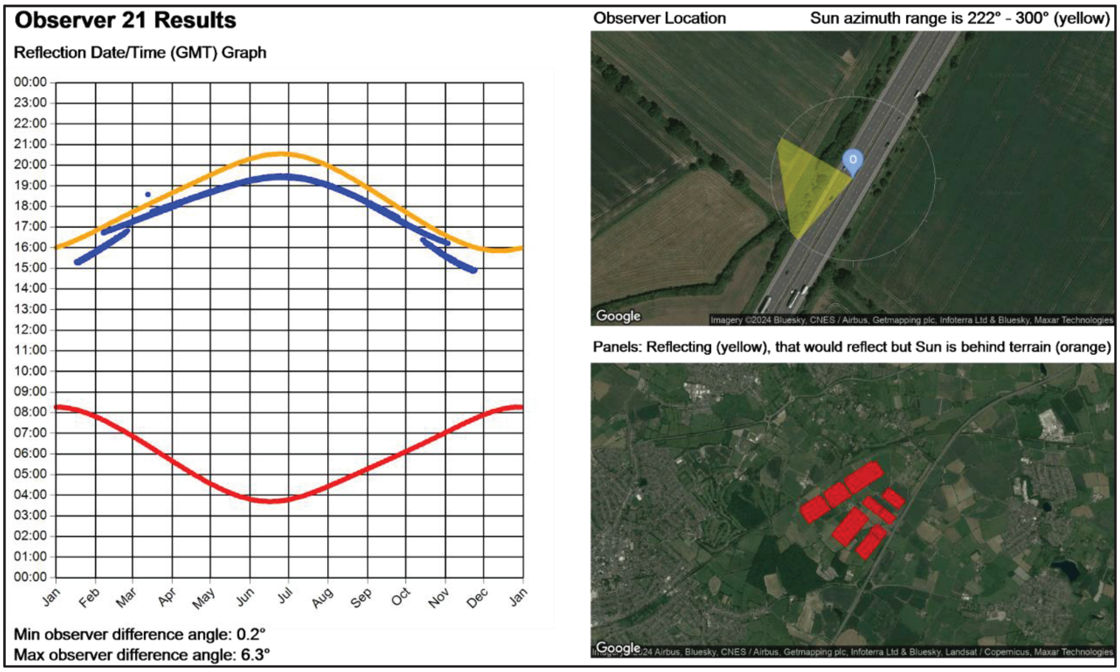
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



## Road Receptors

Modelling results for receptors where a mitigation has been recommended. Full modelling results are available upon request.





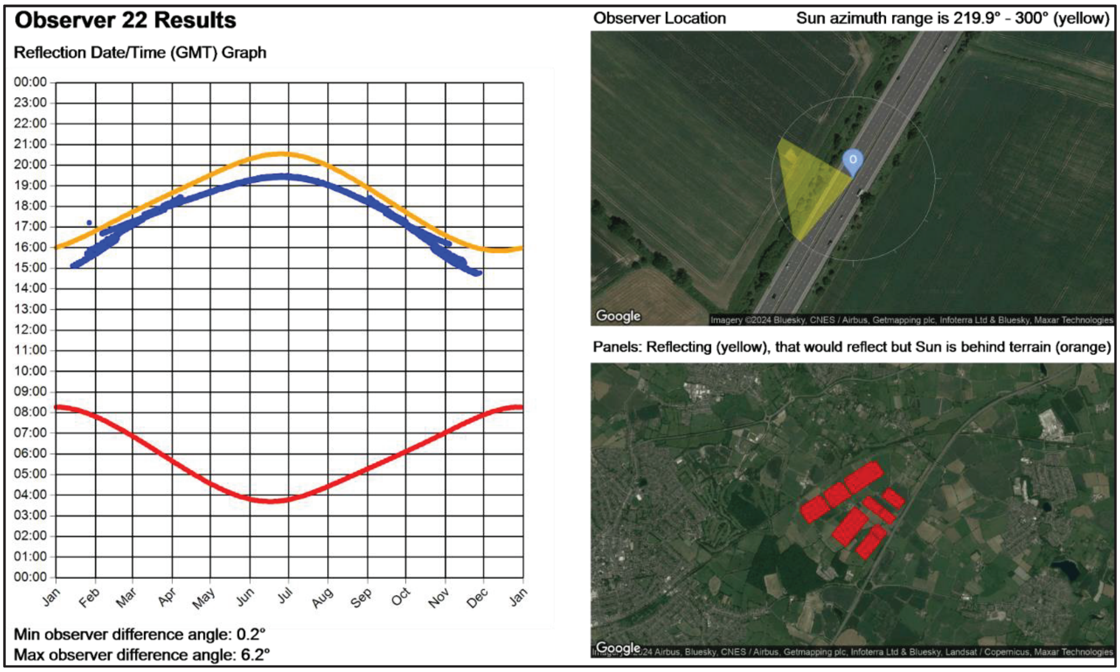
**Observer 21 Results**

Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.2°
Max observer difference angle: 6.3°

Observer Location — Sun azimuth range is 222° - 300° (yellow)

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



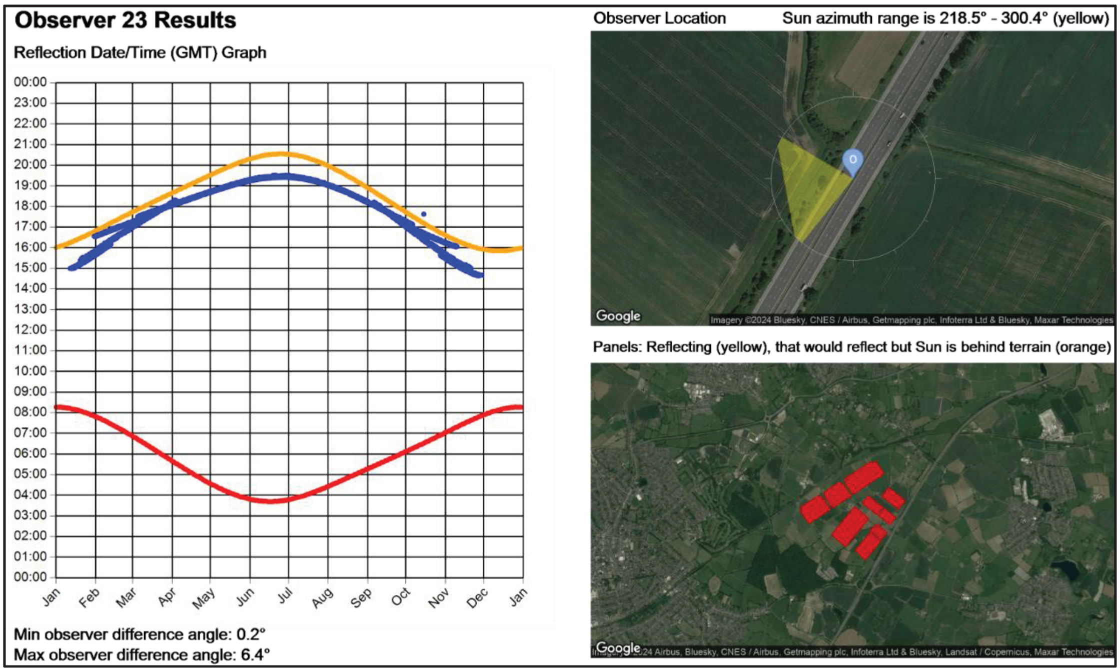
**Observer 22 Results**

Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.2°
Max observer difference angle: 6.2°

