SUNNICA ENERGY FARM

EN010106

Volume 6

Environmental Statement

6.2 Appendix 16C: Glint and Glare Assessment

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

18 November 2021
Version number: 00

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Sunnica Energy Farm

Environmental Statement
Appendix 16A: Glint and Glare Assessment

Regulation Reference:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	EN010106
Application Document Reference	EN010106/APP/6.2
Author	Pager Power

Version	**Date**	**Status of Version**
Rev 00	18 November 2021	Application Version

PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

AECOM

Sunnica Energy Farm

3rd November 2021

PLANNING SOLUTIONS FOR:

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

www.pagerpower.com

PAGERPOWER
Urban & Renewables

ADMINISTRATION PAGE

Job Reference:	9564G
Author:	[redacted]
Telephone:	
Email:	

Reviewed By:	[redacted]
Email:	

Issue	Date	Detail of Changes
1	31st December 2019	Initial issue (9564A)
2	10th July 2020	Consideration of proposed planting around and the addition of new layout (no modelling)
3	26th August 2020	Updated analysis of bridleways and two additional dwelling locations along with administrative revisions
4	7th September 2020	Further administrative revisions and addition of baseline condition impacts (9654C)
5	13th April 2021	Assessment of permissive paths and administrative revisions
6	10th June 2021	Administrative revisions (9564D)
7	20th October 2021	Further revisions (9564G)
8	3rd November 2021	Further revisions

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

T:+44 (0)1787 319001 E:info@pagerpower.com W: [redacted]

EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development known as Sunnica Energy Farm, located on the border of Cambridgeshire and Suffolk in the UK.

The assessment relates to the possible impact upon surrounding road users, railway operations and infrastructure, dwellings, public right of ways, as well as aviation activity associated with RAF Mildenhall, RAF Lakenheath, and Cambridge Airport.

Layout Update

The modelling presented within this report is based on a previous larger layout, with the current Order limits being wholly within the Order limits previously modelled. The panel type and orientations have remained the same.

The overall results therefore remain valid because any impacts will be less than or equal to the modelled scenario, which represents a conservative approach to assessment.

Overall Conclusions

No impacts are possible for RAF Mildenhall as no solar reflections are predicted towards any of the scoped and assessed aviation receptors. No detailed modelling is recommended for RAF Lakenheath or Cambridge Airport as no significant impacts are anticipated at their respective distances and locations. This is based on past assessment experience.

Prior to the establishment of mitigation measures, screening in the form of solid hoarding along the Order limit is required for a small section of the A14. The recommended screening location, which will sufficiently mitigate the significant impacts before the proposed vegetation screening has established, is presented in Section 8.7. A moderate impact is also predicted for three dwellings under baseline conditions, which will remain until the mitigation measures have established and the reflecting panels are obstructed from view.

Once the proposed vegetation screening contained in the Outline Landscape and Ecological Management Plan (OLEMP) has established and the solid hoarding screening can be removed, no significant impacts are predicted towards any of the assessed ground-based receptors, and no further mitigation requirement has been identified.

The assessment results are presented in the following sections.

Assessment Results – Aviation

Solar reflections are not geometrically possible towards the ATC Tower or approach paths for Runway 11/29 at RAF Mildenhall due to the relative location of the Sun path, reflectors, and receptors across the year. No impacts are therefore possible, and no further mitigation is required.

No detailed assessment is recommended for RAF Lakenheath or Cambridge Airport due to the distance from the development and orientation of the runways. It can be safely determined that, based on the assessment criteria, if solar reflections are possible, intensities would have a 'low potential for temporary after image' and would therefore be acceptably low in accordance with industry best practice.

Assessment Results – Railway

Solar reflections are geometrically possible towards 89 out of the 103 assessed train driver receptors along the assessed section of railway line.

Prior to the establishment of mitigation measures, effects are predicted along approximately 200 metres of railway line; however, significant impacts are not predicted because a train driver is expected to have a lower workload than normal, the glare is not predicted to cause disability considering the glare scenario, the train driver will be within the reflection zone momentarily, and the reflections will coincide with direct sunlight, which is a far more intense source of light.

Following the implementation and establishment of the mitigation measures, no impacts are predicted because the proposed screening adjacent to the railway and the proposed screening adjacent to the A14 will significantly obstruct views of the reflecting panels from view.

Assessment Results – Roads

Solar reflections are geometrically possible towards 189 out of the 257 assessed road receptors along the A11, A14, A142, A1304, B1085, and B1102.

Prior to the establishment of mitigation measures, solar reflections are predicted to be experienced along sections of the B1085, A11, and A1304; however, significant impacts are not predicted due to a number of mitigating factors including the classification of the road, the location of the solar reflection relative to the road user's main field of view, and the existing sunlight effects. Following the implementation and establishment of the mitigation measures, some views of the reflecting panels may remain when the proposed screening is not in leaf and therefore this conclusion remains.

Significant impacts are predicted prior to the establishment of mitigation measures towards a small section of the A14 due to the national classification of the road and the solar reflections originating from inside the road user's main field of view. Mitigation in the form of solid hoarding is therefore required along the Order limit until the mitigation measures have obstructed the reflecting panels from view. Following the implementation and establishment of the mitigation measures, no impacts are predicted because the proposed screening will significantly obstruct views of the reflecting panels from view.

Assessment Results – Dwellings

Solar reflections are geometrically possible for 116 out of the 222 assessed dwelling receptors.

Views of the reflecting panels are considered possible for a minority of observers located in the surrounding dwellings prior to the establishment of mitigation measures. At three of these dwellings, a moderate impact is predicted, which will remain until the mitigation measures have established and the reflecting panels are obstructed from view.

Following the implementation and establishment of the mitigation measures, no significant impacts are predicted, and no further mitigation is required. This is because existing vegetation, proposed vegetation, and/or other surrounding dwellings will reduce the duration of effects to less than 3 months per year and 60 minutes per day, or the dwellings are located over 1km from the reflecting panels and so any reflections are not considered significant in accordance with the 1km study area considered appropriate for ground-based receptors (see Section 5.1).

Assessment Results – PRoW, Bridleways, and Permissive Paths

Solar reflections are geometrically possible towards most of the assessed Public Right of Way (PRoW), bridleway, and permissive path receptors.

Screening in the form of existing and proposed vegetation will significantly obstruct the visibility of the reflecting panels for most observers; however, effects at some locations are predicted prior to and following the implementation and establishment of the mitigation measures.

Solar reflections experienced by an observer along the PRoW, bridleway, or permissive path are not deemed to have a significant impact upon the amenity of an observer along a due to the reflections having no associated safety hazard, the intensity of a reflection to common outdoor sources of glare that are frequently visible to observers, and the existing sunlight effects. No significant impacts are therefore predicted upon pedestrians or riders, and no further mitigation is required.

Assessment Results – Horse Facilities

Solar reflections are geometrically possible towards the Snailwell Gallops and British Racing School. Screening in the form of existing vegetation will however obstruct views of the reflecting panels for horse and riders at both horse facilities, which will be further bolstered by the proposed vegetation. No impacts are predicted, and no further mitigation is required.

LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABOUT PAGER POWER

Company Overview

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

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:

a. Renewable energy projects.
b. Building developments.
c. 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 Experience

Pager Power has undertaken over 700 glint and glare assessments in the UK, Europe and internationally. The company's own glint and glare guidance[1] is based on industry experience and extensive consultation with industry stakeholders including airports and aviation regulators.

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

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development known as Sunnica Energy Farm, located on the border of Cambridgeshire and Suffolk in the UK.

The assessment relates to the possible impact upon surrounding road users, railway operations, dwellings, Public Rights of Way (PRoW), and aviation activity associated with RAF Mildenhall, RAF Lakenheath, and Cambridge Airport.

This report contains the following:

a. Solar development details.

b. Explanation of glint and glare.

c. Overview of relevant guidance.

d. Overview of relevant studies.

e. Overview of sun movement.

f. Assessment methodology.

g. Identification of receptors.

h. Glint and glare assessment for identified receptors.

i. Results discussion.

1.2 Glint and Glare Definition

The definition of glint and glare can vary however, the definition used by Pager Power is as follows[2]:

a. Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors.

b. 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.

---

[2] These definitions are aligned with those of the Federal Aviation Administration (FAA) in the United States of America.

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Layout Update

The modelling presented within this report is based on a previous larger layout with the current Order limits being wholly within the Order limits previously modelled. The overall results therefore remain valid because any impacts will be less than or equal to the modelled scenario, which represents a precautionary approach to assessment.

2.2 Solar Panel Areas

Sunnica Energy Farm is split into four separate sites with the following names:

a. Sunnica East Site A;
b. Sunnica East Site B;
c. Sunnica West Site A;
d. Sunnica West Site B.

Figure 1 on the following page shows an aerial image of the previous layout that was used in the modelling[3,4]. Solar panels areas A, B, and C are part of Sunnica East Site A; solar panel areas D and E are part of Sunnica East Site B; solar panel areas F, G, and H are part of Sunnica West Site A; and solar panel area I is part of Sunnica West Site B.

The current layout differs from the assessed layout by the following:

a. Solar panel areas A and F have been removed completely;
b. Solar panel areas D, G, H, and I have been reduced.

The proposed development site plans, showing the current solar panel layout, are presented in Figures 3-1 and 3-2 in the Environmental Statement (ES). The aerial imagery in the remainder of the report also shows the current solar panel layout.

The bounding coordinates have been extrapolated from the previous layout (shown in Figure 1) and are presented in Appendix I.

[3] Copyright © 2021 Google.

[4] Neighbouring solar panel areas were combined where appropriate and so the area assessed is likely slightly greater than the panel area in reality. This is considered a conservative approach.

Figure 1 *Assessed solar panel areas*

2.3 Solar Panel Details

All solar panel areas share the same characteristics and are shown in Table 1 below.

Panel Information	
Azimuth angle (º)	180
Elevation angle (º)	15 – 35
Assessed centre height (m)	1.55 agl

Table 1 *Panel information*

The middle of the solar panel[5] has been used as the assessed height in metres above ground level (agl), which has been chosen as it represents the smallest possible variation in height from the bottom and top of the solar panels. The small variation in panel height for panels within the flood areas[6] will not change the conclusions of the report because the modelling results are unlikely to be meaningfully affected, and the panels will be just as obscured from view due to the maximum height not increasing.

The elevation angle of the solar panels will be between 15 and 35 degrees. The middle elevation angle of 25 degrees has therefore been assessed as this represents the smallest possible variation from the minimum and maximum angles and therefore the smallest possible difference in modelling results. Any changes in panel angle within this range is predicted to slightly change the time in the day in which reflections occur and is not predicted to change duration of effects or the intensity of any reflections.

It can be concluded, based on the above and previous assessment experience, that changing the assessed height and/or elevation angle within the defined ranges will not significantly change the results and conclusions of the report. This is particularly true as most of the receptors will be significantly screened in practice (see Section 8).

2.3.1 Bifacial Panels

Whilst the potential for effects remains the same due to both faces consisting of a reflective surface, it is deemed very unlikely that significant glare effects from the underside of the solar panels are possible towards the surrounding receptors. This is because this face will almost always be facing away from the Sun and the underside of the panel will be angled downward towards the ground. Considering the path of the Sun throughout a typical day in the UK, any reflections will only ever go towards the floor. The possibility of glare effects for the optimised face (the face orientated towards the Sun) remains the same.

The effects of bifacial panels have not been considered further within this assessment.

2.3.2 Additional Reflective Surfaces

Additional infrastructure associated with the proposed development, such as the solar panel frames and supports, are reflective surfaces that could cause solar reflections. However, solar reflections from these surfaces have not been considered within the assessment as they represent a much smaller surface area than the solar panels and they are not flat surfaces where specular reflections are likely to occur. This means they will not significantly add to the identified effects.

[5] Min height = 0.6m, max height = 2.5m.

[6] Min height = 0.85m, max height = 2.5m.

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guidance and Studies

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

a. Specular (mirroring) reflections of the Sun from solar panels are possible;
b. The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence;
c. 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[7].

3.2 Background

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

3.3 Pager Power's Methodology

As there is no standard methodology for assessing glint and glare, Pager Power has developed its own methodology following a peer review of relevant literature, feedback received from key technical stakeholders, and through experience of completing over 700 glint and glare assessments. Using this knowledge and experience, Pager Power has produced its own glint and glare guidance document[8], which has been provided in the appendices of the PEIR.

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

a. Identify receptors in the area surrounding the solar development.
b. Consider direct solar reflections from the solar development towards the identified receptors by undertaking geometric calculations.
c. Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor then no reflection can occur.
d. Based on the results of the geometric calculations and visibility of the panels, determine whether a reflection can occur, and if so, at what time it will occur.

---

[7] 'Technical Guidance for Evaluating Selected Solar Technologies on Airports', 'SunPower Technical Notification' (excerpts presented in Appendix B).
[8] Pager Power Glint and Glare Guidance, Third Edition (3.1), April 2021.

e. Consider both the solar reflection from the solar development and the location of the direct sunlight with respect to the receptor's position.

f. Consider the solar reflection with respect to the published studies and guidance – including intensity calculations where appropriate.

g. Determine whether a significant detrimental impact is expected in line with the process presented in Appendix D.

Within the Pager Power model, the solar development area is defined, as well as the relevant receptor locations. The result is a chart that states whether a reflection can occur, the duration and the panels that can produce the solar reflection towards the receptor.

3.4 Assessment Methodology and Limitations

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

4 AVIATION RECEPTORS

4.1 Aviation Receptors – Overview

The closest aerodrome to the proposed development is RAF Mildenhall. It is located approximately 2.5km northeast of the nearest solar panel and is operated by the Ministry of Defence (MOD). The following section presents the relevant aviation receptors assessed within this report.

4.2 Air Traffic Control Tower

It is important to determine whether a solar reflection can be experienced by personnel within the ATC Tower. The tower co-ordinates have been extrapolated from aerial imagery. The ground elevation has been taken from OSGB36 terrain data and the and ATC Tower height above ground level has been estimated based on available imagery and online resources[9].

Figure 2[10] below shows an aerial image of the ATC Tower location relative to the proposed development.

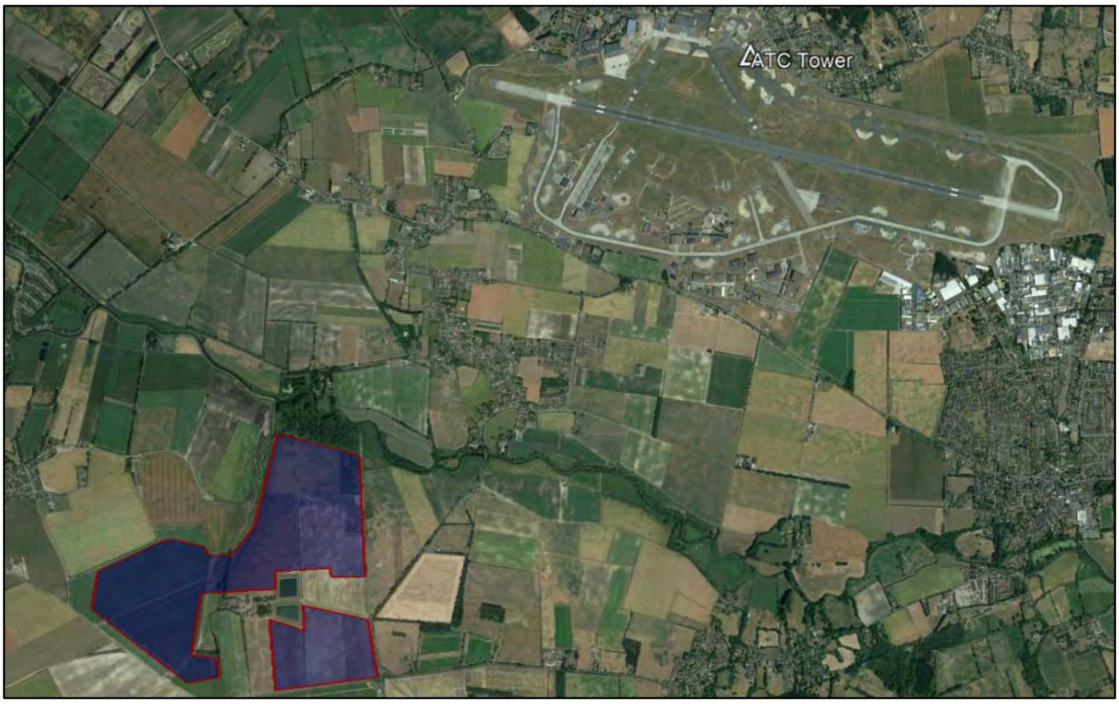


Figure 2 *ATC Tower location – aerial image*

[9] A small variation in height will not change the results of the assessment due to the relative location of the ATC Tower to the proposed development.

[10] Source: Copyright © 2021 Google.

4.3 Approaching Aircraft

It is part of Pager Power's practice and methodology to assess whether a solar reflection can be experienced on the approach paths for the associated approaches. RAF Mildenhall has one operational runway with two approach paths (one from either bearing). The runway designations are as follows:

a. Runway 11/29 – Asphalt/concrete.

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

4.4 Qualitative Aviation Assessment

There is no formal study area within which aviation effects must be modelled. However, in practice, concerns are most often raised for developments within 10 km of a licensed airport. Requests for modelling at ranges of 10-20 km are far less common. Assessment of aviation effects for developments over 20 km from a licensed airfield is a very unusual requirement.

The following aerodromes are located within 10-20 km of the development:

a. RAF Lakenheath is located approximately 10 km northeast of the closest solar panel area in the development;
b. Cambridge Airport is located approximately 19 km southwest of the development.

The location of the aerodromes relative to the proposed development is shown in Figure 3 on the following page[11].

[11] Copyright © 2021 Google.

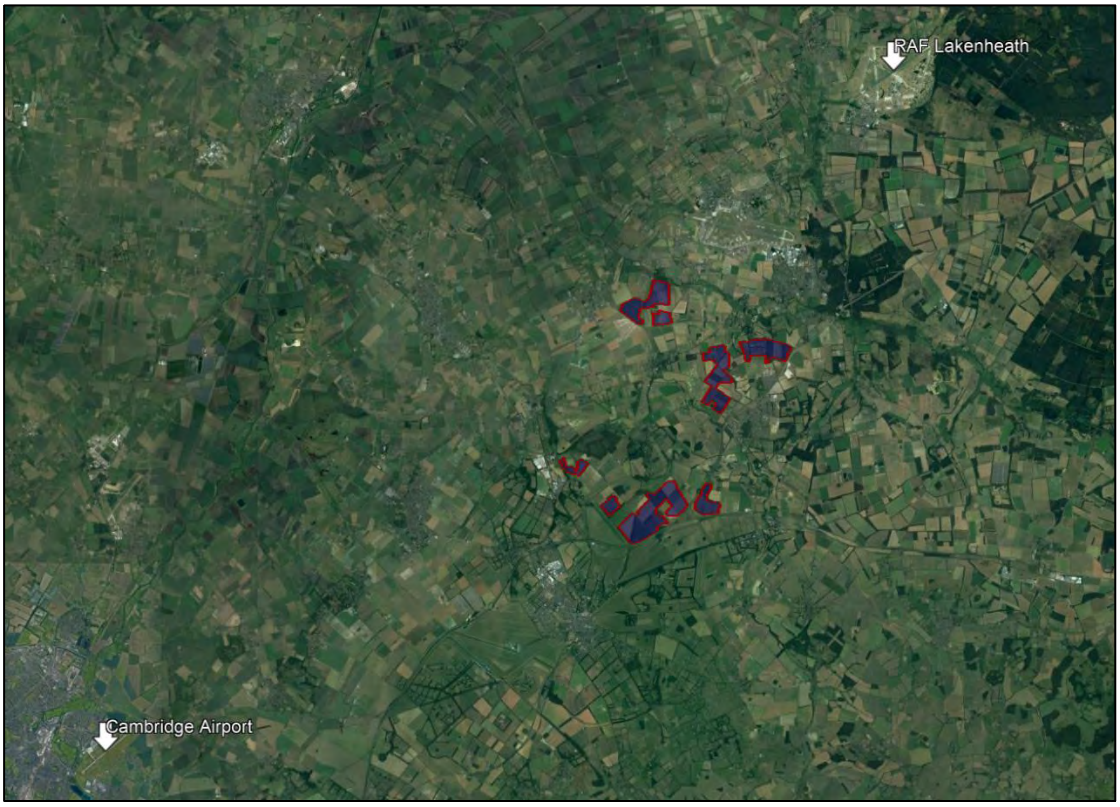


Figure 3 *RAF Lakenheath and Cambridge Airport locations*

4.4.1 Qualitative Aviation Conclusions

For RAF Lakenheath, the runway is oriented southwest/northeast. This means pilots approaching from the southwest will not be looking towards the panels and cannot be affected. Pilots approaching from the northeast could be facing the general development direction however:

a. Reflections towards the north are unlikely to be visible to an approaching pilot at this range for the south-facing panels that have been proposed;

b. Effects would be the same or less significant than the modelled receptors for RAF Mildenhall due to being on similar bearings and at a much further distance from the proposed development.

For Cambridge Airport, the distance from the airport is significant and the runway is also orientated southwest/northeast. This means pilots approaching from northeast will not be looking towards the panels and cannot be affected. It can be safely presumed that if effects are possible towards pilots approaching from southwest, the intensity would have 'low potential for temporary after-image' in the worst case and will therefore be acceptably low in accordance with the associated guidance.

Overall, no significant impacts on aviation interests are expected and no further detailed assessment is deemed necessary.

5 GROUND-BASED RECEPTORS

5.1 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. However, the significance of a reflection decreases with distance. This is 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.

Pager Power considers receptors within a 1km study area appropriate for glint and glare effects on ground-based receptors based upon previous assessments and experience. Receptors within this distance are identified and an initial professional judgement of potential visibility 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 reflections would be possible. A more detailed assessment is undertaken if the modelling reveals a reflection would be geometrically possible.

Reflections towards ground-based receptors to the north of the panels are unlikely at this latitude for fixed panels facing south and have therefore been scoped out.

5.2 Railway Receptors

5.2.1 Signal Receptors

No signals have been identified along the assessed section of railway.

5.2.2 Train Driver Receptors

The impact of a solar reflection upon train drivers is determined by identifying locations along sections of railway that could potentially receive reflections. The analysis has considered sections of railway that:

a. Are within 1km of the proposed development (see Section 5.1); and

b. Have a potential view of the panels.

A total of 103 receptor locations covering approximately 9.7km of railway line have been assessed, approximately every 100m. The location of the assessed train driver receptors (shown as white squares) on the assessed length of railway line is shown in Figure 4 on the following page[12]. The co-ordinate data for the receptor points are presented in Appendix H.

---

[12] Copyright © 2021 Google.

Figure 4 *Assessed railway receptors*

5.3 Road Receptors

Road types have been categorised as:

a. 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;

b. National – Typically a road with a one or more carriageways with a maximum speed limit of up to 60mph or 70mph. These roads typically have fast moving vehicles with moderate to busy traffic density;

c. 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; and

d. Local – Typically roads and lanes with the lowest traffic densities. Speed limits vary.

Assessment is not recommended for local roads, where traffic volumes and/or speeds are likely to be relatively low, as any solar reflections from the proposed development that are experienced by a road user would be considered low impact in accordance with the guidance presented in Appendix D.

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

a. Are within 1km of the proposed development (see Section 5.1); and

b. Have a potential view of the panels.

The assessed road receptor points are shown in Figure 5[13] on the following page. A height of 1.5m above ground level has been taken as typical eye level for a road user. The co-ordinate data for the receptor points are presented in Appendix H.

[13] Copyright © 2021 Google.

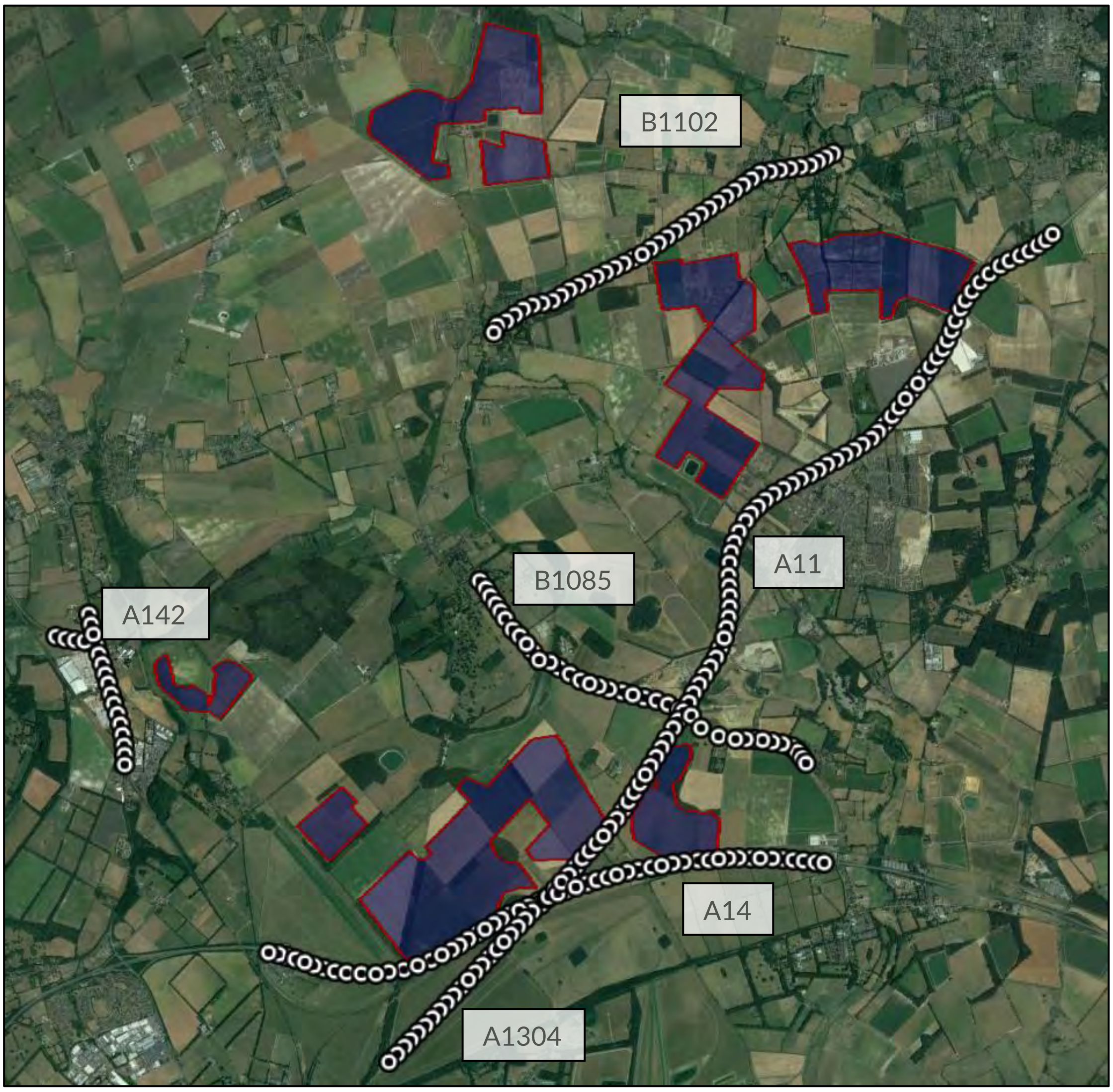


Figure 5 *Assessed road receptors*

5.4 Public Right of Way and Bridleway Receptors

The analysis has considered public right of ways and bridleways that:

a. Are within 1km of the proposed development (see Section 5.1); and
b. Have a potential view of the panels.

