Cottam Solar Project

Environmental Statement

Appendix 16.1: Solar Photovoltaic Glint and Glare Study

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Solar Photovoltaic Glint and Glare Study

Cottam Solar Project

Cottam Solar Project Limited

December 2022





ADMINISTRATION PAGE

Job Reference:	10856I
Date:	October 2022
Author:	Andrea Mariano
Telephone:	[redacted]
Email:	[redacted]

Reviewed By:	Hannah McNaul; Kai Frolic; Michael Sutton
Email:	[redacted]

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2	November 2022	Second issue – Minor amendments
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4	December 2022	Fourth issue – River Trent comment

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 identify the potential receptors associated with the proposed solar development Cottam to be located near Gainsborough, Lincolnshire, England. This glint and glare assessment pertains to the possible impact upon surrounding road safety, residential amenity, railway operation and infrastructure and aviation operations[1].

Pager Power

Pager Power has undertaken over 900 glint and glare assessments in the UK, Europe and internationally. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders including airports and aviation regulators.

Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. The UK CAA guidance is relatively high-level and does not prescribe a formal methodology. Pager Power has reviewed existing guidelines and the available studies in the process of defining its own glint and glare assessment guidance document and methodology[2]. This methodology defines a comprehensive process for determining the impact upon roads, dwellings, railway operation and infrastructure and aviation activity.

Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

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

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[1] Public Rights of Way (PRoW) have not been included within this assessment because they are receptors with "low" sensitivity which means the receptor is tolerant of change without detrimental effect, is of low or local importance.

[2] Pager Power Glint and Glare Guidance, Fourth Edition (4), April 2022.

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

High-Level Assessment of Aviation Receptors

Aviation Receptors – Consultation

Pager Power has consulted with the safeguarding teams at Sturgate Airfield and RAF Scampton with regard to the effect of the proposed development upon aviation activity. The results of the glint and glare were presented and the safeguarding teams have concluded that the proposed development is not predicted to pose a significant risk upon their operations. Both safeguarding teams have not submitted an objection towards the proposed development as part of the pre-application consultation process.

Aviation Receptors – High Level Assessment

Considering the associated guidance and industry best practice it is predicted that the impact of the proposed developments will be acceptable and full technical modelling of aviation receptors associated with Haxey, Hibaldstow, Forwood, and Headon Airfields will not be required. This is because:

- The orientation of the runways is such that the proposed development will be outside the pilot's field of view (this means that, even if solar reflections are predicted towards pilots, the reflection will originate from outside the pilot's field of view and will therefore not be deemed significant);
- If solar reflections are visible, it is likely that any glare towards pilots will have low potential for after-image due to the large separation distance between the airfields and the proposed developments.

High-Level Assessment of Waterways

Pager Power has reviewed the available imagery to identify if any waterway[4-5] exists within 1km from proposed development. No waterway of a size sufficiently large to accommodate navigation has been identified and therefore glint and glare impacts towards waterway users are not considered possible.

The river Trent is circa 5.4km west of Cottam Solar Development (at its closest point). Therefore, if geometrically possible and unscreened, any glint and glare effects will not have a significant impact due to the large separation distance.

High-level Assessment of Public Rights of Way

In Pager Power's experience, significant impacts upon pedestrians/observers along PRoWs from glint and glare are not possible. The reasoning is due to the sensitivity of the receptors (in terms of amenity and safety) being concluded to be of low significance because:

- The typical density of pedestrians on a PRoW is low in a rural environment;
- Any resultant effect is much less serious and has far lesser consequences than, for example, solar reflections experienced towards a road network whereby the resultant impacts of a solar reflection can be much more serious to safety;

[4] A navigable body of water, such as a river, channel, or canal.

[5] River Till is a small river located nearby Cottam 1. This river is too small for navigation and it is not considered within the assessment.

- Glint and glare effects towards receptors on a PRoW are transient, and time and location sensitive whereby a pedestrian could move beyond the solar reflection zone with ease with little impact upon safety or amenity;
- There is no safety hazard associated with reflections towards an observer on a footpath.

Furthermore, any effect will have a low magnitude because:

- It is likely that the existing and the proposed screening is predicted fully remove the visibility of the proposed development for certain PRoW users;
- If effects are possible and unscreened they would typically coincide with direct sunlight. The Sun is a far more significant source of light.
- The reflection intensity is similar for solar panels and still water (and significantly less than reflections from glass and steel[6]) which is frequently a feature of the outdoor environment surrounding public rights of way. Therefore, the reflections are likely to be comparable to those from common outdoor sources whilst navigating the natural and built environment on a regular basis.

Therefore, since no significant impacts are predicted, no full modelling is required.

Assessment Results – Dwelling Receptors

The results of the analysis have shown that reflections from the proposed development are geometrically possible towards some of the identified dwelling receptors. Under the baseline scenario a significant impact is predicted for:

- Fixed System: 7 dwellings (Cottam 1), 2 dwellings (Cottam 2), 3 dwellings (Cottam 3a), 1 dwelling (Cottam 3b).
- Tracking System: 7 dwellings (Cottam 1), 2 dwellings (Cottam 2), 4 dwellings (Cottam 3a), 1 dwelling Cottam 3b).

Within the landscaping plan, the developer has proposed mitigation in the form of vegetation. It is predicted that the proposed mitigation solution will reduce the impact to acceptable levels (the proposed screening is predicted to significantly reduce the visibility[7] of the reflective area from observers located at the ground floor[8]). If necessary, the developer will implement an interim mitigation measure (opaque fence) before planting is established. Therefore, low impact is predicted at worst upon the identified dwelling receptors, and no further mitigation is recommended.

Road Receptors

The results of the analysis have shown that solar reflections from the proposed development are geometrically possible towards some of the identified road receptors. Under the baseline scenario a significant impact (from Cottam 3a only) is predicted for road users travelling along a stretch of Kirton Road - B1205 of circa 2.2km (fixed system) or circa 2.4km (tracking system).

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

[7] Vegetation may provide varying levels of cover, immediately after planting, during winter, and after maintenance (e.g. pruning). The developer will also implement instant screening.

[8] The ground floor is typically considered the main living space and has a greater significance with respect to residential amenity and views from the first floor have been considered within the results discussion where appropriate.

However, the proposed screening is predicted to significantly reduce the visibility of the reflective area for road users travelling along Kirton Road. The height of the screening will be sufficient to significantly reduce visibility[7] of reflecting solar panel for typical road users' drivers. If necessary, the developer will implement an interim mitigation measure (opaque fence) before planting is established. Therefore, a low impact is predicted at worst upon the identified road receptors, and no further mitigation is recommended.

Network Rail Receptors

Railway Signal Receptors

No potential signal locations were identified along the assessed section of railway line using available imagery and have therefore not been assessed. Network Rail has been contacted to confirm the location of any signals at these locations; however, no response has been received to date. Once a response has been received, the report can be updated.

Train Driver Receptors

The results of the analysis have shown that reflections from the proposed development are geometrically possible towards train drivers. Under the baseline scenario a significant impact (from Cottam 3b only) is predicted for train drivers travelling north-east for a section of 2.3km of assessed railway track for the tracking system and a section of 1.9km for the fixed system. However, the proposed screening is predicted to significantly reduce the visibility[7] of the reflective panel area from train driver receptors. Therefore, a low impact is predicted at worst upon the identified train driver receptors, and no further mitigation is recommended.

Cumulative Assessment of Nearby Solar NSIP Projects

The cumulative glint and glare effect of West Burton Solar Project, Gate Burton Energy Park and Tillbridge Solar. Gate Burton Energy Park, West Burton 1 and Tillbridge Solar are sufficiently close to Cottam 1 to share multiple receptors, and this is also true for Tillbridge Solar and Cottam 2.

The shared receptors are as follows:

- Cottam, West Burton 1, 2 and 3 and Gate Burton Energy Park:
  - A section of B1241 near Gainsborough village (specifically road receptor 1 to 13).
  - Dwellings near and within Gainsborough village (specifically dwelling receptors 1 to 14, 15 to 17 and 19 to 34).
  - A section of Till Bridge Lane south of Cottam 1 (specifically road receptors 41 to 46).
- Cottam and Tillbridge Solar:
  - The A631 between Cottam 2 and Tillbridge Solar (specifically road receptor 1 to 27).
  - Dwellings between Cottam 1 and Tillbridge Solar (specifically dwelling receptors 135 to 138) and dwelling 49 between Cottam 2 and Tillbridge Solar.

However, under the baseline conditions, shared receptors are either unlikely to concurrently have visibility of multiple areas (Gate Burton Energy Park and West Burton 1) or, if visibility is possible, (Cottam 1 and 2 and Tillbridge Solar) no significant impact is predicted due to the presence of significant mitigating factors such as: the presence of partial screening reducing views of multiple developments, large separation distance between the receptors and the developments, the Sun being low at the horizon at the time of solar reflections. Therefore, no significant cumulative effects are possible.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 54 countries within Europe, Africa, America, Asia and Australasia.

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

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

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

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

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

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to identify the potential receptors associated with the proposed solar development Cottam to be located near Gainsborough, Lincolnshire, England. This glint and glare assessment pertains to the possible impact upon surrounding road safety, residential amenity, railway operation and infrastructure and aviation operations[9]. A report has therefore been produced that contains the following:

- Presentation of indicative solar development areas;
- Explanation of glint and glare;
- Overview of relevant guidance;
- Overview of relevant studies;
- Identification of receptors:
  - Road receptors;
  - Dwelling receptors;
  - Railway receptors (train driver locations and railway signals);
  - Licensed and unlicensed aerodromes (ATC Towers and approach paths).
- Assessment methodology and process;
- Stakeholders where consultation is required.

1.2 Glint and Glare Definition

The definition of glint and glare is as follows[10-11]:

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

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

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[9] Public Rights of Way (PRoW) have not been included within this assessment because they are receptors with "low" sensitivity which means the receptor is tolerant of change without detrimental effect, is of low or local importance

[10] "These definitions are aligned with those presented within the Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) – published by the Department for Business, Energy & Industrial Strategy in September 2021 and the Federal Aviation Administration in the USA."

[11] 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: 08/12/2021.

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layouts

2.1.1 Cottam 1 – Coates

Figure 1, Figure 2 and Figure 3[12-13] below and in the following page show the proposed site layout plans which demonstrate the worst-case scenario for the purposes of this assessment. The blue areas denote the proposed solar panel locations.

Figure 1 Cottam 1 (Coates) site layout (north site)

[12] Provided to Pager Power by the developer, IGP Ltd.

[13] There are two options for Cottam 1 west site. In this assessment, the one with the largest panel area (Figure 2) has been considered in the modelling since it represents the worst-case scenario.

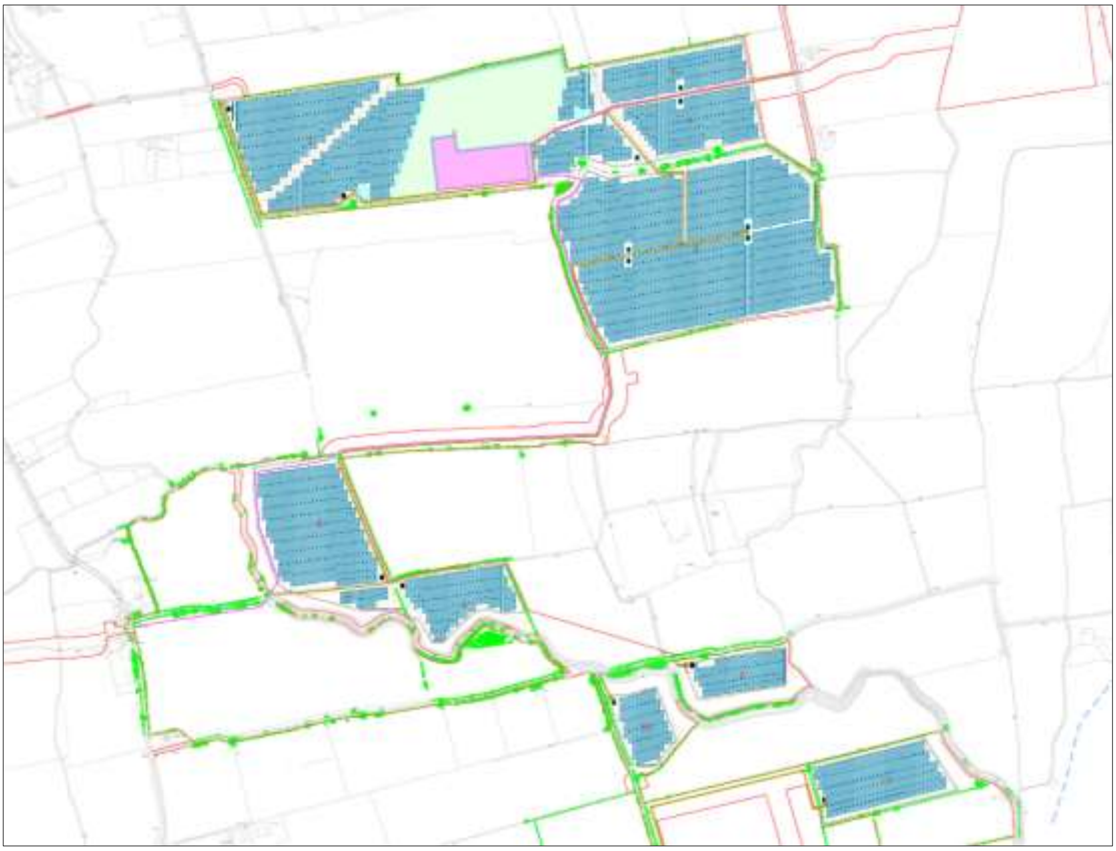

Figure 2 Cottam 1 (Coates) worst-case site layout (west site)

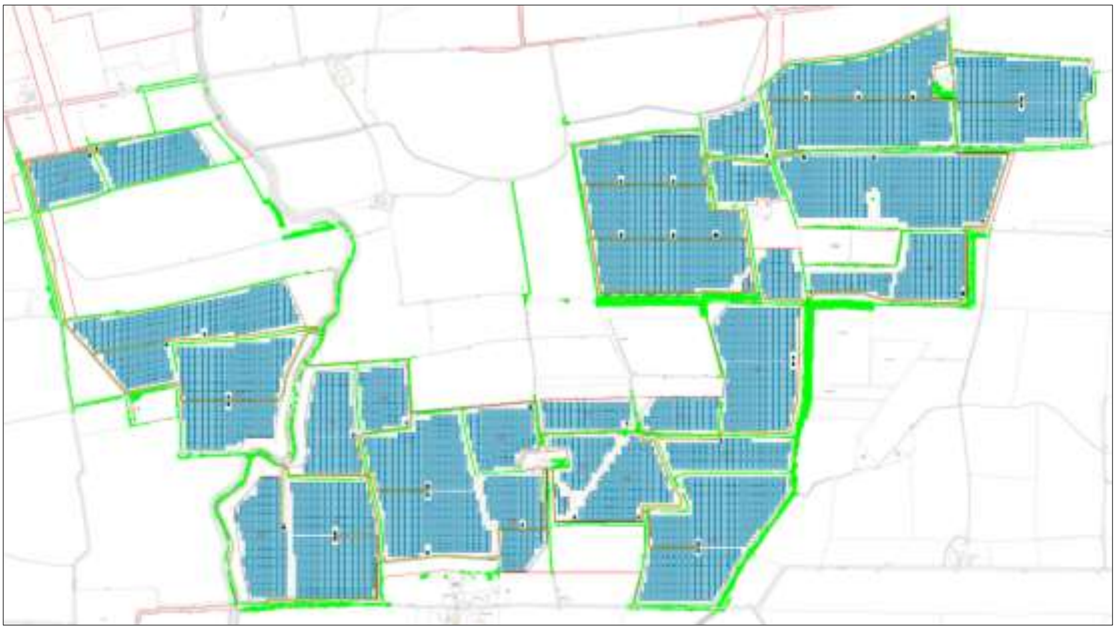

Figure 3 Cottam 1 (Coates) site layout (south site)

2.1.2 Cottam 2 – Corringham Grange Farm

Figure 4 below[12] shows the worst-case site layout plan. The blue areas denote the solar panel locations.

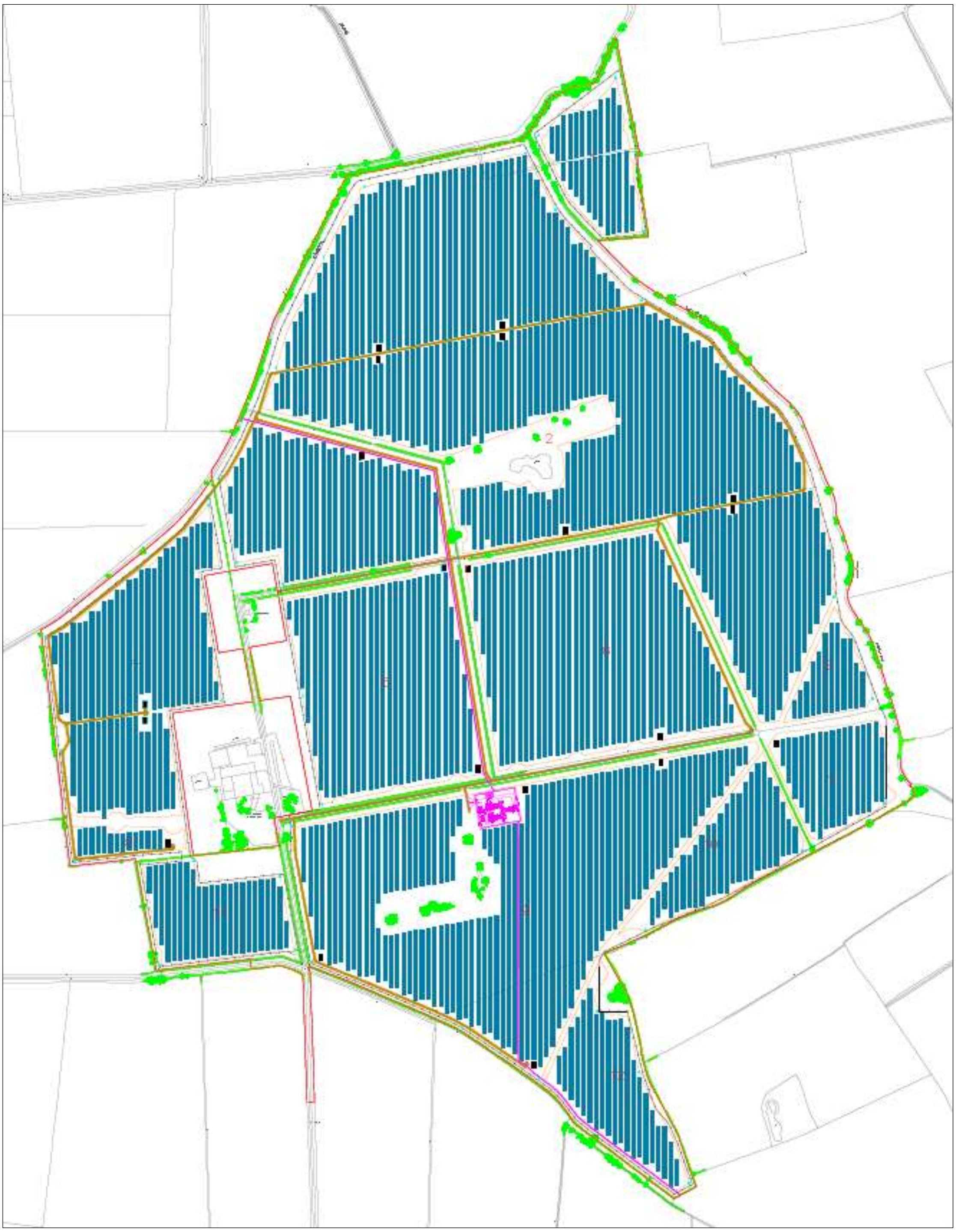

Figure 4 Cottam 2 (Corringham Grange Farm) worst-case site layout

2.1.3 Cottam 3a – Blyton

Figure 5 below[12] shows the worst-case site layout plan. The blue areas denote the solar panel locations.