Observer Location — Sun azimuth range is 219.9° - 300° (yellow)

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



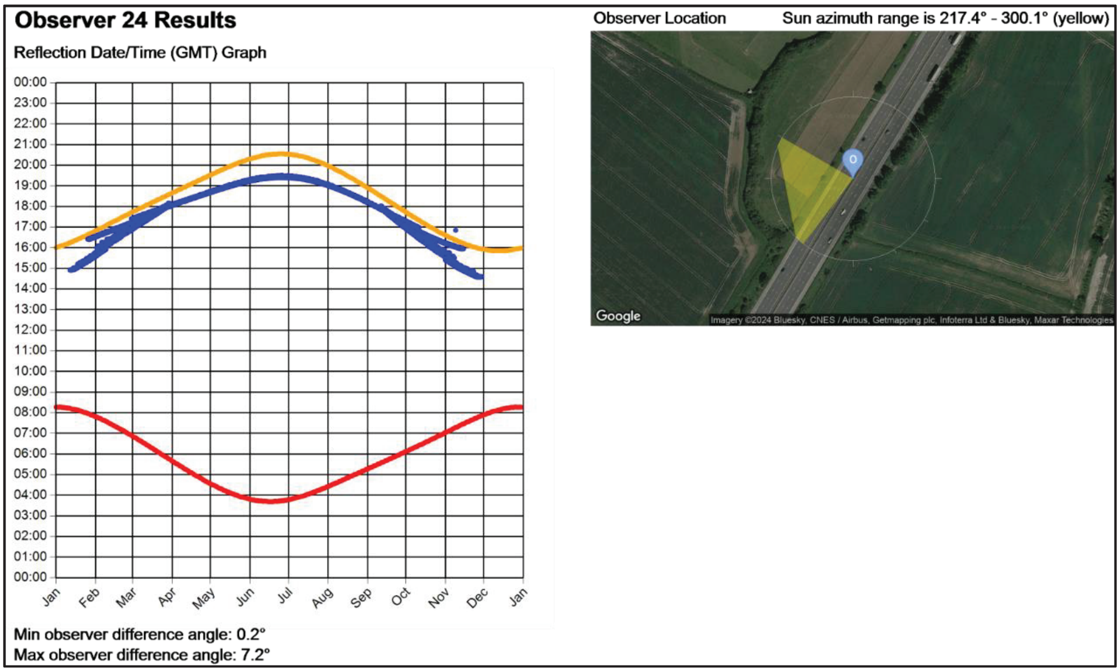
**Observer 23 Results**

Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.2°
Max observer difference angle: 6.4°

Observer Location — Sun azimuth range is 218.5° - 300.4° (yellow)

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



**Observer 24 Results**

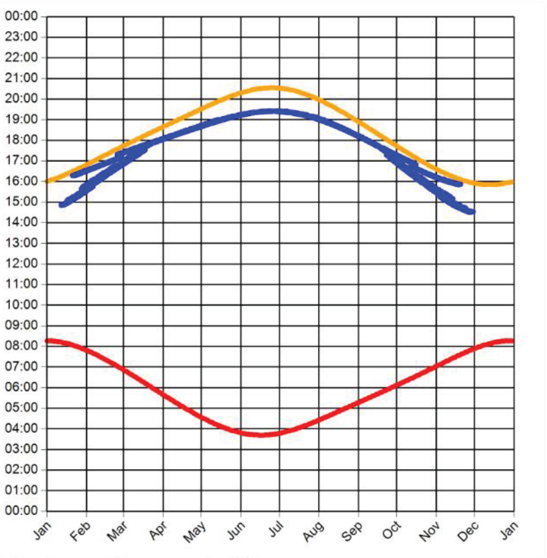
Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.2°
Max observer difference angle: 7.2°

Observer Location — Sun azimuth range is 217.4° - 300.1° (yellow)

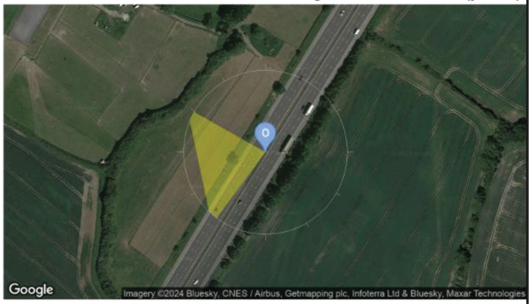
## Observer 25 Results

Reflection Date/Time (GMT) Graph



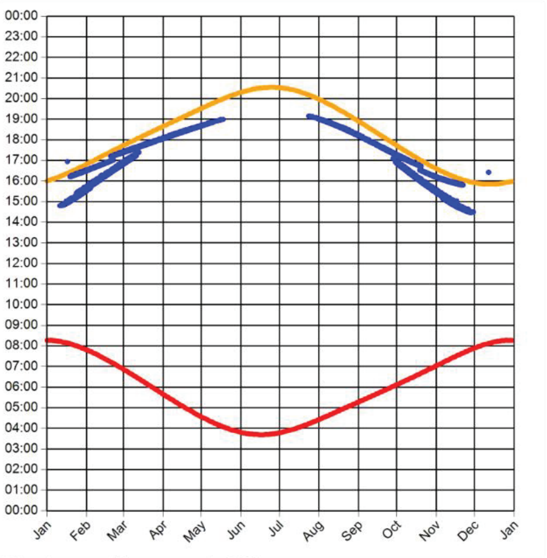
Min observer difference angle: 0.2°
Max observer difference angle: 7.7°

Observer Location — Sun azimuth range is 216.6° - 299.4° (yellow)