A height of 1.8m above ground level has been taken as the typical eye level for a pedestrian on the public right of way and a height of 3.5m above ground level has been taken as the typical eye level for a rider and horse on the bridleways. Terrain elevation heights have been interpolated based on OSGB36 data. The co-ordinates data for the receptor points are presented in Appendix H.

The assessed public right of way (white diamond) and bridleway (yellow diamond) receptor points are shown in Figure 6 below[14,15].

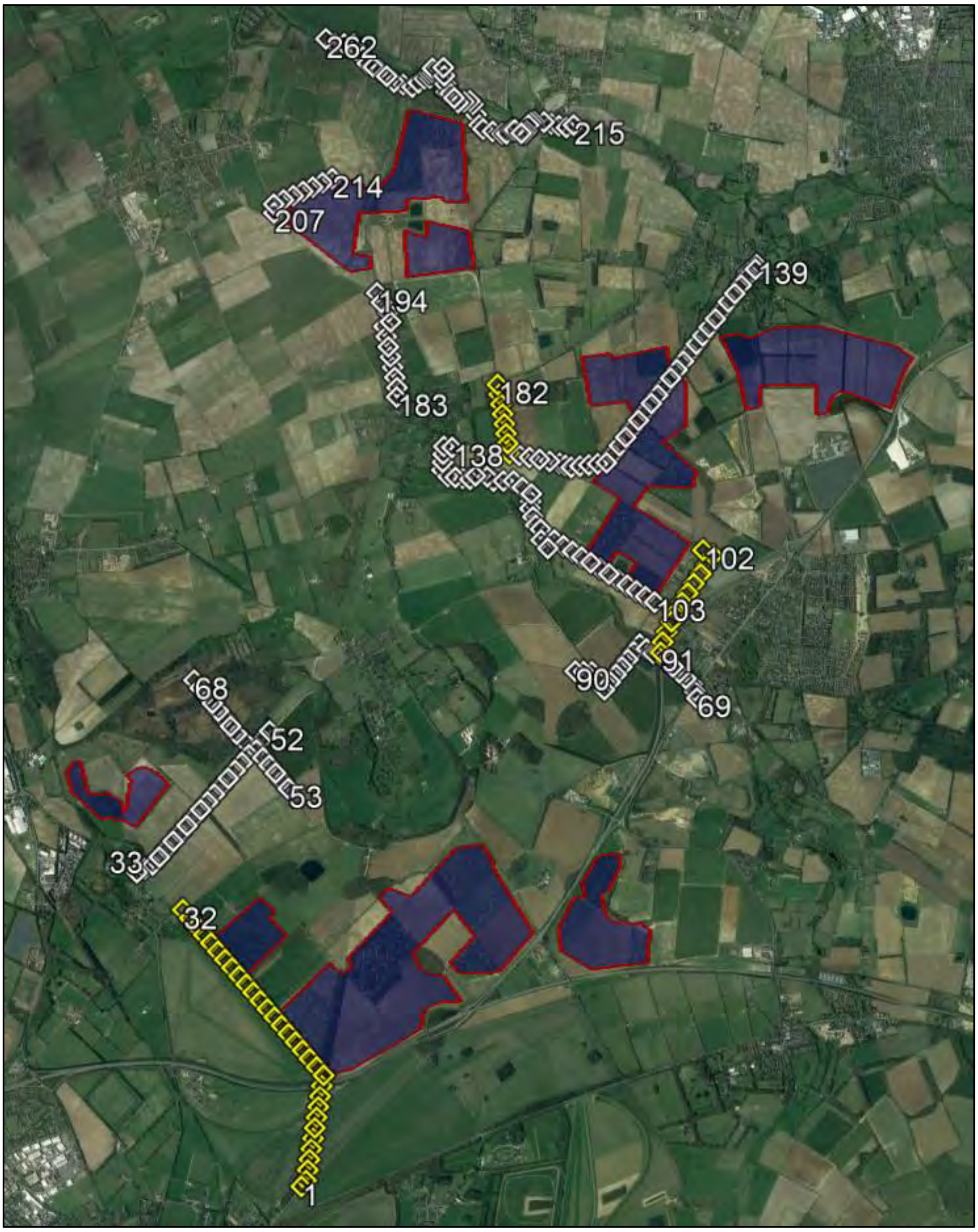


Figure 6 *Assessed public right of way and bridleway receptors*

[14] Copyright © 2021 Google.

[15] Receptors 195 to 206 have been removed as this will become a permissive path.

5.5 Permissive Path Receptors

Four permissive paths have been proposed in the area surrounding the proposed development, specifically along the Order limits of Sunnica East. The permissive path locations are shown as the pink lines in Figure 7[16] below.

A height of 1.8m above ground level has been taken as the typical eye level for a pedestrian on a permissive path. The co-ordinates data for the receptor points are presented in Appendix H.

Figure 7 *Assessed permissive path receptors*

[16] Copyright © 2021 Google.

5.6 Dwelling Receptors

The analysis has considered dwellings that:

a. Are within 1km of the proposed development (see Section 5.1); and
b. Have a potential view of the panels.

In residential areas with many layers of dwellings, only the outer dwellings were considered. This is because the outer layer will mostly block views of the solar panels to dwellings further back and therefore will not be impacted by the solar farm. Any effects upon dwellings with a through view will have similar or less impacts than the closest assessed dwelling.

A height above ground level of 1.8m above ground level has been taken as an average eye level for an observer on the ground floor of a dwelling. Terrain elevation heights have been interpolated based on OSGB36 data. The coordinate data for the receptor points are presented in Appendix H.

An aerial image of the dwelling locations is shown in Figure 8[17] on the following page.

[17] Copyright © 2021 Google.

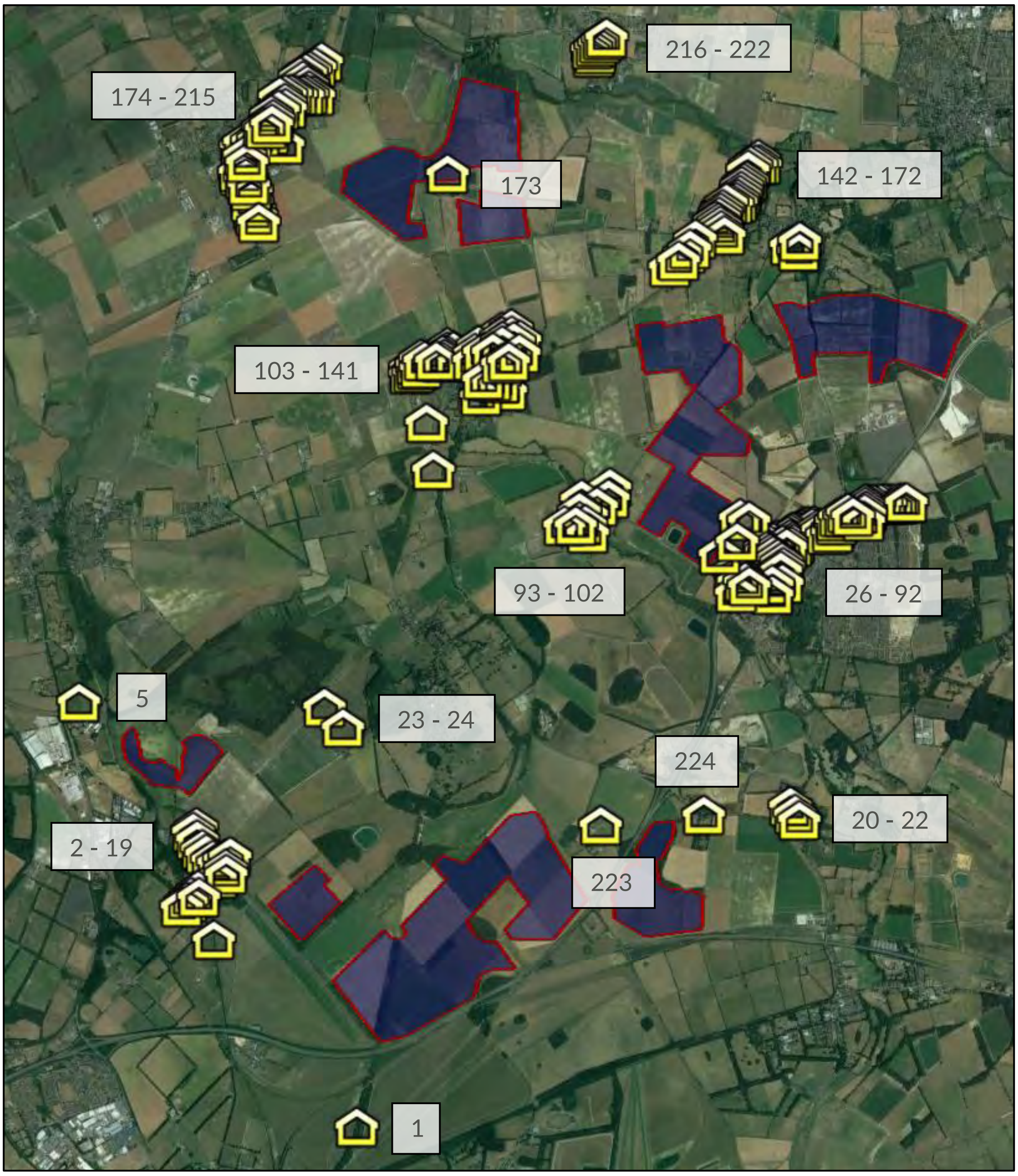


Figure 8 *Assessed dwelling receptors*

5.7 Horse Facility Receptors

The analysis has also included a number of other key receptors relating to horse facilities in the area to determine the impact upon equestrian activity in the area. Sample receptor points were therefore taken at each identified facility.

A height above ground level of 3.5m above ground level has been taken as an average eye level for a horse and rider. Terrain elevation heights have been interpolated based on OSGB36 data. The coordinate data for the receptor points are presented in Appendix H.

The assessed horse facility receptor points are shown in Figure 9[18] below.

Figure 9 *Assessed horse facility receptors*

[18] Copyright © 2021 Google.

6 ASSESSED REFLECTOR AREAS

6.1 Layout Update

The modelling layout presented in this section is based on a previous larger layout, with the current Order limits being wholly within the Order limits previously modelled. The panel type and orientations have remained the same. The overall results therefore remain valid because any impacts will be less than or equal to the modelled scenario, which represents a conservative approach to assessment.

6.2 Reflector Areas

A number of representative panel locations are selected within the proposed reflector areas with the number of modelled reflector points being determined by the size of the reflector area and the assessment resolution. The bounding co-ordinates for the proposed solar development have been extrapolated from the site plans. All ground heights have been based on OSGB36 terrain data.

A resolution of 40m has been chosen for this assessment. This means that a geometric calculation is undertaken for each identified reflector every 40m from within the defined area. This resolution is sufficiently high to maximise the accuracy of the results – increasing the resolution further would not significantly change the modelling output because 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.

The assessed reflector areas are shown in Figure 10 below.

Figure 10 *Assessed reflector areas*

7 GLINT AND GLARE ASSESSMENT – TECHNICAL RESULTS

7.1 Overview

The following section presents an overview of the glare for the identified receptors.

The Pager Power model has been used initially for all receptors. Where solar reflections have been predicted for the aviation receptors, intensity calculations in line with Sandia National Laboratories' methodology have been undertaken by a third-party model[19]. This model calculates the expected intensity of a reflection with respect to the potential for an after-image (or worse) occurring.

The designation used by the model is presented in Table 2 below along with the associated colour coding.

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

Table 2 *Glare intensity designation*

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

In addition, the intensity model allows for assessment of a variety of solar panel surface materials. In the first instance, a surface material of 'smooth glass with an anti-reflective coating' has been assessed.

[19] Forge Solar

7.2 Summary of Results

The tables in the following sections summarise the results of the assessment prior to and following the implementation and establishment of all mitigation measures. Further discussion concerning the significance of any predicted impact is provided in subsequent report sections.

The modelling output for key receptors showing the precise predicted times and the reflecting panel area can be found in Appendix J.

7.3 Geometric Calculation Results Overview – ATC Tower

Receptor	Pager Power Results: Reflection Possible Towards Receptor?		Glare Type	Comment
	am	pm		
ATC Tower	No.	No.	n/a	No solar reflections geometrically possible. No impacts possible.

Table 3 *Geometric analysis results – ATC Tower*

7.4 Geometric Calculation Results Overview – Runway 11 Approach

Receptor	Pager Power Results: Reflection Possible Towards Receptor?		Glare Type	Comment
	am	pm		
Threshold – 2 miles	No.	No.	n/a	No solar reflections geometrically possible. No impacts possible.

Table 4 *Geometric analysis results – Runway 11 Approach*

7.5 Geometric Calculation Results Overview – Runway 29 Approach

Receptor	Pager Power Results		Glare Type	Comment
	Reflection Possible Towards Receptor?			
	am	pm		
Threshold – 2 miles	No.	No.	n/a	No solar reflections geometrically possible. No impacts possible.

Table 5 *Geometric analysis results – Runway 29 Approach*

7.6 Geometric Calculation Results Overview – Train Driver Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
1 – 3	No.	No.	No solar reflections geometrically possible. No impacts possible.
4 - 46	Yes.	No.	Predicted solar reflections will be significantly screened by existing buildings and existing vegetation. No impacts predicted.
47 - 60	No.	No.	No solar reflections geometrically possible. No impacts possible.
61 – 103	No.	Yes.	Predicted solar reflections will be almost entirely screened by existing vegetation. Partial views of the reflecting panels possible for a small section of track. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Proposed vegetation will significantly obstruct the remaining views of the reflecting panels. No impacts predicted following the implementation and establishment of mitigation measures.

Table 6 *Geometric analysis results – Train driver receptors*

7.7 Geometric Calculation Results Overview – Road Receptors

7.7.1 A14 Receptors

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Reflection Possible Towards Receptor?</th><th rowspan="2">Comments</th></tr>
<tr><th>am</th><th>pm</th></tr>
<tr><td>1 – 12</td><td>No.</td><td>Yes.</td><td>Predicted solar reflections will be significantly screened by existing vegetation.
No impacts predicted.</td></tr>
<tr><td>13</td><td>No.</td><td>No.</td><td>No solar reflections geometrically possible.
No impacts possible.</td></tr>
<tr><td>14 - 18</td><td>No.</td><td>Yes.</td><td>Predicted solar reflections will be significantly screened by temporary mitigation for the period of time required for the proposed vegetation to become established.
Following the implementation and establishment of mitigation measures, predicted solar reflections will be significantly screened by proposed vegetation.
No impacts predicted.</td></tr>
<tr><td>19 – 35</td><td>Yes.</td><td>Yes.</td><td rowspan="2">Predicted solar reflections will be partially screened by existing vegetation. Views of the reflecting panels possible for a few sections of road.
No significant impacts predicted prior to the implementation and establishment of mitigation measures.
Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels along two small sections of road possible when vegetation not in leaf.
No significant impacts predicted following the implementation and establishment of mitigation measures.</td></tr>
<tr><td>36 – 54</td><td>No.</td><td>Yes.</td></tr>
</table>

Table 7 *Geometric analysis results – A14*

7.7.2 A142 Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
55 – 66	Yes.	No.	Predicted solar reflections will be screened by existing buildings and/or existing vegetation. No impacts predicted.
67 – 75	No.	No.	No solar reflections geometrically possible. No impacts possible.

Table 8 *Geometric analysis results – A142*

7.7.3 B1085 Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
76 – 99	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
100 – 112	No.	No.	No solar reflections geometrically possible. No impact possible.

Table 9 *Geometric analysis results – B1085*

7.7.4 A11 Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
113 – 153	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
154 – 169	No.	No.	No solar reflections geometrically possible. No impact possible.

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
170 – 176	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
177 – 190	Yes.	Yes.	
191 – 196	Yes.	Yes.	Predicted solar reflections will be almost entirely screened by existing vegetation. Partial views of the reflecting panels possible for a small section of road. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible for a section of road when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.

Table 10 *Geometric analysis results – A11*

7.7.5 A1304 Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
197 – 206	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
207 – 217	No.	No.	No solar reflections geometrically possible. No impact possible.

Table 11 *Geometric analysis results – A1304*

7.7.6 B1102 Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
218 – 234	No.	No.	No solar reflections geometrically possible. No impact possible.
235 – 250	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
251 – 257	No.	No.	No solar reflections geometrically possible. No impact possible.

Table 12 *Geometric analysis results – B1102*

7.8 Geometric Calculation Results Overview – Public Right of Way and Bridleway Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
1 – 11	No.	No.	No solar reflections geometrically possible. No impacts possible.
12 – 29	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
30 – 32	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
33 – 39	No.	No.	No solar reflections geometrically possible. No impacts possible.
40 – 47	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
48 – 55	No.	No.	No solar reflections geometrically possible. No impacts possible.
56	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
57 – 95	No.	No.	No solar reflections geometrically possible. No impact possible.
96 – 102	No.	Yes.	Predicted solar reflections will be mostly screened by existing vegetation. Partial views of the reflecting panels possible for small sections of the bridleway. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
103 – 106	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf.

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
			No significant impacts predicted following the implementation and establishment of mitigation measures.
107 – 108	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted.
109 – 127	Yes.	No.	Predicted solar reflections will be partially screened by existing vegetation. Views of the reflecting panels possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
128 – 145	No.	No.	No solar reflections geometrically possible. No impacts possible.
146 = 147	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
148 – 149	Yes.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts possible.
150	Yes.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
151 – 158	Yes.	Yes.	Although predicted solar reflections in the morning will be significantly screened by existing vegetation, views of the reflecting panels are possible in the evening. No significant impacts predicted.

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
159	Yes.	No.	Views of the reflecting panels cannot be ruled out based on the available imagery. No significant impacts predicted.
160 – 164	Yes.	No.	Predicted solar reflections will be mostly screened by existing vegetation. Partial views of the reflecting panels possible. No significant impacts predicted.
165 – 174	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
175 – 179	Yes.	No.	Predicted solar reflections will be partially screened by existing vegetation. Views of the reflecting panels possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
180 – 182	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
183 – 194	No.	No.	No solar reflections geometrically possible. No impacts possible.

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
206 – 214	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
215 – 228	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
229 – 233	No.	Yes.	Predicted solar reflections will be partially screened by existing vegetation. Views of the reflecting panels possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
234 – 262	No.	No.	No solar reflections geometrically possible. No impacts possible.

Table 13 *Geometric analysis results – Public right of way and bridleway receptors*

7.9 Geometric Calculation Results Overview – Dwelling Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
1	No.	No.	No solar reflections geometrically possible. No impacts possible.
2 – 19	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
20 – 24	No.	Yes.	
25 – 33	No.	No.	No solar reflections geometrically possible. No impacts possible.
34 – 36	No.	Yes.	Predicted solar reflections will be partially screened by existing vegetation. Views of the reflecting panels possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
37 – 39	No.	No.	No solar reflections geometrically possible. No impacts possible.
40 – 92	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation and/or other dwellings, which will be further bolstered by proposed vegetation. No impacts predicted.
93 – 102	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation and/or surrounding buildings, which will be further bolstered by proposed vegetation. No impacts predicted.

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
103 – 115	No.	No.	No solar reflections geometrically possible. No impacts possible.
116 – 144	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation and/or other dwellings, which will be further bolstered by proposed vegetation. No impacts predicted.
145 – 148	No.	Yes.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
147 – 172	No.	No.	No solar reflections geometrically possible. No impacts possible.
173	Yes.	Yes.	Although predicted solar reflections in the morning will be significantly screened by existing vegetation, partial views of the reflecting panels are possible in the evening. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
174 – 182	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
183 – 184	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
185	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
186	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.
187 – 190	Yes.	No.	Predicted solar reflections will be partially screened by other dwellings and surrounding buildings. Views of the reflecting panels possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
191 – 194	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation. No impacts predicted.

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Reflection Possible Towards Receptor?</th><th rowspan="2">Comments</th></tr>
<tr><th>am</th><th>pm</th></tr>
<tr><td>195 – 199</td><td>Yes.</td><td>No.</td><td>Predicted solar reflections will originate from solar panels that are over 1km from the dwelling.
No significant impacts predicted.</td></tr>
<tr><td>200 – 207</td><td>Yes.</td><td>No.</td><td>Predicted solar reflections will be significantly screened by other dwellings and buildings.
No impacts predicted.</td></tr>
<tr><td>207</td><td>Yes.</td><td>No.</td><td>Predicted solar reflections will originate from solar panels that are over 1km from the dwelling.
No significant impacts predicted.</td></tr>
<tr><td>208 – 215</td><td>Yes.</td><td>No.</td><td>Predicted solar reflections will be significantly screened by existing vegetation.
No impacts predicted.</td></tr>
<tr><td>216 – 222</td><td>No.</td><td>No.</td><td>No solar reflection geometrically possible.
No impacts possible.</td></tr>
<tr><td>223</td><td>Yes.</td><td>Yes.</td><td rowspan="2">Predicted solar reflections will be significantly screened by existing vegetation, which will be further bolstered by proposed vegetation.
No impacts predicted.</td></tr>
<tr><td>224</td><td>No.</td><td>Yes</td></tr>
</table>

Table 14 *Geometric analysis results – Dwelling receptors*

7.10 Geometric Calculation Results Overview – Permissive Path Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
1 – 2	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.
3	No.	No.	No solar reflections geometrically possible. No impacts possible.
4	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
5	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted.
6 – 8	Yes.	No.	Views of the reflecting panels are possible. No significant impacts predicted prior to the implementation and establishment of mitigation measures. Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf. No significant impacts predicted following the implementation and establishment of mitigation measures.

Table 15 *Geometric analysis results – Permissive paths receptors*

7.11 Geometric Calculation Results Overview – Horse Facility Receptors

Receptor	Reflection Possible Towards Receptor?		Comments
	am	pm	
Snailwell Gallops	Yes.	No.	Predicted solar reflections will be significantly screened by existing vegetation. No impacts predicted.
British Racing School			
Limekins Gallops	No.	No.	No solar reflection geometrically possible. No impacts possible.
Godolphin Stables			
Bury Hill Gallops	No.	No.	No solar reflection geometrically possible. No impacts possible.
Long Hill Gallops			

Table 16 *Geometric analysis results – Horse facility receptors*

8 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

8.1 Overview

The results of the glint and glare assessment prior to the implementation and establishment of the mitigation measures have been presented in the following sub-sections where the impacts are predicted to differ from the results following the implementation and establishment of the mitigation measures and have potential to be significant.

8.2 Proposed Screening

The Applicant proposes planting to further reduce the views of the panels, which is presented in the Outline Landscape and Ecological Management Plan (OLEMP). It is understood that this planting should grow at 20 centimetres per year, based on typical growth rates in the UK. Year 1 proposed native hedgerows would be between 0.6 – 0.8m in height, with existing and proposed hedgerows being managed and maintained between 2 – 3m in height. Tree planting would be between 1 – 3.5m in height, with Year 15 tree planting ranging between 4 – 6.5m in height.

The proposed screening will be deciduous species and therefore provide the most screening in the summer months when the vegetation is in leaf, and the least screening during the winter months. It is possible that the deciduous vegetation will provide significant screening when not in leaf, especially if there are multiple layers of vegetation; however, it is assumed that the vegetation will not provide significant screening during the months of October to March inclusive to remain conservative. Increased evergreen species will be planted along a section of the A14 to provide sufficient screening all year round for road receptors 14 – 18.

Temporary mitigation measures are recommended where effects are predicted to cause a safety hazard and are not recommended where effects are predicted to cause an amenity issue. Any recommended temporary mitigation will be required for the period of time required for the proposed vegetation to become established.

8.3 ATC Tower

The analysis has shown that solar reflections towards the ATC Tower at RAF Mildenhall are not geometrically possible.

No significant impact upon the ATC Tower is therefore expected.

8.4 Runway 11/29 Approaches

The analysis has shown that solar reflections from the proposed solar development towards either of the RAF Mildenhall 2-mile approach paths for runway 11/29 are not geometrically possible.

No significant impact upon either approach path is therefore expected.

8.5 Railway Results

The modelling has shown that solar reflections are geometrically possible towards 89 out of the 103 assessed train driver receptors along the assessed section of railway. For train driver receptors, the key considerations to determine the impact significance are:

a. Whether a reflection is predicted to be experienced in practice.
b. The location of the reflecting panel relative to a train driver's direction of travel (a reflection directly in front of a driver is more hazardous than a reflection from a location off to one side).
c. The likely workload of the train driver (i.e. is the solar reflection towards a section of track where a signal, crossing, switching point, or station is sited).

8.5.1 Pre-Mitigation Results

Prior to the establishment of mitigation measures, effects are predicted to be experienced by train drivers travelling west/southwest along approximately 200m of railway line, shown as the yellow line in Figure 11[20] on the following page.

Although solar reflections will be experienced along this stretch, a train driver is not expected to have a greater workload than normal because no signals, train stations, crossings, or switching points have been located along the assessed section of railway line. Solar reflections will also coincide with direct sunlight, which is a far more intense source of light, and the intensity of the reflection is not predicted to cause significant disability considering the glare scenario and time the train driver will be within the reflection zone.

No significant impacts are predicted towards the train drivers, and no temporary mitigation is therefore required.

[20] Copyright © 2021 Google.