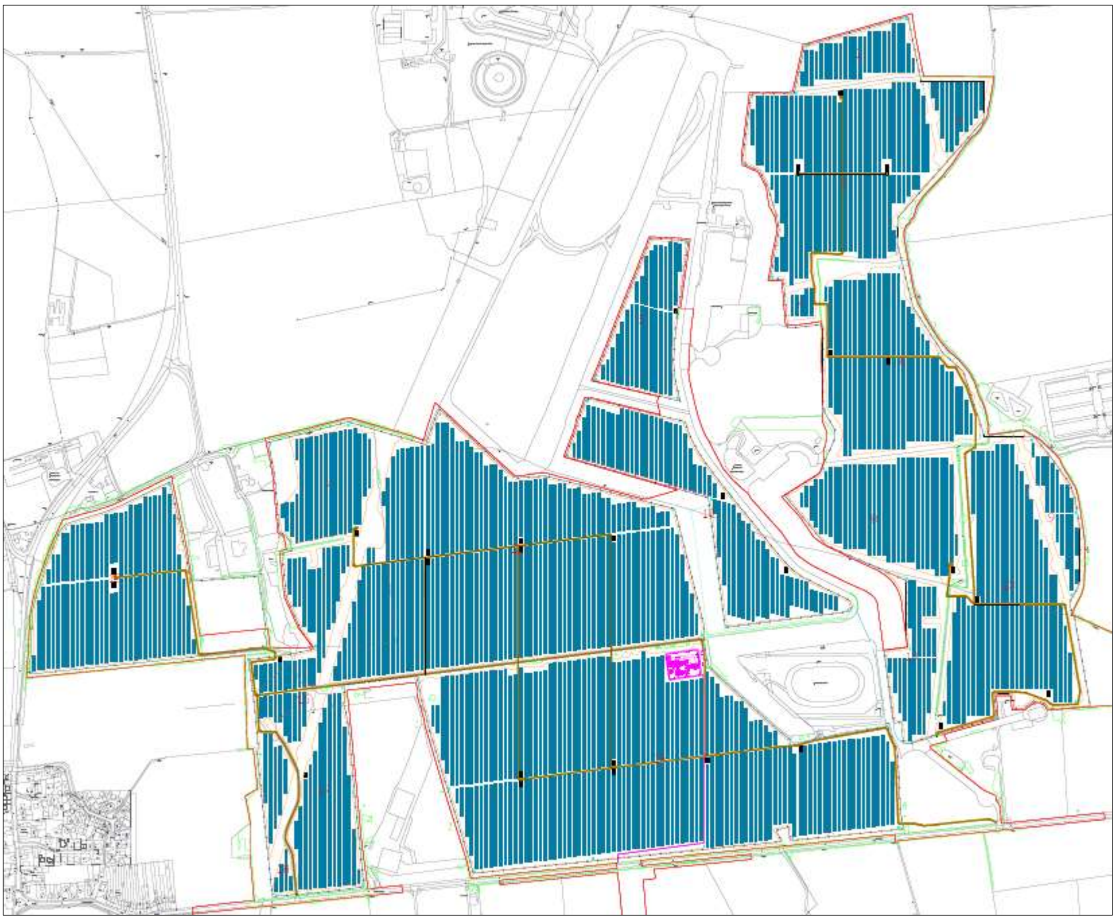

Figure 5 Cottam 3a (Blyton) site layout

2.1.4 Cottam 3b

Figure 6 below[12] shows the worst-case site layout plan. The blue areas denote the solar panel locations.

Figure 6 Cottam 3b area

2.2 Proposed Development Location – Aerial Image

Figure 7 below shows the panel areas (yellow outlined polygons).

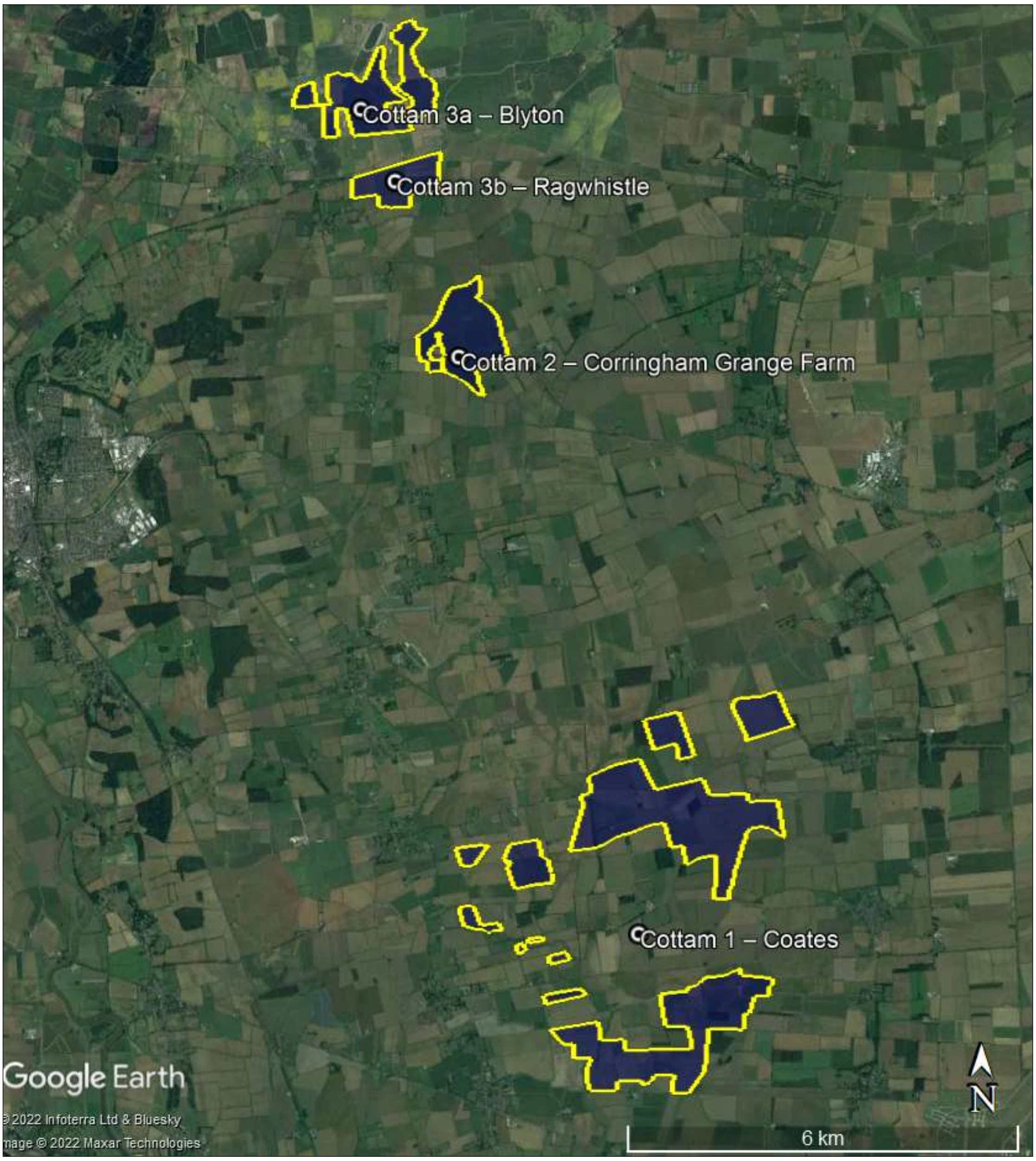

Figure 7 Proposed development location – aerial image

2.3 Solar Panel Technical Information

The Applicant has requested to model the sites considering two mounting options: fixed and tracking. The characteristics used in the modelling are shown in the sections below.

2.3.1 Fixed System

Solar Panel Technical Information	
Assessed centre-height[14-15] (m)	2.05 agl (above ground level)
Tilt[16] (°)	25
Orientation (°)	180 (due south)

Table 1 Fixed panel system: solar panel technical information

2.3.2 Solar Panel Backtracking

The technical information used for the modelling are presented in Table 2 below.

Solar Panel Technical Information	
Assessed centre-height (m)	1.8 agl (above ground level)
Tracking	Horizontal Single Axis tracks Sun East to West
Tilt of tracking axis (°)	0
Orientation of tracking axis (°)	180
Offset angle of module (°)	0
Tracker Range of Motion (°)	±60
Resting angle (°)	0
Surface material	Smooth glass without an ARC (anti-reflective coating)

Table 2 Tracking panel system: solar panel technical information

Shading considerations dictate the panel tilt. This is affected by:

- The elevation angle of the Sun;
- The vertical tilt of the panels;

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[14] The middle of the solar panel 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 will not change the conclusions of the report because the modelling results are unlikely to be meaningfully affected. When the visibility of the solar panels for ground-based receptors is discussed, the maximum height of the panel is considered since it will be the most visible part of the panel.

[15] The heights of the panels (minimum = 0.60m and maximum = 3.5m) have been provided. A centre height of 2.05m (0.6+((3.5-0.6)/2)) has been used for the assessment.

[16] A tilt range has been provided: 15-35deg. A mid-value has been used for the assessment. Changes in tilt might result in glare occurring at different times during the day, however, this will not affect the impact of glint and glare effects.

- The spacing between the panel rows.

This means that early in the morning and late in the evening, the panels will not be directed exactly towards the Sun, as the loss from shading of the panels (caused by facing the sun directly when the Sun is low in the horizon), would be greater than the loss from lowering the panels to a less direct angle in order to avoid the shading Figure 8 below illustrates this.

The graphics in Figure 8 show two lines illustrating the paths of light from the Sun towards the solar panels. In reality, the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The figure is for illustrative purposes only.

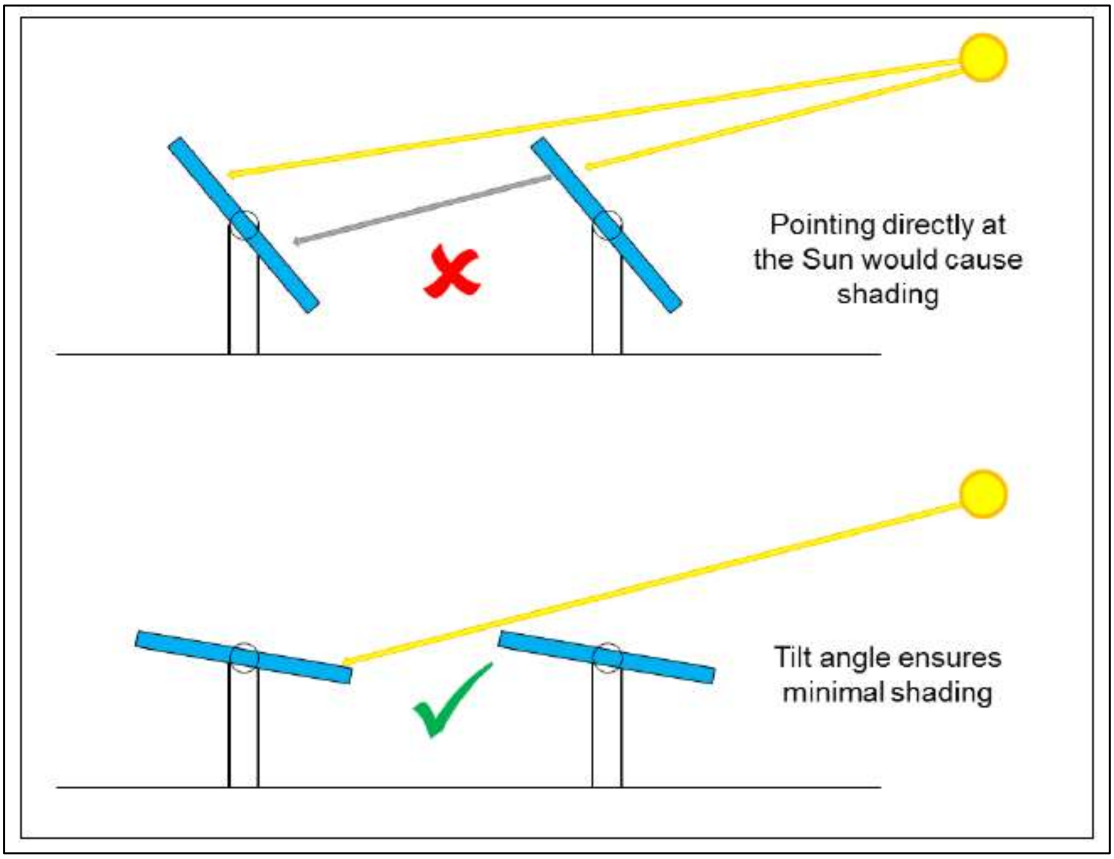

Figure 8 Shading Considerations

Later in the day, the panels can be directed towards the Sun without any shading issues. This is illustrated in Figure 9 below.

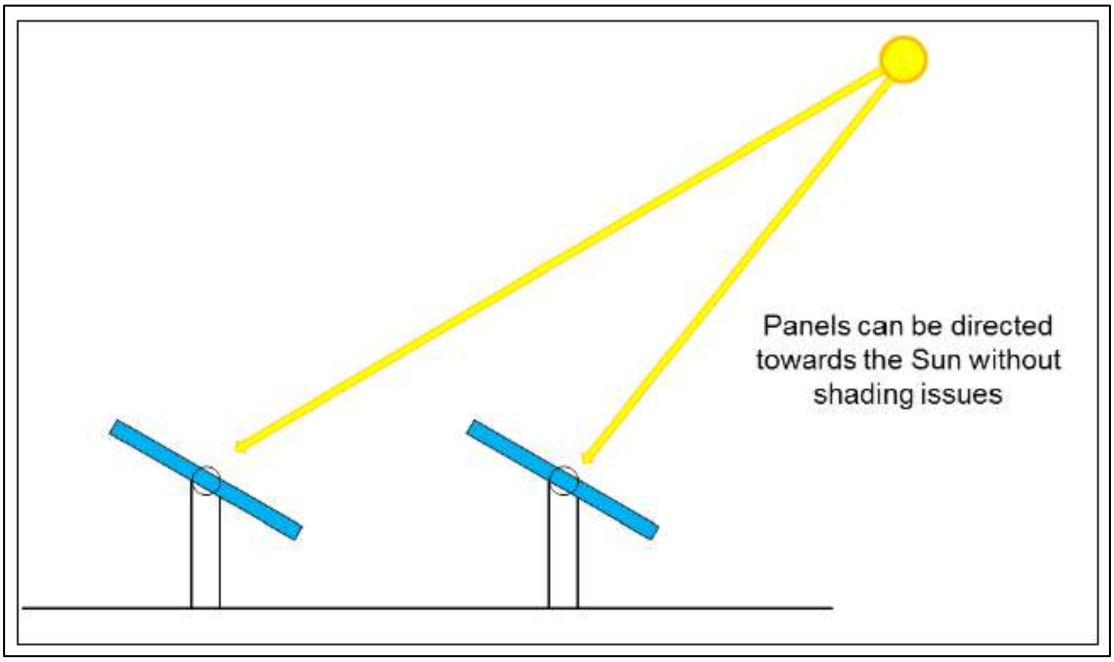

Figure 9 Panel alignment at high solar angles

The solar panels backtrack (where the panel angle gradually declines to prevent shading) by reverting to 0 degrees (flat) once the maximum elevation angle of the panels (60 degrees) becomes ineffective due to the low height of the Sun above the horizon and to avoid shading.

2.3.3 Back Tracking Solar Panel Model

Back tracking systems are sensitive to panel length, row spacing, topography and the level of shading which varies throughout the year. The Forge Solar model used in this assessment is a widely accepted model within this area. The model approximates a backtracking system by assuming the panels instantaneously revert to its resting angle of 0 degrees whenever the sun is outside the rotation range (60 degrees in this instance). Panels with a maximum tracking angle of 60 degrees and resting angle of 0 degrees would therefore lie horizontally from sunrise until the Sun enters the rotation range, and immediately after the sun leaves the rotation range until sunset daily. This definition is taken from Forge and by rotation range it is assumed the panels remain at 0 degrees until the Sun reaches 30 degrees above the horizon – when the Sun is at right angles to the panels at 60 degrees. It is understood that this option was created specifically to account for backtracking to the extent possible.

Whilst this model simplifies the backtracking process to be used by the solar panels within the solar development, panels that revert to their resting angle immediately in many cases present a worst-case scenario for reflectors. This is because flatter panels can produce solar reflections in a much greater range of azimuth angles at ground level. The results would in most cases be more conservative than modelling a detailed back tracking system.