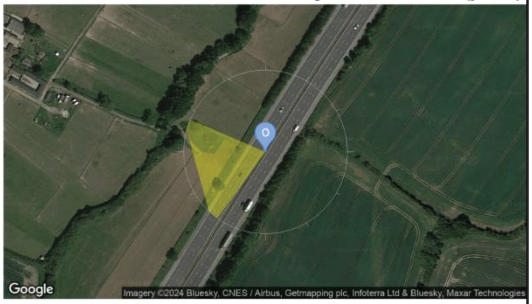
## Observer 26 Results

Reflection Date/Time (GMT) Graph

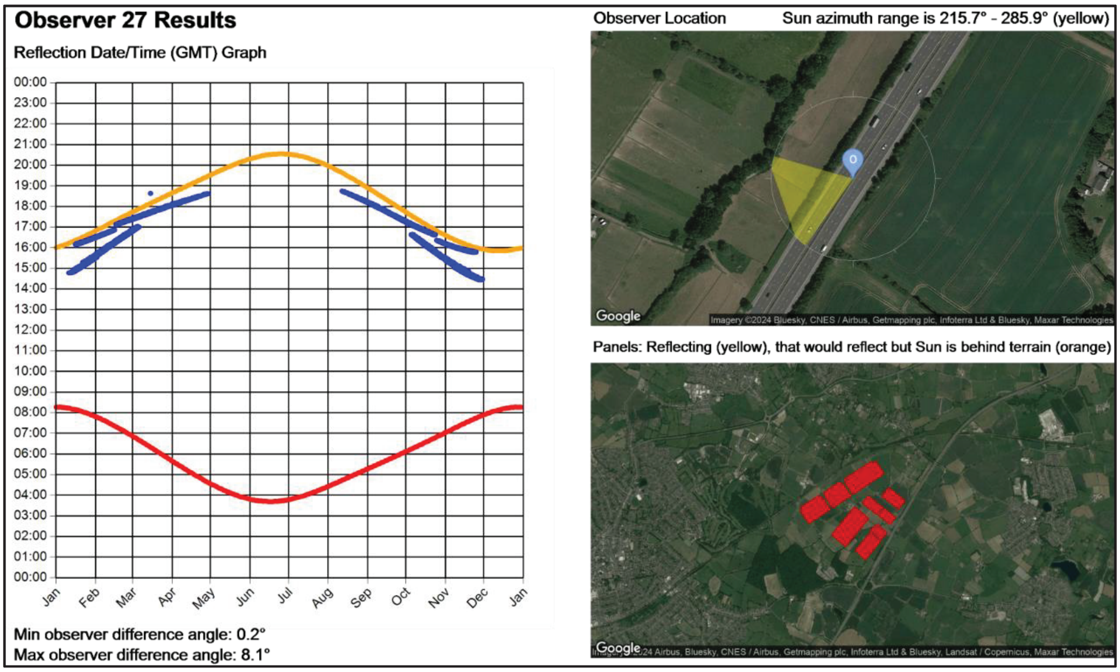


Min observer difference angle: 0.2°
Max observer difference angle: 7.9°

Observer Location — Sun azimuth range is 216.1° - 293.3° (yellow)

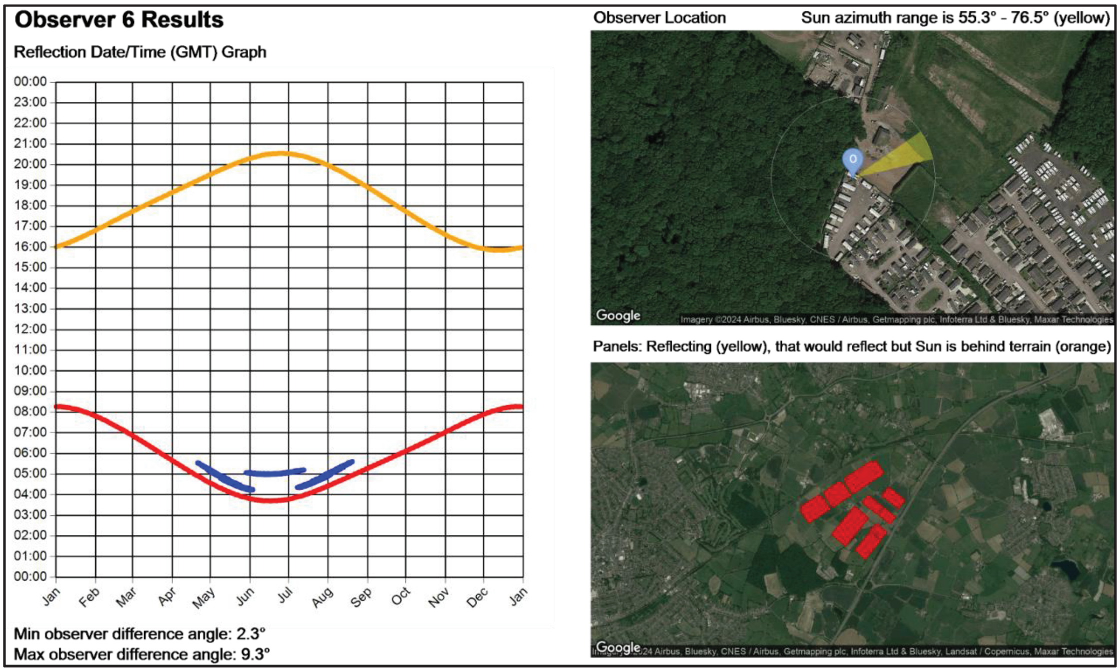


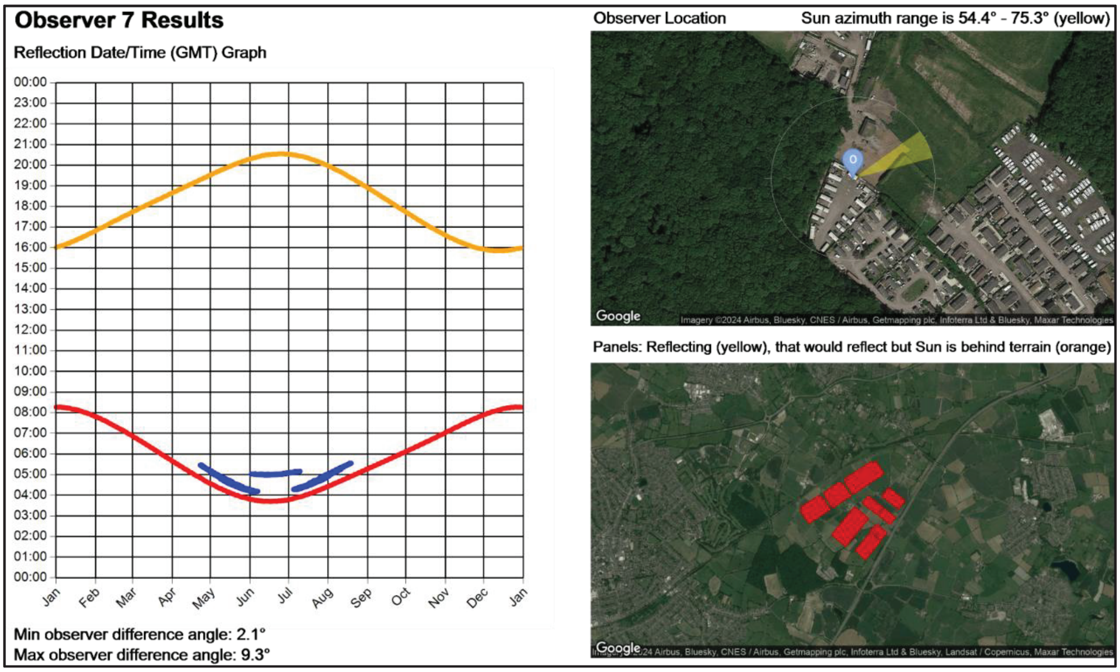
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



## Dwelling Receptors

Modelling results for receptors where a low impact is predicted are presented. Full modelling results are available upon request.