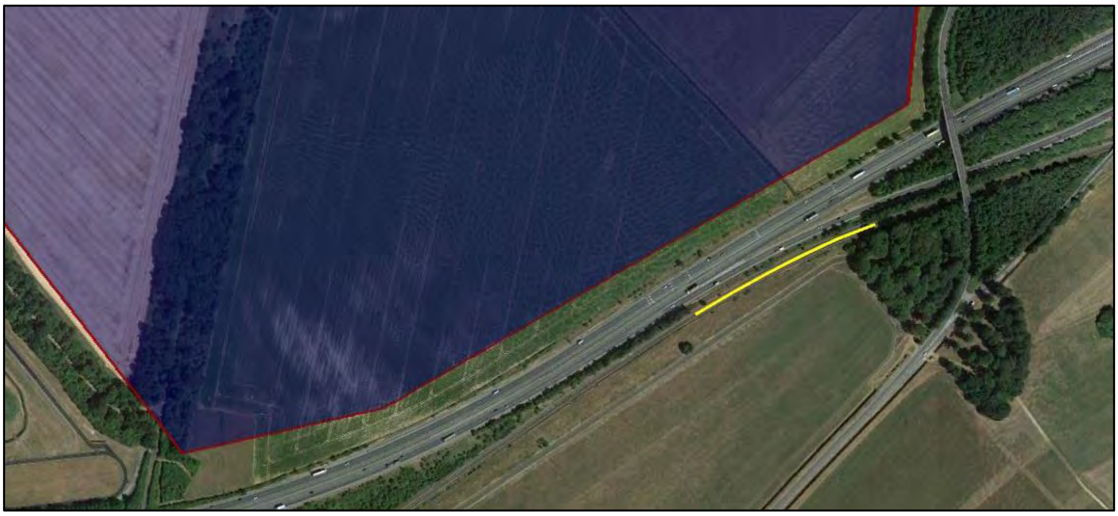


Figure 11 *Railway reflection zone prior to the establishment of mitigation measures*

8.5.2 Post-Mitigation Results

Following the implementation and establishment of the mitigation measures, screening in the form of existing vegetation, proposed vegetation, and/or existing surrounding buildings will obstruct views of the reflecting panels for train drivers along the entirety of the railway line.

The sections of railway where solar reflections are geometrically possible (green lines) and areas of significant screening (white areas) are shown in Figure 12 below and Figure 13[18] on the following page.

No impacts upon train drivers are predicted along the assessed section of railway, and no further mitigation is required.

Figure 12 *Significantly screened section of railway line (between receptors 4 and 46)*

Figure 13 *Significantly screened section of railway line (between receptors 61 and 103)*

8.6 Road Results

The modelling has shown that solar reflections are predicted towards 189 out of the 257 assessed road receptors. For road users, the key considerations to determine the impact significance are:

a. Whether a reflection is predicted to be experienced in practice.

b. The type of road (and associated likely traffic levels/speeds).

c. The location of the reflecting panel relative to a road user's direction of travel (a reflection directly in front of a driver is more hazardous than a reflection from a location off to one side).

8.6.1 Pre-Mitigation Results

Prior to the establishment of mitigation measures, views of the reflecting panels are considered possible along sections of the A14, B1085, A11, and A1304. The following has therefore been considered for each road:

a. A14 – Effects are predicted to be experienced along two sections of the A14 with differing glare scenarios:

   i. For one section of road, effects will not originate from directly in front of a road user effects will be experienced along just a small stretch of the road, and effects will coincide with direct sunlight which is a far more significant source of light. No significant impacts predicted towards this section of the A14, and temporary mitigation is not required.

ii. For the other section of road, although the glare will only be experienced momentarily and effects will coincide with direct sunlight, the solar reflections will originate from directly in front of a road user. Significant impacts are therefore predicted towards this section of the A14, and temporary mitigation is required.

b. B1085 – Effects will coincide with direct sunlight which is a far more significant source of light. The significance of the impacts are also reduced due to the minor classification of the road. No significant impacts predicted towards the B1085, and temporary mitigation is therefore not required.

c. A11 – Solar reflections towards road users will not originate from directly in front of a road user, effects will be experienced along just a small stretch of the road, and effects will coincide with direct sunlight which is a far more significant source of light. No significant impacts predicted towards A11, and temporary mitigation is therefore not required.

d. A1304 – Effects will coincide with direct sunlight, which is a far more intense source of light. Solar reflections will also not originate from directly in front of a road user. No significant impacts predicted towards A1304, and temporary mitigation is not required.

Until the proposed vegetation screening has obstructed the reflecting panels from view, screening in the form of solid hoarding along the Order limits is required along a small section of the A14. The location of the screening is shown as the orange line in Figure 14[20] below and presented in Chapter 16.3 of the Environmental Statement (ES).

Figure 14 *Recommended temporary screening location along A14*

8.6.2 Post-Mitigation Results

Following the implementation and establishment of the mitigation measures, the Landscape and Visual Assessment has confirmed all views of the proposed development along the section of the A14 where significant impacts are possible, will be obstructed by proposed vegetation. Accordingly, no impacts upon road users along this section of road are predicted.

For the remaining sections of the A14, B1085, A11, and A1304, some partial views of the reflecting panels may be possible when the vegetation is not in leaf; however, no significant impacts are predicted due to the same mitigating factors outlined in the previous sub-section. No further mitigation is therefore required.

Figures 15 to 21[21] below and on the following pages show the sections of each road where effects are predicted to be significantly screened (green lines) and where effects are predicted to be experienced (yellow lines). The screening locations are shown as the white outlined areas.

Figure 15 *Post mitigation effects towards the A14*

[21] Copyright © 2021 Google.

Figure 16 *Post mitigation effects towards the A142*

Figure 17 *Post mitigation effects towards the B1085*

Figure 18 *Post mitigation effects towards the A11 (Sunnica West)*

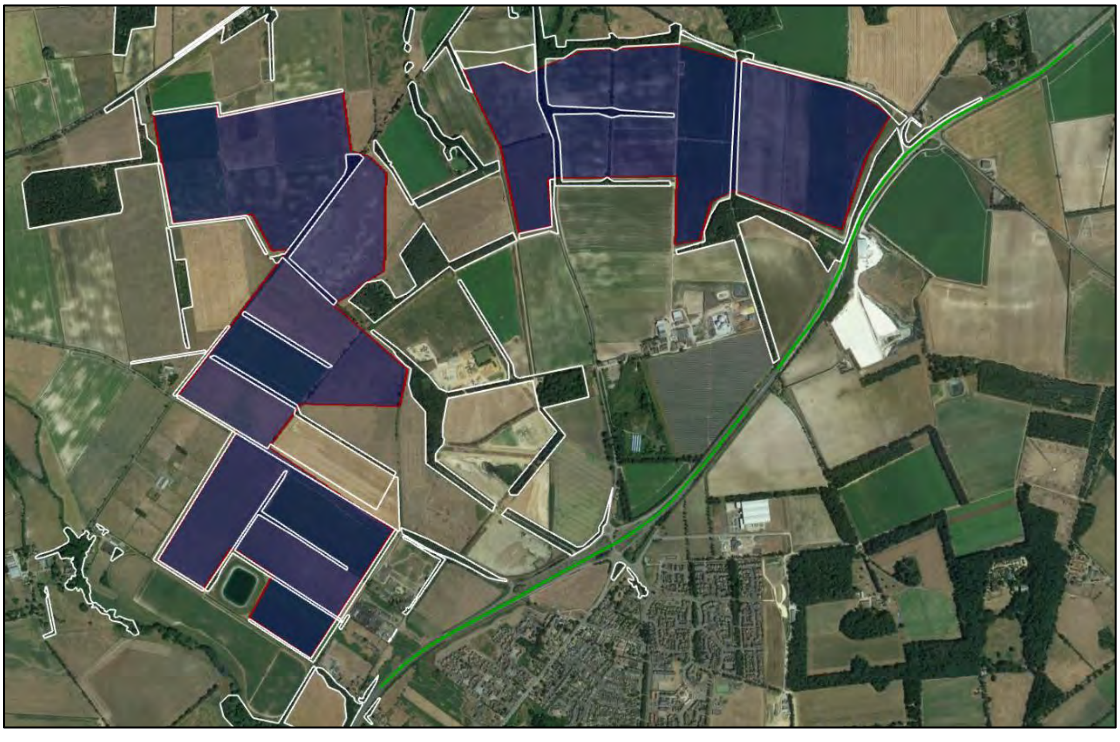


Figure 19 *Post mitigation effects towards the A11 (Sunnica East)*

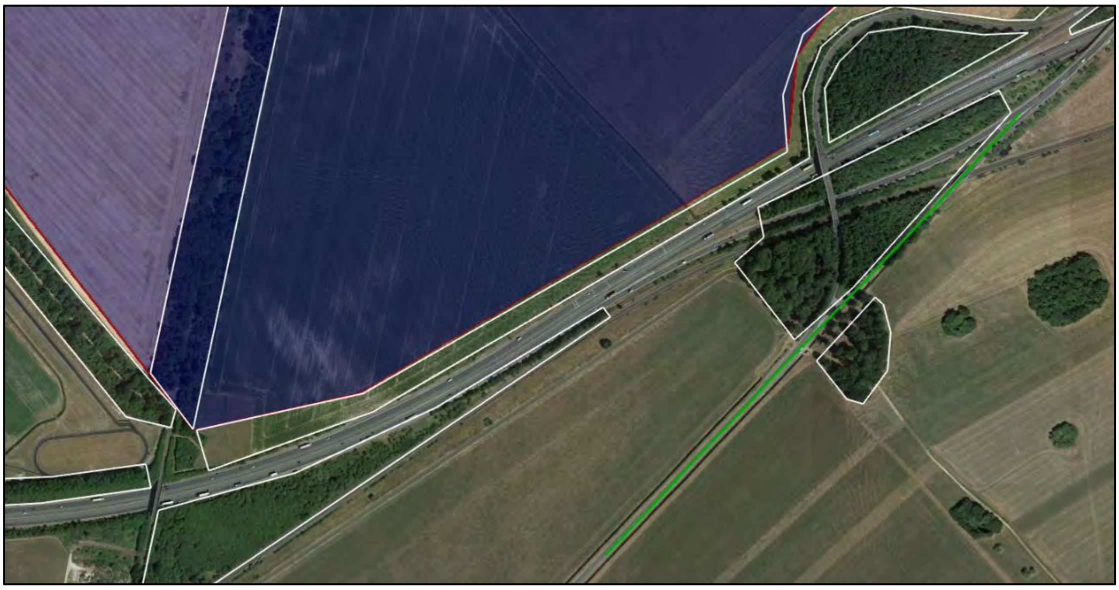


Figure 20 *Post mitigation effects towards the A1304*

Figure 21 *Post mitigation effects towards the B1102*

8.7 Public Right of Way and Bridleway Results

Compared to road users and train drivers, safety is much less of a concern for pedestrians on a public right of way or horse and riders on a bridleway. The impact significance has therefore been considered in the context of the amenity of an observer.

The modelling has shown that solar reflections are geometrically possible towards 144 out of the 262 assessed public right of way and bridleway receptors. The considerations for determining impact significance for observers at locations along the public right of ways and bridleways where views of the reflecting panels is deemed possible are:

a. The duration of effects.

b. The intensity of potential reflections compared to common outdoor sources of glare.
c. The relative position of the Sun and the reflection.
d. Associated hazards caused by potential glare.

Therefore, the following has been considered:

a. Effects would last for up to approximately 20 minutes per day for a static observer (this would be a worst case of 10 minutes in the morning and 10 minutes in the afternoon/evening).
b. It should be considered that where reflections are visible to an observer, their intensity will be comparable to reflections from still water. Reflections from solar panels are less intense than reflections from glass or steel.
c. Reflections would generally coincide with direct sunlight, such that an observer looking towards a reflecting panel would also be looking towards the sun. Direct sunlight is significantly more intense than a reflection from a solar panel.
d. Reflections towards an observer on a footpath do not have an associated safety hazard – the worst-case scenario would be discomfort when looking towards a reflecting panel.

Screening in the form of existing and/or proposed vegetation will further reduce the impact by significantly blocking views of the solar panels at almost all the locations along the surrounding public rights of way and bridleways.

Overall, the potential impact on observers using the surrounding public rights of way and horse and riders using the surrounding bridleways is assessed as low. No further mitigation is therefore required.

8.8 Permissive Path Results

The modelling has shown that solar reflections are geometrically possible towards seven out of the eight assessed permissive path receptors.

The impact significance for a pedestrian along a permissive path has been considered in the context of the amenity of an observer. Therefore, the following has been considered:

a. Effects would last for up to approximately 10 minutes per day for a static observer (this would be a worst case of 10 minutes in the morning).
b. It should be considered that where reflections are visible to an observer, their intensity will be comparable to reflections from still water. Reflections from solar panels are less intense than reflections from glass or steel.
c. Reflections would generally coincide with direct sunlight, such that an observer looking towards a reflecting panel would also be looking

towards the Sun. Direct sunlight is significantly more intense than a reflection from a solar panel.

d. Reflections towards an observer on a footpath do not have an associated safety hazard – the worst-case scenario would be discomfort when looking towards a reflecting panel.

Screening in the form of existing and/or proposed vegetation will further reduce the impact by significantly blocking views of the solar panels at some of the locations along the permissive paths.

Overall, the potential impact on pedestrians using the surrounding permissive paths is assessed as low. No further mitigation is therefore required.

8.9 Dwelling Results

The results of the modelling have shown that solar reflections are geometrically possible towards 118 out of the 224 assessed dwelling receptors. For dwelling receptors, the key considerations to determine the impact significance are:

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

8.9.1 Pre-Mitigation Results

Significant impacts are not predicted for 115 of the dwellings in accordance with the impact significance defined in Appendix D because the duration of effects is predicted to be less than 3 months per year and less than 60 minutes per day, or there are sufficient mitigating factors that will reduce the level of impact.

Prior to the implementation establishment of the mitigation measures, a moderate impact is predicted upon three dwellings (receptors 34-36), which will remain until the proposed vegetation screening has established and the reflecting panels are obstructed from view.

8.9.2 Post-Mitigation Results

Following the implementation and establishment of the mitigation measures, no significant impacts upon the surrounding dwellings are predicted and no further mitigation is required, because:

a. The existing vegetation, proposed vegetation, and/or other surrounding dwellings will sufficiently reduce the duration of effects to less than 3 months per year and 60 minutes per day; or
b. An observer will be located over 1km from the closest reflecting panels, which are insignificant in accordance with the 1km study area considered appropriate for ground-based receptors.

Dwellings at each residential area where solar reflections are predicted are shown in Figures 22 to 29[22] on the following pages. The screening locations are shown as the white outlined areas.

[22] Copyright © 2021 Google.

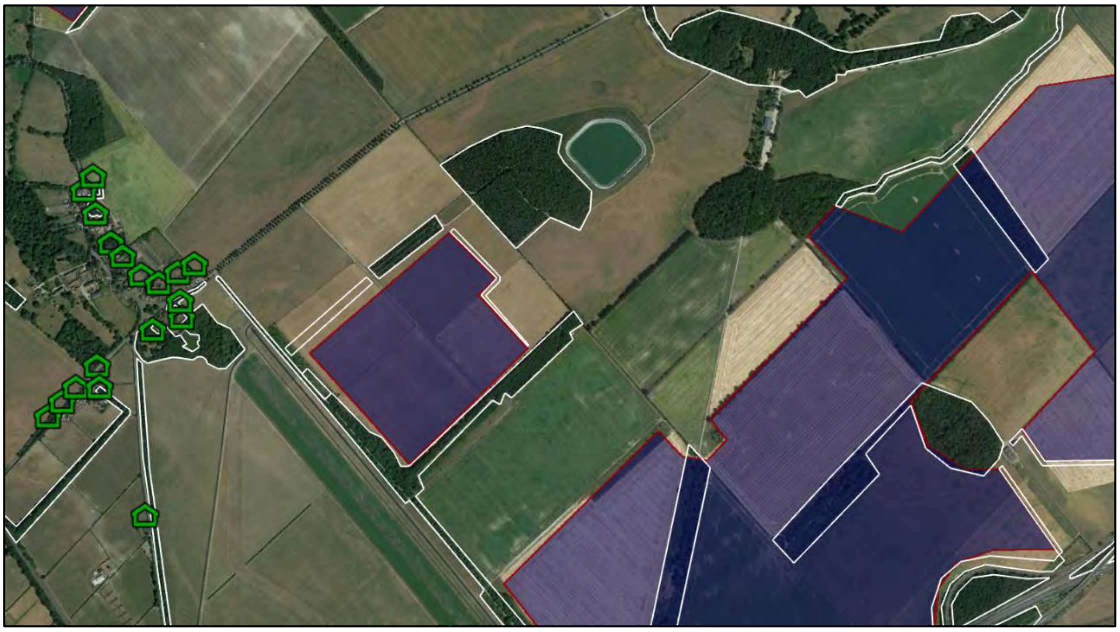


Figure 22 *Snailwell dwellings*

Figure 23 *Chippenham dwellings*

Figure 24 *Kennett dwellings*

Figure 25 *Red Lodge dwellings*

Figure 26 *Badlingham Manor dwellings*

Figure 27 *Freckenham dwellings*

Figure 28 *Worlington dwellings*

Figure 29 *Isleham dwellings*

8.10 Horse Facility Results

The results of the analysis show that reflections are predicted towards Snailwell Gallops and British Racing School. Solar reflections are not predicted to be experienced in practice due to screening in the form of existing vegetation surrounding and within the Order limits. The white areas in Figure 30[23] below show the areas of significant vegetation screening.

No impacts are therefore predicted upon the surrounding horse facilities, and no further mitigation is required.

Figure 30 *Horse facilities*

[23] Copyright © 2021 Google.

9 OVERALL CONCLUSIONS

9.1 Assessment Results – Aviation

Solar reflections are not geometrically possible towards the ATC Tower or approach paths for Runway 11/29 at RAF Mildenhall due to the relative location of the Sun path, reflectors, and receptors across the year. No impacts are therefore possible, and no further mitigation is required.

No detailed assessment is recommended for RAF Lakenheath or Cambridge Airport due to the distance from the development and orientation of the runways. It can be safely determined that, based on the assessment criteria, if solar reflections are possible, intensities would have a 'low potential for temporary after image' and would therefore be acceptably low in accordance with industry best practice.

9.2 Assessment Results – Railway

Solar reflections are geometrically possible towards 89 out of the 103 assessed train driver receptors along the assessed section of railway line.

Prior to the establishment of mitigation measures, effects are predicted along approximately 200 metres of railway line; however, significant impacts are not predicted because a train driver is expected to have a lower workload than normal, the glare is not predicted to cause disability considering the glare scenario, the train driver will be within the reflection zone momentarily, and the reflections will coincide with direct sunlight, which is a far more intense source of light.

Following the implementation and establishment of the mitigation measures, no impacts are predicted because the proposed screening adjacent to the railway and the proposed screening adjacent to the A14 will significantly obstruct views of the reflecting panels from view.

9.3 Assessment Results – Roads

Solar reflections are geometrically possible towards 189 out of the 257 assessed road receptors along the A11, A14, A142, A1304, B1085, and B1102.

Prior to the establishment of mitigation measures, solar reflections are predicted to be experienced along sections of the B1085, A11, and A1304; however, significant impacts are not predicted due to a number of mitigating factors including the classification of the road, the location of the solar reflection relative to the road user's main field of view, and the existing sunlight effects. Following the implementation and establishment of the mitigation measures, some views of the reflecting panels may remain when the proposed screening is not in leaf and therefore this conclusion remains.

Significant impacts are predicted prior to the establishment of mitigation measures towards a small section of the A14 due to the national classification of the road and the solar reflections originating from inside the road user's main field of view. Mitigation in the form of solid hoarding is therefore required along the Order limit until the mitigation measures have obstructed the reflecting panels from view. Following the implementation and establishment of the mitigation measures, no impacts are predicted because the proposed screening will significantly obstruct views of the reflecting panels from view.

9.4 Assessment Results – Dwellings

Solar reflections are geometrically possible for 116 out of the 222 assessed dwelling receptors.

Views of the reflecting panels are considered possible for a minority of observers located in the surrounding dwellings prior to the establishment of mitigation measures. At three of these dwellings, a moderate impact is predicted, which will remain until the mitigation measures have established and the reflecting panels are obstructed from view.

Following the implementation and establishment of the mitigation measures, no significant impacts are predicted, and no further mitigation is required. This is because existing vegetation, proposed vegetation, and/or other surrounding dwellings will reduce the duration of effects to less than 3 months per year and 60 minutes per day, or the dwellings are located over 1km from the reflecting panels and so any reflections are not considered significant in accordance with the 1km study area considered appropriate for ground-based receptors (see Section 5.1).

9.5 Assessment Results – PRoW, Bridleways, and Permissive Paths

Solar reflections are geometrically possible towards most of the assessed Public Right of Way (PRoW), bridleway, and permissive path receptors.

Screening in the form of existing and proposed vegetation will significantly obstruct the visibility of the reflecting panels for most observers; however, effects at some locations are predicted prior to and following the implementation and establishment of the mitigation measures.

Solar reflections experienced by an observer along the PRoW, bridleway, or permissive path are not deemed to have a significant impact upon the amenity of an observer along a due to the reflections having no associated safety hazard, the intensity of a reflection to common outdoor sources of glare that are frequently visible to observers, and the existing sunlight effects. No significant impacts are therefore predicted upon pedestrians or riders, and no further mitigation is required.

9.6 Assessment Results – Horse Facilities

Solar reflections are geometrically possible towards the Snailwell Gallops and British Racing School. Screening in the form of existing vegetation will however obstruct views of the reflecting panels for horse and riders at both horse facilities, which will be further bolstered by the proposed vegetation. No impacts are predicted, and no further mitigation is required.

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

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: 17/06/2020

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare are, however, provided for 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[25] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

Aviation Assessment Guidance

The UK Civil Aviation Authority (CAA) issued interim guidance relating to Solar Photovoltaic Systems (SPV) on 17 December 2010 and was subject to a CAA information alert 2010/53. The formal policy was cancelled on September 7th, 2012[26] however the advice is still applicable[27] until a formal policy is developed. The relevant aviation guidance from the CAA is presented in the section below.

CAA Interim Guidance

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

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

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

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

---

[25] Solar Photovoltaic Development – Glint and Glare Guidance, Third Edition, December 2020. Pager Power.

[26] Archived at Pager Power

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

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

12. If an installation of SPV systems is planned on-aerodrome (i.e. within its licensed boundary) then it is recommended that data on the reflectivity of the solar panel material should be included in any assessment before installation approval can be granted. Although approval for installation is the responsibility of the ALH[28], as part of a condition of a CAA Aerodrome Licence, the ALH is required to obtain prior consent from CAA Aerodrome Standards Department before any work is begun or approval to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Aerodrome Infrastructure.

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

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

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

FAA Guidance

The most comprehensive guidelines available for the assessment of solar developments near aerodromes were produced initially in November 2010 by the United States Federal Aviation Administration (FAA) and updated in 2013.

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports'*[29] and the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports'*[30]. In April 2018 the FAA released a new version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports'*[31].

An overview of the methodology presented within the 2013 interim guidance and adopted by the FAA is presented below. This methodology is not presented within the 2018 guidance.

---

[28] Aerodrome Licence Holder.

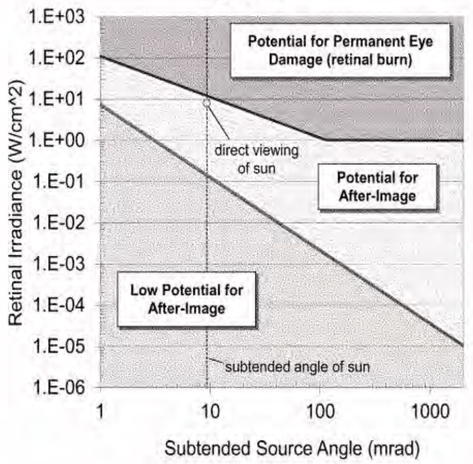
[29] Archived at Pager Power

[30] Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports, Department of Transportation, Federal Aviation Administration (FAA), date: 10/2013, accessed on: 20/03/2019

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

- *Solar energy systems located on an airport that is not federally-obligated or located outside the property of a federally-obligated airport are not subject to this policy.*
- *Proponents of solar energy systems located off-airport property or on non-federally-obligated airports are strongly encouraged to consider the requirements of this policy when siting such system.*
- *FAA adopts the Solar Glare Hazard Analysis Plot…. as the standard for measuring the ocular impact of any proposed solar energy system on a federally-obligated airport. This is shown in the figure below.*

Figure 1



Solar Glare Ocular Hazard Plot: The potential ocular hazard from solar glare is a function of retinal irradiance and the subtended angle (size/distance) of the glare source. It should be noted that the ratio of spectrally weighted solar illuminance to solar irradiance at the earth's surface yields a conversion factor of ~100 lumens/W. Plot adapted from Ho et al., 2011.

Chart References: Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards from Concentrating Solar Power Plants: Analytical Models and Experimental Validation, J. Solar Energy Engineering, August 2011, Vol. 133, 031021-1 – 031021-9.

Solar Glare Hazard Analysis Plot (FAA)

- *To obtain FAA approval to revise an airport layout plan to depict a solar installation and/or a "no objection" … the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards:*
- *No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATC) cab, and*
- *No potential for glare or "low potential for after-image" … along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50)*

feet above the landing threshold using a standard three (3) degree glidepath.

- *Ocular impact must be analysed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon.*

The bullets highlighted above state there should be 'no potential for glare' at that ATC Tower and 'no' or 'low potential for glare' on the approach paths.

Key points from the 2018 FAA guidance are presented below.

a. *Reflectivity refers to light that is reflected off surfaces. The potential effects of reflectivity are glint (a momentary flash of bright light) and glare (a continuous source of bright light). These two effects are referred to hereinafter as "glare," which can cause a brief loss of vision, also known as flash blindness*[32]*.*

b. *The amount of light reflected off a solar panel surface depends on the amount of sunlight hitting the surface, its surface reflectivity, geographic location, time of year, cloud cover, and solar panel orientation.*

c. *As illustrated on Figure 16*[33]*, flat, smooth surfaces reflect a more concentrated amount of sunlight back to the receiver, which is referred to as specular reflection. The more a surface is polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.*

d. *Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:*

    i. *A qualitative analysis of potential impact in consultation with the Control Tower, pilots and airport officials;*

    ii. *A demonstration field test with solar panels at the proposed site in coordination with FAA Tower personnel;*

    iii. *A geometric analysis to determine days and times when an impact is predicted.*

e. *The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and system design.*

---

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

[33] First figure in Appendix B.