3 HIGH-LEVEL ASSESSMENT OF AVIATION RECEPTORS AND CONSULTATION

3.1 Overview of Aviation Receptors

Seven active airfields have been identified for the assessment, these are:

1. Haxey Airfield: 8.3km north-west of Cottam 3b, two approaches 18/36;
2. Hibaldstow Airfield: 11.6km north-east of Cottam 3b, four approaches 08/26 and 15/33;
3. Kirton in Lindsey Airfield: 6.6km east of Cottam 3b, four approaches 03/21 and 12/30;
4. Sturgate Airfield: 3.2km south of Cottam 2, two approaches 09/27;
5. Forwood Farm Airfield: 10.5km west of Cottam 1, two approaches 02/20;
6. RAF Scampton: 4.2km south-east of Cottam 1, two approaches 04/24;
7. Headon Airfield: 14.6km south-west of Cottam 1, four approaches 05/23 and 14/32;

Their locations (including runway approach paths) relative to the proposed developments are shown in Figure 10 on the following page. Receptor details can be found in Appendix A.

3.2 Aviation Receptors – Consultation

Pager Power has consulted with the safeguarding teams at Sturgate and RAF Scampton safeguarding teams with regard to the effect of the proposed development (Cottam 1, 2, 3a and 3b) upon aviation operation at the two airfields. Both safeguarding teams have responded with no objection.

3.3 Aviation Receptors – High Level Assessment

The orientation of the runways is such that the proposed development will be outside the pilot's field of view for pilots approaching thresholds 36 (Haxey Airfield), 08 and 33 (Hibaldstow Airfield), 20 (Forwood Farm Aifield) and 14, 23, 32 (Headon Airfield). This means that, even if solar reflections are predicted towards pilots, the reflection will originate from outside the pilot's field of view and will therefore not be deemed significant.

If solar reflections are deemed geometrically possible for aircraft approaching thresholds 18 (Haxey Airfield), 15 and 26 (Hibaldstow Airfield), 02 (Forwood Farm Airfield) and 05 (Headon Airfield) they will be within the pilots' field of view. However, in Pager Power's experience and expertise, it can be safely presumed that, it is likely that at this distance any glare towards pilots will have low potential for after-image. These conclusions are valid for all proposed sites.

This impact is acceptable considering the associated guidance and industry best practices and full technical modelling of aviation receptors associated with Haxey, Hibaldstow, Forwood, Headon Airfields is not required.

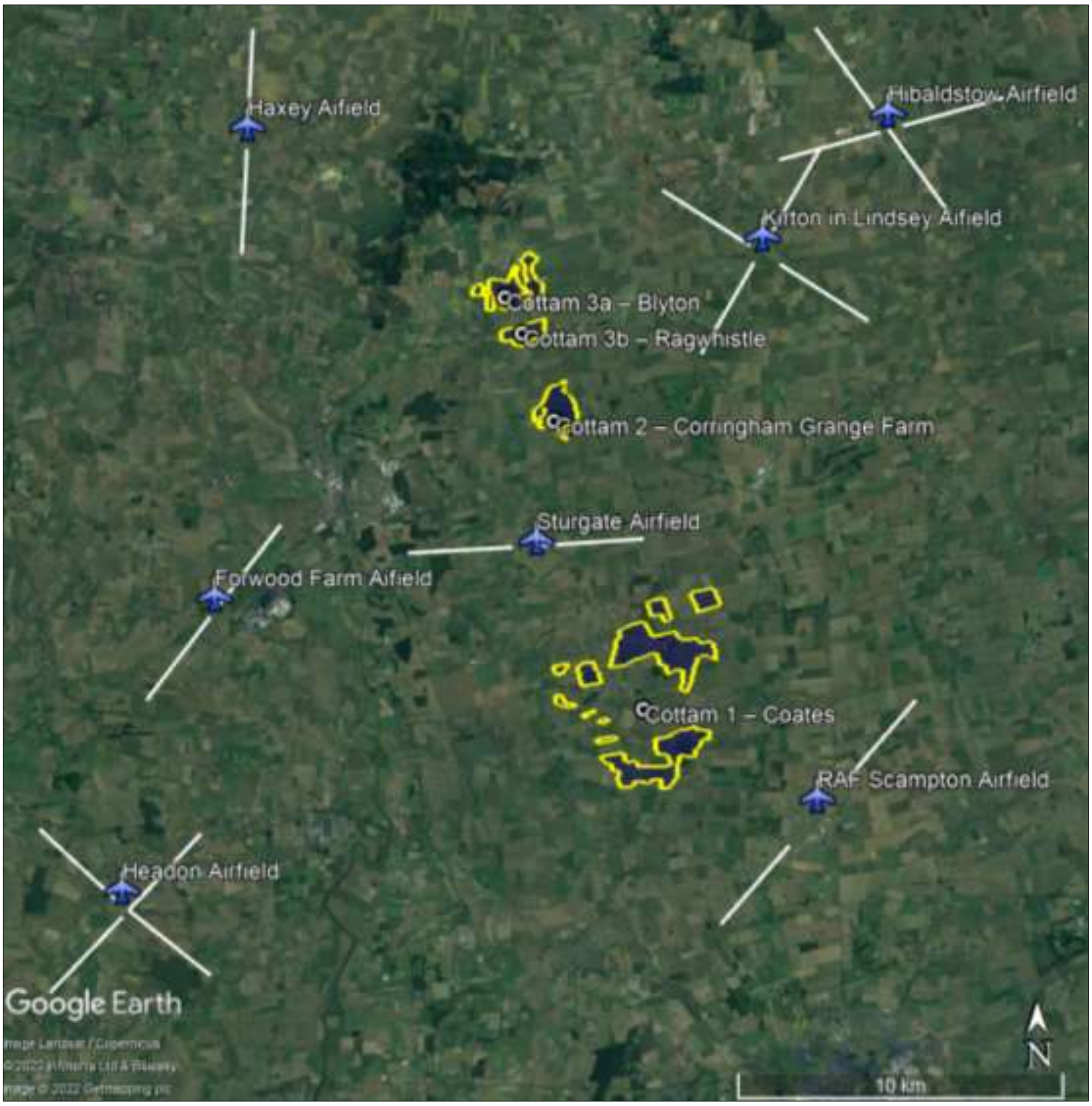

Figure 10 Licenced and unlicensed airfield locations relative to the proposed developments

4 GLINT AND GLARE ASSESSMENT METHODOLOGY

4.1 Guidance and Studies

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

- Specular reflections of the Sun from solar panels are possible.
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence.
- Published guidance[17] 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 (i.e. Bare Aluminium, Water or Snow).

4.2 Background

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

4.3 Methodology

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

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

4.4 Assessment Methodology and Limitations

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

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[17] See Appendix B

5 IDENTIFICATION OF RECEPTORS

5.1 Ground-Based Receptors

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

The above parameters and extensive experience over a significant number of glint and glare assessments undertaken, show that a 1km assessment area from the proposed panel area is appropriate for glint and glare effects on ground-based receptors (road users and dwellings), and a 500m[18] assessment area is appropriate for railway receptors. Receptors have been modelled with the panel areas respective to their 1km assessment area; however, a cumulative assessment area has been presented in the following figures.

Potential receptors within the 1km assessment areas are identified based on mapping and aerial photography of the region. The initial judgement is made based on high-level consideration of aerial photography and mapping i.e. receptors are excluded if it is clear from the outset that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible.

Terrain elevation heights have been interpolated based on Ordnance Survey of Great Britain (OSGB) 50m Panorama data. Receptor details can be found in Appendix G.

5.2 Dwelling Receptors

The analysis has considered dwellings that:

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

5.2.1 Cottam 1

In total, 171 dwelling receptors points have been identified for the assessment of this area. The assessed dwellings are shown from Figure 11 to Figure 20 on the following pages.

For the dwellings, a height of 1.8 metres above ground level has been taken as typical eye level for an observer on the ground floor of the dwelling[19]. In residential areas with multiple layers of dwellings, only the outer dwellings have been considered for assessment. This is because they will mostly obscure views of the solar panels to the dwellings behind them, which will therefore not be impacted by the proposed development because line of sight will be removed, or they will experience comparable effects to the closest assessed dwelling.

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[18] This smaller study area has been identified during consultation with Network Rail.

[19] This height is used for modelling purposes and all floors are considered in the results discussion where approapriate.

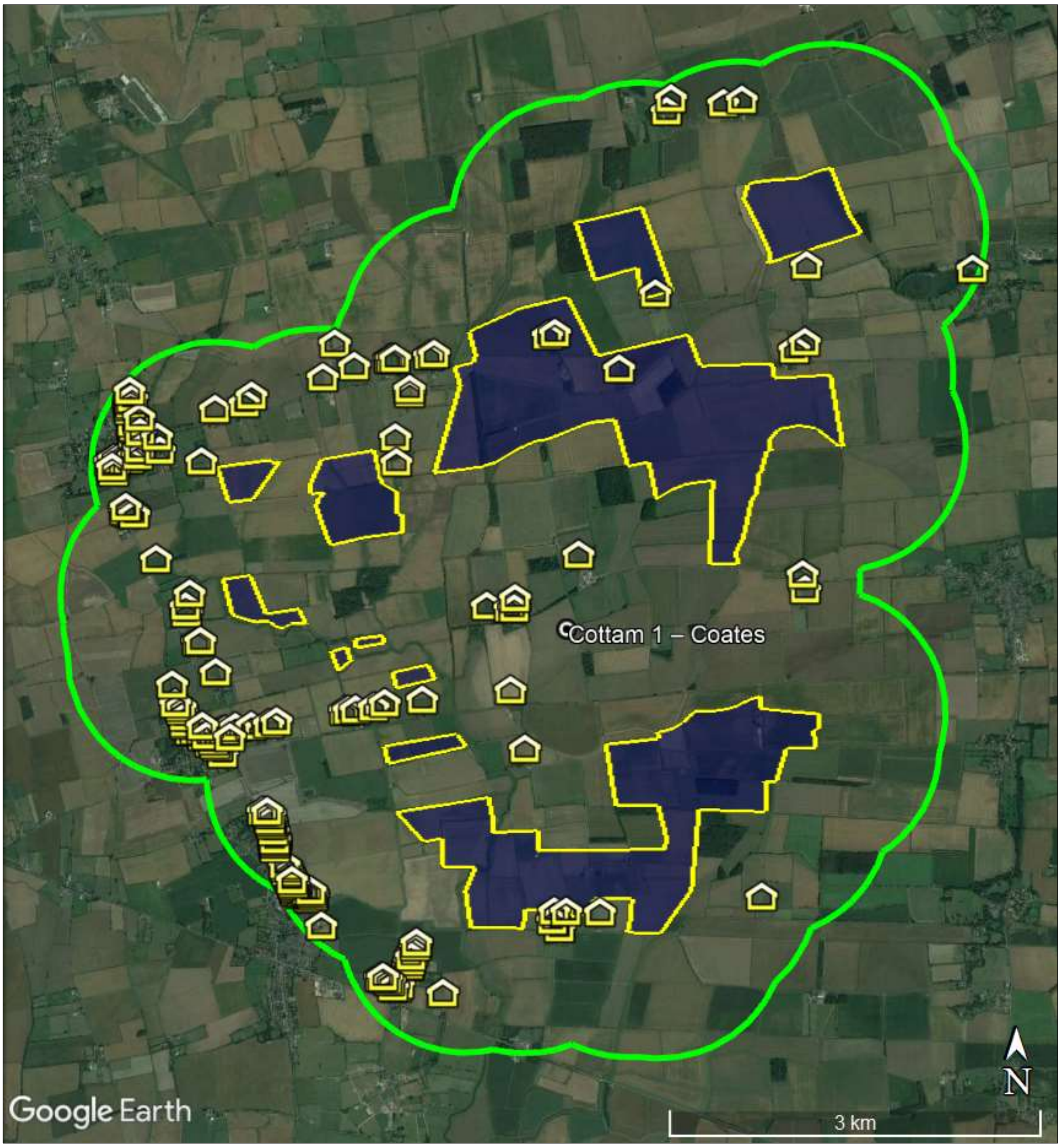

Figure 11 Cottam 1: all dwelling locations 1 to 171

Figure 12 Cottam 1: dwelling locations 1 to 33 and 166 to 171

Figure 13 Cottam 1: dwelling locations 34 to 40

Figure 14 Cottam 1: dwelling locations 41 to 68

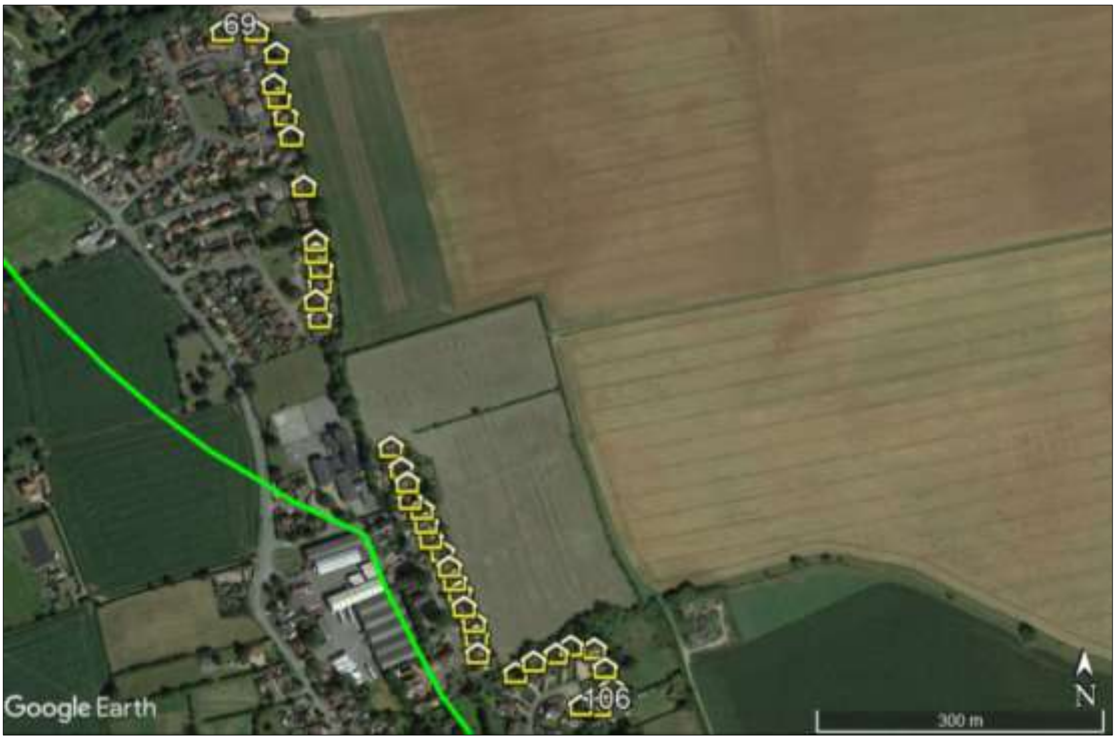

Figure 15 Cottam 1: dwelling locations 69 to 106

Figure 16 Cottam 1: dwelling locations 107 to 122

Figure 17 Cottam 1: dwelling locations 123 to 128

Figure 18 Cottam 1: dwelling locations 129, 130 and 143 to 155

Figure 19 Cottam 1: dwelling locations 131 to 142

Figure 20 Cottam 1: dwelling locations 156 to 165

5.2.2 Cottam 2

In total, 53 dwelling receptors points have been identified for the assessment of this area. The assessed dwellings are shown from Figure 21 to Figure 25 on the following pages.

Figure 21 Cottam 2: all dwelling locations 1 to 53

Figure 22 Cottam 2: dwelling locations 1 to 6

Figure 23 Cottam 2: dwelling locations 7 to 26

Figure 24 Cottam 2: dwelling locations 27 to 48

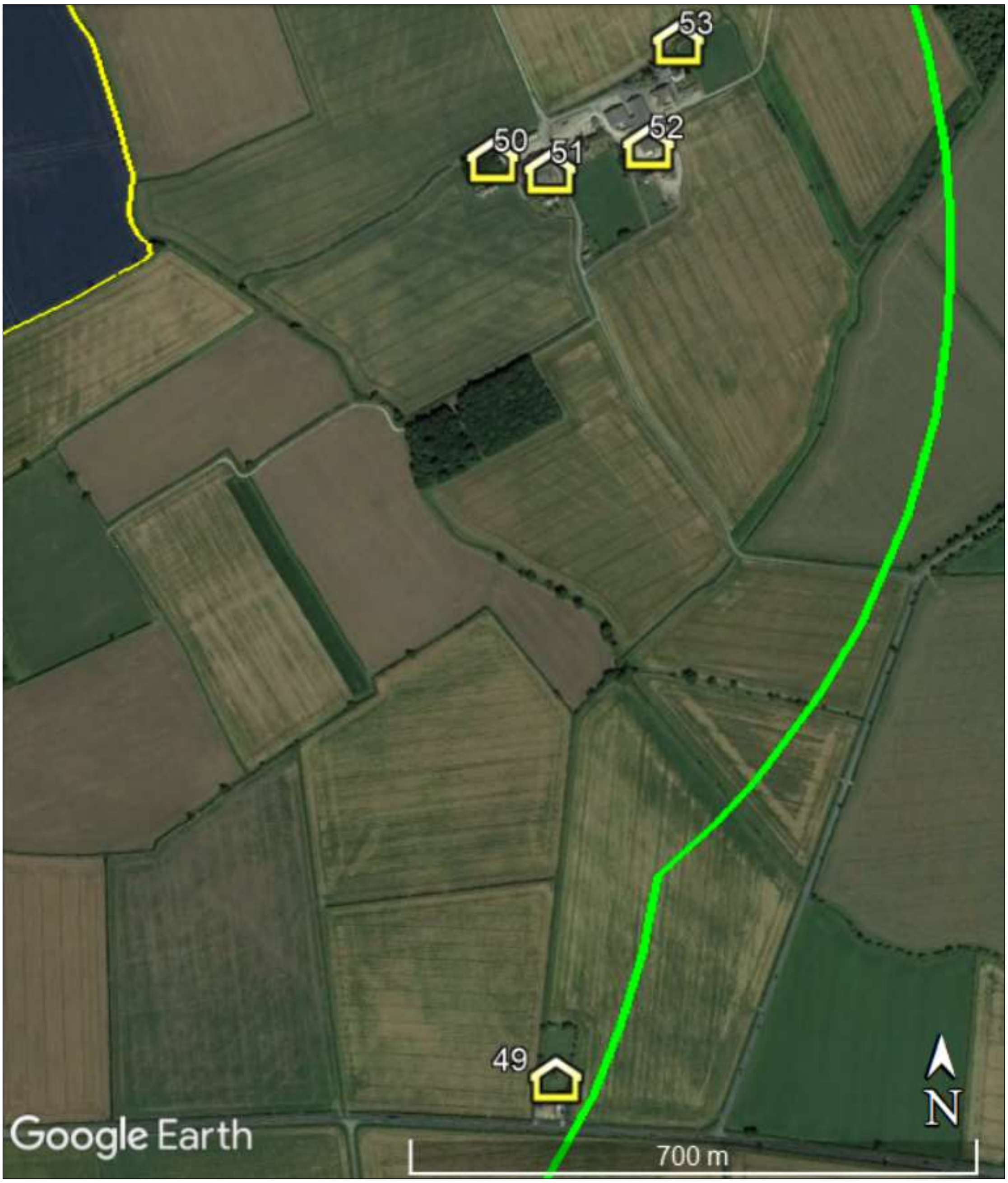

Figure 25 Cottam 2: dwelling locations 49 to 53

5.2.3 Cottam 3a

In total, 59 dwelling receptors points have been identified for the assessment of this area. The assessed dwellings are shown from Figure 26 to Figure 29 on the following pages.