**Observer 7 Results**

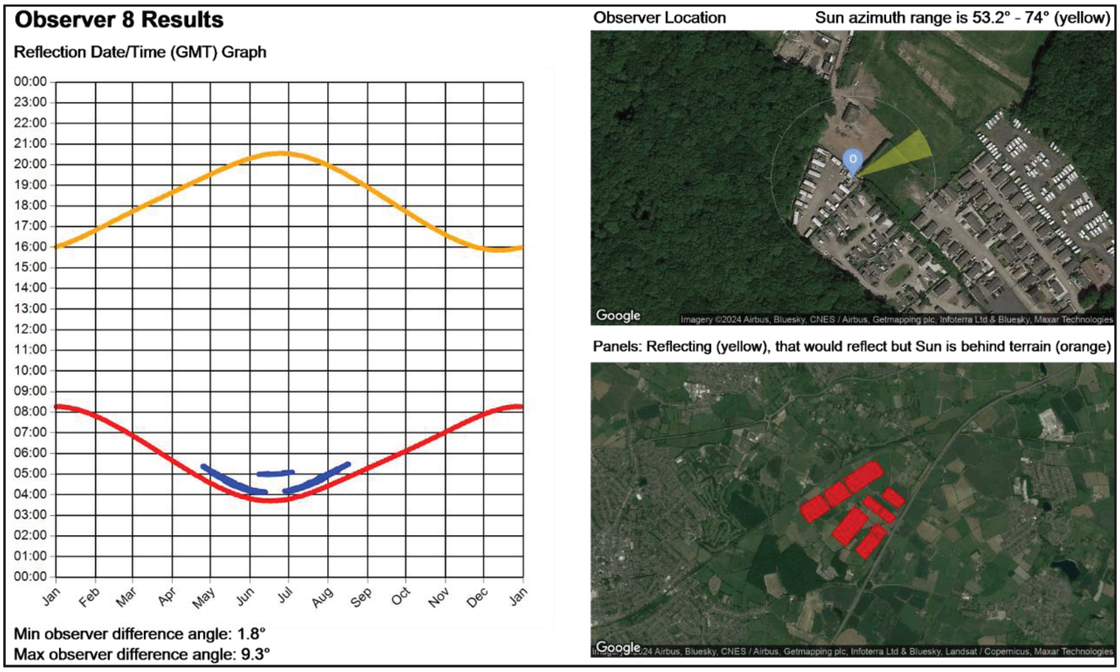
Reflection Date/Time (GMT) Graph

Observer Location

Sun azimuth range is 54.4° - 75.3° (yellow)

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

Min observer difference angle: 2.1°
Max observer difference angle: 9.3°



**Observer 8 Results**

Reflection Date/Time (GMT) Graph

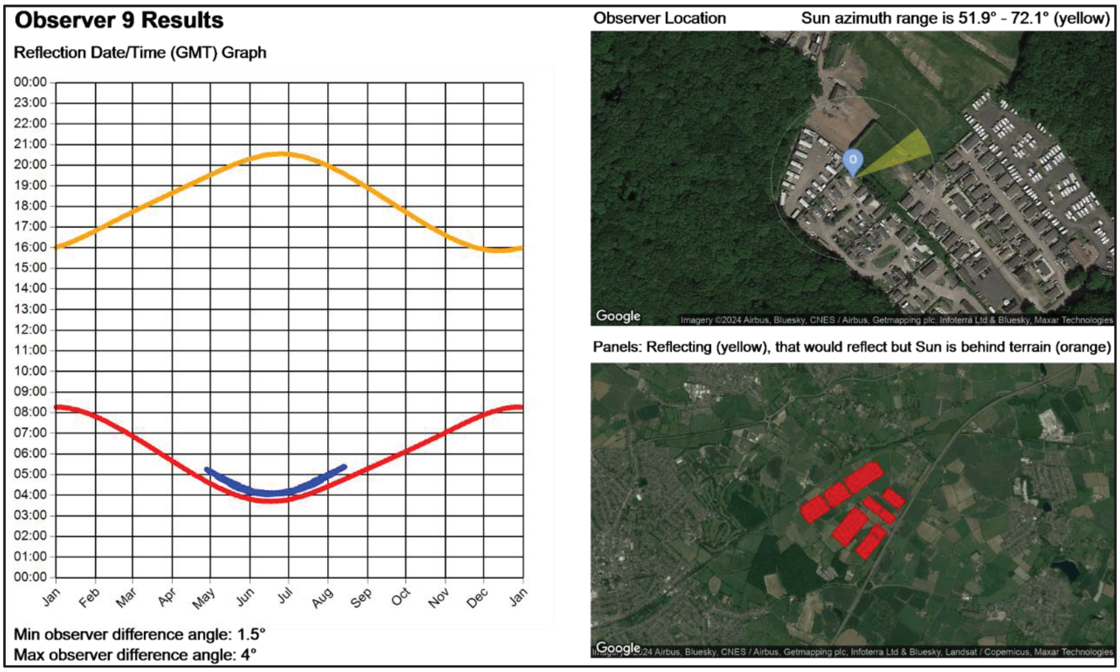
Observer Location

Sun azimuth range is 53.2° - 74° (yellow)

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

Min observer difference angle: 1.8°
Max observer difference angle: 9.3°

## Observer 9 Results



Reflection Date/Time (GMT) Graph

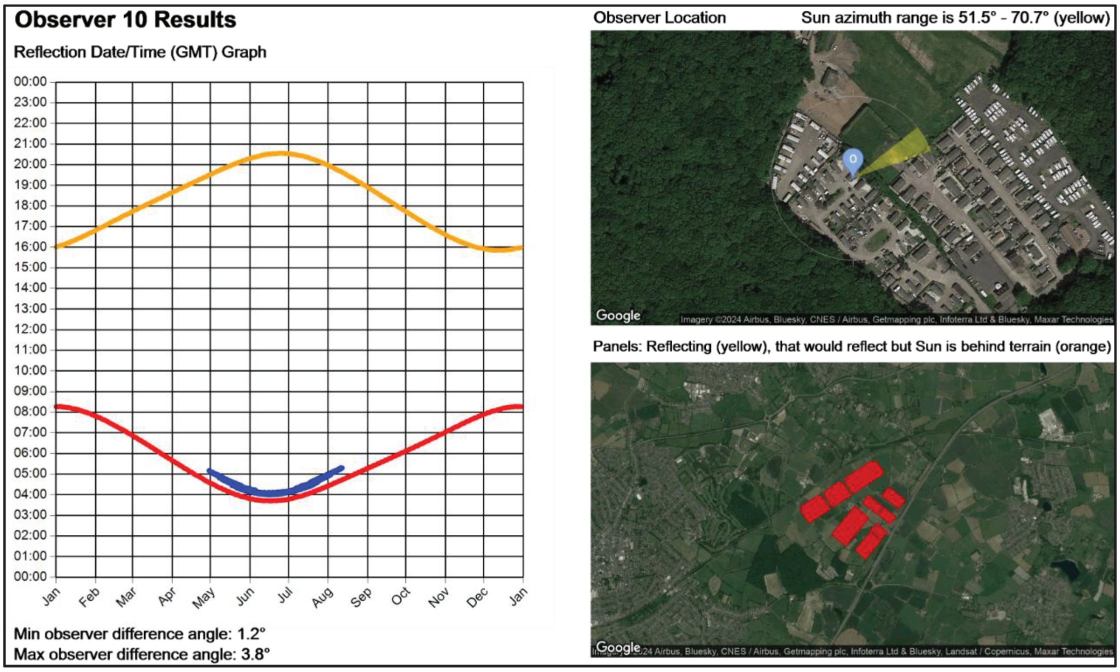
Observer Location

Sun azimuth range is 51.9° - 72.1° (yellow)