- ***1. Assessing Baseline Reflectivity Conditions** – Reflection in the form of glare is present in current aviation operations. The existing sources of glare come from glass windows, auto surface parking, rooftops, and water bodies. At airports, existing reflecting surfaces may include hangar roofs, surface parking, and glassy office buildings. To minimize unexpected glare, windows of air traffic control towers and airplane cockpits are coated with anti-reflective glazing. Operators also wear polarized eye wear. Potential glare from solar panels should be viewed in this context. Any airport considering a solar PV project should first review existing sources of glare at the airport and the effectiveness of measures used to mitigate that glare.*
- ***2. Tests in the Field** – Potential glare from solar panels can easily be viewed at the airport through a field test. A few airports have coordinated these tests with FAA Air Traffic Controllers to assess the significance of glare impacts. To conduct such a test, a sponsor can take a solar panel out to proposed location of the solar project, and tilt the panel in different directions to evaluate the potential for glare onto the air traffic control tower. For the two known cases where a field test was conducted, tower personnel determined the glare was not significant. If there is a significant glare impact, the project can be modified by ensuring panels are not directed in that direction.*
- ***3. Geometric Analysis** – Geometric studies are the most technical approach for reflectivity issues. They are conducted when glare is difficult to assess through other methods. Studies of glare can employ geometry and the known path of the sun to predict when sunlight will reflect off of a fixed surface (like a solar panel) and contact a fixed receptor (e.g., control tower). At any given site, the sun moves across the sky every day and its path in the sky changes throughout year. This in turn alters the destination of the resultant reflections since the angle of reflection for the solar panels will be the same as the angle at which the sun hits the panels. The larger the reflective surface, the greater the likelihood of glare impacts.*
- *Facilities placed in remote locations, like the desert, will be far from receptors and therefore potential impacts are limited to passing aircraft. Because the intensity of the light reflected from the solar panel decreases with increasing distance, an appropriate question is how far you need to be from a solar reflected surface to avoid flash blindness. It is known that this distance is directly proportional to the size of the array in question*34 *but still requires further research to definitively answer.*

---

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

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

Air Navigation Order (ANO) 2009

In some instances, an aviation stakeholder can refer to the ANO 2009 with regard to safeguarding. Key points from the document are presented below.

Endangering safety of an aircraft

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

Lights liable to endanger

221.

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

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

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

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

(a) to extinguish or screen the light; and

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

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

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

Lights which dazzle or distract

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

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

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'35 which details the requirement for assessing glare towards railway signals.

Reflections and glare

<u>Rationale</u>

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

<u>Guidance</u>

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.

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

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.

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'36 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.

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

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.

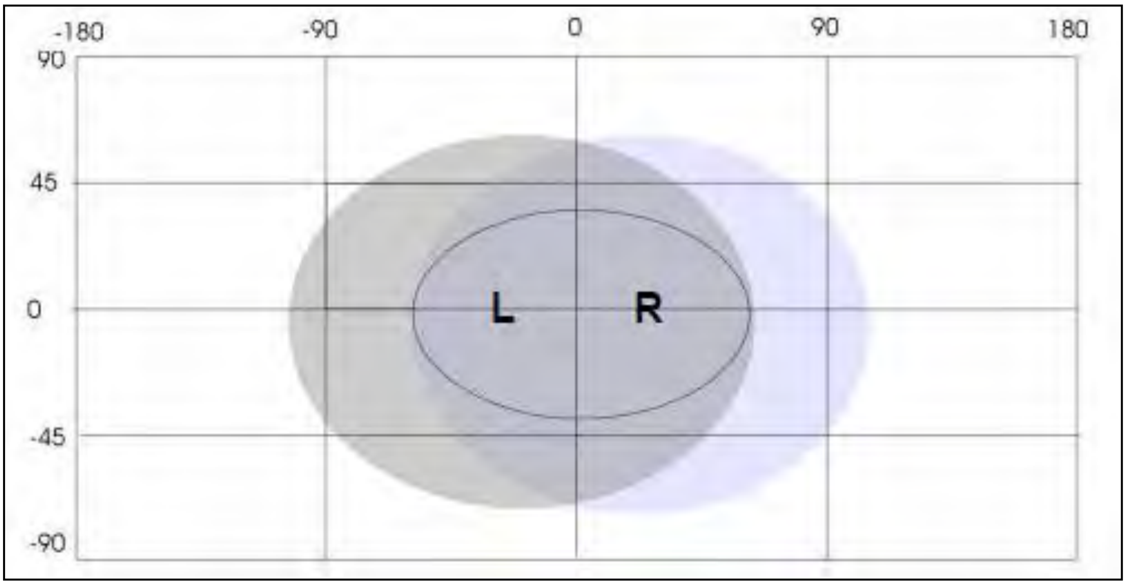


Figure G 21 - Field of view

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° 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.

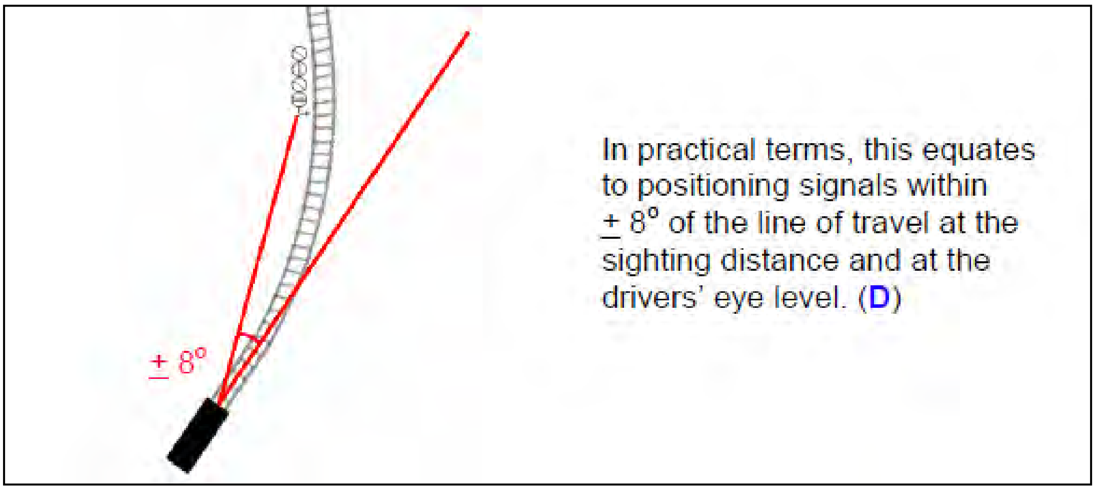


Figure G 22 - Signal positioning

‘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 8º 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 8º 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 8º cone at 25.46 m in front of the driver*

Table G 5 – 8º 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 extract below is taken from section B5 (pages 8-9) of the 'Guidance on Signal Positioning and Visibility' which details the required minimum reading time for a train driver when approaching a signal.

'B5.2.2 Determining the assessed minimum reading time

GE/RT8037

The assessed minimum reading time shall be no less than eight seconds travelling time before the signal.

The assessed minimum reading time shall be greater than eight seconds where there is an increased likelihood of misread or failure to observe. Circumstances where this applies include, but are not necessarily limited to, the following:

a) the time taken to identify the signal is longer (for example, because the signal being viewed is one of a number of signals on a gantry, or because the signal is viewed against a complex background)

b) the time taken to interpret the information presented by the signal is longer (for example, because the signal is capable of presenting route information for a complex layout ahead)

c) there is a risk that the need to perform other duties could cause distraction from viewing the signal correctly (for example, the observance of lineside signs, a station stop between the caution and stop signals, or DOO (P) duties)

d) the control of the train speed is influenced by other factors (for example, anticipation of the signal aspect changing).

The assessed minimum reading time shall be determined using a structured format approved by the infrastructure controller.'

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:

a. An LED railway signal produces a more intense light making them more visible to approaching trains when compared to the traditional filament bulb technology[37];
b. 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[38,39,40] claim that LED signal lights significantly reduce or completely remove the likelihood of a phantom aspect illumination occurring.

---

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

[38] Source: [redacted] (Last accessed 21.02.18).

[39] Source: [redacted] (Last accessed 21.02.18).

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

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

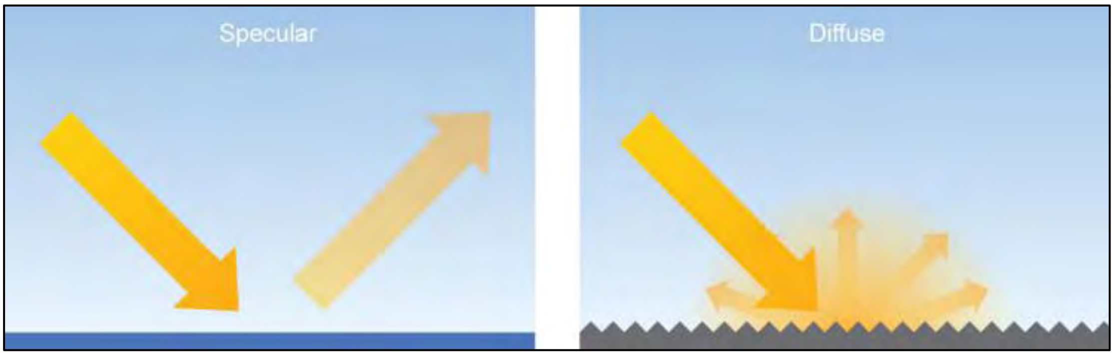
Overview

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

There are no specific studies for determining the effect of reflections from solar panels with respect to dwellings. 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[41], taken from the FAA guidance, 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

---

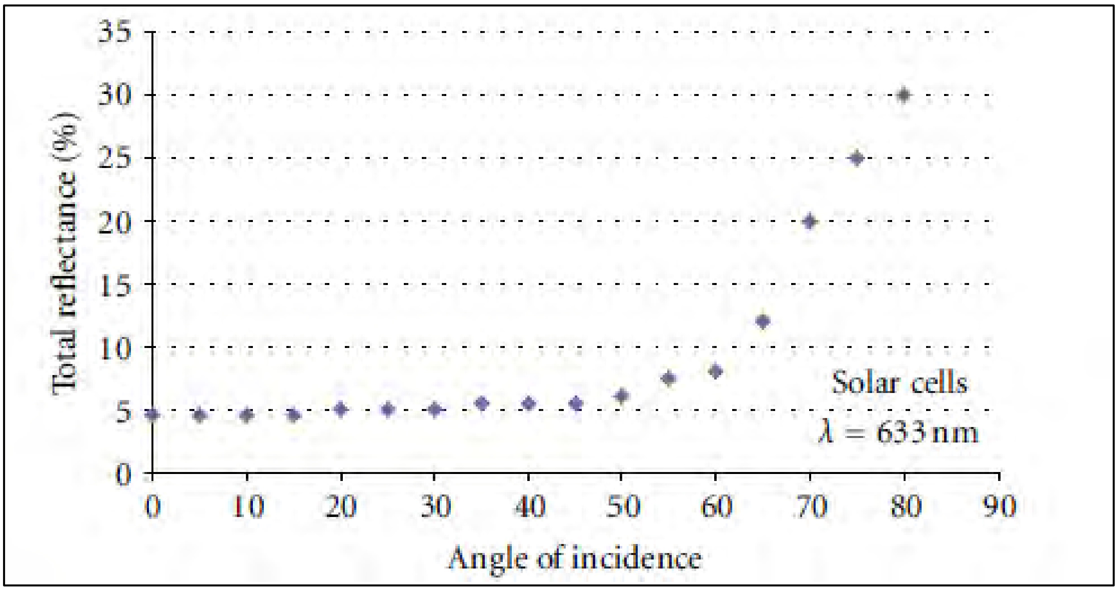
41 [redacted]

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*[42]". 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:

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

b. 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.

---

42 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"[43]

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[44] within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected[45]
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.

[43] FAA, November (2010): *Technical Guidance for Evaluating Selected Solar Technologies on Airports.*
[44] [redacted]
[45] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification[46] to '*increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment'.* The study revealed that the reflectivity of a solar panel is considerably lower than that 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.

Figures within the document show the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel. 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 produced from these surfaces.

[46] 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:

a. Time.

b. Date.

c. Latitude.

d. Longitude.

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

a. The Sun is at its highest around midday and is to the south at this time.

b. The Sun rises highest on 21 June (longest day).

c. 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.

APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

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

Impact Significance Definition

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

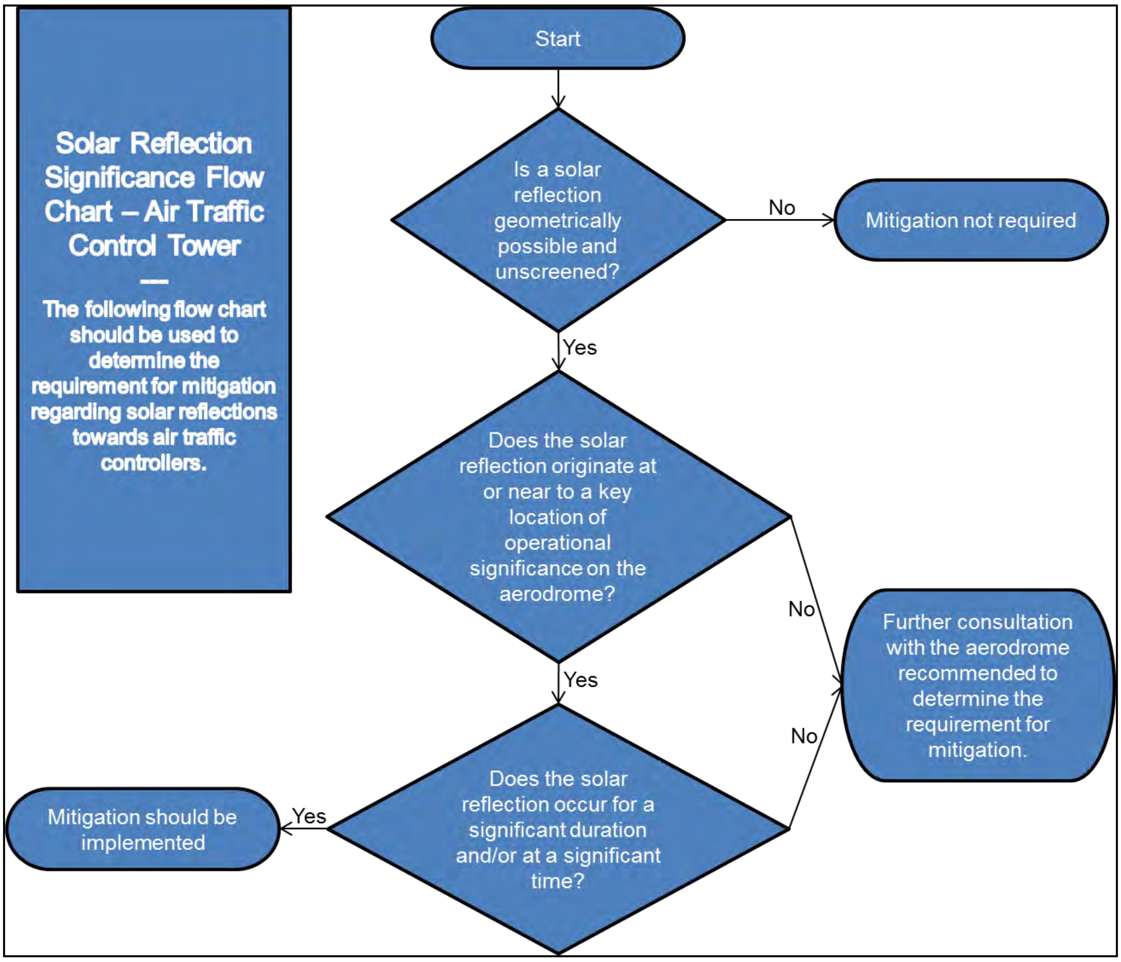
Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels.	No mitigation required.
Moderate	A solar reflection is geometrically possible and visible for less than either 60 minutes per day or 3 months per year and therefore occurring under conditions that do not represent a worst-case.	Whilst the impact may be acceptable, consultation and/or further analysis should be undertaken to determine the requirement for mitigation.
Major	A solar reflection is geometrically possible and visible for more than 60 minutes per day and more than 3 months per year and therefore under conditions that will produce a significant impact.	Mitigation will be required if the proposed solar development is to proceed.

Impact Significance	Definition	Mitigation Requirement
	Mitigation and consultation is recommended.	

Impact significance definition

Assessment Process – ATC Tower

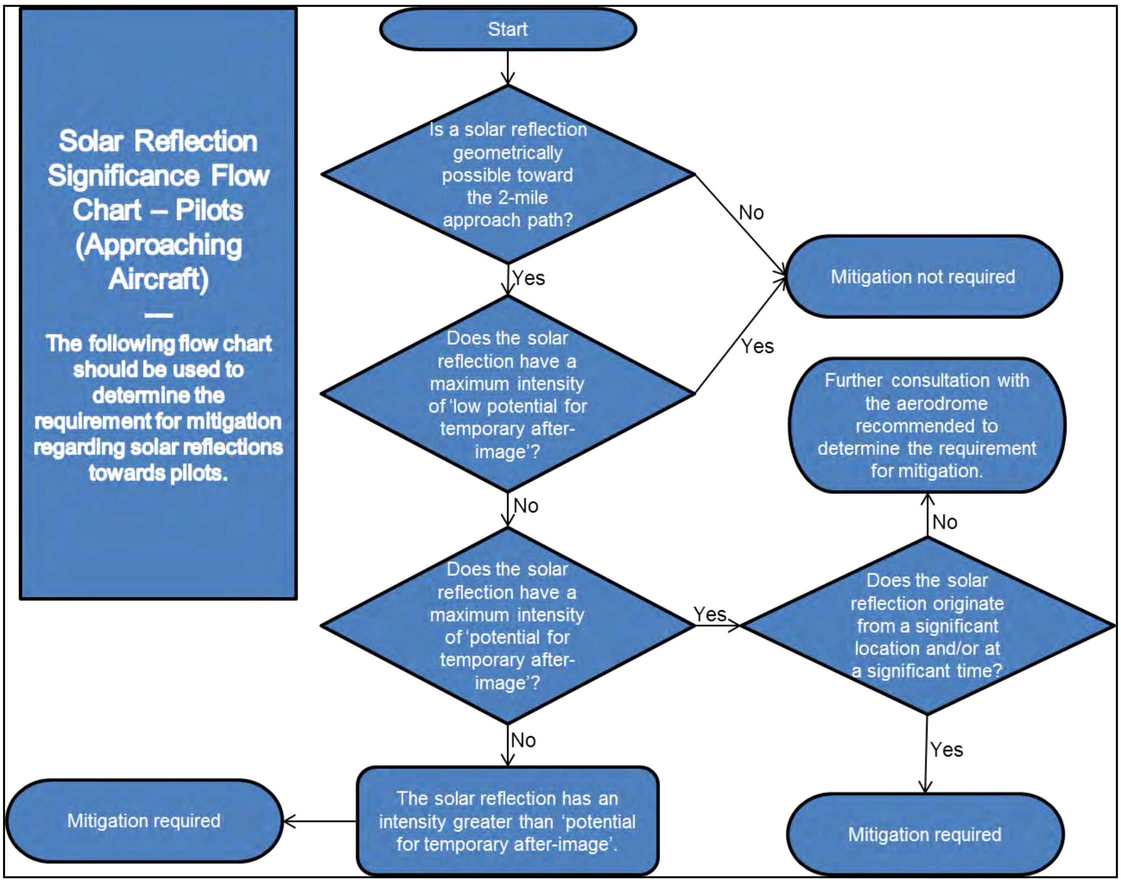
The charts relate to the determining the potential impact upon the ATC Tower.



ATC Tower mitigation requirement flow chart

Assessment Process – Approaching Aircraft

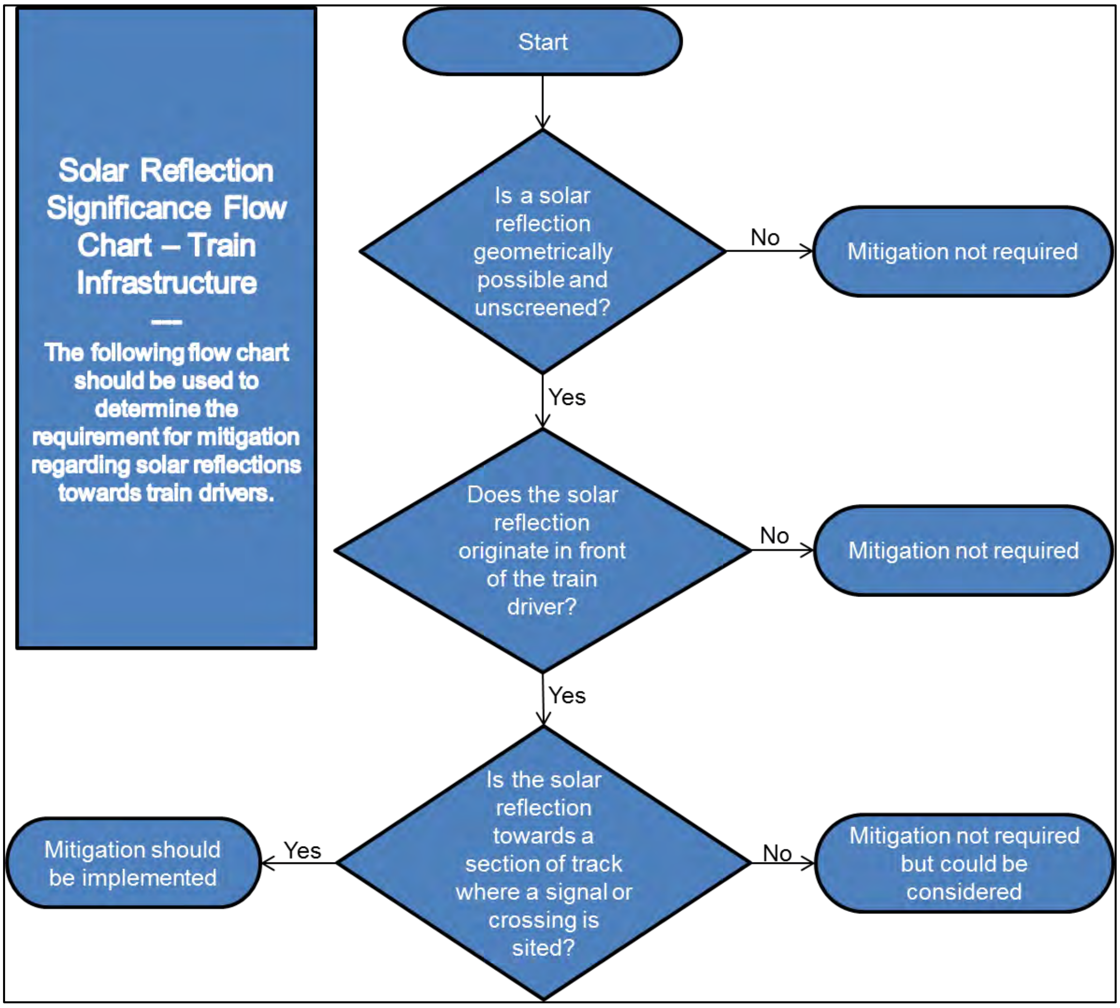
The flow chart presented below has been followed to determine the potential impact upon approaching aircraft.



Approaching aircraft receptor mitigation requirement flow chart

Assessment process for Train Driver Receptors

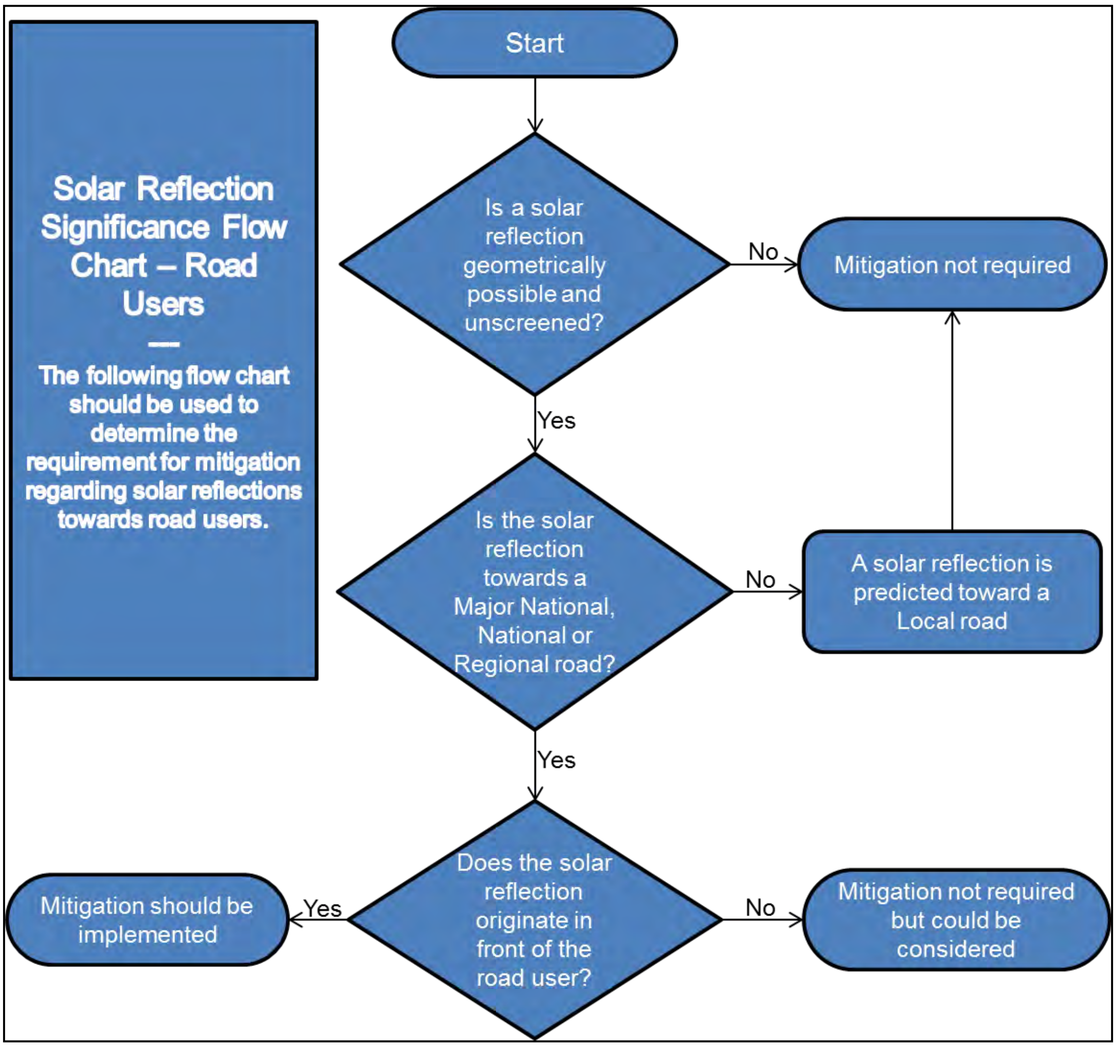
The flow chart presented below has been followed to determine the mitigation requirement for train driver receptors.