Figure 26 Cottam 3a: all dwelling locations 1 to 59

Figure 27 Cottam 3a: dwelling locations 1 and 2

Figure 28 Cottam 3a: dwelling locations 3 to 47

Figure 29 Cottam 3a: dwelling locations 48 to 59

5.2.4 Cottam 3b

In total, 61 dwelling receptor points have been identified for the assessment of this area. The assessed dwellings are shown from Figure 30 to Figure 37 on the following pages.

Figure 30 Cottam 3b: all dwelling locations 1 to 61

Figure 31 Cottam 3b: dwelling locations 1 to 25

Figure 32 Cottam 3b: dwelling locations 26 to 28

Figure 33 Cottam 3b: dwelling locations 29 to 33

Figure 34 Cottam 3b: dwelling locations 34 to 55

Figure 35 Cottam 3b: dwelling locations 56 and 57

Figure 36 Cottam 3b: dwelling locations 58 and 59

Figure 37 Cottam 3b: dwelling locations 60 and 61

5.3 Road Receptors

Road types can generally be categorised as:

- Major National – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 70mph. These roads typically have fast moving vehicles with busy traffic.

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

Major National, National and Regional are predicted to have higher level of traffic compared to local roads and have higher sensitivity. Therefore, these roads are taken forwards for the technical modelling.

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

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

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

5.3.1 Cottam 1

In total, 46 road receptor locations have been identified for the assessment consisting of two roads: the B1241 (blue line – receptors 1 to 30, see Figure 38 on the following page) and Till Bridge Lane (orange line – receptors 31 to 46, see Figure 39 on page 48).

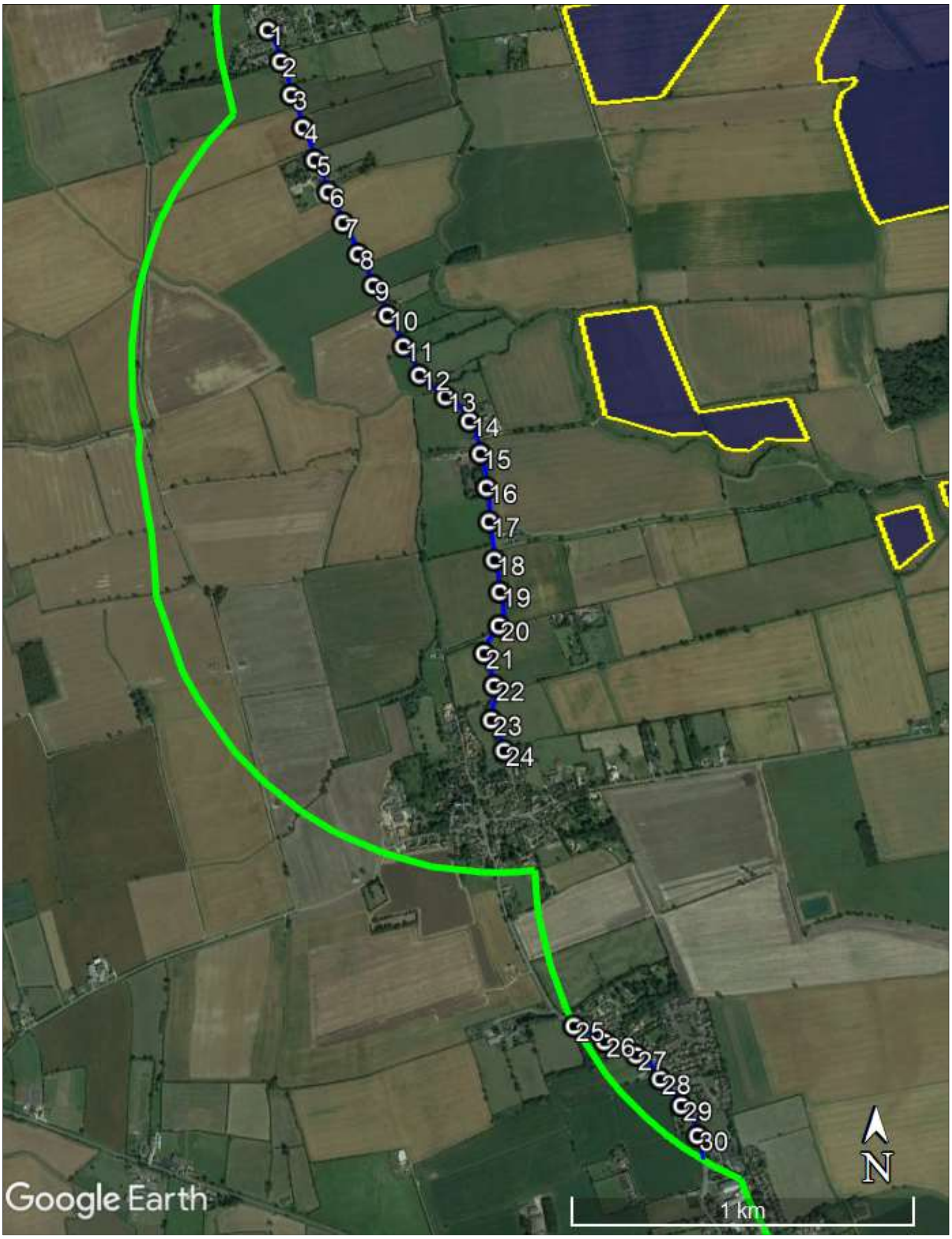

Figure 38 Cottam 1, B1241: identified road receptors

Figure 39 Cottam 1, Till Bridge Lane: identified road receptors

5.3.2 Cottam 2

In total, 27 road receptor locations have been identified for the assessment consisting of one road: the A631 (blue line – receptors 1 to 27, see Figure 40 below).

Figure 40 Cottam 2, A631: identified road receptors

5.3.3 Cottam 3a

In total, 61 road receptor locations have been identified for the assessment consisting of three roads: Laughton Road (blue line – receptors 1 to 18, see Figure 41 below), Kirton Road (orange line – receptors 19 to 54, see Figure 42 on the following page) and Station Road (yellow line – receptors 55 to 61, see Figure 43 on the following page).

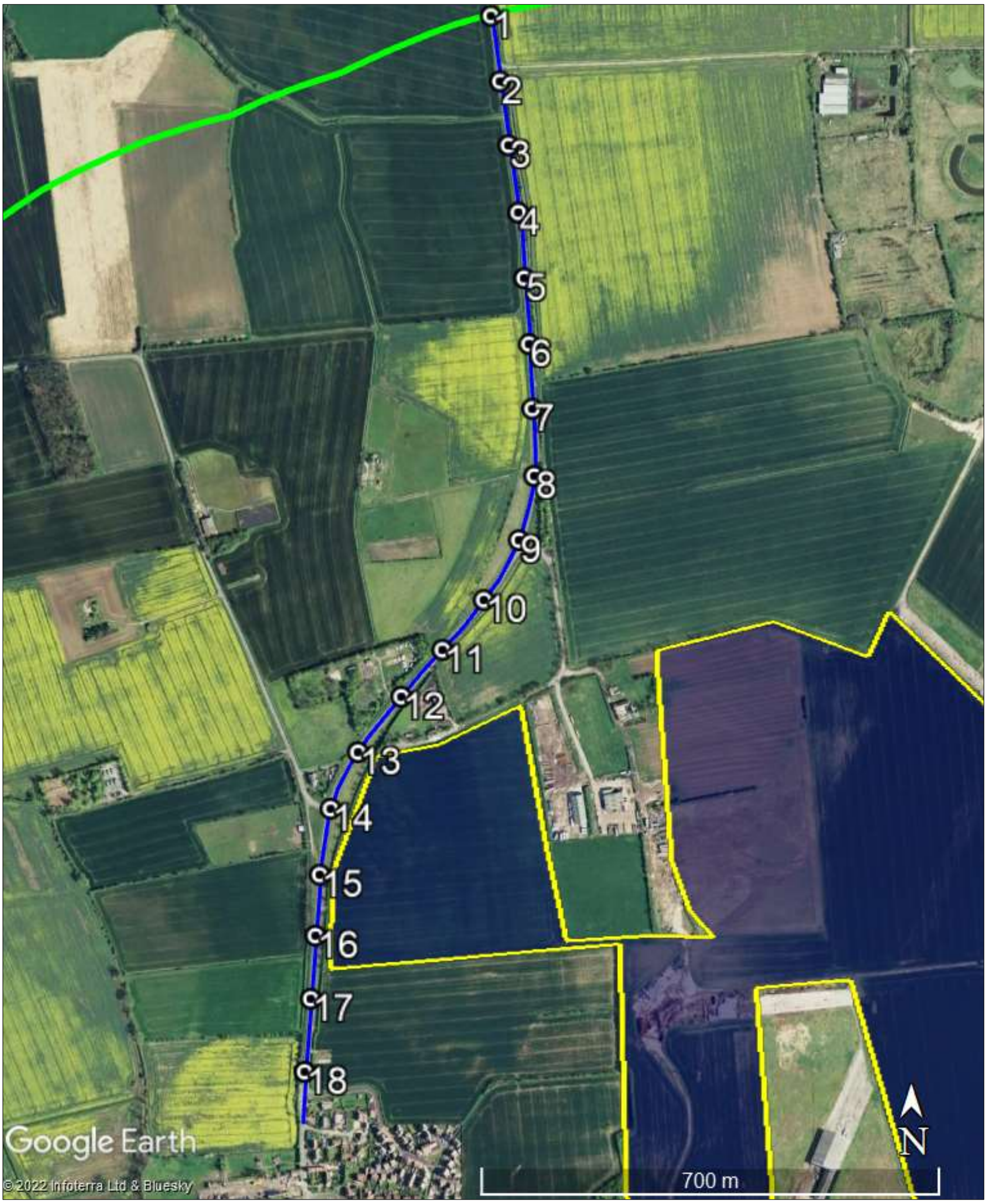

Figure 41 Cottam 3a, Laughton Road: identified road receptors

Figure 42 Cottam 3a, Kirton Road: identified road receptors

Figure 43 Cottam 3a, Station Road: identified road receptors

5.3.4 Cottam 3b

In total, 49 road receptor locations have been identified for the assessment consisting of three roads: Station Road (blue line – receptors 1 to 20, see Figure 44 below) and Kirton Road (yellow line – receptors 21 to 49, see Figure 45 below).

Figure 44 Cottam 3b, Station Road: identified road receptors

Figure 45 Cottam 3b, Kirton Road: identified road receptors

5.4 Railway Receptors

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

1. The development producing solar reflections towards train drivers;
2. The development producing solar reflections that affect railway signals.

With respect to point 1, a reflective panel could produce solar reflections towards a train driver. If this reflection occurs where a railway signal, crossing etc., is present, or where the driver's workload is particularly high, the solar reflection may affect operations. This is deemed to be the most concern with respect to solar reflections.

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

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

'Light emitted from a Signal lens assembly that has originated from an external source (usually the sun) and has been internally reflected within the Signal Head in such a way that the lens assembly gives the appearance of being lit.[20]*'*

5.4.1 Glint and Glare Definition

As well as the glint and glare definition presented in Section 1.3, glare can also be categorised as causing visual discomfort whereby an observer would instinctively look away, or cause disability whereby objects become difficult to see. The guidance produced by the Commission Internationale de L'Eclairage (CIE) describes disability glare as[21]:

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

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

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

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[20] Source: Glossary of Signalling Terms, Railway Group Guidance Note GK/GN0802. Issue One. Date April 2004.
[21] CIE 146:2002 & CIE 147:2002 Collection on glare (2002).

5.4.2 Railway Signal Receptors

The analysis has considered railway signal receptors that:

- Are within 500 metres of the proposed development;
- Have a potential view of the panels.

The impact of solar reflections upon railway signals has been assessed by considering the height and location of any identified signals. No potential signal locations were identified along the assessed section of railway line using available imagery and have therefore not been assessed. Network Rail has been contacted to confirm the location of any signals at these locations; however, no response has been received to date. Once a response has been received, the report can be updated.

5.4.3 Train Driver Receptors

The analysis has considered train driver receptors that:

- Are within the 500m assessment area;
- Have a potential view of the panels.

The identified train driver receptor points along the assessed section of railway line are shown in Figure 46 below. Based on previous consultation[22], a train driver's eye level is typically 2.75m above rail level.

Figure 46 Cottam 3b, train driver locations

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

6 GLINT AND GLARE ASSESSMENT – TECHNICAL RESULTS

6.1 Evaluation of Effects

The tables in the following subsections present the results of the technical analysis. The final column summarises the predicted impact considering the level of identified screening based on a desk-based review of the available imagery. The significance of the predicted effects has been evaluated in accordance with Pager Power's published guidance document[23]. The flowcharts setting out the impact characterisation are presented in Appendix D[24]. The list of assumptions and limitations are presented in Appendix F. The modelling output for key receptors can be found in Appendix H. When evaluating visibility in the context of glint and glare, it is only the *reflecting* panel area that must be considered. For example, if the western half of the development is visible, but reflections would only be possible from the eastern half, it can be concluded that the reflecting area is not visible and no impacts are predicted. This is why there can be instances where visibility of the development is predicted, but glint and glare issues are screened. Receptors are included within the assessment based on the potential visibility of the development as a whole, among other factors. Once the modelling output has been generated, the assessment can be refined to evaluate the visibility of the reflecting area specifically.

6.2 Summary of Results

The tables in the following subsections summarise the results of the assessment. The predicted glare times are based solely on bare-earth terrain i.e. without consideration of screening from buildings and vegetation.

The significance of any predicted impact is discussed in the subsequent report sections. The modelling output showing the precise predicted times and the reflecting panel area is shown in Appendix H.

[23] Solar Photovoltaic Development – Glint and Glare Guidance Issue 4.0, August 2022.

[24] There is no standard methodology for evaluating effects on ground-based receptors beyond a kilometre. These receptors have been considered based on first principles and the general methodology for ground-based receptors, keeping in mind the relative safety/amenity implications for differing receptor types.

6.3 Geometric Calculation Results – Dwelling Receptors

Refer to Section 7.1 on page 82 for a discussion of the following results. The tracking system calculation result are reported in Section 6.3.2 on page 64.

6.3.1 Fixed System

6.3.1.1 Cottam 1

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 17	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
18	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
19 – 25	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
26 – 27	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
28	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
29	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
30 – 32	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
33 – 38	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
39 – 41	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
42 – 44	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
45 – 51	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
52 – 53	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
54 – 60	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
61	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
62	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
63	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
64 – 68	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
69 – 97	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
98 – 107	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
108	Yes.	No.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
109 – 124	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
125	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce views of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
126	Yes.	Yes.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
127	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the views of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
128	No.	Yes.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
129	No.	Yes.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
130	No.	Yes.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
131 – 132	Yes.	Yes.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing screening and mitigating factors and further mitigation is not judged a requirement.
133	Yes.	Yes.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
134	Yes.	Yes.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
135 – 139	No.	No.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
140 – 141	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the views of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
142	Yes.	Yes.	The dwelling is within the ownership of Cottam 1 landowner and the owner is planning its demolition. Therefore, no mitigation is required.
143 – 148	Yes.	Yes.	Solar reflections geometrically possible. However, low impact is predicted due to a combination of existing mitigating factors and further mitigation is not judged a requirement.
149	Yes.	Yes.	Solar reflections geometrically possible. However, they are predicted to occur for less than 3 months per year and less than 60 minutes per day. Therefore, low impact is predicted, and no mitigation is recommended.
150 – 154	Yes.	No.	Solar reflections geometrically possible. However, they are predicted to occur for less than 3 months per year and less than 60 minutes per day.
155	Yes.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
156 – 157	Yes.	No.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the views of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
158 – 162	Yes.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
163 – 170	Yes.	Yes.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and mitigation is not required.
171	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce views of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.

Table 3 Geometric analysis results for dwelling receptors (Cottam 1)

6.3.1.2 Cottam 2

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 6	Yes.	No.	Solar reflections geometrically possible. However, they are predicted to occur for less than 3 months per year and less than 60 minutes per day.
7	No.	No.	No solar reflections geometrically possible. No impact is predicted.
8 – 9	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
10 – 26	Yes.	No.	Solar reflections geometrically possible. However, screening in the form of existing vegetation and other buildings has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
27 – 48	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
49	No.	No.	No solar reflections geometrically possible. No impact is predicted.
50 – 53	No.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.