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

Min observer difference angle: 1.5°
Max observer difference angle: 4°

## Observer 10 Results



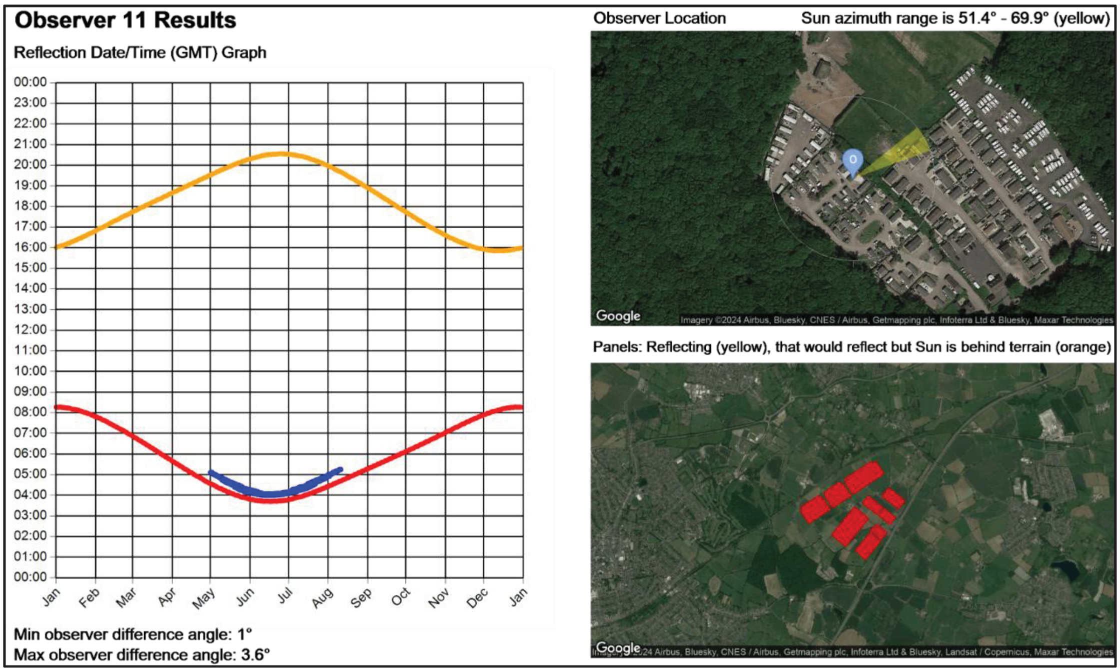
Reflection Date/Time (GMT) Graph

Observer Location

Sun azimuth range is 51.5° - 70.7° (yellow)

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

Min observer difference angle: 1.2°
Max observer difference angle: 3.8°



**Observer 11 Results**

Reflection Date/Time (GMT) Graph

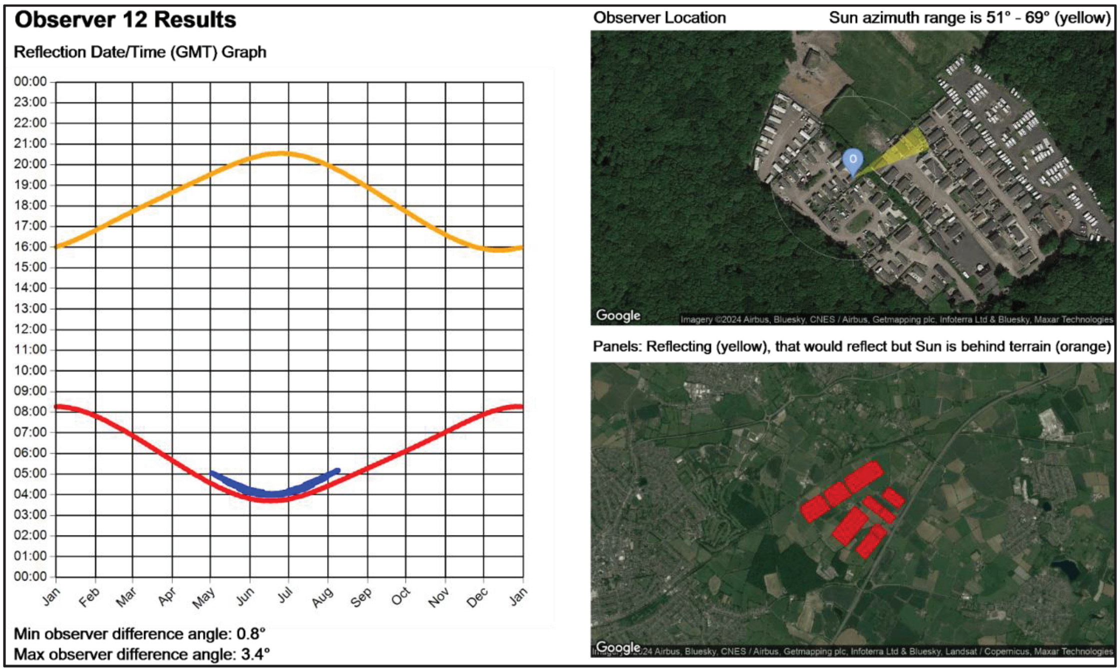
Observer Location

Sun azimuth range is 51.4° - 69.9° (yellow)

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

Min observer difference angle: 1°

Max observer difference angle: 3.6°



**Observer 12 Results**

Reflection Date/Time (GMT) Graph

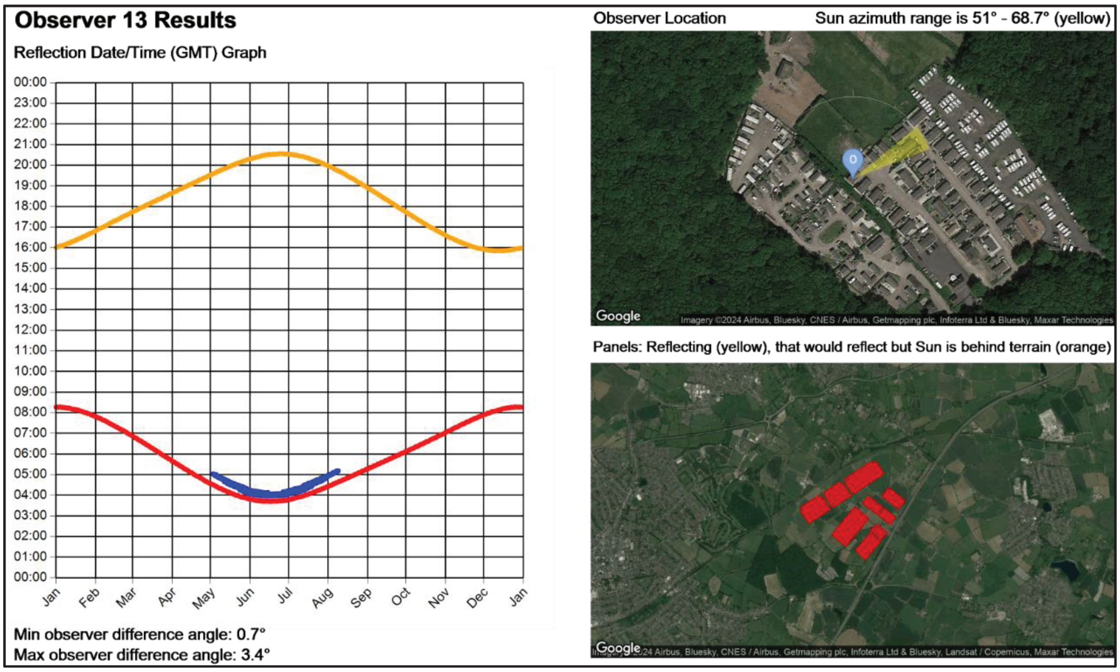
Observer Location

Sun azimuth range is 51° - 69° (yellow)