Train driver receptor mitigation requirement flow chart (solar panels)

Assessment Process for Road Receptors

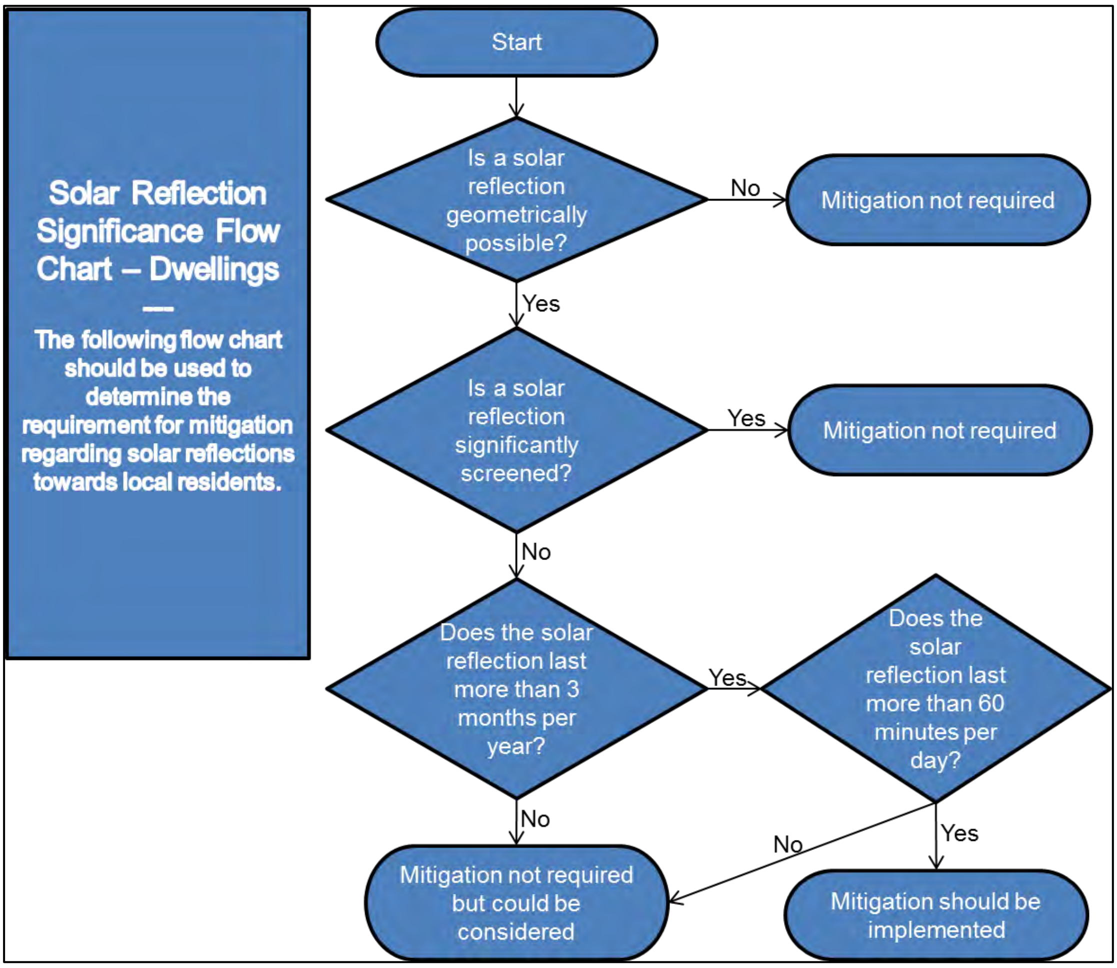
The flow chart presented below has been followed to determine the mitigation requirement for road receptors.



Road receptor mitigation requirement flow chart

Assessment Process for Dwelling Receptors

The flow chart presented below has been followed to determine the mitigation requirement for dwelling receptors.



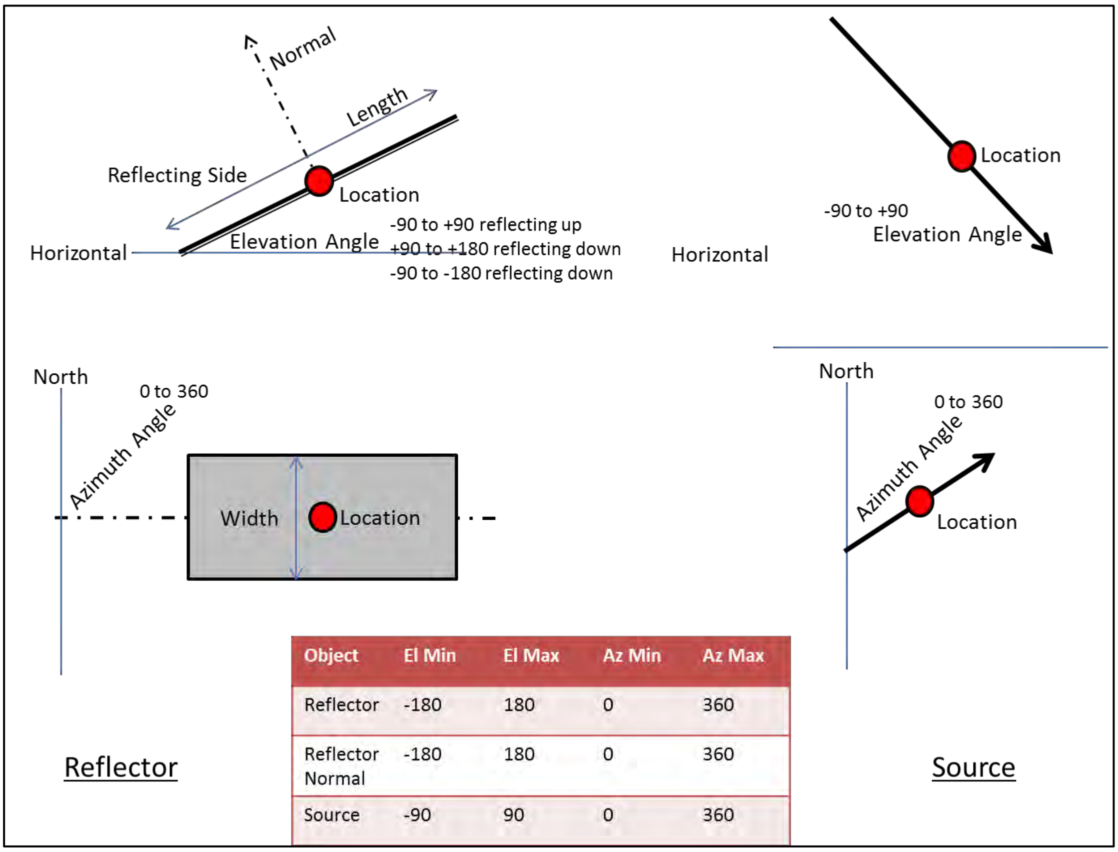
Dwelling receptor mitigation requirement flow chart

APPENDIX E – PAGER POWER'S REFLECTION CALCULATIONS METHODOLOGY

The calculations are three dimensional and complex, accounting for:

a. The Earth's orbit around the Sun;
b. The Earth's rotation;
c. The Earth's orientation;
d. The reflector's location;
e. 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:

a. Use the Latitude and Longitude of reflector as the reference for calculation purposes;
b. Calculate the Azimuth and Elevation of the normal to the reflector;
c. Calculate the 3D angle between the source and the normal;
d. 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;
e. Calculate the Azimuth and Elevation of the reflection in accordance with the following:
    i. The angle between source and normal is equal to angle between normal and reflection;
    ii. Source, Normal and Reflection are in the same plane.

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Pager Power's Model

The modelling has been based on an elevation angle of 25 degrees. It is assumed that this panel elevation angle represents the elevation angle for all of the panels within the solar development unless otherwise stated. As stated in the report, a variation in the defined range of angle (15-35) will not significantly change the results of the report, particularly as most effects will be screened.

It is assumed that the panel azimuth angle provided by the developer represents the azimuth angle for all of the panels within the solar development unless otherwise stated.

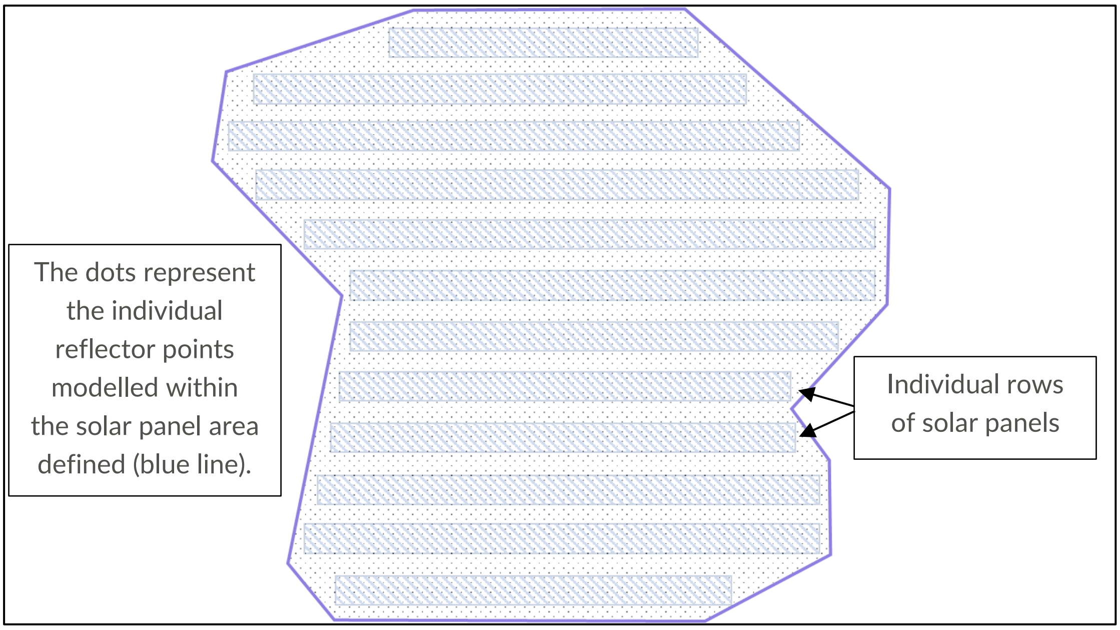
Only a reflection from the face of the panel has been considered. Solar reflections from the frame have not been considered as the they represent a much lower surface area than the solar panels and will therefore not significantly add to the effects.

The model assumes that a receptor can view the face of every panel within the proposed development area whilst this, in most cases, will not occur due to, for example, shielding from other solar panels. Therefore, any predicted reflection from the face of a solar panel that is not visible to a receptor will not occur and the overall predicted reflection time is likely to be reduced in practice. This is in line with the conservative approach to the assessment.

A single reflection point on the panel has been chosen for the geometric calculations. This will suitably determine whether a reflection can be experienced at a location and the general time of year and duration of this 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 enough to change the conclusions of the report.

Whilst line of sight to the development from receptors has been considered, only available street view imagery and satellite mapping has been used. 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. In this case, the imagery was taken from 2018 and is expected to representative of the perspective at each location.

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 resolution) with the geometric characteristics of the panel. A panel area is however defined to encapsulate all possible panel locations. See the figure on the following page which illustrates this process.



Solar panel area modelling overview

APPENDIX G – AVIATION RECEPTOR DETAILS

ATC Receptor Details

The details are presented in the table below.

Longitude (°)	Latitude (°)	Ground Height (m amsl)	ATC Tower Height (m agl)	Overall Assessed Height (m amsl)
0.484073	52.367041	9	20	29

ATC tower receptor details

The Approach Path for Aircraft Landing on Runway 11

The table below presents the data for the assessed locations for aircraft on approach to runway 05. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.2m) above the runway threshold (8.23m/27ft amsl).

No.	Longitude (°)	Latitude (°)	Distance from Runway Threshold (m)	Assessed Altitude (m) (m amsl)
0	0.46633	52.36483	Threshold	23.47
1	0.46402	52.36517	160.9	31.89
2	0.46172	52.36551	321.9	40.31
3	0.45941	52.36584	482.8	48.74
4	0.45710	52.36618	643.7	57.16
5	0.45480	52.36652	804.7	65.58
6	0.45249	52.36686	965.6	74.01
7	0.45018	52.36720	1126.5	82.43
8	0.44788	52.36754	1287.5	90.85
9	0.44557	52.36787	1448.4	99.27
10	0.44327	52.36821	1609.3	107.70
11	0.44096	52.36855	1770.3	116.12
12	0.43865	52.36889	1931.2	124.54
13	0.43635	52.36923	2092.1	132.96

No.	Longitude (°)	Latitude (°)	Distance from Runway Threshold (m)	Assessed Altitude (m) (m amsl)
14	0.43404	52.36956	2253.1	141.39
15	0.43173	52.36990	2414.0	149.81
16	0.42943	52.37024	2575.0	158.23
17	0.42712	52.37058	2735.9	166.65
18	0.42482	52.37092	2896.8	175.08
19	0.42251	52.37125	3057.8	183.50
20	0.42020	52.37159	2 miles	191.92

Assessed receptor (aircraft) locations on the approach path for runway 11

The Approach Path for Aircraft Landing on Runway 29

The table below presents the data for the assessed locations for aircraft on approach to runway 23. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.2m) above the runway threshold (10.06m/33ft amsl).

No.	Longitude (°)	Latitude (°)	Distance from Runway Threshold (m)	Assessed Altitude (m) (m amsl)
0	0.50648	52.35903	Threshold	25.30
1	0.50879	52.35869	160.9	33.72
2	0.51109	52.35835	321.9	42.14
3	0.51340	52.35802	482.8	50.57
4	0.51570	52.35768	643.7	58.99
5	0.51801	52.35734	804.7	67.41
6	0.52032	52.35700	965.6	75.83
7	0.52262	52.35666	1126.5	84.26
8	0.52493	52.35633	1287.5	92.68
9	0.52723	52.35599	1448.4	101.10
10	0.52954	52.35565	1609.3	109.52
11	0.53185	52.35531	1770.3	117.95
12	0.53415	52.35497	1931.2	126.37

No.	Longitude (°)	Latitude (°)	Distance from Runway Threshold (m)	Assessed Altitude (m) (m amsl)
13	0.53646	52.35464	2092.1	134.79
14	0.53876	52.35430	2253.1	143.22
15	0.54107	52.35396	2414.0	151.64
16	0.54338	52.35362	2575.0	160.06
17	0.54568	52.35328	2735.9	168.48
18	0.54799	52.35294	2896.8	176.91
19	0.55029	52.35261	3057.8	185.33
20	0.55260	52.35227	2 miles	193.75

Assessed receptor (aircraft) locations on the approach path for runway 29

APPENDIX H – GROUND RECEPTOR DETAILS

Terrain Height

All ground heights are interpolated based on OSGB Panorama data.

Railway Receptor Data

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.37991	52.29606	53	0.42599	52.26400
2	0.38072	52.29532	54	0.42725	52.26429
3	0.38152	52.29458	55	0.42852	52.26459
4	0.38233	52.29385	56	0.42964	52.26505
5	0.38314	52.29311	57	0.43076	52.26552
6	0.38395	52.29237	58	0.43188	52.26598
7	0.38475	52.29164	59	0.43300	52.26645
8	0.38556	52.29090	60	0.43412	52.26691
9	0.38637	52.29016	61	0.43523	52.26738
10	0.38718	52.28943	62	0.43635	52.26784
11	0.38798	52.28869	63	0.43747	52.26830
12	0.38879	52.28795	64	0.43859	52.26877
13	0.38960	52.28722	65	0.43971	52.26923
14	0.39041	52.28648	66	0.44083	52.26970
15	0.39121	52.28574	67	0.44209	52.27005
16	0.39202	52.28500	68	0.44335	52.27039
17	0.39283	52.28427	69	0.44461	52.27074
18	0.39364	52.28353	70	0.44597	52.27100
19	0.39444	52.28279	71	0.44733	52.27126
20	0.39525	52.28206	72	0.44868	52.27152
21	0.39606	52.28132	73	0.45004	52.27178
22	0.39687	52.28058	74	0.45140	52.27204

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
23	0.39767	52.27985	75	0.45276	52.27230
24	0.39848	52.27911	76	0.45412	52.27257
25	0.39929	52.27837	77	0.45548	52.27283
26	0.40010	52.27764	78	0.45683	52.27309
27	0.40090	52.27690	79	0.45819	52.27335
28	0.40171	52.27616	80	0.45955	52.27361
29	0.40252	52.27542	81	0.46091	52.27387
30	0.40333	52.27469	82	0.46227	52.27413
31	0.40414	52.27395	83	0.46362	52.27439
32	0.40494	52.27321	84	0.46498	52.27465
33	0.40575	52.27248	85	0.46634	52.27491
34	0.40656	52.27174	86	0.46770	52.27517
35	0.40737	52.27100	87	0.46906	52.27543
36	0.40817	52.27027	88	0.47042	52.27569
37	0.40898	52.26953	89	0.47177	52.27596
38	0.40979	52.26879	90	0.47313	52.27622
39	0.41060	52.26806	91	0.47449	52.27648
40	0.41140	52.26732	92	0.47585	52.27674
41	0.41221	52.26658	93	0.47721	52.27700
42	0.41302	52.26585	94	0.47851	52.27718
43	0.41415	52.26536	95	0.47982	52.27735
44	0.41527	52.26487	96	0.48113	52.27753
45	0.41640	52.26438	97	0.48222	52.27757
46	0.41753	52.26390	98	0.48331	52.27761
47	0.41871	52.26380	99	0.48440	52.27766
48	0.41990	52.26370	100	0.48586	52.27756
49	0.42109	52.26360	101	0.48732	52.27746

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
50	0.42227	52.26351	102	0.48878	52.27736
51	0.42346	52.26341	103	0.49024	52.27727
52	0.42472	52.26370			

Road Receptor Data - A14

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	0.41319	52.26878	28	0.45140	52.27338
2	0.41459	52.26865	29	0.45285	52.27374
3	0.41568	52.26846	30	0.45391	52.27399
4	0.41686	52.26824	31	0.45534	52.27431
5	0.41816	52.26798	32	0.45682	52.27460
6	0.41941	52.26769	33	0.45818	52.27487
7	0.42078	52.26744	34	0.45967	52.27511
8	0.42229	52.26722	35	0.46094	52.27534
9	0.42390	52.26708	36	0.46242	52.27560
10	0.42593	52.26702	37	0.46395	52.27577
11	0.42794	52.26699	38	0.46569	52.27598
12	0.42970	52.26719	39	0.46713	52.27611
13	0.43177	52.26736	40	0.46865	52.27629
14	0.43366	52.26772	41	0.47017	52.27641
15	0.43548	52.26815	42	0.47214	52.27655
16	0.43699	52.26862	43	0.47358	52.27656
17	0.43836	52.26905	44	0.47493	52.27665
18	0.43946	52.26945	45	0.47630	52.27673
19	0.44061	52.26993	46	0.47767	52.27676
20	0.44186	52.27041	47	0.47932	52.27674
21	0.44290	52.27077	48	0.48062	52.27672
22	0.44414	52.27123	49	0.48232	52.27670

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
23	0.44521	52.27164	50	0.48375	52.27666
24	0.44625	52.27201	51	0.48515	52.27657
25	0.44756	52.27234	52	0.48657	52.27649
26	0.44886	52.27269	53	0.48820	52.27640
27	0.45032	52.27310	54	0.48938	52.27623

Road Receptor Data – A142

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
55	0.39340	52.28455	65	0.39029	52.29303
56	0.39339	52.28540	66	0.38982	52.29384
57	0.39331	52.28620	67	0.38941	52.29467
58	0.39310	52.28708	68	0.38908	52.29551
59	0.39279	52.28797	69	0.38876	52.29636
60	0.39239	52.28883	70	0.38844	52.29720
61	0.39189	52.28970	72	0.38787	52.29493
62	0.39150	52.29050	73	0.38654	52.29500
63	0.39109	52.29140	74	0.38522	52.29513
64	0.39070	52.29218	75	0.38392	52.29533

Road Receptor Data – B1085

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
76	0.48692	52.28471	95	0.45993	52.29091
77	0.48639	52.28515	96	0.45854	52.29117
78	0.48575	52.28566	97	0.45723	52.29138
79	0.48499	52.28607	98	0.45595	52.29168
80	0.48369	52.28633	99	0.45449	52.29218
81	0.48231	52.28648	100	0.45305	52.29270
82	0.48096	52.28663	101	0.45183	52.29317

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
83	0.47985	52.28670	102	0.45030	52.29336
84	0.47868	52.28671	103	0.44942	52.29410
85	0.47724	52.28672	104	0.44857	52.29472
86	0.47493	52.28697	105	0.44762	52.29540
87	0.47252	52.28766	106	0.44666	52.29594
88	0.47118	52.28871	107	0.44564	52.29685
89	0.46956	52.28921	108	0.44495	52.29748
90	0.46796	52.28965	109	0.44432	52.29811
91	0.46639	52.28998	110	0.44357	52.29875
92	0.46473	52.29018	111	0.44298	52.29939
93	0.46317	52.29045	112	0.44214	52.30003
94	0.46170	52.29067			

Road Receptor Data – A11

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
113	0.52089	52.32915	166	0.47514	52.29439
114	0.51993	52.32863	167	0.47462	52.29360
115	0.51888	52.32821	168	0.47384	52.29285
116	0.51765	52.32772	169	0.47307	52.29210
117	0.51640	52.32734	170	0.47229	52.29135
118	0.51492	52.32692	171	0.47152	52.29060
119	0.51369	52.32649	172	0.47090	52.28981
120	0.51217	52.32582	173	0.47010	52.28907
121	0.51090	52.32511	174	0.46938	52.28830
122	0.50977	52.32435	175	0.46874	52.28767
123	0.50883	52.32358	176	0.46779	52.28676

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
124	0.50817	52.32287	177	0.46712	52.28602
125	0.50745	52.32185	178	0.46638	52.28527
126	0.50693	52.32101	179	0.46560	52.28449
127	0.50633	52.32022	180	0.46486	52.28375
128	0.50570	52.31947	181	0.46410	52.28301
129	0.50490	52.31876	182	0.46330	52.28224
130	0.50403	52.31801	183	0.46253	52.28150
131	0.50319	52.31733	184	0.46183	52.28079
132	0.50232	52.31660	185	0.46098	52.28005
133	0.50147	52.31597	186	0.46003	52.27934
134	0.50060	52.31531	187	0.45913	52.27861
135	0.49972	52.31458	188	0.45816	52.27797
136	0.49879	52.31386	189	0.45718	52.27734
137	0.49783	52.31320	190	0.45621	52.27670
138	0.49686	52.31253	191	0.45523	52.27607
139	0.49599	52.31198	192	0.45426	52.27543
140	0.49476	52.31150	193	0.45328	52.27480
141	0.49360	52.31102	194	0.45231	52.27416
142	0.49240	52.31062	195	0.45133	52.27352
143	0.49118	52.31017	196	0.45054	52.27284
144	0.48989	52.30981	197	0.44938	52.27225
145	0.48873	52.30935	198	0.44841	52.27162
146	0.48753	52.30896	199	0.44743	52.27098
147	0.48629	52.30859	200	0.44646	52.27035
148	0.48510	52.30817	201	0.44549	52.26971

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
149	0.48389	52.30777	202	0.44451	52.26908
150	0.48259	52.30733	203	0.44354	52.26844
151	0.48141	52.30682	204	0.44256	52.26780
152	0.48039	52.30629	205	0.44159	52.26717
153	0.47944	52.30571	206	0.44061	52.26653
154	0.47867	52.30507	207	0.43964	52.26590
155	0.47774	52.30416	208	0.43866	52.26526
156	0.47709	52.30326	209	0.43769	52.26463
157	0.47667	52.30245	210	0.43671	52.26399
158	0.47645	52.30155	211	0.43574	52.26336
159	0.47631	52.30049	212	0.43476	52.26272
160	0.47639	52.29961	213	0.43375	52.26214
161	0.47648	52.29878	214	0.43273	52.26151
162	0.47646	52.29784	215	0.43190	52.26097
163	0.47633	52.29697	216	0.43090	52.26033
164	0.47601	52.29609	217	0.42976	52.25967
165	0.47570	52.29522			

Road Receptor Data – B1102

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
218	0.49073	52.33596	238	0.46680	52.32844
219	0.48970	52.33562	239	0.46564	52.32795
220	0.48866	52.33529	240	0.46448	52.32746
221	0.48763	52.33495	241	0.46323	52.32708
222	0.48624	52.33482	242	0.46199	52.32671
223	0.48485	52.33469	243	0.46074	52.32634

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
224	0.48347	52.33456	244	0.45950	52.32596
225	220	52.33444	245	0.45825	52.32559
226	0.48070	52.33431	246	0.45701	52.32522
227	0.47954	52.33382	247	0.45576	52.32484
228	0.47838	52.33333	248	0.45452	52.32447
229	0.47722	52.33284	249	0.45327	52.32410
230	0.47606	52.33235	250	0.45202	52.32372
231	0.47490	52.33186	251	0.45078	52.32335
232	0.47375	52.33137	252	0.44953	52.32298
233	0.47259	52.33088	253	0.44829	52.32260
234	0.47143	52.33039	254	0.44704	52.32223
235	0.47027	52.32990	255	0.44580	52.32186
236	0.46911	52.32941	256	0.44455	52.32148
237	0.46795	52.32893	257	0.44407	52.32089

Public Right of Way Receptor Data

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
1	0.42861	52.25909	120	0.44904	52.31681
2	0.42921	52.25956	121	0.44807	52.31688
3	0.42944	52.26042	122	0.44725	52.31741
4	0.42967	52.26127	123	0.44733	52.31805
5	0.42990	52.26212	124	0.44742	52.31869
6	0.43013	52.26297	125	0.44750	52.31933
7	0.43037	52.26383	126	0.44860	52.31925
8	0.43060	52.26468	127	0.48924	52.33413
9	0.43083	52.26553	128	0.48907	52.33378
10	0.43106	52.26638	129	0.48811	52.33350
11	0.43129	52.26724	130	0.48801	52.33318

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
12	0.43152	52.26809	131	0.48715	52.33249
13	0.43058	52.26876	132	0.48630	52.33180
14	0.42964	52.26943	133	0.48544	52.33111
15	0.42870	52.27011	134	0.48458	52.33042
16	0.42777	52.27078	135	0.48373	52.32973
17	0.42683	52.27145	136	0.48287	52.32904
18	0.42589	52.27213	137	0.48202	52.32835
19	0.42495	52.27280	138	0.48116	52.32766
20	0.42401	52.27347	139	0.48031	52.32697
21	0.42308	52.27414	140	0.47945	52.32628
22	0.42214	52.27482	141	0.47859	52.32559
23	0.42120	52.27549	142	0.47774	52.32490
24	0.42026	52.27616	143	0.47688	52.32421
25	0.41932	52.27684	144	0.47603	52.32352
26	0.41839	52.27751	145	0.47517	52.32283
27	0.41745	52.27818	146	0.47432	52.32214
28	0.41651	52.27885	147	0.47346	52.32145
29	0.41557	52.27953	148	0.47260	52.32076
30	0.41463	52.28020	149	0.47175	52.32007
31	0.41370	52.28087	150	0.47089	52.31938
32	0.41276	52.28155	151	0.47004	52.31869
33	0.40663	52.28458	152	0.46918	52.31800
34	0.40767	52.28489	153	0.46800	52.31791
35	0.40871	52.28521	154	0.46683	52.31781
36	0.40962	52.28585	155	0.46565	52.31772
37	0.41054	52.28649	156	0.46447	52.31762
38	0.41145	52.28713	157	0.46371	52.31778