Table 4 Geometric analysis results for dwelling receptors (Cottam 2)

6.3.1.3 Cottam 3a

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 2	Yes.	No.	Solar reflections geometrically possible. However, screening in the form of existing vegetation and other buildings has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
3	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
4 – 49	Yes.	No.	Solar reflections geometrically possible. However, screening in the form of existing vegetation and other buildings has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
50 – 51	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
52	Yes.	No.	Solar reflections geometrically possible. However, they are predicted to occur for less than 3 months per year and less than 60 minutes per day. Furthermore, the developer has proposed screening in the form of vegetation to reduce the visibility of the reflective area.
53 – 54	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
55	No.	Yes.	Solar reflections geometrically possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
56	No.	Yes.	Solar reflections geometrically possible. However, screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
57 – 58	No.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
59	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 5 Geometric analysis results for dwelling receptors (Cottam 3a)

6.3.1.4 Cottam 3b

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 27	No.	No.	No solar reflections geometrically possible. No impact is predicted.
28 – 31	Yes.	No.	Solar reflections geometrically possible. However, they are predicted to occur for less than 3 months per year and less than 60 minutes per day.
32	Yes.	No.	Solar reflections geometrically possible. However, screening in the form of terrain and vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
33	Yes.	No.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development. Therefore, no impact is predicted, and no further mitigation is required.
34 – 55	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
56 – 57	No.	No.	No solar reflections geometrically possible. No impact is predicted.
58 – 59	No.	Yes.	Solar reflections geometrically possible. However, screening in the form of terrain and vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
60	No.	No.	No solar reflections geometrically possible. No impact is predicted.
61	No.	Yes.	Solar reflections geometrically possible. However, they are predicted to occur for less than 3 months per year and less than 60 minutes per day.

Table 6 Geometric analysis results for dwelling receptors (Cottam 3b)

6.3.2 Tracking System

6.3.2.1 Cottam 1

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1-122	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
123	Yes.	Yes.	The model output shows that solar reflections are possible. However, it is likely that the existing screening in the form of vegetation significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and no mitigation is required.
124	Yes.	Yes.	The model output shows that solar reflections are possible. However, it is likely that the existing screening in the form of vegetation significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and no mitigation is required.
125	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to reduce the visibility of the proposed development. Therefore, low impact is predicted, and no further mitigation is required.
126	Yes.	Yes.	The model output shows that solar reflections are possible. However, it is likely that the existing screening in the form of vegetation and buildings will significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and no mitigation is required.
127	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce views of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
128-130	No.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
131-132	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
133-134	Yes.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
135-139	No.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
140-141	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
142	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
143-148	Yes.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
149-154	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement
155	Yes.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
156 – 157	Yes.	No.	The model output shows that solar reflections are possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
158-159	Yes.	Yes.	The model output shows that solar reflections are possible. However, it is likely that the existing screening in the form of vegetation and buildings significantly reduce the visibility of the reflective area. Therefore, no impact is predicted, and no mitigation is required.
160-170	Yes.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
171	Yes	No	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.

Table 7 Geometric analysis results for dwelling receptors (Cottam 1)

6.3.2.2 Cottam 2

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1-6	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
7	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
8-9	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
10	Yes.	No.	Solar reflections geometrically possible. However, screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
11-23	No.	No.	No solar reflections geometrically possible. No impact is predicted.
24-26	Yes.	No.	Solar reflections geometrically possible. However, screening in the form of other buildings has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
27-35	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
36-48	No.	No.	No solar reflections geometrically possible. No impact is predicted.
49	No.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
50-53	No.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.

Table 8 Geometric analysis results for dwelling receptors (Cottam 2)

6.3.2.3 Cottam 3a

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
2	Yes.	No.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
3	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.
4	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
5-49	No.	No.	No solar reflections geometrically possible. No impact is predicted.
50 – 52	Yes.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
53-54	Yes.	Yes.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, low impact is predicted, and no further mitigation is required.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
55-57	No.	Yes.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.

Table 9 Geometric analysis results for dwelling receptors (Cottam 3a)

6.3.2.4 Cottam 3b

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 28	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
29 – 31	No.	No.	No solar reflections geometrically possible. No impact is predicted.
33	Yes.	No.	The model output shows that solar reflections are possible. However, a combination of existing and proposed screening is predicted to significantly reduce the visibility of the proposed development from an observer located at the ground floor. Therefore, no impact is predicted, and no further mitigation is required.
34	No.	No.	No solar reflections geometrically possible. No impact is predicted.
35 – 40	Yes.	No.	Solar reflections geometrically possible. However, due to a combination of existing mitigating factors further mitigation is not judged a requirement.
41 – 46	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
47 – 49	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Dwelling Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
50 – 54	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
55-61	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 10 Geometric analysis results for dwelling receptors (Cottam 3b)

6.4 Geometric Calculation Results – Road Receptors

Refer to Section 7.2 on page 104 for a discussion of the following results. The tracking system calculation result are reported in 6.4.2 on page 7676.

6.4.1 Fixed System

6.4.1.1 Cottam 1

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1-2	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
3-9	Yes.	No.	Solar reflections geometrically possible. However, significant mitigating factors have been identified. Low impact is predicted, and no mitigation is required.
10-17	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
18-20	Yes.	No.	Solar reflections geometrically possible. However, the reflective panel area will be outside the field of view of road users[25]. Low impact is predicted, and no mitigation is required.
21-30	Yes.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.

Table 11 Geometric analysis results for road receptors (B1241)

[25] 50 degrees on both sides considering the direction of travel.

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
31 – 39	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
40 – 46	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 12 Geometric analysis results for road receptors (Tillbridge Lane)

6.4.1.2 Cottam 2

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 10	Yes.	No.	Solar reflections geometrically possible. However, it is likely that screening in the form of existing vegetation, terrain or buildings will significantly reduce the visibility of the proposed development. Furthermore, the reflective area will be located at a significant distance. Therefore, maximum low impact is predicted mitigation is not recommended.
11 – 27	No.	No.	Solar reflections geometrically possible. However, existing screening is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.

Table 13 Geometric analysis results for road receptors (A631)

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6.4.1.3 Cottam 3a

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 2	No.	No.	No solar reflections geometrically possible. No impact is predicted.
1-12	Yes.	No.	Solar reflections geometrically possible. However, the reflective surface will be outside the road's field of focus (50 degrees either side of the direction of travel). It is also likely that screening in the form of existing vegetation, terrain or buildings will reduce the views of the proposed development. Therefore, maximum low impact is predicted mitigation is not recommended.
13	Yes.	No.	Solar reflections geometrically possible. However, the reflective surface will be outside the road's field of focus (50 degrees either side of the direction of travel). Furthermore, some existing screening in the form of vegetation has been identified which will reduce the visibility of the proposed development. Low impact is predicted.
14-18	Yes.	No.	Solar reflections geometrically possible. However, the reflective surface will be outside the road's field of focus (50 degrees either side of the direction of travel). It is also likely that screening in the form of existing vegetation, terrain or buildings will significantly reduce the views of the proposed development. Therefore, maximum low impact is predicted mitigation is not recommended.

Table 14 Geometric analysis results for road receptors (Laughton Road)

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
19-22	Yes.	No.	No solar reflections geometrically possible. No impact is predicted.

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
23 – 33	Yes.	Yes.	Solar reflections geometrically possible. The developer has proposed screening which is predicted to significantly reduce the visibility of the reflective area. No impact is predicted, and no further mitigation is required.
34 – 37	No.	Yes.	Solar reflections geometrically possible. The developer has proposed screening which is predicted to significantly reduce th visibility of the reflective area. No impact is predicted, and no further mitigation is required.
38 – 39	No.	Yes.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
40 – 41	No.	Yes.	Solar reflections geometrically possible. However, the reflective surface will be outside the road's field of focus (50 degrees either side of the direction of travel). Furthermore, some existing screening in the form of vegetation has been identified. Low impact is predicted.
42 – 48	No.	Yes.	Solar reflections geometrically possible. The developer has proposed screening which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted, and no further mitigation is required.
49 – 54	No.	Yes.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.

Table 15 Geometric analysis results for road receptors (Kirton Road)

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
55 – 60	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified. No impact is predicted.
61	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 16 Geometric analysis results for road receptors (Station Road)

6.4.1.4 Cottam 3b

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 3	No.	No.	No solar reflections geometrically possible. No impact is predicted.
4 – 18	Yes.	No.	Solar reflections geometrically possible. However, the reflective surface will be outside the road's field of focus (50 degrees either side of the direction of travel). It is also likely that screening in the form of existing vegetation, terrain or buildings will reduce views of the proposed development. Therefore, maximum low impact is predicted mitigation is not recommended.
19 – 20	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 17 Geometric analysis results for road receptors (Station Road)

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
21 – 49	Yes.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 18 Geometric analysis results for road receptors (Kirton Road)

6.4.2 Tracking System

6.4.2.1 Cottam 1

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1-2	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
3-9	Yes.	No.	Solar reflections geometrically possible. However, significant mitigating factors have been identified. Low impact is predicted.
10-17	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
18-20	Yes.	No.	Solar reflections geometrically possible. However, the reflective panel area will be outside the field of view of road users. Low impact is predicted, and no mitigation is required.
21-30	Yes.	No.	Solar reflections geometrically possible. However, existing screening has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.

Table 19 Geometric analysis results for road receptors (B1241)

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
31-34	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
35-36	No.	No.	No solar reflections geometrically possible. No impact is predicted.
37	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
38-46	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 20 Geometric analysis results for road receptors (Tillbridge Lane)

6.4.2.2 Cottam 2

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1-5	No.	No.	No solar reflections geometrically possible. No impact is predicted.
6-12	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
13-18	No.	No.	No solar reflections geometrically possible. No impact is predicted.
19-27	No.	Yes.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.

Table 21 Geometric analysis results for road receptors (A631)

6.4.2.3 Cottam 3a

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1-9	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the proposed development. No impact is predicted.
10-11	Yes.	No.	Solar reflections geometrically possible. However, the reflective area will be outside the 50 degrees field of focus. Furthermore, some existing screening in the form of vegetation has been identified. Low impact is predicted.
12	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified. No impact is predicted.
13	No.	Yes.	Solar reflections geometrically possible. However, the reflective area will be outside the 50 degrees field of focus. Furthermore, some existing screening in the form of vegetation has been identified. Low impact is predicted.
14-18	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 22 Geometric analysis results for road receptors (Laughton Road)

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
19-20	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
21-37	Yes.	Yes.	Solar reflections geometrically possible. The developer has proposed screening which is predicted to significantly reduce the visibility of the reflective area. No impact is predicted, and no further mitigation is required.
38-39	No.	Yes.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the reflective area. No impact is predicted.
40-41	No.	Yes.	Solar reflections geometrically possible. However, the reflective area will be outside the 50 degrees field of focus. Furthermore, some existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the reflective area for some receptors. Low impact is predicted.
42-48	No.	Yes.	Solar reflections geometrically possible. The developer has proposed screening which is predicted to significantly reduce the visibility of the reflective area. No impact is predicted, and no further mitigation is required.
49-54	No.	Yes.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the reflective area. No impact is predicted.

Table 23 Geometric analysis results for road receptors (Kirton Road)

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
55-61	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 24 Geometric analysis results for road receptors (Station Road)

6.4.2.4 Cottam 3b

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 14	No.	No.	No solar reflections geometrically possible. No impact is predicted.
15	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the reflective area. No impact is predicted.
16 – 20	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 25 Geometric analysis results for road receptors (Station Road)

Road Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
21 – 33	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified which is predicted to significantly reduce the visibility of the reflective area. No impact is predicted.
34 – 49	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 26 Geometric analysis results for road receptors (Kirton Road)

6.5 Geometric Calculation Results – Train Driver Receptors

Refer to Section 7.3 on page 112 for a discussion of the following results. The tracking system calculation result Section is 6.5.2 on page 81.

6.5.1 Fixed System

6.5.1.1 Cottam 3b

Railway Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 19	Yes.	No.	Solar reflections geometrically possible. However, the developer has proposed instant screening which is predicted to significantly reduce views of the reflective area. No impact is predicted.
20 – 26	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 27 Geometric analysis results for train driver receptors

6.5.2 Tracking System

6.5.2.1 Cottam 3b

Railway Receptor	Are Solar Reflections Geometrically Possible? (GMT)		Comment
	am	pm	
1 – 2	Yes.	No.	Solar reflections geometrically possible. However, existing screening in the form of vegetation has been identified. No impact is predicted.
3 – 26	No.	No.	No solar reflections geometrically possible. No impact is predicted.

Table 28 Geometric analysis results for train driver receptors

7 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

7.1 Dwelling Results

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

- Whether a significant reflection is predicted to be experienced in practice.
- The duration of the predicted effects, relative to thresholds[26] of:
    - 3 months per year.
    - 60 minutes per day.

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

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

- The separation distance to the panel area. Larger separation distances reduce the proportion of an observer's field of view that is affected by glare.
- The position of the Sun. Effects that coincide with direct sunlight appear less prominent than those that do not. The Sun is a far more significant source of light.
- Whether solar reflections will be experienced from all storeys. The ground floor is typically considered the main living space[27] and therefore has a greater significance with respect to residential amenity.
- Whether the dwelling appears to have windows facing the reflecting areas. An observer may need to look at an acute angle to observe the reflecting areas.

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

A conservative review of the available imagery has been undertaken within the desk-based assessment, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing screening will remove effects.

[26] This threshold was identified by Pager Power and implemented within its Glint and Glare guidance. The threshold is derived from the shadow flicker guidance which states that effects for more than 30 minutes per day, over 30 hours of the year are significant and requires mitigation. Since effects of glint and glare less significant than shadow flicker, the duration beyond which mitigation should be required for glint and glare is longer than for shadow flicker.

[27] This is true for most dwellings however it does not apply to apartment blocks where the main living area is located on each floor and visibility from each floor is considered.

7.1.1 Fixed System

7.1.1.1 Cottam 1

Solar reflections are geometrically possible for 166 out of the 171 identified dwelling receptors. Under the baseline scenario a significant impact is predicted for seven out of the 166 dwelling receptors (dwelling receptors 125, 127, 140, 141, 156, 157 and 171 – see dwellings in orange in Figure 47 on the following page). Other dwellings will experience either a low impact or no impact due to the following reasons:

- Existing screening in the form of vegetation, terrain or building will significantly reduce the visibility of the reflective area from an observer located within the dwelling (no impact);
- If visibility of the reflective area is possible one or more of the following mitigating factors have been identified (low impact):
    - The distance between the dwellings and the reflective area is sufficiently large to reduce the glint and glare significance;
    - The reflective area is not visible to observers located at the ground floor;
    - Sun light and reflective area are predicted to originate from the same point in space (the Sun is a much brighter source of light).

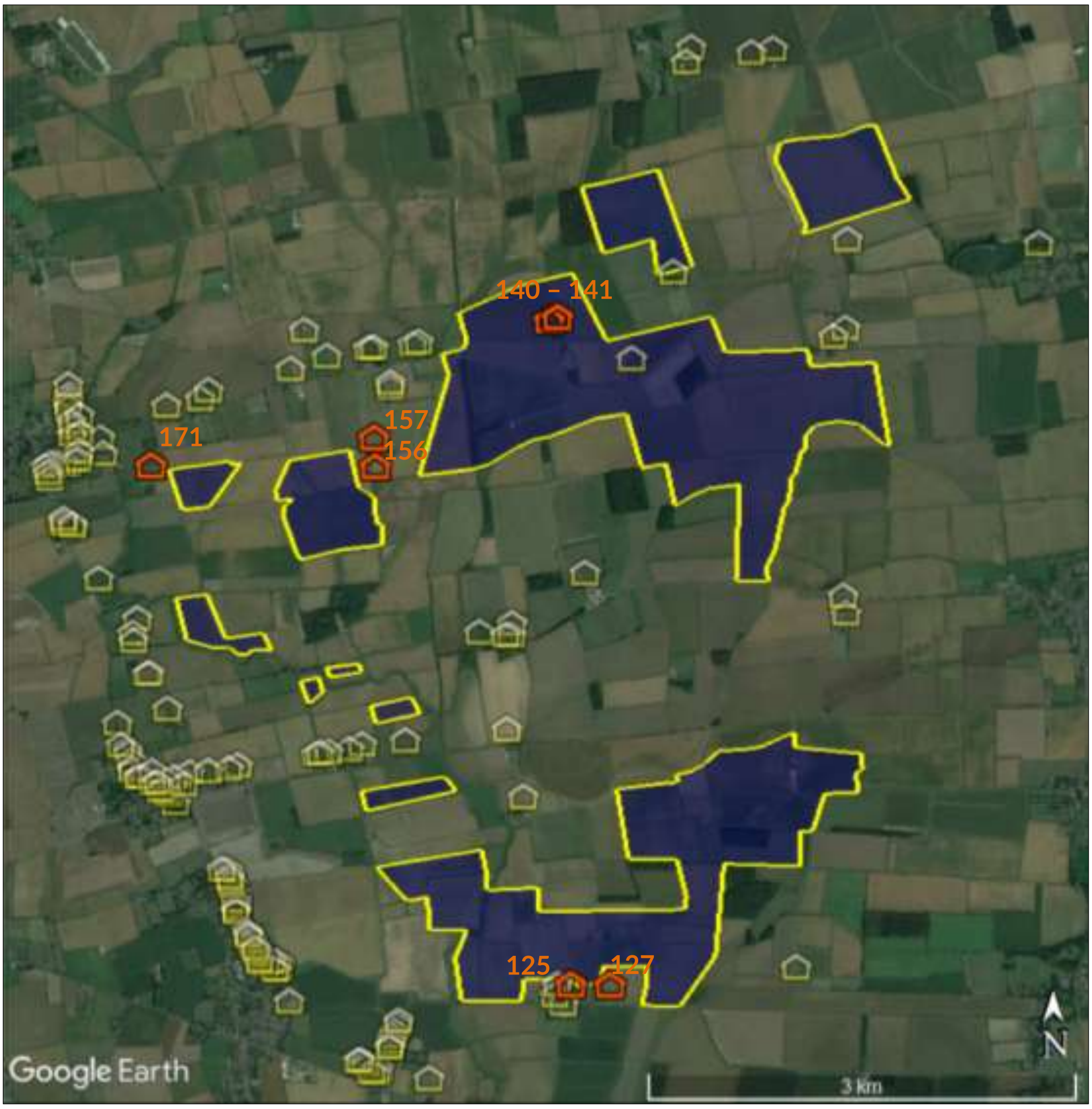

Figure 47 Cottam 1: dwellings where a significant impact is predicted under the baseline scenario

In order to reduce the impact, the developer has proposed screening in the form of vegetation. The proposed screening is shown in Figure 48 to Figure 51 on the following pages (the reflective areas are represented by the yellow areas). It is predicted that the proposed screening will significantly reduce the views of the reflective area from an observer located at the ground floor. If necessary, the developer will implement an interim mitigation measure (opaque fence) before the screening in the form of vegetation is established. Therefore, a maximum low impact is predicted, and no further mitigation is recommended.