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

Min observer difference angle: 0.8°

Max observer difference angle: 3.4°



**Observer 13 Results**

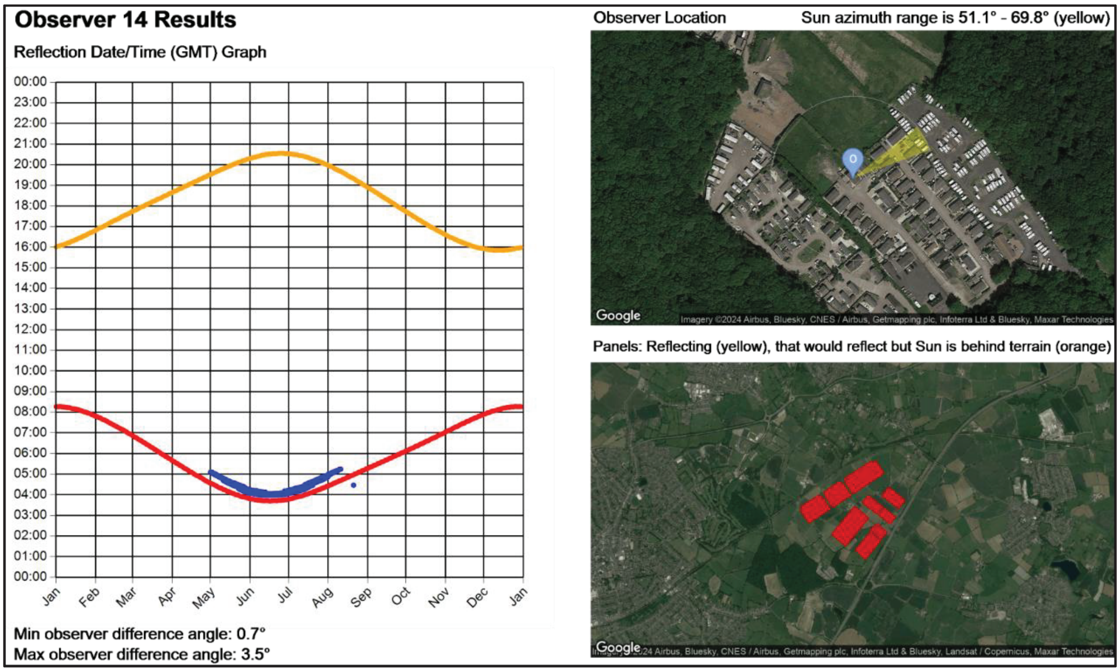
Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.7°
Max observer difference angle: 3.4°

Observer Location

Sun azimuth range is 51° - 68.7° (yellow)

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



**Observer 14 Results**

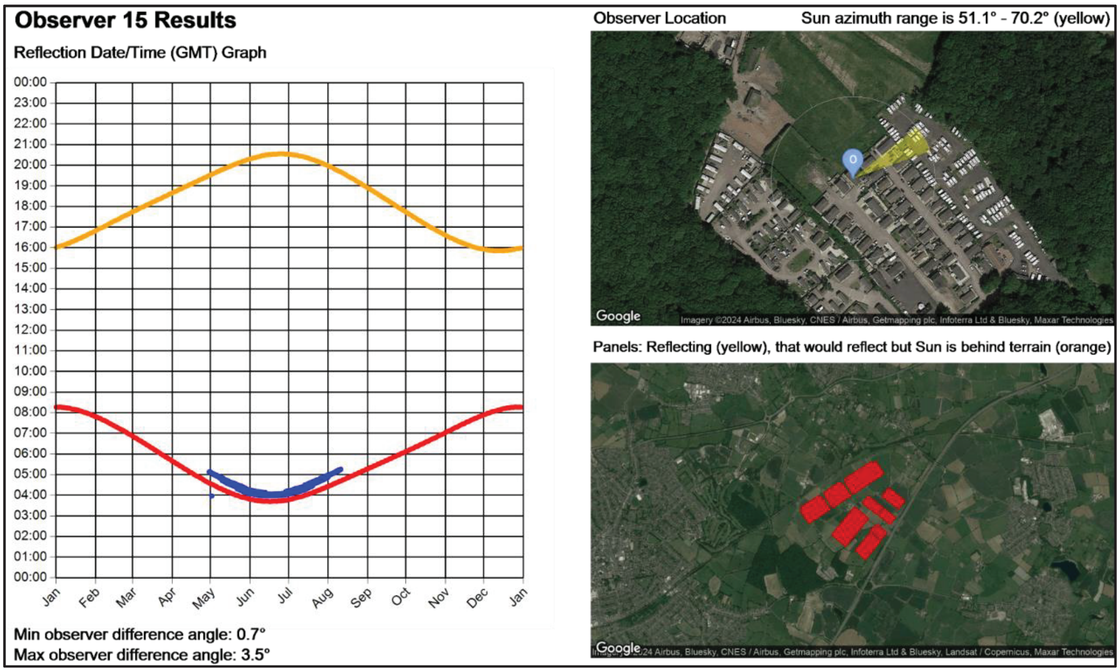
Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.7°
Max observer difference angle: 3.5°

Observer Location

Sun azimuth range is 51.1° - 69.8° (yellow)

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



**Observer 15 Results**

Reflection Date/Time (GMT) Graph

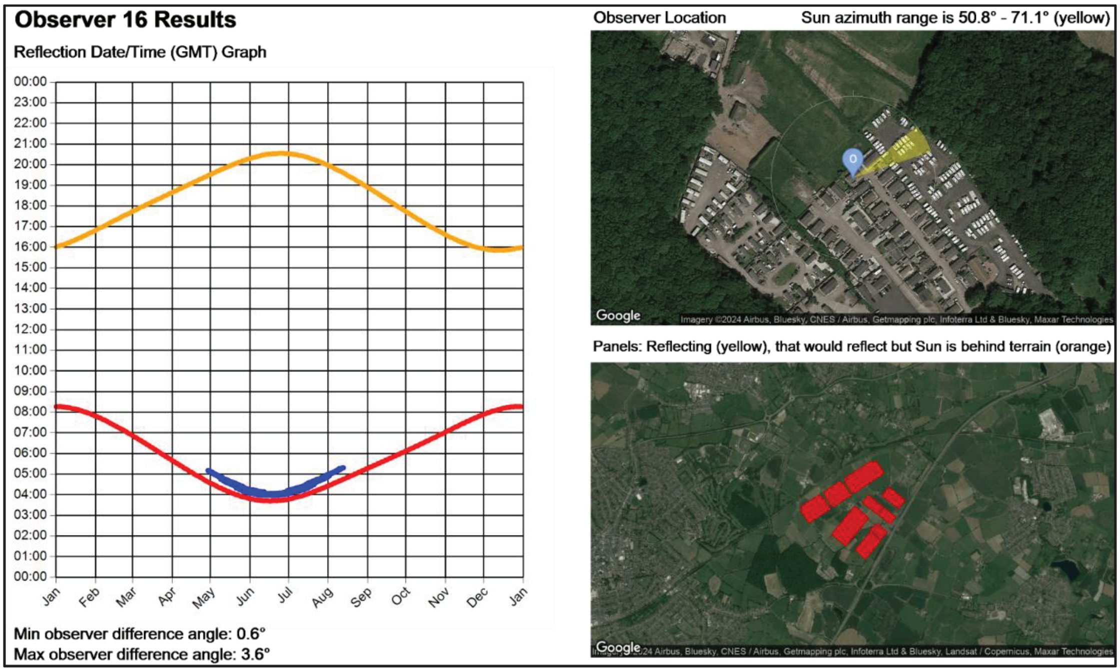
Min observer difference angle: 0.7°

Max observer difference angle: 3.5°

Observer Location

Sun azimuth range is 51.1° - 70.2° (yellow)