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
39	0.41237	52.28777	158	0.46295	52.31795
40	0.41329	52.28841	159	0.46160	52.31811
41	0.41420	52.28905	160	0.46026	52.31827
42	0.41512	52.28970	161	0.45892	52.31844
43	0.41604	52.29034	162	0.45758	52.31860
44	0.41695	52.29098	163	0.45624	52.31877
45	0.41787	52.29162	164	0.45601	52.31957
46	0.41879	52.29226	165	0.45579	52.32037
47	0.41970	52.29290	166	0.45556	52.32117
48	0.42062	52.29354	167	0.45533	52.32197
49	0.42153	52.29419	168	0.45511	52.32277
50	0.42245	52.29483	169	0.45488	52.32357
51	0.42337	52.29547	170	0.45466	52.32437
52	0.42428	52.29611	171	0.44121	52.32336
53	0.42679	52.29144	172	0.44125	52.32413
54	0.42594	52.29206	173	0.44096	52.32496
55	0.42509	52.29269	174	0.44067	52.32579
56	0.42424	52.29332	175	0.44039	52.32662
57	0.42339	52.29395	176	0.44010	52.32745
58	0.42255	52.29457	177	0.43981	52.32829
59	0.42187	52.29475	178	0.43952	52.32912
60	0.42089	52.29532	179	0.43891	52.32992
61	0.41991	52.29588	180	0.43829	52.33073
62	0.41910	52.29650	181	0.43767	52.33153
63	0.41829	52.29713	182	0.43705	52.33234
64	0.41747	52.29776	183	0.43603	52.33268
65	0.41666	52.29838	184	0.43500	52.33303

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
66	0.41585	52.29901	185	0.43398	52.33338
67	0.41504	52.29963	186	0.43284	52.33392
68	0.41423	52.30026	187	0.43170	52.33446
69	0.48121	52.29880	188	0.43056	52.33499
70	0.48090	52.29936	189	0.42942	52.33553
71	0.48059	52.29992	190	0.42829	52.33607
72	0.47973	52.30040	191	0.42715	52.33661
73	0.47888	52.30088	192	0.42601	52.33715
74	0.47802	52.30136	193	0.42487	52.33768
75	0.47717	52.30184	194	0.42484	52.33839
76	0.47683	52.30220	207	0.45954	52.34581
77	0.47605	52.30260	208	0.45911	52.34574
78	0.47541	52.30246	209	0.45880	52.34555
79	0.47450	52.30283	210	0.45856	52.34506
80	0.47359	52.30320	211	0.45828	52.34490
81	0.47281	52.30258	212	0.45784	52.34490
82	0.47203	52.30196	213	0.45695	52.34517
83	0.47124	52.30135	214	0.45661	52.34515
84	0.47046	52.30073	215	0.45585	52.34485
85	0.46968	52.30011	216	0.45528	52.34484
86	0.46889	52.29949	217	0.45401	52.34504
87	0.46805	52.30022	218	0.45275	52.34524
88	0.46720	52.30094	219	0.45223	52.34555
89	0.46611	52.30097	220	0.45180	52.34641
90	0.46502	52.30101	221	0.45137	52.34726
91	0.47558	52.30663	222	0.45095	52.34753
92	0.47437	52.30709	223	0.45017	52.34746

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
93	0.47315	52.30755	224	0.44939	52.34739
94	0.47194	52.30801	225	0.44887	52.34777
95	0.47072	52.30847	226	0.44836	52.34814
96	0.46951	52.30893	227	0.44783	52.34826
97	0.46829	52.30939	228	0.44770	52.34892
98	0.46708	52.30985	229	0.44757	52.34959
99	0.46587	52.31031	230	0.44744	52.35025
100	0.46465	52.31077	231	0.44598	52.35019
101	0.46344	52.31123	232	0.44598	52.34989
102	0.46222	52.31169	233	0.44561	52.34980
103	0.46136	52.31102	234	0.44563	52.34941
104	0.46046	52.31169	235	0.44493	52.34934
105	0.46041	52.31257	236	0.44411	52.34900
106	0.45976	52.31291	237	0.44328	52.34866
107	0.45937	52.31359	238	0.44207	52.34887
108	0.45898	52.31426	239	0.44085	52.34908
109	0.45907	52.31486	240	0.43987	52.34955
110	0.45916	52.31546	241	0.43889	52.35003
111	0.45797	52.31599	242	0.43809	52.35031
112	0.45678	52.31652	243	0.43729	52.35059
113	0.45545	52.31651	244	0.43668	52.35112
114	0.45411	52.31650	245	0.43608	52.35164
115	0.45329	52.31686	246	0.43548	52.35217
116	0.45247	52.31722	247	0.43419	52.35218
117	0.45173	52.31694	248	0.43290	52.35220
118	0.45099	52.31665	249	0.43175	52.35260
119	0.45001	52.31673	249	0.43175	52.35260

Permissive Path Receptors

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
1	0.46782	52.31245	5	0.49450	52.32912
2	0.46893	52.31557	6	0.43603	52.33268
3	0.48121	52.32940	7	0.43170	52.33446
4	0.48687	52.32873	8	0.42715	52.33661

Dwelling Receptor Data

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
1	0.42871	52.25936	113	0.43922	52.32183
2	0.40959	52.27456	114	0.44015	52.32173
3	0.40534	52.27723	115	0.44032	52.32199
4	0.40597	52.27763	116	0.44007	52.32230
5	0.40659	52.27803	117	0.44071	52.32226
6	0.40764	52.27803	118	0.44071	52.32259
7	0.40753	52.27861	119	0.44150	52.32261
8	0.41001	52.27958	120	0.44071	52.32294
9	0.41129	52.27992	121	0.44522	52.31897
10	0.41121	52.28035	122	0.44852	52.31938
11	0.41023	52.28084	123	0.44755	52.32004
12	0.41108	52.28113	124	0.44650	52.32018
13	0.41180	52.28135	125	0.44552	52.32029
14	0.40945	52.28106	126	0.44803	52.32159
15	0.40860	52.28156	127	0.44890	52.32178
16	0.40806	52.28192	128	0.45031	52.32246
17	0.40736	52.28272	129	0.44424	52.32185
18	0.40683	52.28335	130	0.44438	52.32246
19	0.40723	52.28373	131	0.44562	52.32255
20	0.48762	52.28432	132	0.44679	52.32254

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
21	0.48707	52.28482	133	0.44488	52.32310
22	0.48642	52.28547	134	0.44803	52.32308
23	0.42680	52.29188	135	0.44808	52.32344
24	0.42433	52.29355	136	0.44957	52.32341
25	0.39156	52.29395	137	0.45042	52.32354
26	0.47924	52.30288	138	0.44798	52.32381
27	0.48098	52.30344	139	0.44930	52.32388
28	0.47957	52.30382	140	0.44796	52.32419
29	0.48045	52.30379	141	0.44926	52.32447
30	0.47993	52.30411	142	0.48765	52.33077
31	0.47967	52.30437	143	0.48659	52.33126
32	0.47906	52.30473	144	0.48777	52.33159
33	0.47706	52.30601	145	0.47044	52.32963
34	0.47937	52.30705	146	0.47159	52.33002
35	0.48097	52.30876	147	0.47243	52.33062
36	0.47978	52.30896	148	0.47310	52.33099
37	0.48405	52.30272	149	0.47384	52.33180
38	0.48406	52.30355	150	0.47770	52.33210
39	0.48539	52.30366	151	0.47729	52.33249
40	0.48519	52.30468	152	0.47716	52.33288
41	0.48550	52.30497	153	0.47691	52.33313
42	0.48533	52.30539	154	0.47646	52.33327
43	0.48482	52.30567	155	0.47699	52.33360
44	0.48414	52.30591	156	0.47720	52.33394
45	0.48378	52.30611	157	0.47744	52.33422
46	0.48330	52.30628	158	0.47761	52.33444
47	0.48316	52.30656	159	0.47797	52.33474

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
48	0.48368	52.30680	160	0.47870	52.33466
49	0.48421	52.30698	161	0.47927	52.33481
50	0.48458	52.30718	162	0.47945	52.33507
51	0.48500	52.30698	163	0.47977	52.33538
52	0.48544	52.30678	164	0.47993	52.33571
53	0.48599	52.30657	165	0.48002	52.33611
54	0.48663	52.30666	166	0.48030	52.33637
55	0.48693	52.30688	167	0.48068	52.33655
56	0.48680	52.30711	168	0.48088	52.33746
57	0.48646	52.30728	169	0.48120	52.33779
58	0.48618	52.30751	170	0.48190	52.33787
59	0.48653	52.30769	171	0.48249	52.33789
60	0.48679	52.30784	172	0.48225	52.33830
61	0.48733	52.30782	173	0.44073	52.33715
62	0.48774	52.30788	174	0.41551	52.33314
63	0.48798	52.30807	175	0.41514	52.33369
64	0.48824	52.30826	176	0.41486	52.33421
65	0.48885	52.30830	177	0.41453	52.33482
66	0.48942	52.30819	178	0.41450	52.33573
67	0.48960	52.30836	179	0.41418	52.33618
68	0.49035	52.30816	180	0.41377	52.33671
69	0.49079	52.30802	181	0.41306	52.33696
70	0.49143	52.30763	182	0.41299	52.33727
71	0.49213	52.30780	183	0.41394	52.33804
72	0.49224	52.30812	184	0.41379	52.33845
73	0.49262	52.30841	185	0.41360	52.33885
74	0.49267	52.30873	186	0.41316	52.33935

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
75	0.49310	52.30909	187	0.41360	52.33969
76	0.49377	52.30909	188	0.41470	52.33978
77	0.49416	52.30940	189	0.41554	52.33993
78	0.49482	52.30912	190	0.41592	52.34026
79	0.49626	52.30872	191	0.41676	52.34034
80	0.49639	52.30935	192	0.41630	52.34051
81	0.49656	52.30958	193	0.41649	52.34078
82	0.49650	52.30988	194	0.41619	52.34092
83	0.49646	52.31013	195	0.41671	52.34138
84	0.49690	52.31010	196	0.41744	52.34134
85	0.49757	52.31011	197	0.41719	52.34193
86	0.49849	52.31014	198	0.41813	52.34233
87	0.49909	52.31017	199	0.41909	52.34247
88	0.49968	52.31017	200	0.41903	52.34289
89	0.50018	52.31013	201	0.41831	52.34344
90	0.50097	52.31019	202	0.41905	52.34360
91	0.50154	52.31023	203	0.41980	52.34363
92	0.50194	52.31025	204	0.42048	52.34355
93	0.45944	52.30775	205	0.42138	52.34353
94	0.45912	52.30847	206	0.42192	52.34361
95	0.45784	52.30839	207	0.42286	52.34352
96	0.45633	52.30836	208	0.42220	52.34392
97	0.45929	52.30929	209	0.42199	52.34438
98	0.45833	52.30954	210	0.42141	52.34474
99	0.45864	52.31054	211	0.42105	52.34507
100	0.46066	52.30994	212	0.42179	52.34537
101	0.46221	52.31059	213	0.42230	52.34555

Dwelling	Longitude (°)	Latitude (°)	Dwelling	Longitude (°)	Latitude (°)
102	0.46241	52.31149	214	0.42302	52.34582
103	0.43883	52.31292	215	0.42389	52.34630
104	0.43794	52.31677	216	0.46027	52.34665
105	0.43578	52.32077	217	0.46047	52.34693
106	0.43626	52.32087	218	0.46008	52.34731
107	0.43584	52.32127	219	0.46061	52.34753
108	0.43674	52.32111	220	0.46106	52.34780
109	0.43721	52.32122	221	0.46154	52.34807
110	0.43669	52.32154	222	0.46195	52.34826
111	0.43719	52.32200	223	0.46117	52.28392
112	0.43766	52.32183	224	0.47489	52.28475

Horse Facilities Data

Name	Longitude (°)	Latitude (°)
Snailwell Gallops	0.41823	52.27185
British Racing School	0.41418	52.26730
Limekins Gallops	0.42805	52.25762
Godolphin Stables	0.41200	52.25600
Bury Hill Gallops	0.43402	52.25540
Long Hill Gallops	0.41407	52.24681

APPENDIX I – SOLAR PANEL MODEL DETAILS

Panel Boundary Data – Area A

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.423082	52.334226	06	0.438862	52.329221
02	0.428651	52.335095	07	0.42789	52.325578
03	0.434436	52.332677	08	0.424603	52.329145

04	0.435976	52.331053	09	0.427061	52.329984
05	0.437748	52.330725			

Panel Boundary Data – Area B

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.442817	52.346822	11	0.437728	52.33387
02	0.449937	52.345721	12	0.434963	52.333579
03	0.450459	52.339237	13	0.426621	52.337507
04	0.447473	52.339232	14	0.427152	52.33949
05	0.447401	52.339694	15	0.432688	52.341109
06	0.442634	52.339508	16	0.433681	52.341217
07	0.442626	52.33857	17	0.436422	52.340848
08	0.436167	52.338348	18	0.436846	52.340379
09	0.435326	52.335062	19	0.438817	52.340369
10	0.437591	52.334849	20	0.440747	52.34186

Panel Boundary Data – Area C

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.442643	52.33318	04	0.445027	52.337704
02	0.442111	52.336957	05	0.450679	52.336945
03	0.445179	52.336378	06	0.451544	52.333906

Panel Boundary Data – Area D

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.473523	52.330344	18	0.474306	52.315965
02	0.477198	52.330577	19	0.480537	52.313731
03	0.478014	52.330463	20	0.478538	52.311833
04	0.478455	52.329157	21	0.480171	52.311381
05	0.480813	52.329151	22	0.475292	52.306807
06	0.480747	52.328592	23	0.46615	52.310377
07	0.480966	52.328179	24	0.470918	52.315086
08	0.480544	52.327639	25	0.467407	52.316393
09	0.478772	52.327482	26	0.473957	52.321704
10	0.478863	52.326022	27	0.473009	52.321644
11	0.47802	52.32527	28	0.471786	52.322977
12	0.479617	52.324436	29	0.467035	52.322655
13	0.479681	52.320893	30	0.466467	52.324749
14	0.47662	52.319694	31	0.470126	52.325075
15	0.480765	52.317582	32	0.46949	52.328422
16	0.480332	52.317128	33	0.473132	52.328626
17	0.480294	52.316049	34	0.473134	52.329824

Panel Boundary Data – Area E

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.484419	52.328267	10	0.500586	52.323839
02	0.486607	52.328515	11	0.499207	52.323417
03	0.488277	52.328139	12	0.498569	52.322039
04	0.49157	52.328972	13	0.49707	52.321888
05	0.49736	52.329143	14	0.497183	52.324375
06	0.507524	52.327547	15	0.489495	52.324298
07	0.509963	52.326595	16	0.489715	52.32258
08	0.508516	52.325055	17	0.487752	52.322308
09	0.507012	52.322401	18	0.486677	52.325387

Panel Boundary Data – Area F

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.452214	52.292454	08	0.463727	52.284448
02	0.456074	52.291128	09	0.463269	52.283916
03	0.463999	52.289715	10	0.459493	52.287168
04	0.465935	52.289674	11	0.458387	52.287466
05	0.468	52.288971	12	0.457294	52.287006
06	0.467531	52.287647	13	0.451893	52.290121
07	0.465463	52.284978			

Panel Boundary Data – Area G

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.470129	52.287666	13	0.474726	52.280981
02	0.470895	52.28691	14	0.473604	52.280726
03	0.471118	52.285843	15	0.473951	52.280064
04	0.470652	52.284389	16	0.474884	52.280167
05	0.469859	52.283433	17	0.464376	52.276219

06	0.468461	52.282793	18	0.461462	52.278671
07	0.468962	52.281136	19	0.461635	52.279661
08	0.470677	52.280466	20	0.464448	52.282541
09	0.472127	52.280787	21	0.466434	52.282459
10	0.469685	52.281969	22	0.465839	52.283741
11	0.470871	52.283803	23	0.469131	52.287031
12	0.474915	52.283543			

Panel Boundary Data – Area H

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.423657	52.283113	17	0.448334	52.277296
02	0.433263	52.276261	18	0.451574	52.279429
03	0.434466	52.27646	19	0.448767	52.281587
04	0.435289	52.277018	20	0.443378	52.278054
05	0.434585	52.277567	21	0.444034	52.276849
06	0.440604	52.281385	22	0.44549	52.276201
07	0.438928	52.282499	23	0.447291	52.276251
08	0.440248	52.283309	24	0.449837	52.27409
09	0.443044	52.282646	25	0.447099	52.274059
10	0.449076	52.286594	26	0.445446	52.273696
11	0.45251	52.286918	27	0.444639	52.27303
12	0.453833	52.28564	28	0.44444	52.27186
13	0.454218	52.284785	29	0.43537	52.268629
14	0.459311	52.279697	30	0.431836	52.268144
15	0.454829	52.276517	31	0.416665	52.279203
16	0.449386	52.276456			

Panel Boundary Data – Area I

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
01	0.410813	52.291849	08	0.398697	52.293532

02	0.406343	52.288298	09	0.402337	52.293873
03	0.404797	52.288894	10	0.403004	52.293701
04	0.401536	52.289057	11	0.405067	52.292202
05	0.39806	52.290844	12	0.406013	52.29291
06	0.397388	52.292323	13	0.407479	52.293177
07	0.397834	52.293094	14	0.408908	52.292872

APPENDIX J – DETAILLED MODELLING RESULTS

Overview

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

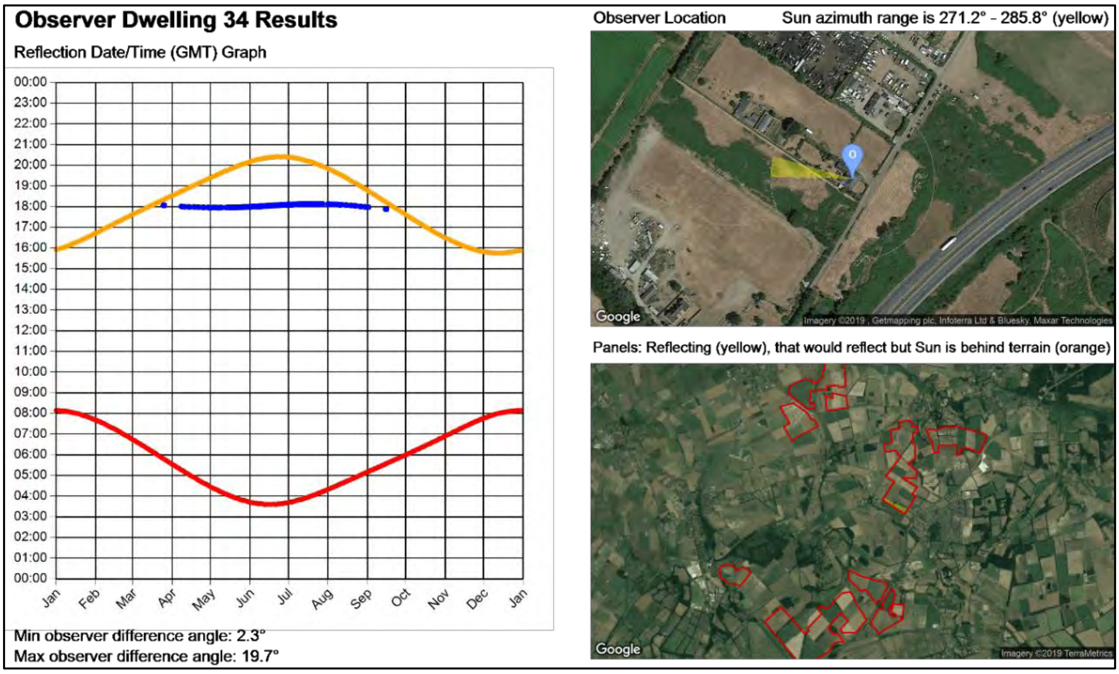
a. The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of the report;

b. 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;

c. 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.

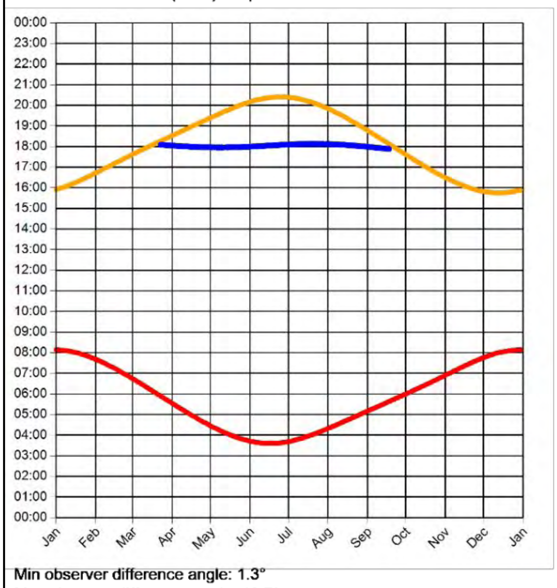
d. The sunrise and sunset curves throughout the year (red and yellow lines).

Dwelling Receptors



Observer Dwelling 35 Results

Reflection Date/Time (GMT) Graph



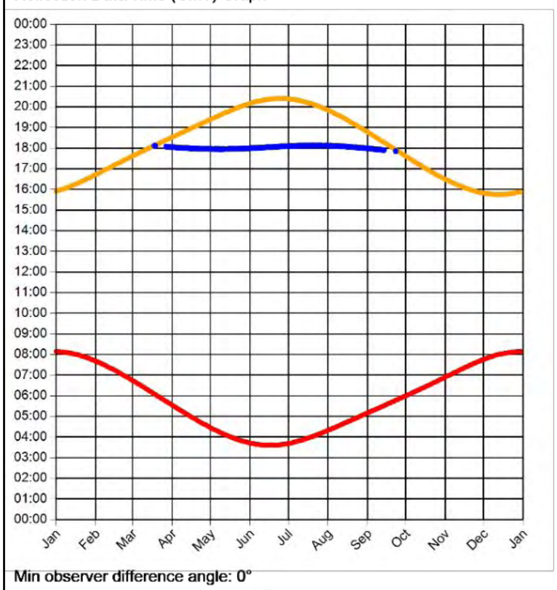
Min observer difference angle: 1.3°
Max observer difference angle: 19.7°

Observer Location — Sun azimuth range is 270.9° - 285.8° (yellow)

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

Observer Dwelling 36 Results

Reflection Date/Time (GMT) Graph

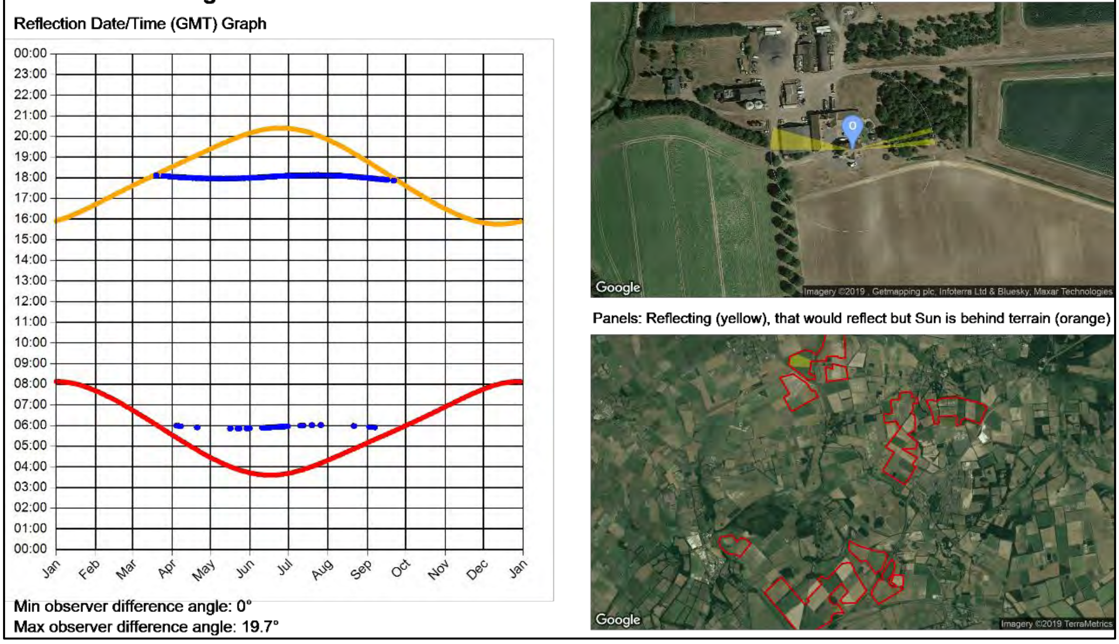


Min observer difference angle: 0°
Max observer difference angle: 19.7°

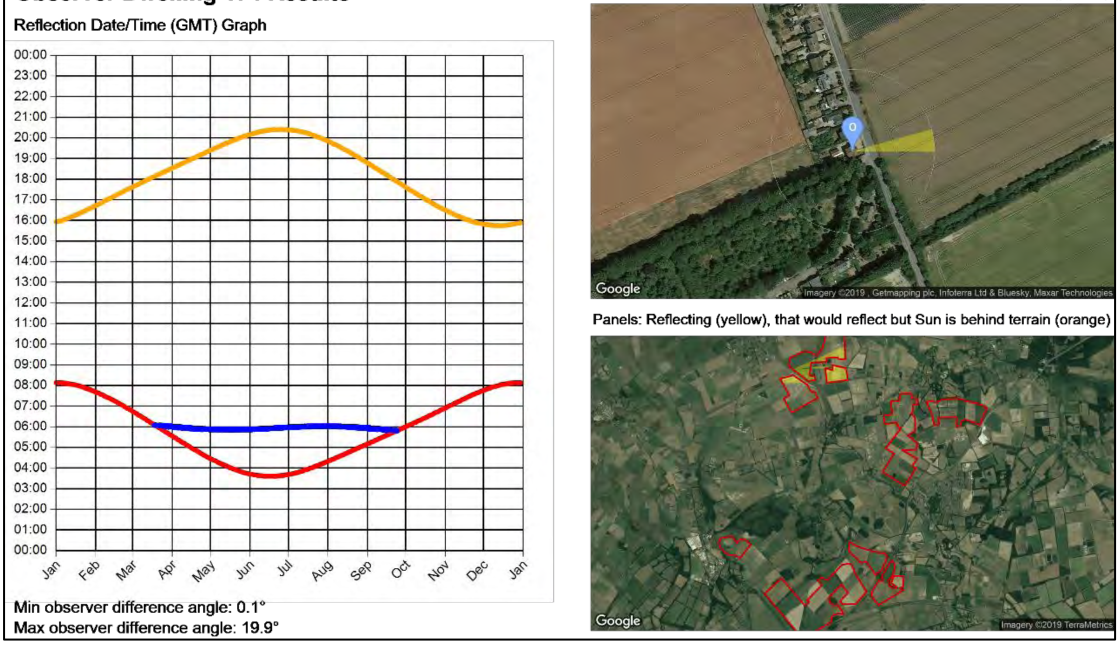
Observer Location — Sun azimuth range is 269.7° - 285.8° (yellow)