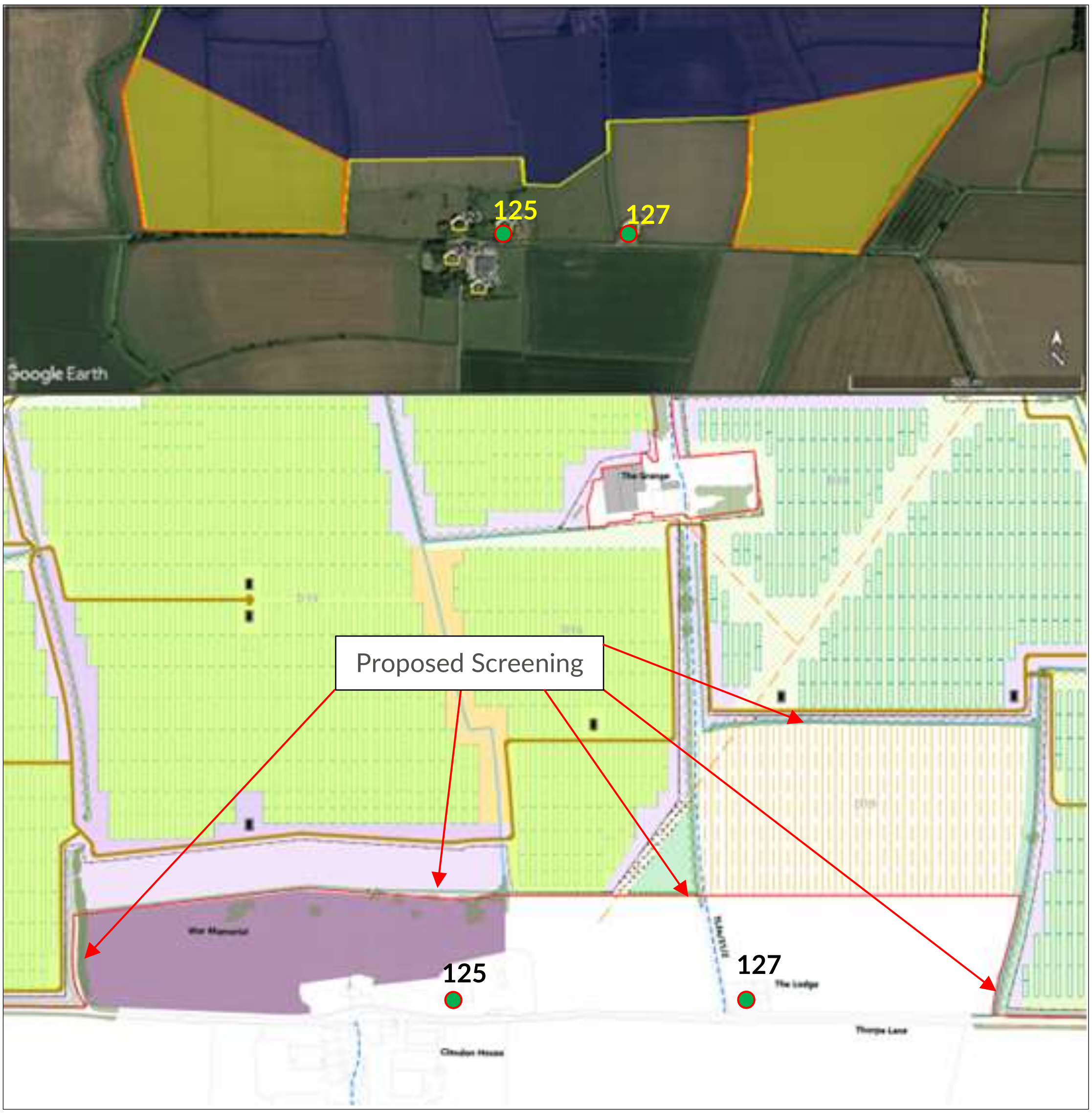

Figure 48 Reflecting area and proposed screening for dwellings 125-127

Figure 49 Reflecting area and proposed screening for dwellings 140-141

Figure 50 Reflecting area and proposed screening for dwellings 156 to 157[28]

[28] The image is taken from an older drawing. The image was not updated with the new drawings since the old one shows better the proposed screening to be installed on the site boundary

Figure 51 Reflecting area and proposed screening for dwelling 171

7.1.1.2 Cottam 2

Solar reflections are geometrically possible for 52 out of the 53 identified dwelling receptors. Under the baseline scenario a significant impact is predicted for two dwelling receptors (dwelling receptors 8 and 9 – see dwelling in orange in Figure 52 on the following page).

Figure 52 Cottam 2: dwellings where a significant impact is predicted under the baseline scenario

In order to reduce the impact the developer has proposed screening in the form of vegetation which is predicted to sufficiently reduce the visibility of the reflective area from observers located at the ground floor. This is shown in Figure 53 on the following page (the reflective area is represented by the yellow area). If necessary, the developer will implement an interim mitigation measure (opaque fence) before the screening in the form of vegetation is established. Therefore, a maximum low impact is predicted, and no further mitigation is recommended.

Figure 53 Reflecting area and proposed screening for dwellings 8 and 9

7.1.1.3 Cottam 3a

Solar reflections are geometrically possible for 56 out of the 59 dwelling receptors. Under the baseline scenario a significant impact is predicted for three dwelling receptors (dwelling receptors 3, 53 and 54 – see dwellings in orange in Figure 54 below).

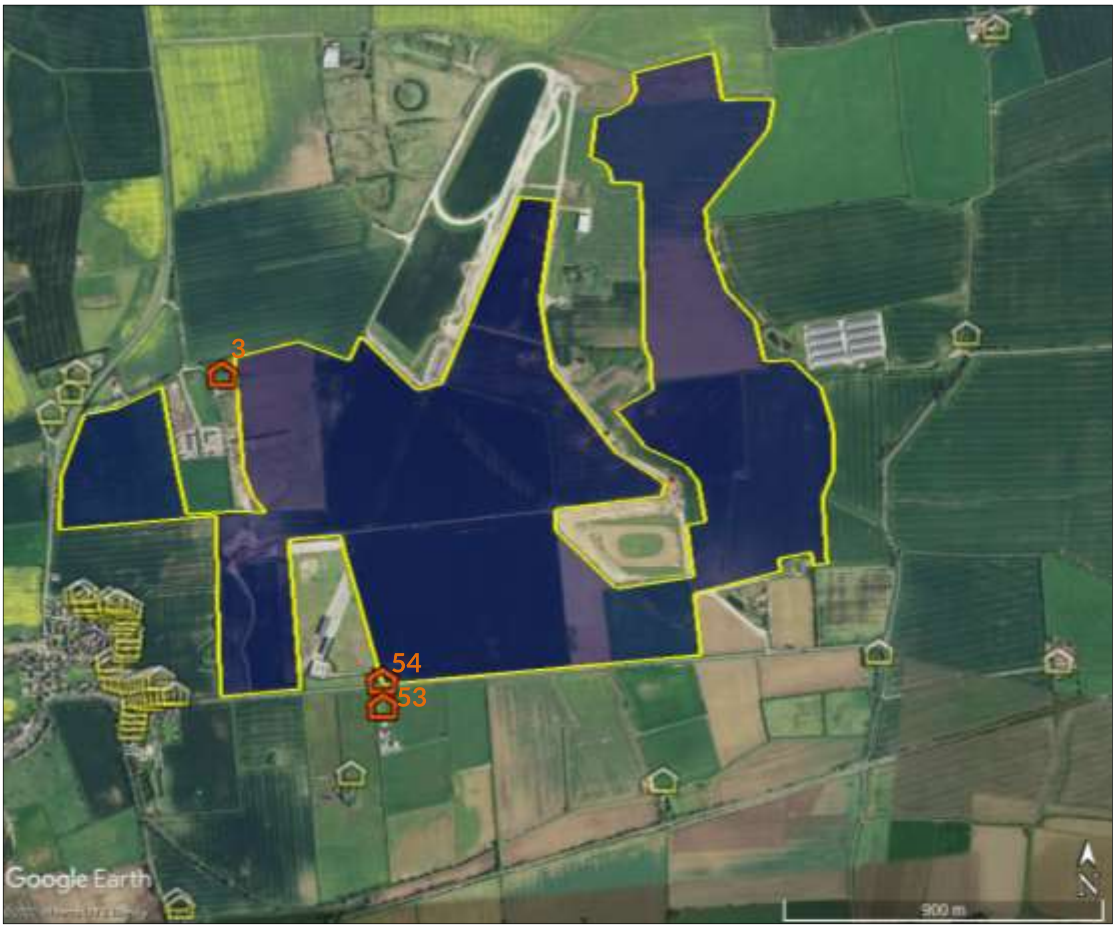

Figure 54 Cottam 3a: dwellings where a significant impact is predicted under the baseline scenario

In order to reduce the impact, the developer has proposed screening in the form of vegetation which is predicted to sufficiently reduce the visibility of the reflective area from observers located at the ground floor. This is shown in Figure 55 below and Figure 56 on the following pages (the reflective area is represented by the yellow area). If necessary, the developer will implement an interim mitigation measure (opaque fence) before the screening in the form of vegetation is established. Therefore, maximum low impact is predicted, and no further mitigation is recommended.

Figure 55 Reflecting area and proposed screening for dwelling 3

Figure 56 Reflecting area and proposed screening for dwellings 53 and 54

7.1.1.4 Cottam 3b

Solar reflections are geometrically possible for 33 out of the 61 dwelling receptors. Of the 33 identified dwelling receptors mitigation is judged a requirement for one (dwelling receptor 33 – see dwelling in orange in Figure 57 on the following page).

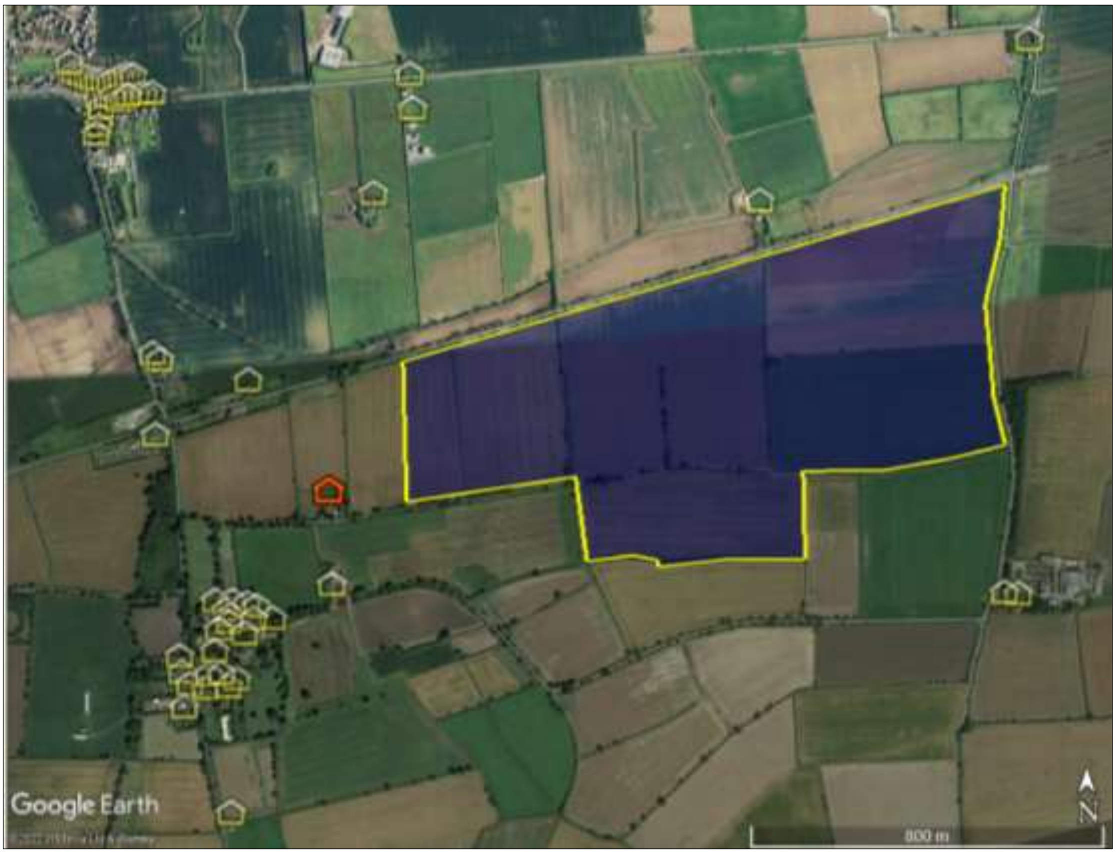

Figure 57 Cottam 3b: dwellings where a significant impact is predicted under the baseline scenario

In order to reduce the impact, the developer has proposed screening in the form of vegetation which is predicted to sufficiently reduce the visibility of the reflective area from observers located at the ground floor. This is shown in Figure 58 on the following page (the reflective area is represented by the yellow area). If necessary, the developer will implement an interim mitigation measure (opaque fence) before the screening in the form of vegetation is established. Therefore, a maximum low impact is predicted, and no further mitigation is recommended.

Figure 58 Recommended screening for dwelling 33

7.1.2 Tracking System

7.1.2.1 Cottam 1

Solar reflections are geometrically possible for all the 171 identified dwelling receptors. Under the baseline scenario a significant impact is predicted for seven out of the 171 dwelling receptors (dwelling receptors 125, 127, 140, 141, 156, 157 and 171). These receptors have been discussed in Section 7.1.1.1 on page 83. While the reflective area is predicted to be slightly larger for the tracking system (see Figure 59 to Figure 64 below and on the following pages), the proposed screening shown in Figure 48 to Figure 51 on the previous pages is predicted to significantly reduce the views of the reflective panels from an observer located at the ground floor. If necessary, the developer will implement an interim mitigation measure (opaque fence) or it will change the operation of the tracking system to avoid backtracking[29] to reduce impacts before the screening in the form of vegetation is established. Therefore, no significant impact is predicted, and no further mitigation is recommended.

Figure 59 Reflective area for dwellings 125-127

Figure 60 Reflective area for dwellings 131-132

[29] Solar backtracking is a tracking control program that aims to minimize PV panel-on-panel shading, thus avoiding production losses (usually to avoid losses this angle is set to 0° when the Sun is low at the horizon – morning and evening). This backtracking angle can be changed to eliminate glare towards the railway receptors.

Figure 61 Reflective area for dwellings 140-141

Figure 62 Reflective area for dwellings 142

Figure 63 Reflective area for dwellings 149 to 154

Figure 64 Reflective area for dwellings 156 to 157

7.1.2.2 Cottam 2

Solar reflections are geometrically possible for 26 out of the 53 identified dwelling receptors. Under the baseline scenario a significant impact is predicted for two dwelling receptors (dwelling receptors 8 and 9). These receptors have been discussed in Section 7.1.1.2 on page 88. While the reflective area is predicted to be slightly larger for the tracking system (see Figure 65 below), the proposed screening shown in Figure 53 on page 90 is predicted to significantly reduce views of the reflective panels from an observer located at the ground floor. If necessary, the developer will implement an interim mitigation measure (opaque fence) or it will change the operation of the tracking system to avoid backtracking to reduce impacts before the screening in the form of vegetation is established. Therefore, no significant impact is predicted, and no further mitigation is recommended.

Figure 65 Reflective area for dwellings 8 and 9

7.1.2.3 Cottam 3a

Solar reflections are geometrically possible for 56 out of the 59 dwelling receptors. Under the baseline scenario a significant impact is predicted for four dwelling receptors (dwelling receptors 2, 3, 53 and 54). Some of these receptors have been discussed in Section 0 on page 91 (3, 53 and 54). While the reflective area is predicted to be slightly larger for the tracking system (see Figure 66 and Figure 67 on the following page), the proposed screening shown in Figure 55 and Figure 56 on page 92 and 93 is predicted to effectively significantly reduce views of the reflective panels from an observer located at the ground floor.

Figure 66 Recommended screening for dwellings 1

Figure 67 Reflective area for dwellings 51 and 52

For the remaining receptor (dwelling 2) it is predicted that the proposed screening will also significantly reduce the visibility of the reflective area (see Figure 68 below). If necessary, the developer will implement an interim mitigation measure (opaque fence) or it will change the operation of the tracking system to avoid backtracking to reduce impacts before the screening in the form of vegetation is established. Therefore, no significant impact is predicted, and no further mitigation is recommended.

Figure 68 Reflecting area and proposed screening for dwelling 2

7.1.2.5 Cottam 3b

Solar reflections are geometrically possible for 48 out of the 61 dwelling receptors. Of the 48 identified dwelling receptors mitigation is judged a requirement for only one (dwelling receptor 33). This receptor has been discussed in Section 0 on page 94. While the reflective area is predicted to be slightly larger for the tracking system (see Figure 68 on the following page), the proposed screening shown in Figure 58 on page 95 is predicted to effectively significantly reduce views of the reflecting solar panels from an observer located at the ground floor. If necessary, the developer will implement an interim mitigation measure (opaque fence) or it will change the operation of the tracking system to avoid backtracking to reduce impacts before the screening in the form of vegetation is established. Therefore, no significant impact is predicted, and no further mitigation is recommended.

Figure 69 Reflective area for dwelling 33

7.1.2.7 Cumulative Effects Cottam 3a and 3b

Some dwellings are predicted to be within the 1km boundary of both Cottam 3a and 3b and can experience glare from both sites. These dwellings are shown in Figure 70 below.