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



**Observer 16 Results**

Reflection Date/Time (GMT) Graph

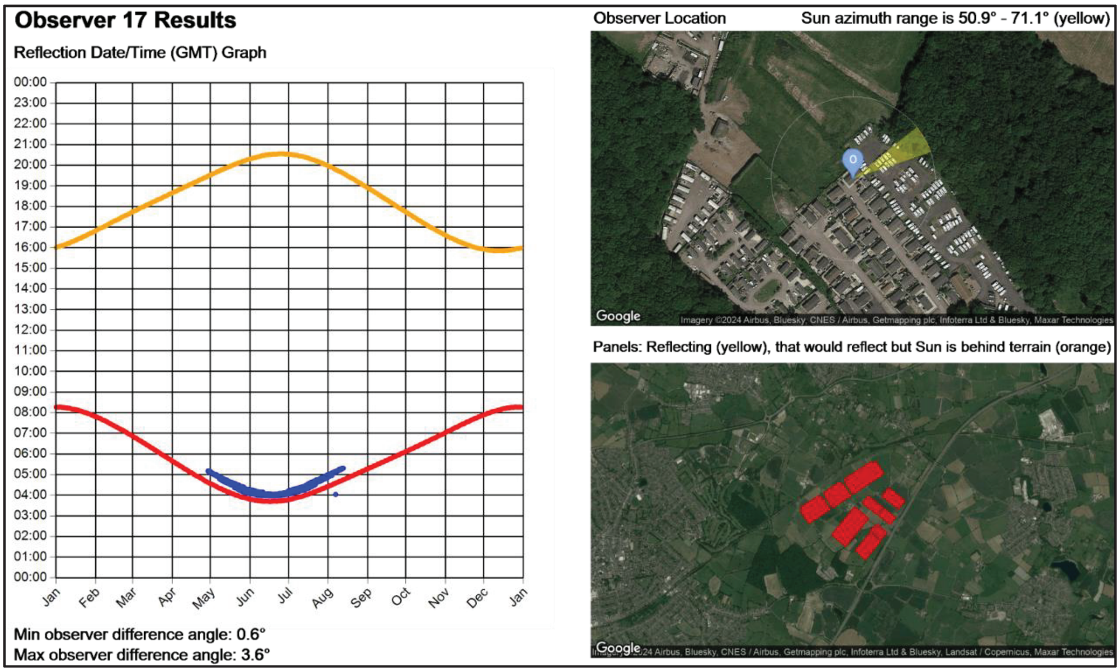
Min observer difference angle: 0.6°

Max observer difference angle: 3.6°

Observer Location

Sun azimuth range is 50.8° - 71.1° (yellow)

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



**Observer 17 Results**

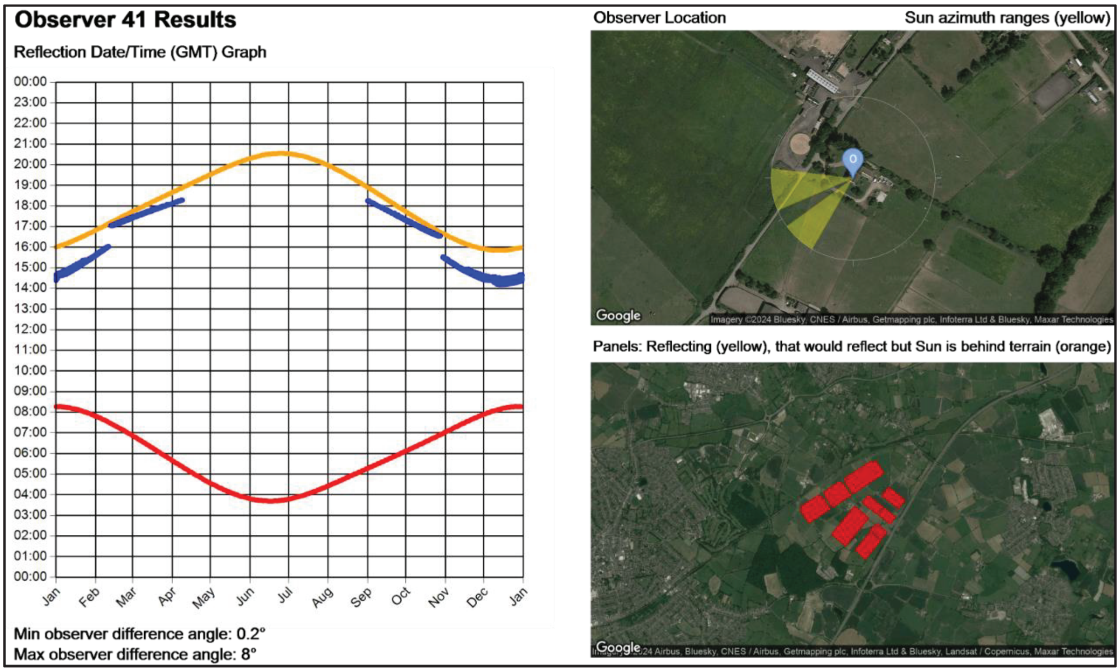
Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.6°
Max observer difference angle: 3.6°

Observer Location

Sun azimuth range is 50.9° - 71.1° (yellow)