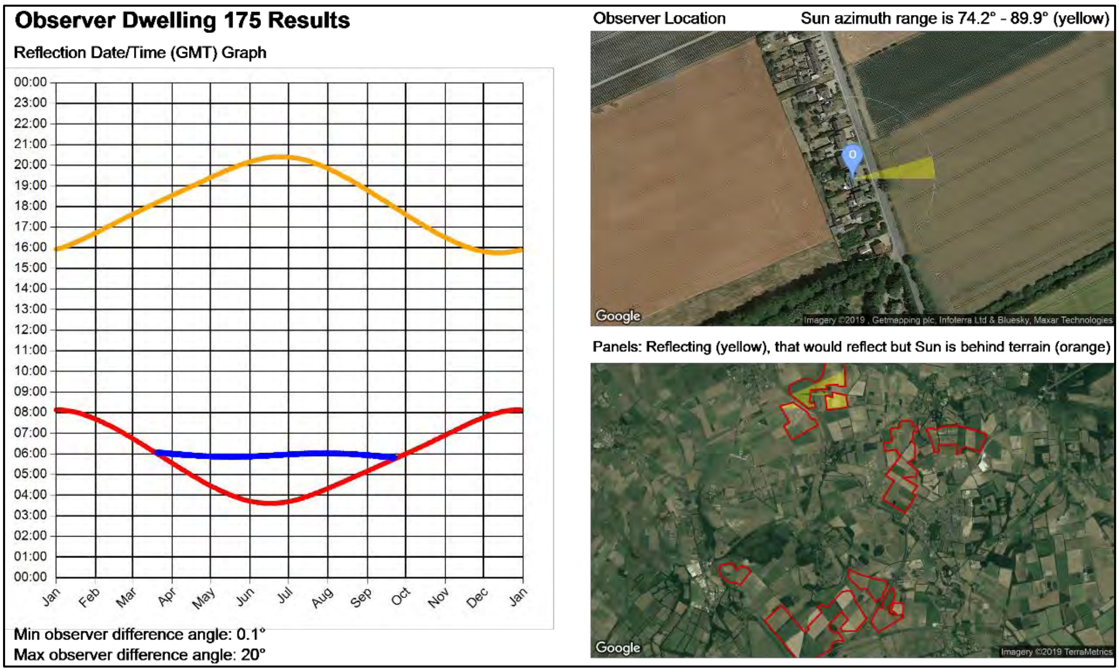
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

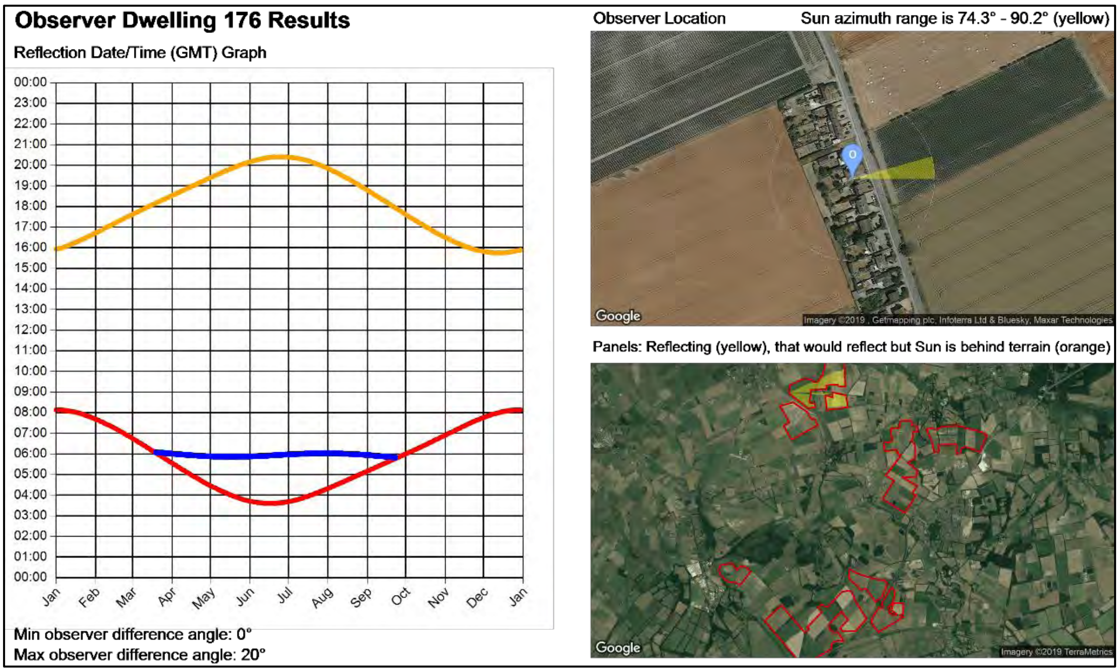
Observer Dwelling 173 Results



Observer Dwelling 174 Results

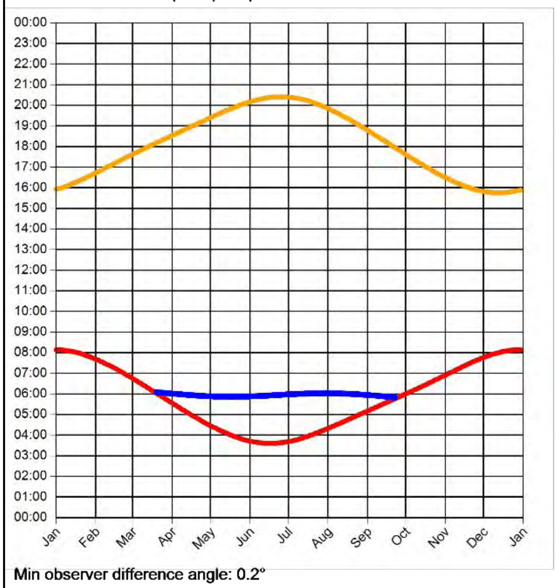



Observer Dwelling 175 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 0.1°
Max observer difference angle: 20°
Observer Location
Sun azimuth range is 74.2° - 89.9° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer Dwelling 176 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: 20°
Observer Location
Sun azimuth range is 74.3° - 90.2° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Observer Dwelling 177 Results

Reflection Date/Time (GMT) Graph



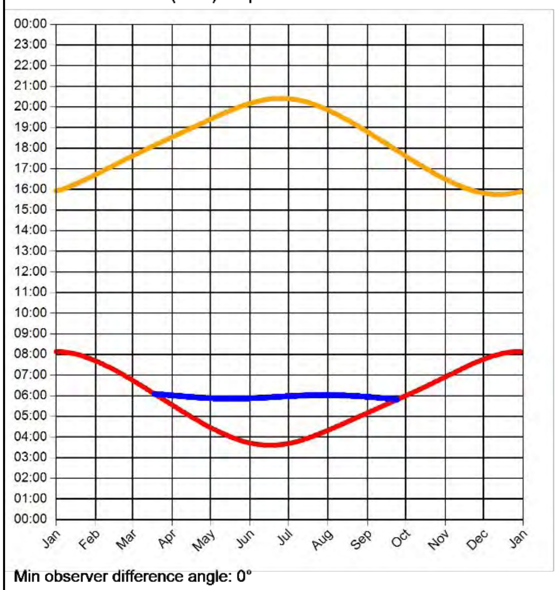
Min observer difference angle: 0.2°
Max observer difference angle: 20°

Observer Location — Sun azimuth range is 74.3° - 90.3° (yellow)

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

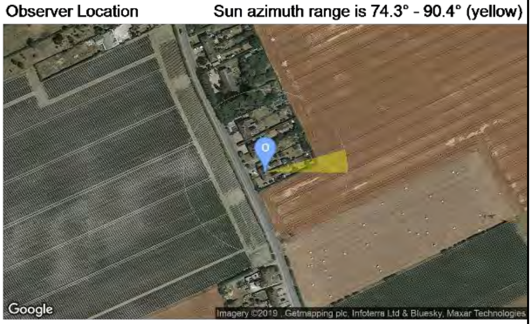
Observer Dwelling 178 Results

Reflection Date/Time (GMT) Graph



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

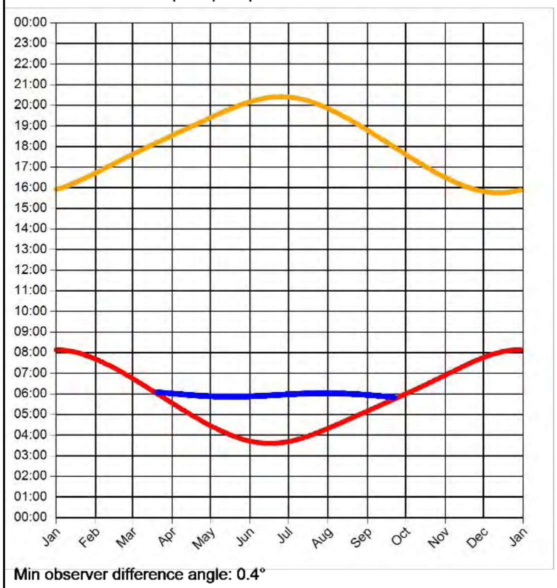
Observer Location — Sun azimuth range is 74.3° - 90.4° (yellow)



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

Observer Dwelling 179 Results

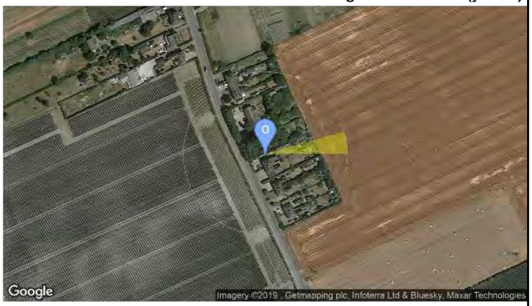
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.4°
Max observer difference angle: 20.1°

Observer Location

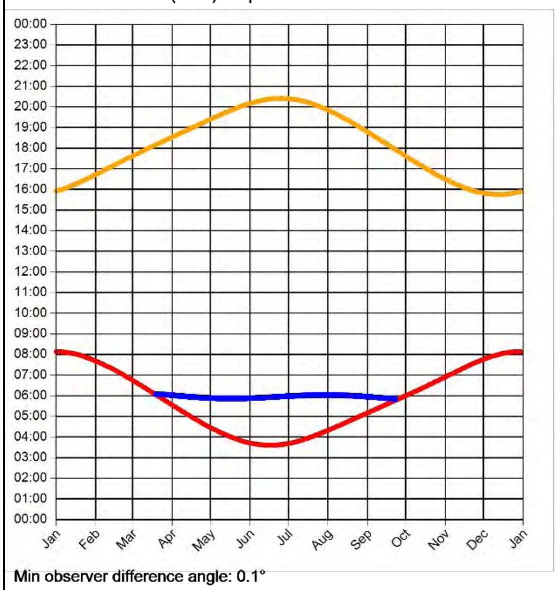
Sun azimuth range is 74.3° - 90° (yellow)



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

Observer Dwelling 180 Results

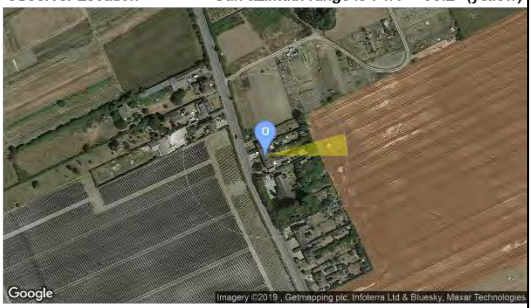
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 20.1°

Observer Location

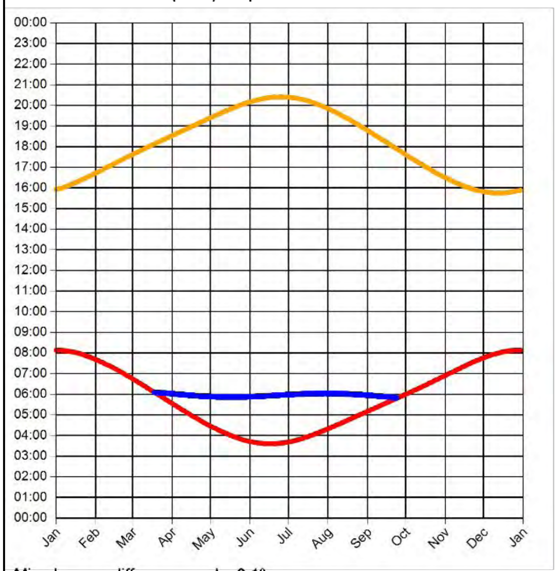
Sun azimuth range is 74.4° - 90.2° (yellow)



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

Observer Dwelling 181 Results

Reflection Date/Time (GMT) Graph



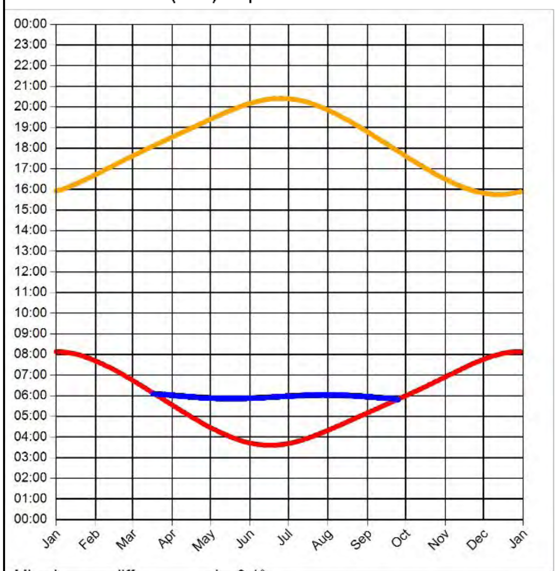
Min observer difference angle: 0.1°
Max observer difference angle: 20.1°

Observer Location — Sun azimuth range is 74.4° - 90.4° (yellow)

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

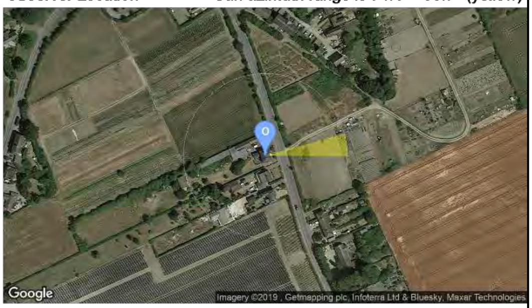
Observer Dwelling 182 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 20.1°

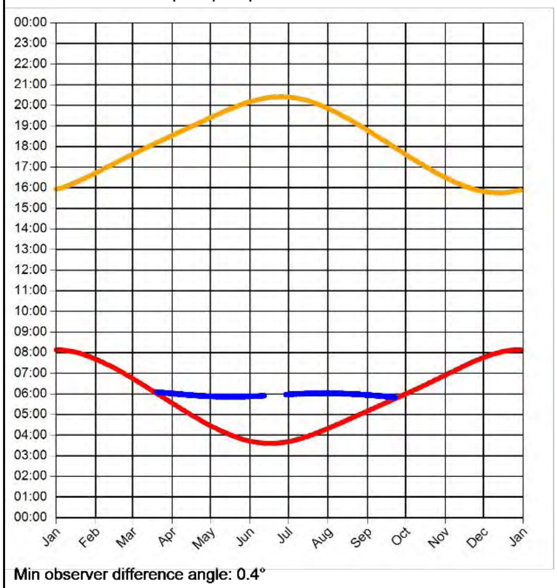
Observer Location — Sun azimuth range is 74.4° - 90.7° (yellow)



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

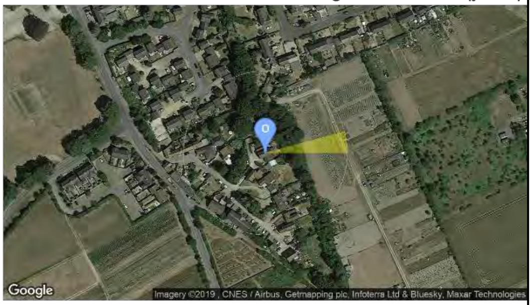
Observer Dwelling 185 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.4°
Max observer difference angle: 19.6°

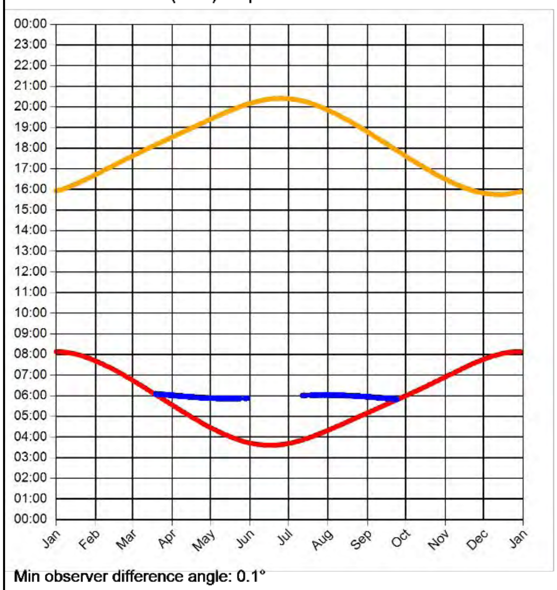
Observer Location — Sun azimuth range is 74.6° - 90.1° (yellow)



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

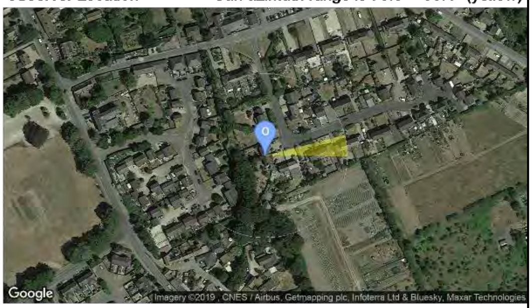
Observer Dwelling 187 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 18.6°

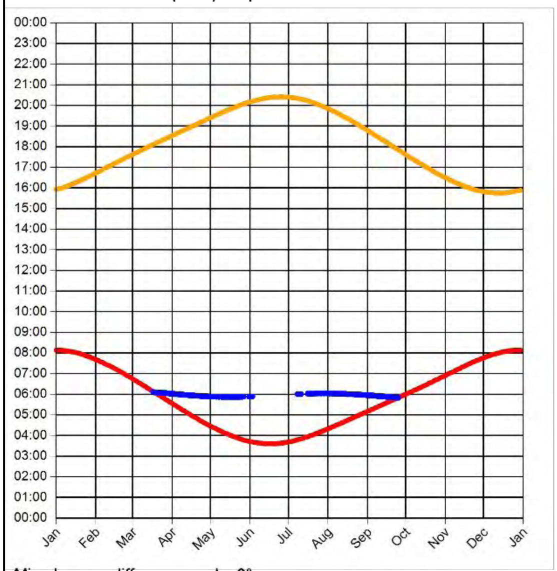
Observer Location — Sun azimuth range is 75.5° - 90.4° (yellow)



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

Observer Dwelling 188 Results

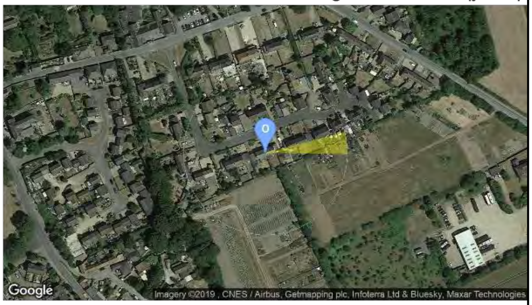
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 19.1°

Observer Location

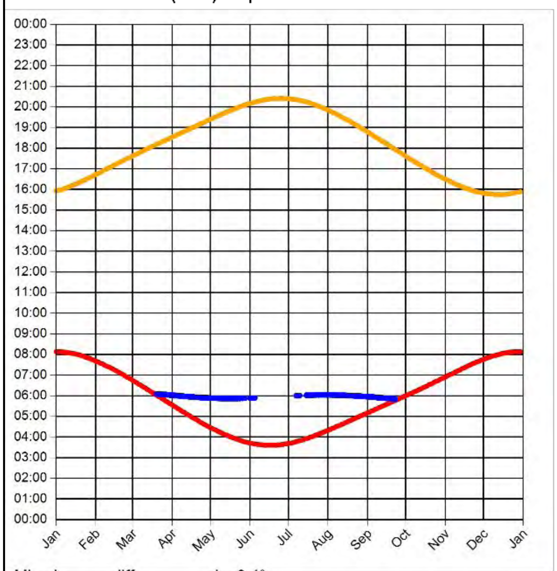
Sun azimuth range is 75.2° - 90.9° (yellow)



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

Observer Dwelling 189 Results

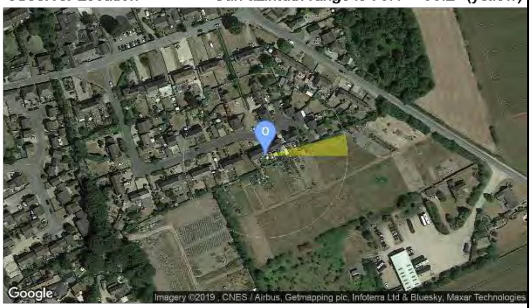
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.4°
Max observer difference angle: 19.3°

Observer Location

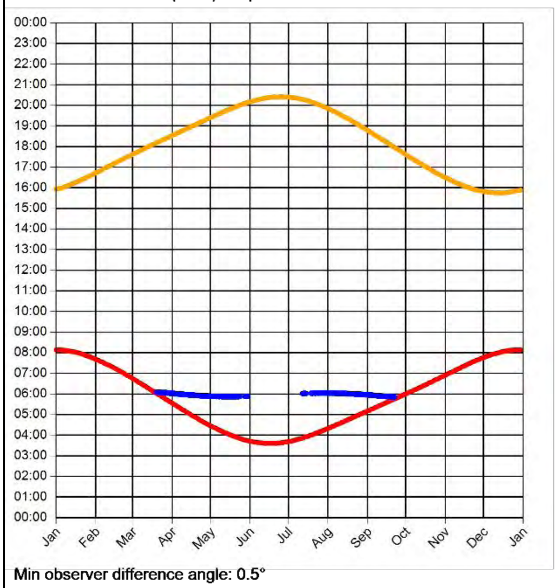
Sun azimuth range is 75.1° - 90.2° (yellow)



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

Observer Dwelling 190 Results

Reflection Date/Time (GMT) Graph



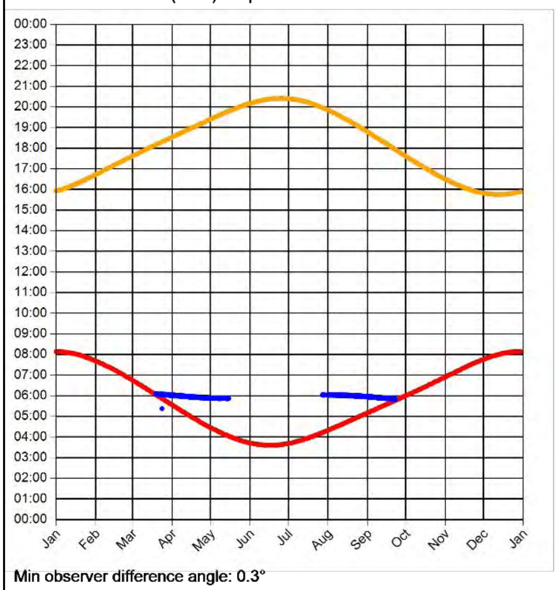
Min observer difference angle: 0.5°
Max observer difference angle: 18.8°

Observer Location — Sun azimuth range is 75.6° - 90.1° (yellow)

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

Observer Dwelling 195 Results

Reflection Date/Time (GMT) Graph



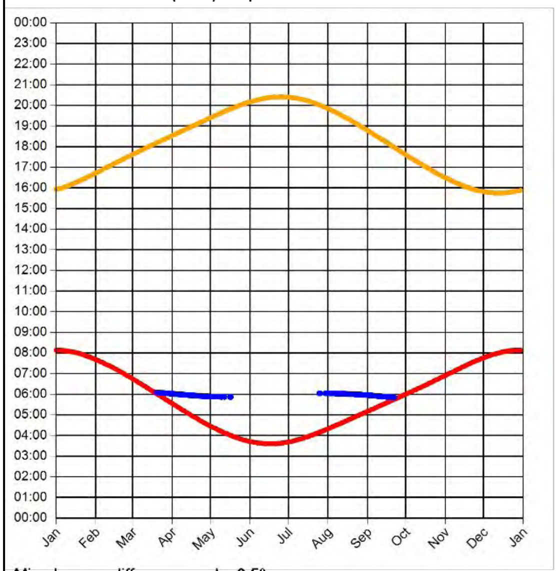
Min observer difference angle: 0.3°
Max observer difference angle: 16.4°

Observer Location — Sun azimuth range is 77.6° - 90.2° (yellow)

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

Observer Dwelling 196 Results

Reflection Date/Time (GMT) Graph



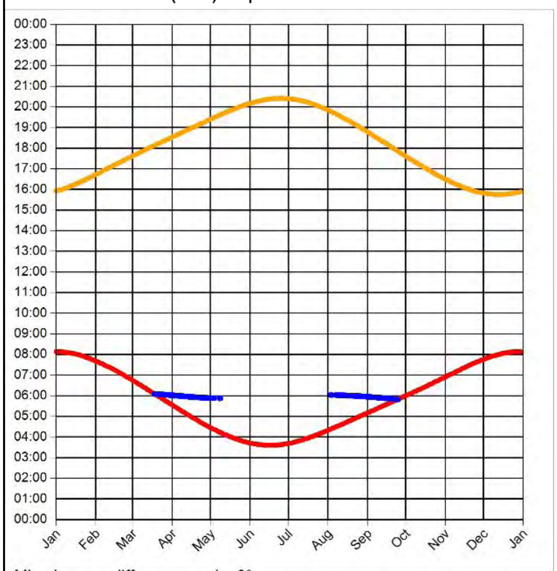
Min observer difference angle: 0.5°
Max observer difference angle: 16.9°