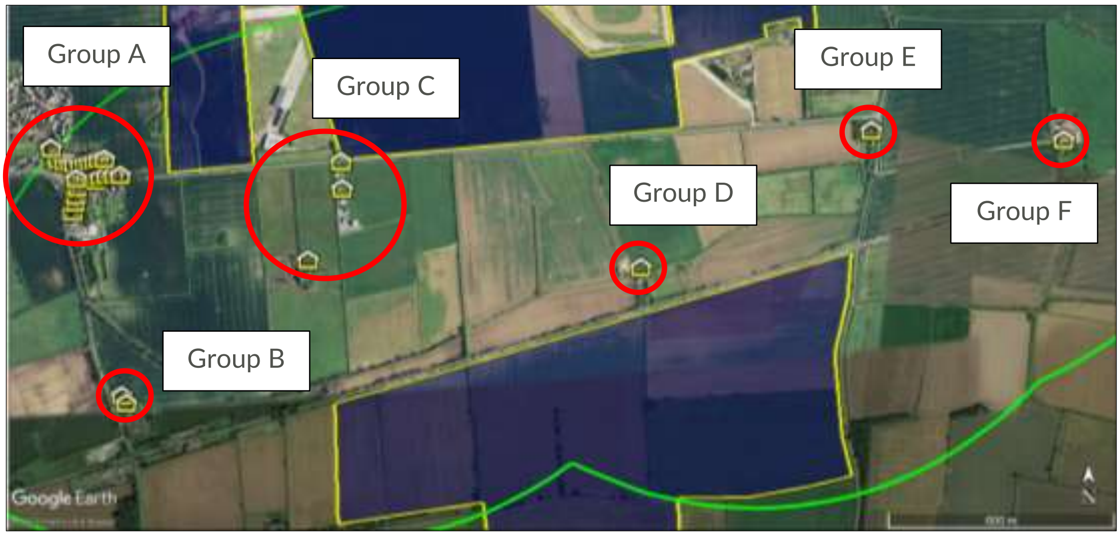

Figure 70 Dwelling receptors within Cottam 3a and 3b 1km boundary

The analysis has shown the following:

- Groups A and B: will not have visibility of the reflective area of Cottam 3a and it is unlikely that an observer located within one of those dwellings will have visibility of the reflective area of Cottam 3b due to existing screening (vegetation, buildings and terrain);
- Groups C and D: the developer has proposed screening in the form of vegetation to significantly reduce views of the reflective area from Cottam 3a. It is likely that the proposed screening to mitigate the impact upon train drivers will also be effective at removing the visibility of the reflective area of Cottam 3b;
- Group E and F: existing screening will significantly reduce views of both sites.

Overall cumulative effects from both sites are not predicted to result in a significant impact upon the identified dwellings. Only groups C and D will have some visibility of both sites under the baseline scenario. However, the proposed mitigating strategies are likely to significantly reduce views of the reflective area. Therefore, no significant cumulative impact is predicted upon those dwellings located within 1km from Cottam 3a and 3b.

7.2 Road Results

For road users along major national, national and regional roads, the key considerations are:

- Whether a reflection is predicted to be experienced in practice.
- The location of the reflecting panels 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).

Where reflections are predicted to be experienced from outside of a road user's field of view (50 degrees either side of the direction of travel), the impact significance is low, and mitigation is not required.

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

- Whether visibility is likely for elevated drivers (applicable to dual carriageways and motorways only) – there is typically a higher density of elevated drivers (such as HGVs) along dual carriageways and motorways compared to other types of road;
- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side;
- The separation distance to the panel area – larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not.

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

7.2.1 Fixed System

7.2.1.1 Cottam 1

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along all identified roads. While for Till Bridge Lane existing screening in the form of vegetation is predicted to significantly reduce the visibility of the proposed development, for B124 views of the reflective area remain possible. However, the impact is predicted to be not significant due to a combination of screening and other mitigating factors such as:

- The solar reflective area being outside the road user's field of focus (50° either side of the direction of travel – see Figure 71 on the following page);
- The large separation distance between the reflective area; and
- the receptors and the Sun light and the solar reflections originating approximately from the same point in space.

Therefore, no significant impact is predicted, and mitigation is not judged a requirement for any of these roads.

Figure 71 B124: road receptor 8 and relative reflective area

Figure 72 Till Bridge Lane: road receptors and existing screening

7.2.1.2 Cottam 2

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along the A631. However, it is likely that screening in the form of existing vegetation (see Figure 73 on the following page), terrain or buildings will significantly reduce views of the proposed development. If the reflections are not fully screened by the existing screening the following should be considered:

- At its closest point the development is 450m away from the road. Therefore, the reflective area will always be at a significant distance from a road user;
- The solar reflective area is predicted, for certain receptors, to be outside the road user's field of focus (50° either side of the direction of travel);
- In all cases solar reflections are predicted to occur when the Sun is low at the horizon. Therefore, the reflective area and the Sun which is a much brighter source of light.

Therefore, maximum low impact is predicted mitigation is not recommended. The large separation distance between the reflective area and the receptors and the Sun light and the solar reflections originating approximately from the same point in space. Therefore, no significant impact is predicted, and mitigation is not judged a requirement for any of these roads.

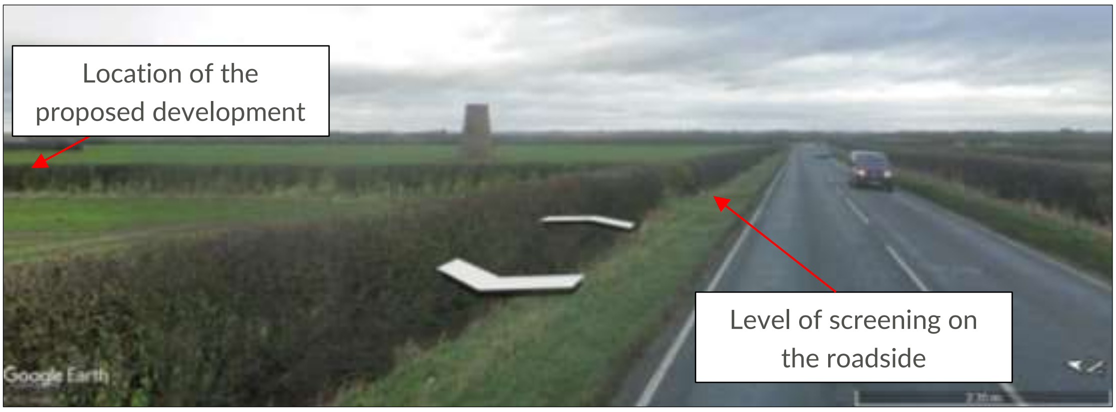

Figure 73 Till Bridge Lane: roadside screening (receptor 9)

7.2.1.3 Cottam 3a

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along all identified roads. While for Laughton Road and Station Road there is no need for mitigation, due to a combination of screening and other mitigating factors such as: the solar reflective area being outside the road user's field of focus (50° either side of the direction of travel), the large separation distance between the reflective area and the receptors and the Sun light and the solar reflections originating approximately from the same point in space, mitigation should be implemented to reduce the impacts for road users travelling along some sections of Kirton Road.

The results of the analysis have shown that reflections are expected to be experienced by road users along approximately 2.2km of road, between road receptors 23 and 37 and between 42 and 48. The affected locations and the proposed screening location are shown in Figure 74 and Figure 75 on page 107 and 108.

It is predicted that the proposed screening will significantly reduce views of the reflective area for road users travelling along Kirton Road. The height of the screening will be sufficient to significantly reduce the visibility of the reflecting solar panel from typical road users' drivers. If necessary, the developer will implement an interim mitigation measure (opaque fence) before the screening in the form of vegetation is established.

Figure 74 Reflecting area and proposed screening for road receptors 23-37

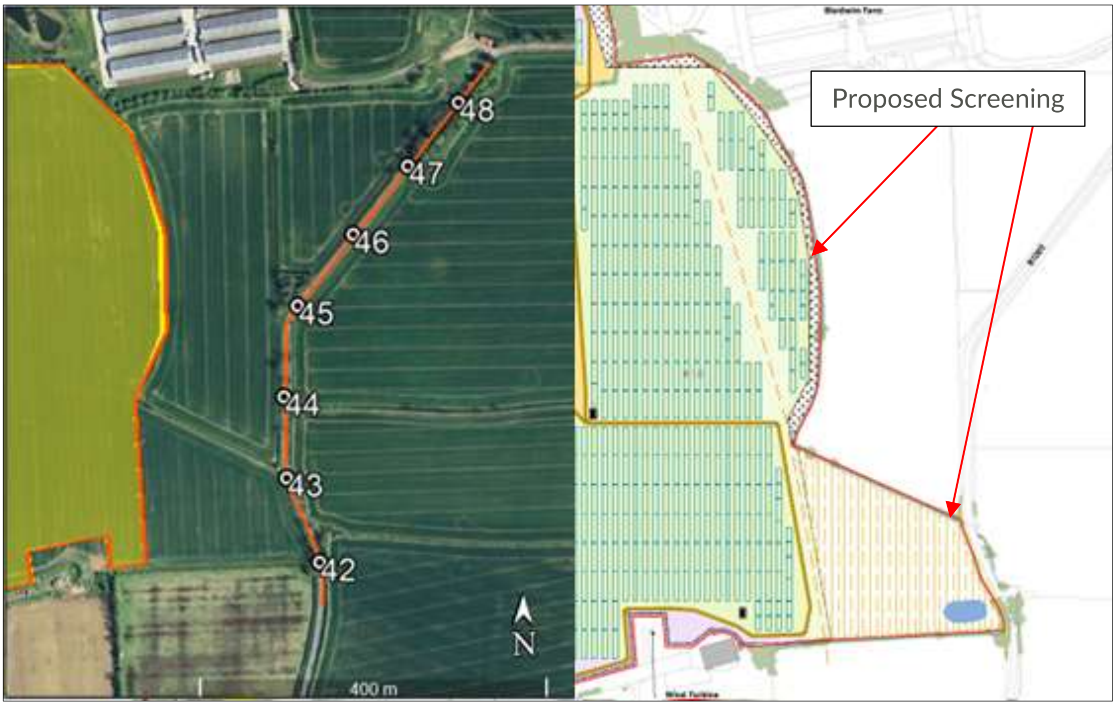

Figure 75 Reflecting area and proposed screening for road receptors 42-48

7.2.1.4 Cottam 3b

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along all identified roads. However, due to a combination of screening and other mitigating factors such as: the solar reflective area being outside the road user's field of focus (50° either side of the direction of travel), the large separation distance between the reflective area and the receptors and the Sun light and the solar reflections originating approximately from the same point in space. Therefore, no significant impact is predicted, and mitigation is not judged a requirement for any of these roads.

Figure 76 Kirton Road: roadside screening (receptor 31)

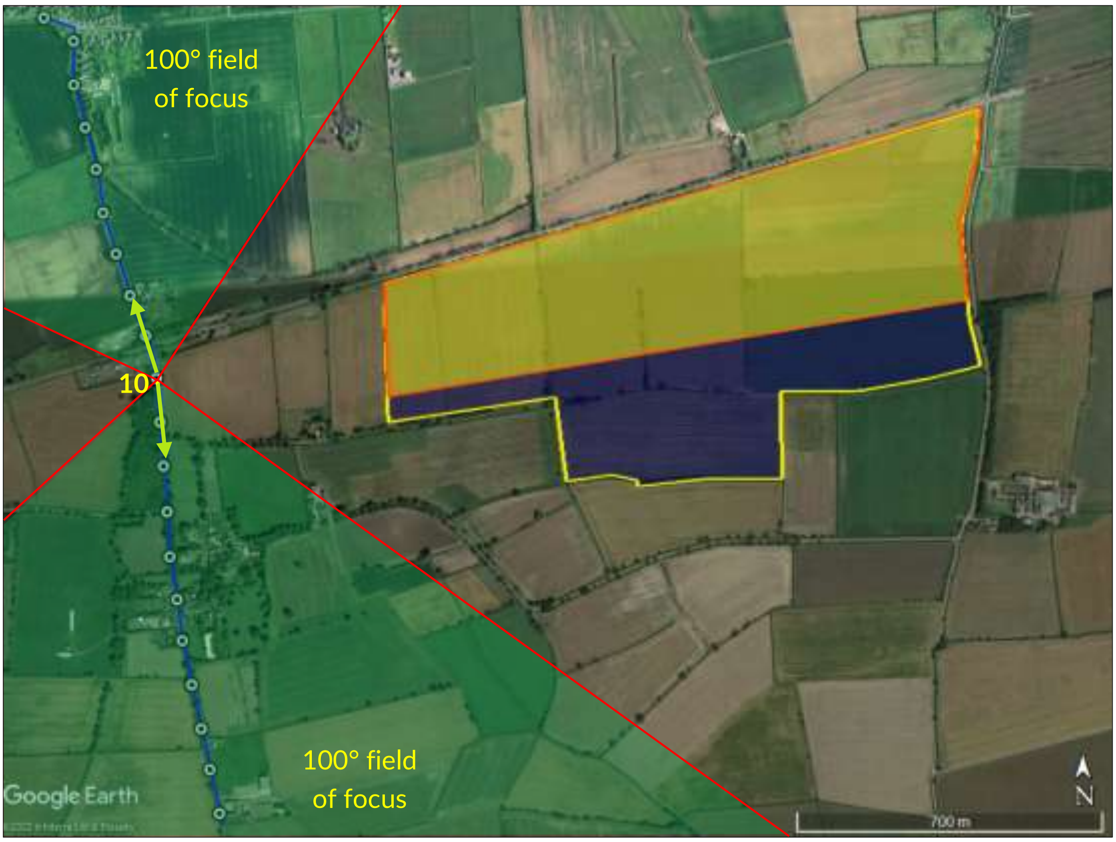

Figure 77 Station Road: road receptor 10 and relative reflective area

7.2.2 Tracking System

7.2.2.1 Cottam 1

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along all identified roads. However, due to a combination of screening and other mitigating factors mitigation is not judge a requirement for any of these roads.

7.2.2.2 Cottam 2

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along all identified roads. However, due to a combination of screening and other mitigating factors mitigation is not judge a requirement for any of these roads.

7.2.2.3 Cottam 3a

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along all identified roads. While for Laughton Road and Station Road there is no need for mitigation, due to a combination of screening and other mitigating factors, mitigation should be implemented to reduce the impacts for road users travelling along some sections of Kirton Road. The results of the analysis have shown that reflections are expected to be experienced by road users along approximately 2.4km of road, between road receptors 21 and 37 and between 42 and 48. These are approximately the same stretches of road discussed in Section 7.2.1.3 on page 106 (in the case of tracking panels solar reflections are also predicted to occur for drivers travelling across receptors 21 and 22 – see Figure 78 below). It is predicted that the proposed screening will significantly reduce the views of the reflective area for road users travelling along Kirton Road. The height of the screening will be sufficient to significantly reduce the visibility of the reflecting solar panel from typical road users' drivers. If necessary, the developer will implement an interim mitigation measure (opaque fence) or it will change the operation of the tracking system to avoid backtracking to reduce impacts before the screening in the form of vegetation is established.

Figure 78 Reflecting area and proposed screening for road receptors 21-37

7.2.2.4 Cottam 3b

The results of the analysis have shown that solar reflections are geometrically possible for road users travelling along all identified roads. However, due to a combination of screening and other mitigating factors such as: the solar reflective area being outside the road user's field of focus (50° either side of the direction of travel), the large separation distance between the reflective area and the receptors and the Sun light and the solar reflections originating approximately from the same point in space. Therefore, no significant impact is predicted, and mitigation is not judged a requirement for any of these roads.

7.2.2.5 Cumulative Effects Cottam 3a and 3b

Some roads receptors along Station and Kirton Road are predicted to be within the 1km boundary of both Cottam 3a and 3b and can experience glare from both sites. These road receptors are shown in Figure 79 below.

Figure 79 Road receptors within Cottam 3a and 3b 1km boundary

The analysis has shown the following:

- Station Road (blue line): drivers travelling along identified receptors will have no visibility of either of the two sites due to existing screening (hedgerows on the roadside, other vegetation and buildings);
- Kirton Road (orange line): the developer has proposed screening in the form of vegetation to significantly reduce views of the reflective area from Cottam 3a. Existing vegetation will significantly reduce views of the Cottam 3b.

Overall cumulative effects from both sites are not predicted to result in a significant impact upon road users since visibility of both sites concurrently is not possible under the baseline scenario.

7.3 Railway Results

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

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

Where reflections originate from outside of a train driver's field of view (30 degrees either side of the direction of travel), the impact significance is low, and mitigation is not required.

Where reflections originate from inside of a train driver's field of view but there are mitigating circumstances, the impact significance is low and mitigation is not recommended.

Where reflections originate from inside of a train driver's field of view and there is a lack of sufficient mitigating factors, a moderate impact is predicted and mitigation is not recommended.

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

7.3.1 Fixed System

7.3.1.1 Cottam 3b

The results of the analysis have shown that solar reflections are geometrically possible for train drivers travelling along 19 out of the 26 identified receptors (see Figure 80 on the following page), equivalent to circa 2km of assessed railway line. Under the current baseline scenario a train driver is predicted to have almost unobstructed visibility of the reflecting area (some existing screening between the proposed development and the railway line might provide sufficient screening however, gaps in the vegetation remain). The reflecting area is expected to be in front of the train driver. The developer has proposed instant screening on the northern and western sides of the proposed development to reduce impacts. Therefore, no impact is predicted, and no further mitigation is required.

Figure 80 Reflecting area and proposed screening for train driver receptors 1 to 19

7.3.2 Tracking System

7.3.2.1 Cottam 3b

The results of the analysis have shown that solar reflections are geometrically possible for train drivers travelling along 23 out of the 26 identified receptors (equivalent to 2.3km of railway track). Existing and proposed screening is predicted to significantly reduce the visibility of the reflective area. The developer has also proposed to use a different backtracking angle to fully remove solar reflections. Therefore, no impact is predicted, and no further mitigation is required.

Table 29 Reflecting area and proposed screening for train driver receptors 4 to 26

8 CUMULATIVE ASSESSMENT OF NEARBY SOLAR NSIP

8.1 Introduction

The Applicant has requested Pager Power to consider the cumulative glint and glare effect of other known solar NSIP projects (West Burton Solar Project, Gate Burton Energy Park and Tillbridge Solar[30]). These sites are located in the proximity of the proposed development Cottam (specifically Cottam 1 see Figure 81 below and Figure 82 on the following page).