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



**Observer 41 Results**

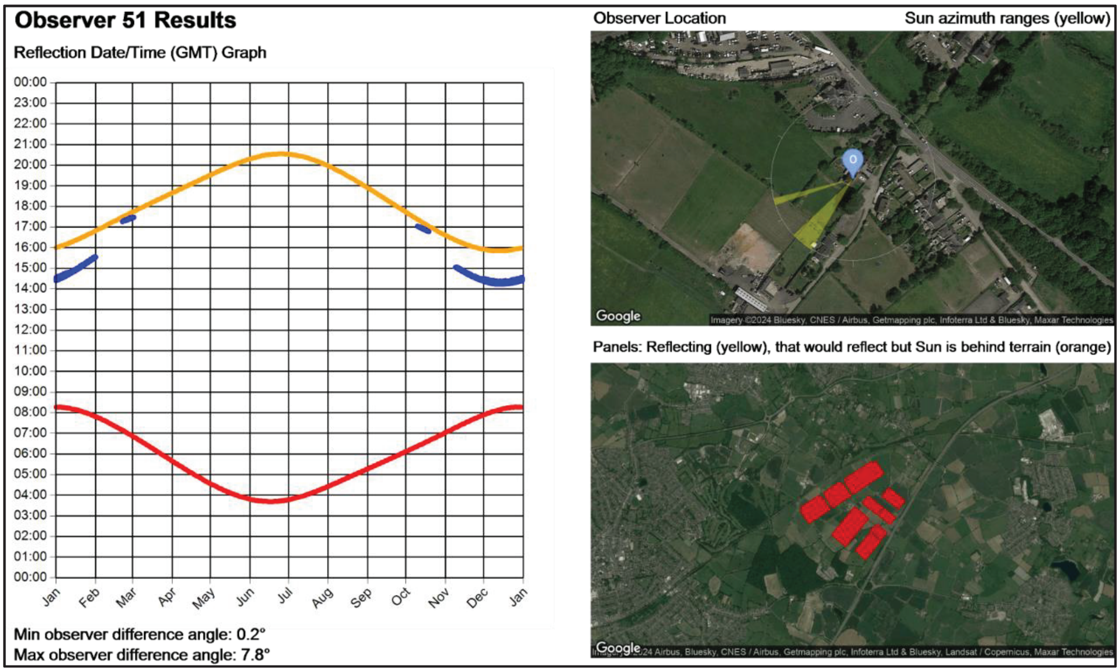
Reflection Date/Time (GMT) Graph

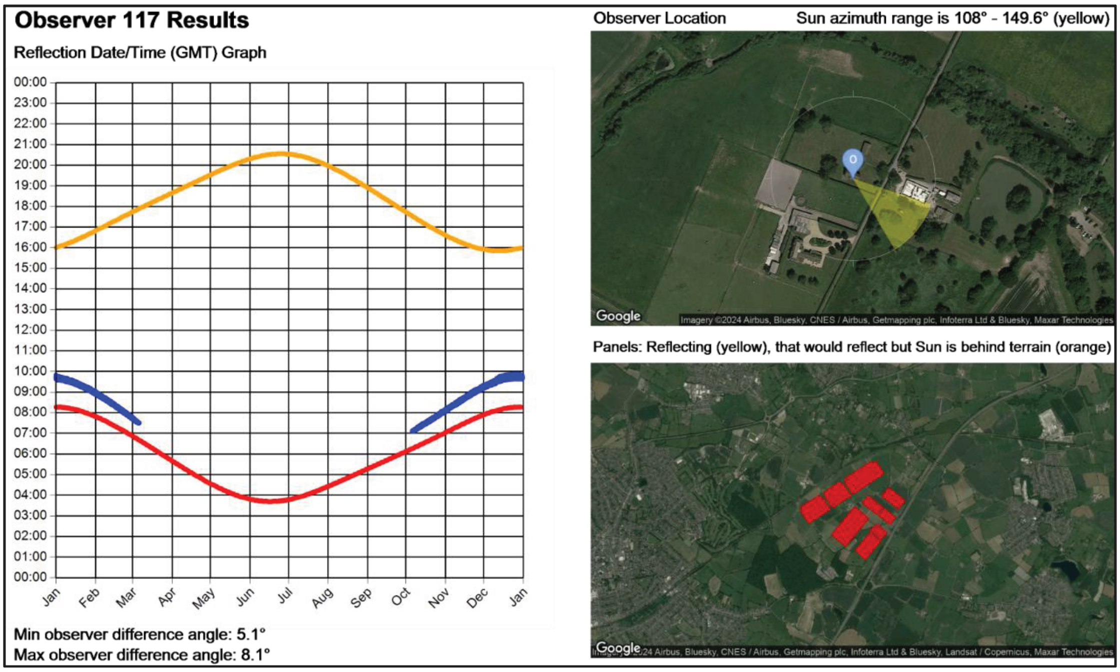
Min observer difference angle: 0.2°
Max observer difference angle: 8°

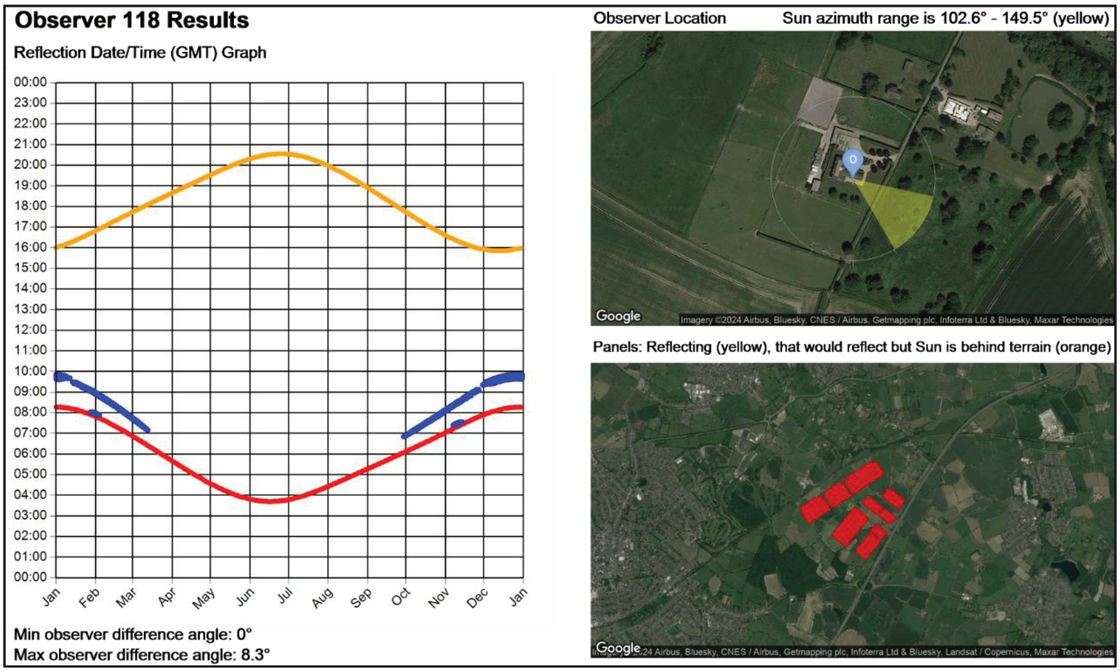
Observer Location

Sun azimuth ranges (yellow)

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


Observer 51 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: 0.2°
Max observer difference angle: 7.8°
Observer Location
Sun azimuth ranges (yellow)
Google
Imagery ©2024 Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat / Copernicus, Maxar Technologies


Observer 117 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: 5.1°
Max observer difference angle: 8.1°
Observer Location
Sun azimuth range is 108° - 149.6° (yellow)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat / Copernicus, Maxar Technologies


Observer 118 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°
Max observer difference angle: 8.3°
Observer Location
Sun azimuth range is 102.6° - 149.5° (yellow)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Maxar Technologies
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google
Imagery ©2024 Airbus, Bluesky, CNES / Airbus, Getmapping plc, Infoterra Ltd & Bluesky, Landsat / Copernicus, Maxar Technologies

PAGERPOWER
Urban & Renewables

**Pager Power Limited**
Stour Valley Business Centre
Sudbury
Suffolk
CO10 7GB

[redacted]