Observer Location — Sun azimuth range is 77.2° - 90.1° (yellow)

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

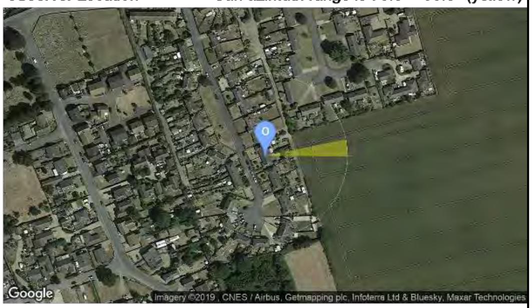
Observer Dwelling 197 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 15.1°

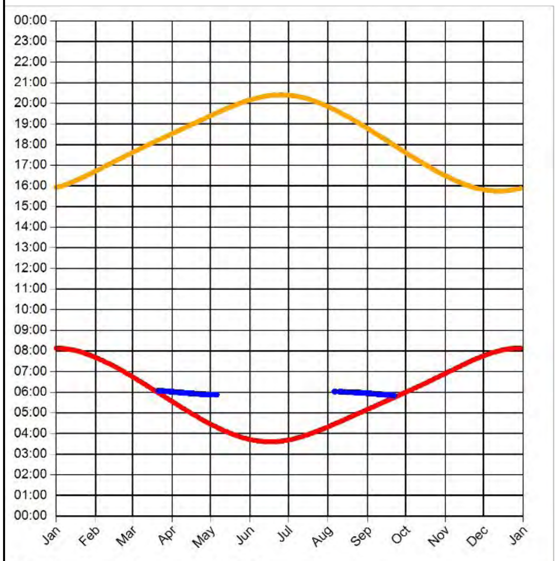
Observer Location — Sun azimuth range is 78.6° - 90.6° (yellow)



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

Observer Dwelling 198 Results

Reflection Date/Time (GMT) Graph



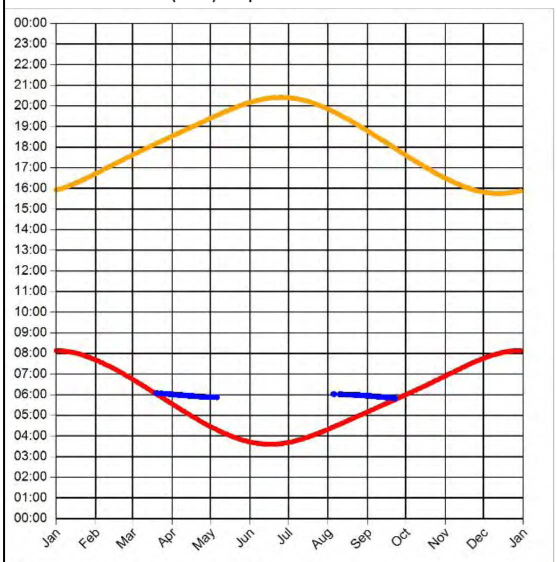
Min observer difference angle: 0.6°
Max observer difference angle: 14.5°

Observer Location Sun azimuth range is 79.1° - 89.9° (yellow)

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

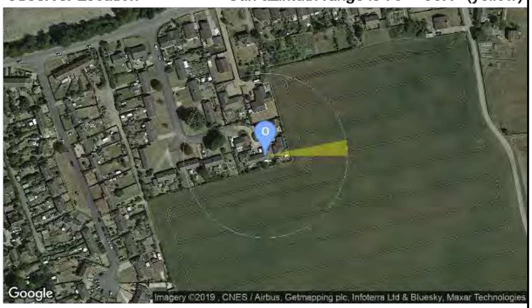
Observer Dwelling 199 Results

Reflection Date/Time (GMT) Graph

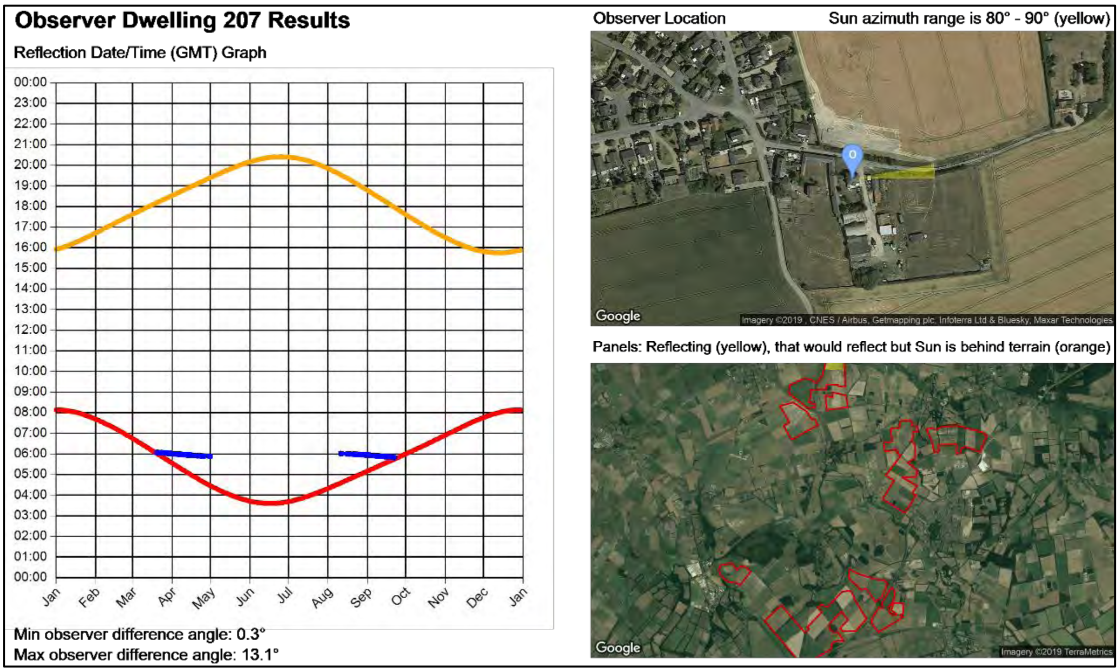


Min observer difference angle: 0.2°
Max observer difference angle: 14.5°

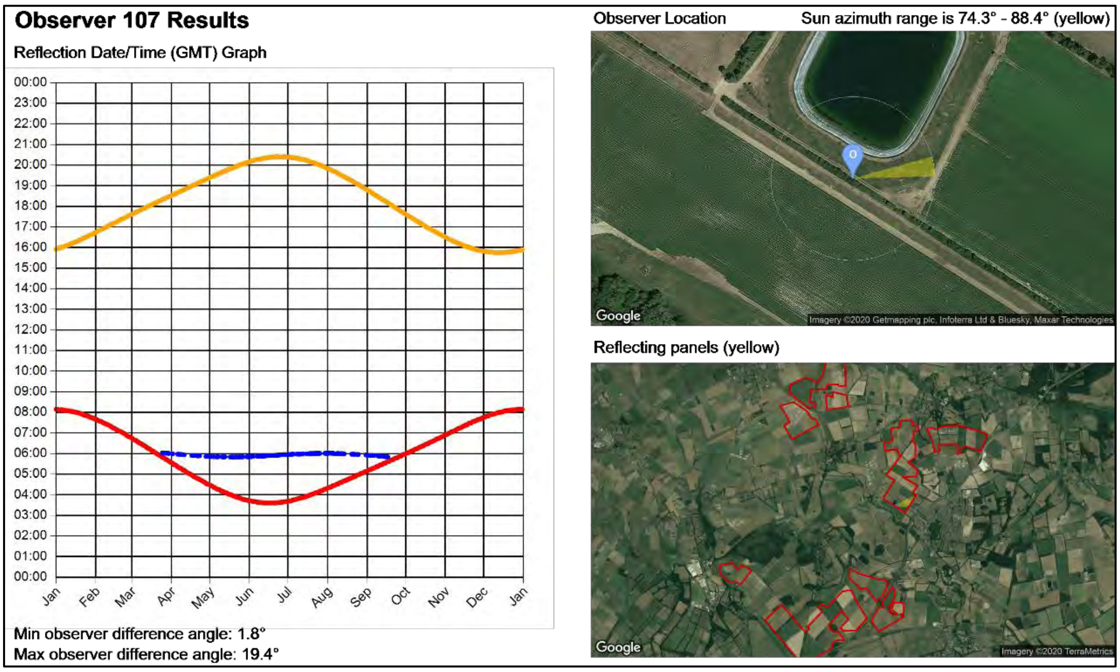
Observer Location Sun azimuth range is 79° - 90.1° (yellow)



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

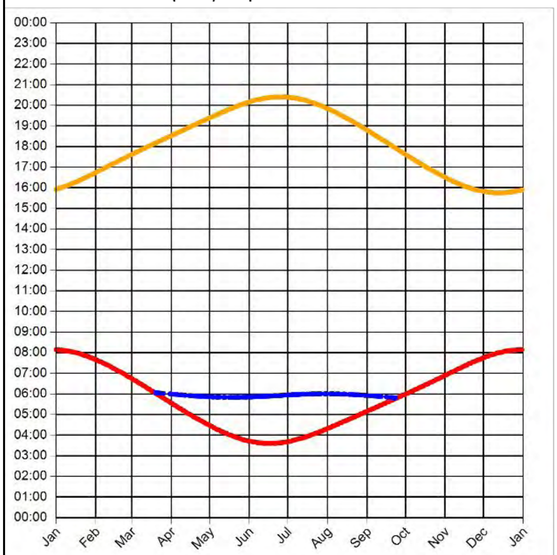


Public Right of Way and Bridleway Receptors



Observer 108 Results

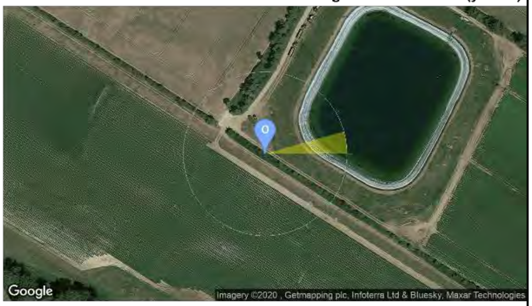
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 19.5°

Observer Location

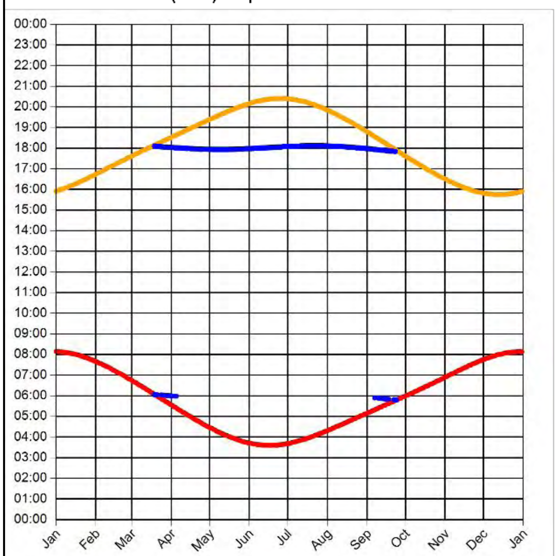
Sun azimuth range is 74.2° - 89.8° (yellow)



Reflecting panels (yellow)

Observer 149 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 20.2°

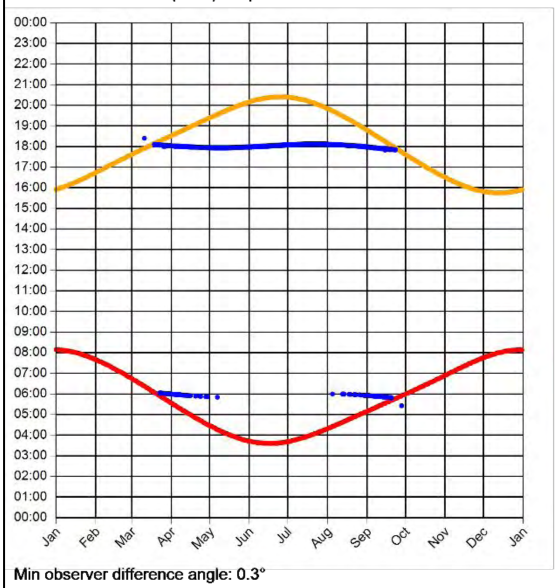
Observer Location

Sun azimuth ranges (yellow)

Reflecting panels (yellow)

Observer 150 Results

Reflection Date/Time (GMT) Graph



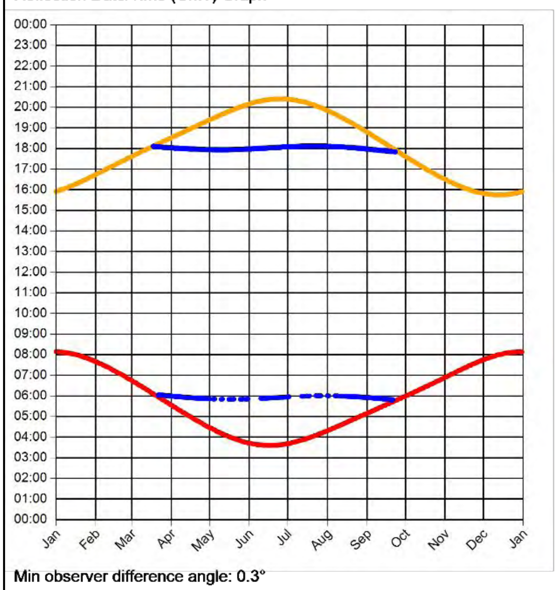
Min observer difference angle: 0.3°
Max observer difference angle: 20.1°

Observer Location — Sun azimuth ranges (yellow)

Reflecting panels (yellow)

Observer 151 Results

Reflection Date/Time (GMT) Graph



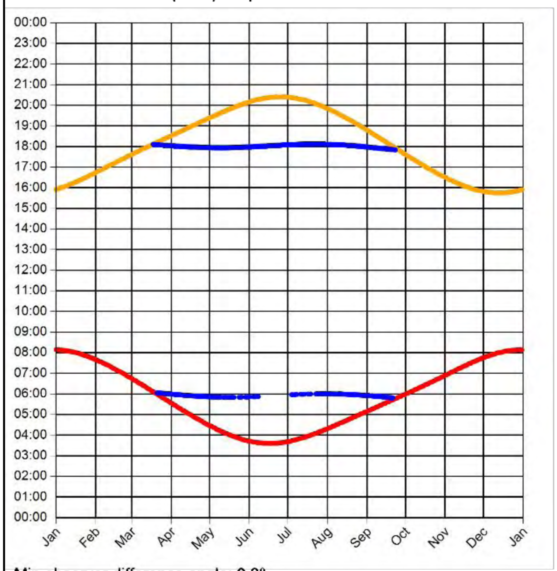
Min observer difference angle: 0.3°
Max observer difference angle: 19.8°

Observer Location — Sun azimuth ranges (yellow)

Reflecting panels (yellow)

Observer 152 Results

Reflection Date/Time (GMT) Graph



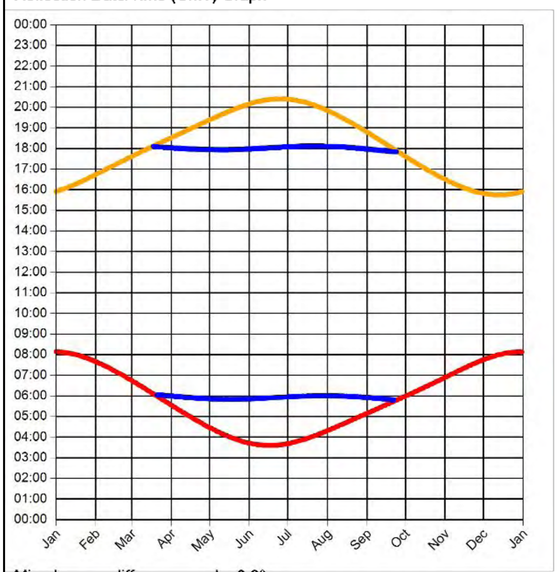
Min observer difference angle: 0.3°
Max observer difference angle: 19.8°

Observer Location | Sun azimuth ranges (yellow)

Reflecting panels (yellow)

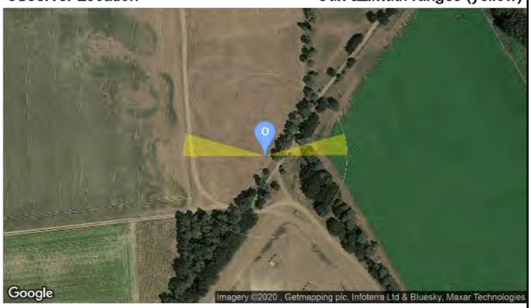
Observer 153 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.3°
Max observer difference angle: 19.8°

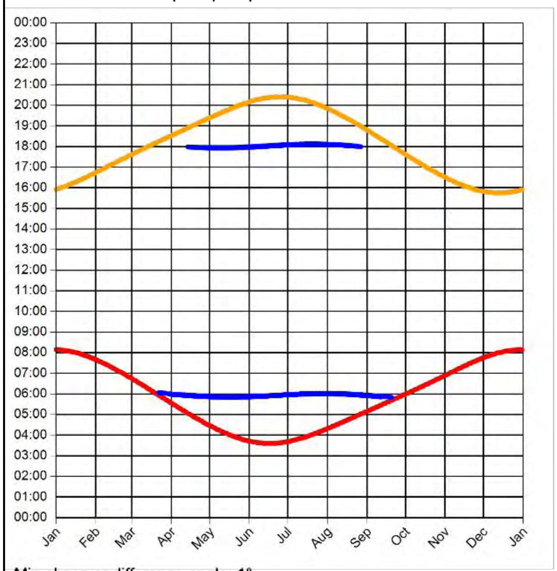
Observer Location | Sun azimuth ranges (yellow)



Reflecting panels (yellow)

Observer 160 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 1°
Max observer difference angle: 20°

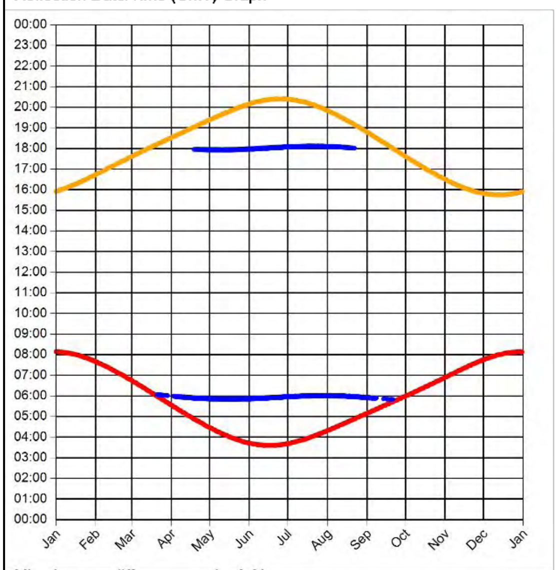
Observer Location

Sun azimuth ranges (yellow)

Reflecting panels (yellow)

Observer 161 Results

Reflection Date/Time (GMT) Graph

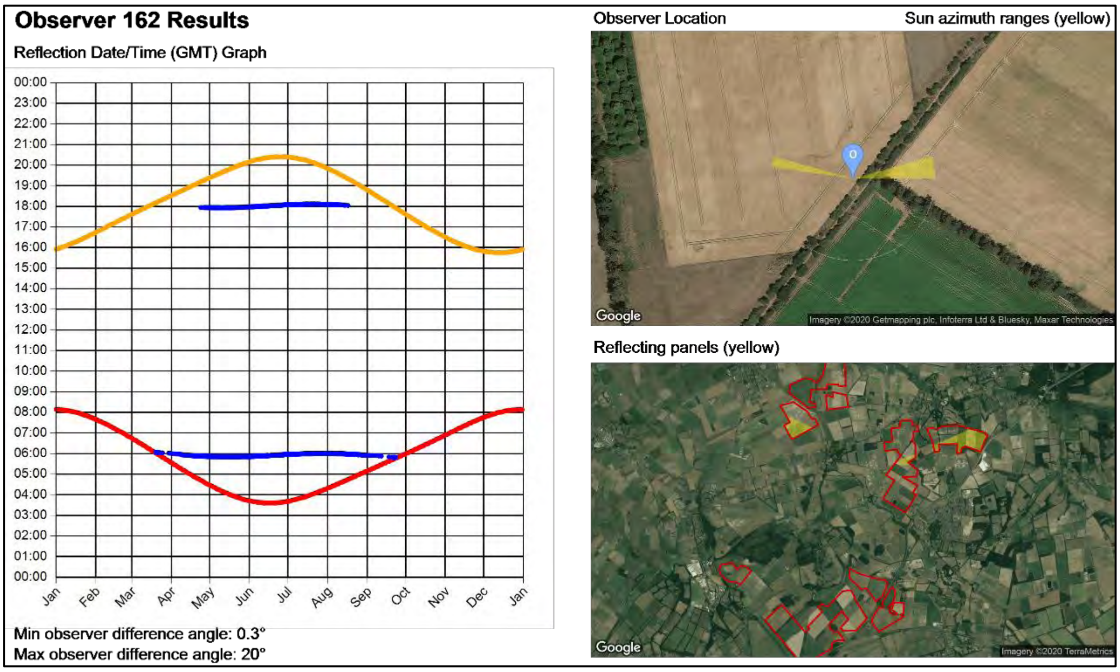


Min observer difference angle: 0.9°
Max observer difference angle: 20°

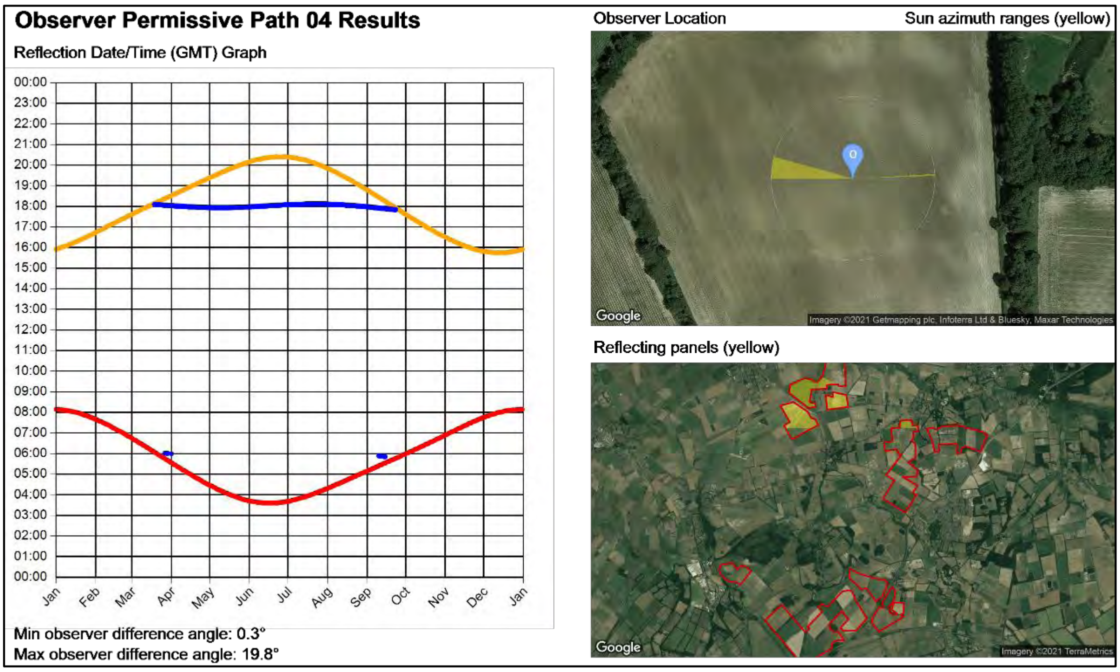
Observer Location

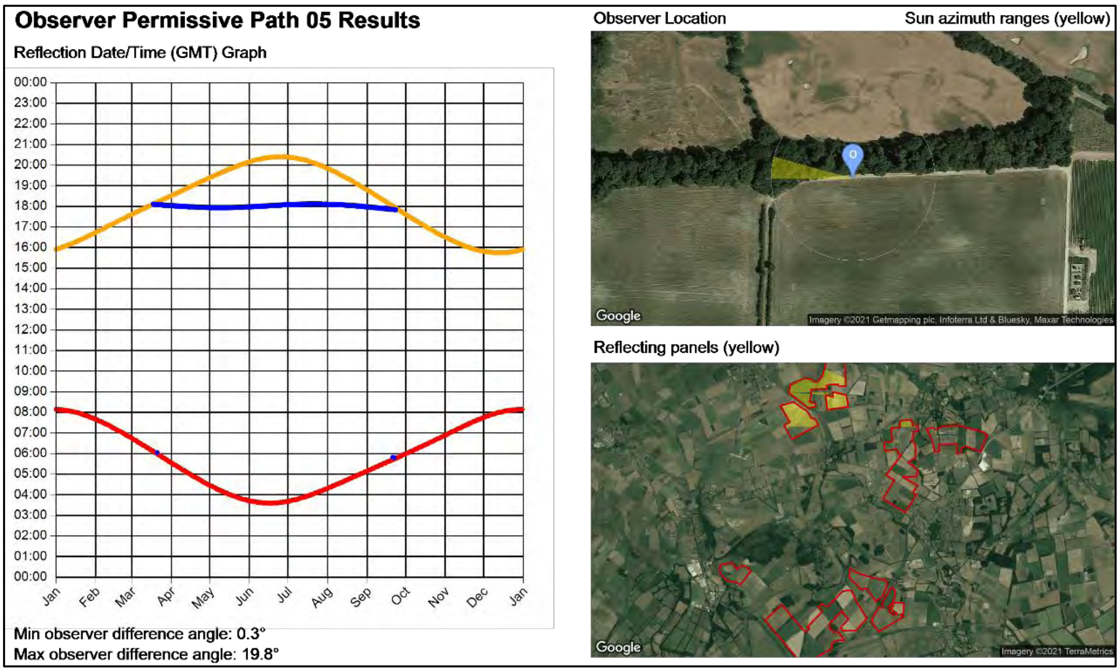
Sun azimuth ranges (yellow)

Reflecting panels (yellow)


Observer 162 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: 0.3°
Max observer difference angle: 20°
Observer Location
Sun azimuth ranges (yellow)
Google
Reflecting panels (yellow)
Google

Permissive Path Receptors





PAGERPOWER
Urban & Renewables

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

Tel: +44 1787 319001 **Email:** info@pagerpower.com [redacted]