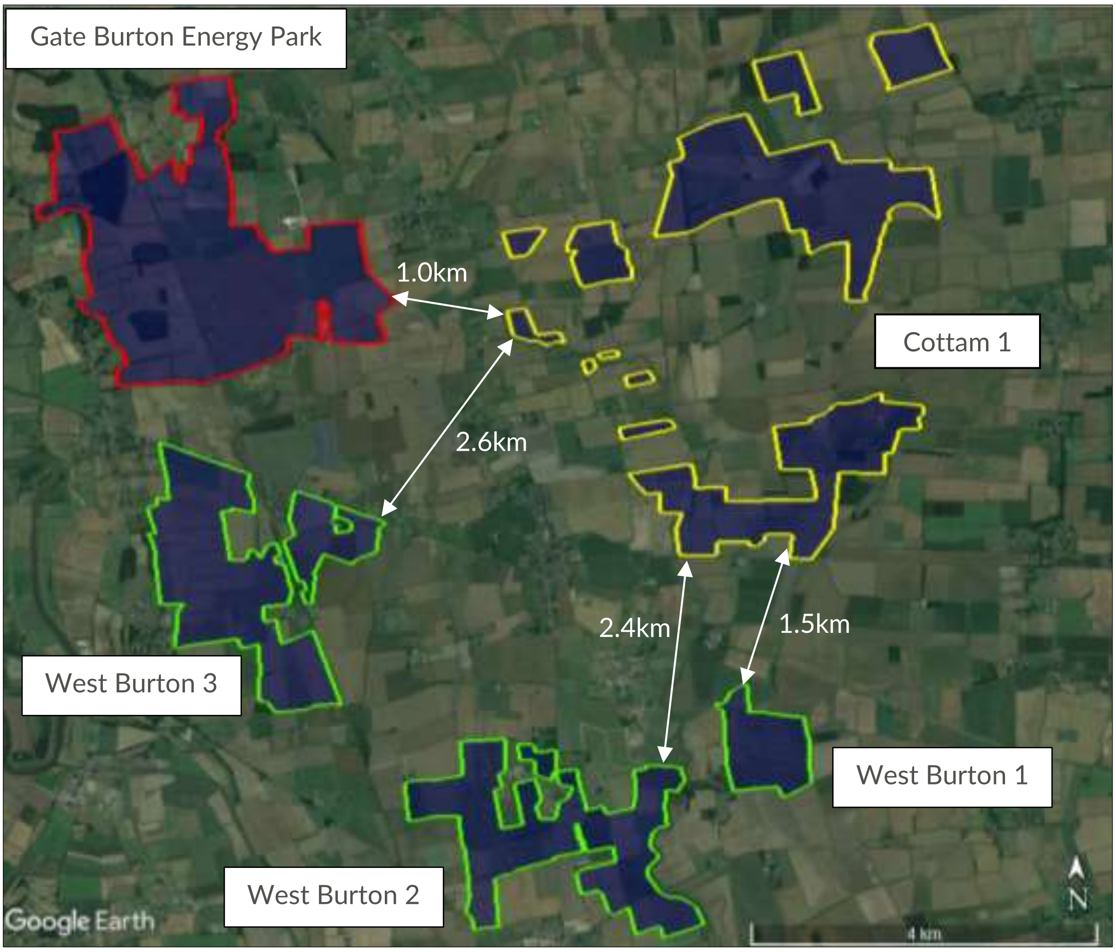

Figure 81 Location of Cottam 1 relative to West Burton 1, 2 and 3 and Gate Burton Energy Park

[30] Only NSIP projects were considered, as requested and identified by The Applicant.

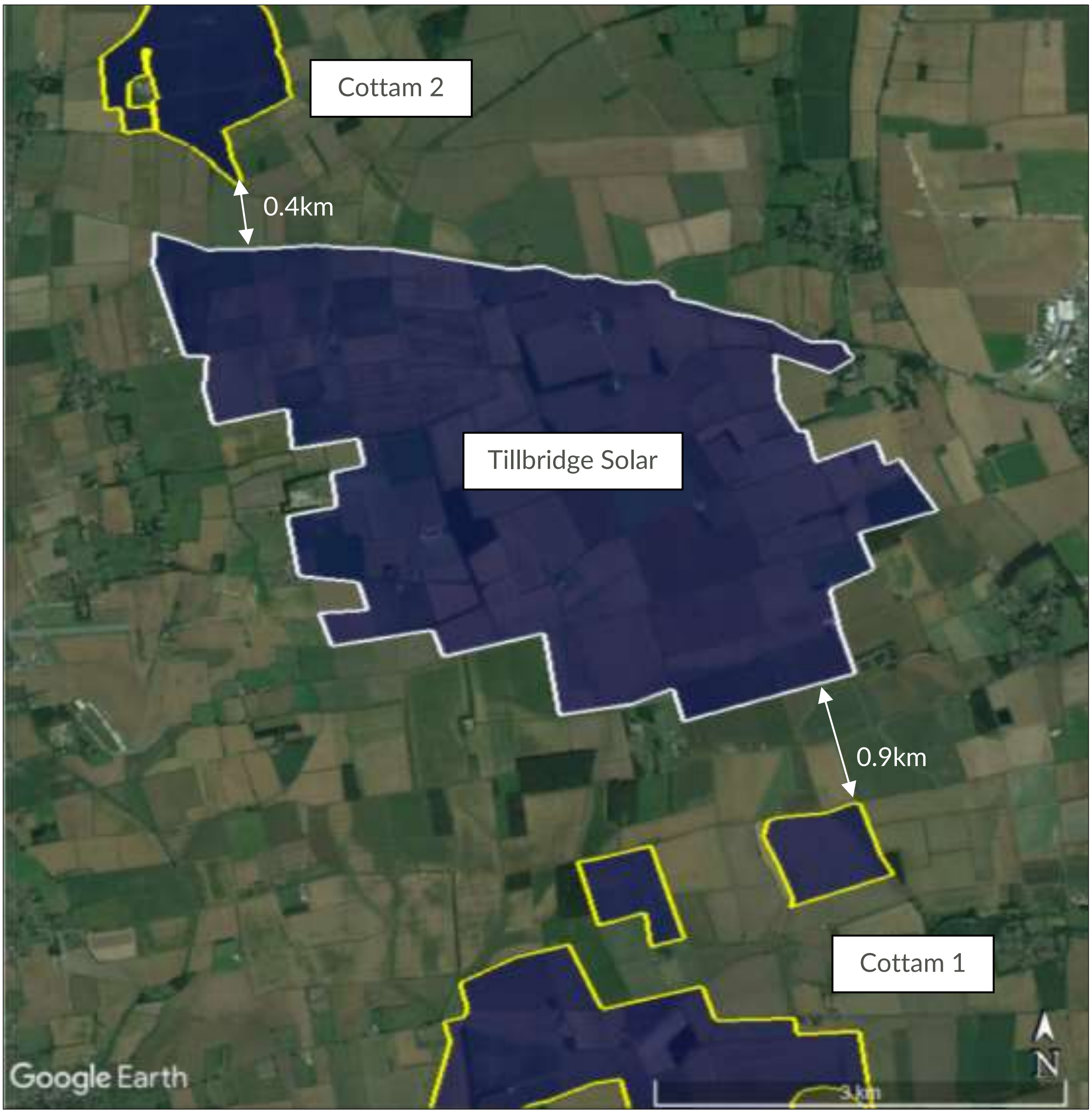

Figure 82 Location of Cottam 1 and 2 relative to Tillbridge Solar

8.1.1 Cumulative assessment: Cottam, West Burton 1, 2 and 3 and Gate Burton Energy Park

Significance of effects reduces to acceptable levels beyond 1km, therefore significant cumulative effects are only possible for receptors sited between Cottam 1 and West Burton 1 and for receptors sited between Cottam 1 and Gate Burton Energy Park. Gate Burton Energy Park and West Burton 2 are sufficiently close to Cottam 1 to share multiple receptors.

The receptors located within 1km from both Cottam 1 and Gate Burton Energy Park and 1km from both West Burton 1 and for Cottam 1 are shown in Figure 83 and Figure 84 on the following page (within the white shaded area). The review of the available imagery showed that due to existing screening (other dwellings, vegetation or terrain) visibility of both sites is not predicted for the dwellings and road receptors located within the white area. Therefore, under the baseline conditions, shared receptors are not predicted to have concurrent visibility of multiple areas. Therefore, significant cumulative effects are not considered likely.

Figure 83 Shared dwelling and road receptors between Cottam 1 and Gate Burton Energy Park (section of B1241 near Gainsborough village road receptor 1 to 13 and dwelling receptors 1 to 14, 15 to 17 and 19 to 34)

Figure 84 Shared dwelling and road receptors between Cottam 1 and West Burton 1 (section of Till Bridge Lane south of Cottam 1 specifically road receptors 41 to 46)

8.1.2 Cumulative assessment: Cottam and Tillbridge Solar

Significance of effects reduces to acceptable levels beyond 1km, therefore significant cumulative effects are possible for receptors between Cottam 1 and Tillbridge Solar and for receptors between Cottam 2 and Tillbridge Solar.

The receptors located within 1km from Cottam 1 and Tillbridge Solar and 1km from Cottam 2 and Tillbridge Solar are shown in Figure 85 on the following page (within the white shaded area).

Based on the geographic location between Cottam 1 and Tillbridge Solar, solar reflections can only be geometrically possible from both developments if tracking panels are utilised. However, even if tracking panels were utilised, any impact is not predicted be significant due to the presence of mitigating factors such as: the presence of partial screening reducing views of both developments, large separation distance between the receptors and Cottam 1, the Sun being low at the horizon at the time of solar reflections.

If solar reflections are geometrically possible towards dwellings and road (A631) receptors between Cottam 1 and Tillbridge Solar are not predicted to be significant due to the presence of mitigating factors such as: presence of partial screening reducing views of both developments, large separation distance between the receptors and Cottam 2, the Sun being low at the horizon at the time of solar reflections.

Therefore, under the baseline conditions, shared receptors are not predicted to experience a significant impact.

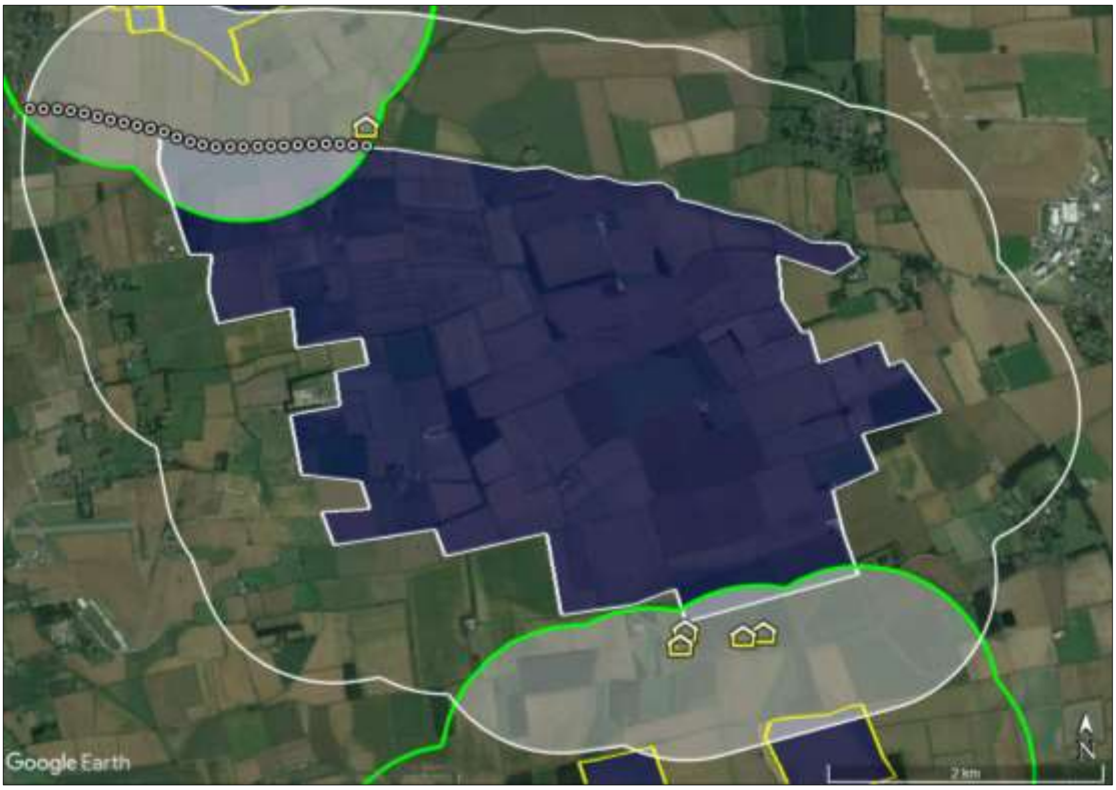

Figure 85 Shared dwelling and road receptors between Cottam 1 and Gate Burton Energy Park (the A631 road receptors 1 to 27 and dwelling receptors 135 to 138)

9 OVERALL CONCLUSIONS

9.1 High-Level Assessment of Aviation Receptors

9.1.1 Aviation Receptors – Consultation

Pager Power has consulted with the safeguarding teams at Sturgate Airfield and RAF Scampton with regard to the effect of the proposed development upon aviation activity. The results of the glint and glare were presented and the safeguarding teams have concluded that the proposed development is not predicted to pose a significant risk upon their operations. Both safeguarding teams have not submitted an objection towards the proposed development as part of the pre-application consultation process.

9.1.2 Aviation Receptors – High Level Assessment

Considering the associated guidance and industry best practice it is predicted that the impact of the proposed developments will be acceptable and full technical modelling of aviation receptors associated with Haxey, Hibaldstow, Forwood, and Headon Airfields will not be required. This is because:

- The orientation of the runways is such that the proposed development will be outside the pilot's field of view (this means that, even if solar reflections are predicted towards pilots, the reflection will originate from outside the pilot's field of view and will therefore not be deemed significant);
- If solar reflections are visible, it is likely that any glare towards pilots will have low potential for after-image due to the large separation distance between the airfields and the proposed developments.

9.2 High-Level Assessment of Waterways

Pager Power has reviewed the available imagery to identify if any waterway[31-32] exists within 1km from proposed development. No waterway of a size sufficiently large to accommodate navigation has been identified and therefore glint and glare impacts towards waterway users are not considered possible.

The river Trent is circa 5.4km west of Cottam Solar Development (at its closest point). Therefore, if geometrically possible and unscreened, any glint and glare effects will not have a significant impact due to the large separation distance.

[31] A navigable body of water, such as a river, channel, or canal.

[32] River Till is a small river located nearby Cottam 1. This river is too small for navigation and it is not considered within the assessment.

9.3 High-level Assessment of Public Rights of Way

In Pager Power's experience, significant impacts upon pedestrians/observers along PRoWs from glint and glare are not possible. The reasoning is due to the sensitivity of the receptors (in terms of amenity and safety) being concluded to be of low significance because:

- The typical density of pedestrians on a PRoW is low in a rural environment;
- Any resultant effect is much less serious and has far lesser consequences than, for example, solar reflections experienced towards a road network whereby the resultant impacts of a solar reflection can be much more serious to safety;
- Glint and glare effects towards receptors on a PRoW are transient, and time and location sensitive whereby a pedestrian could move beyond the solar reflection zone with ease with little impact upon safety or amenity;
- There is no safety hazard associated with reflections towards an observer on a footpath.

Furthermore, any effect will have a low magnitude because:

- It is likely that the existing and the proposed screening is predicted fully remove the visibility of the proposed development for certain PRoW users;
- If effects are possible and unscreened they would typically coincide with direct sunlight. The Sun is a far more significant source of light.
- The reflection intensity is similar for solar panels and still water (and significantly less than reflections from glass and steel[33]) which is frequently a feature of the outdoor environment surrounding public rights of way. Therefore, the reflections are likely to be comparable to those from common outdoor sources whilst navigating the natural and built environment on a regular basis.

Therefore, since no significant impacts are predicted, no full modelling is required.

9.4 Assessment Results – Dwelling Receptors

The results of the analysis have shown that reflections from the proposed development are geometrically possible towards some of the identified dwelling receptors. Under the baseline scenario a significant impact is predicted for:

- Fixed System: 7 dwellings (Cottam 1), 2 dwellings (Cottam 2), 3 dwellings (Cottam 3a), 1 dwelling (Cottam 3b).
- Tracking System: 7 dwellings (Cottam 1), 2 dwellings (Cottam 2), 4 dwellings (Cottam 3a), 1 dwelling Cottam 3b).

Within the landscaping plan, the developer has proposed mitigation in the form of vegetation. It is predicted that the proposed mitigation solution will reduce the impact to acceptable levels (the proposed screening is predicted to significantly reduce the visibility[34] of the reflective area from

[33] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).
[34] Vegetation may provide varying levels of cover, immediately after planting, during winter, and after maintenance (e.g. pruning). The developer will also implement instant screening.

observers located at the ground floor[35]). If necessary, the developer will implement an interim mitigation measure (opaque fence) before planting is established.

Therefore, low impact is predicted at worst upon the identified dwelling receptors, and no further mitigation is recommended.

9.5 Road Receptors

The results of the analysis have shown that solar reflections from the proposed development are geometrically possible towards some of the identified road receptors. Under the baseline scenario a significant impact (from Cottam 3a only) is predicted for road users travelling along a stretch of Kirton Road - B1205 of circa 2.2km (fixed system) or circa 2.4km (tracking system).

However, the proposed screening is predicted to significantly reduce the visibility of the reflective area for road users travelling along Kirton Road. The height of the screening will be sufficient to significantly reduce visibility[7] of reflecting solar panel for typical road user's drivers. If necessary, the developer will implement an interim mitigation measure (opaque fence) before planting is established.

Therefore, a low impact is predicted at worst upon the identified road receptors, and no further mitigation is recommended.

9.6 Network Rail Receptors

9.6.1 Railway Signal Receptors

No potential signal locations were identified along the assessed section of railway line using available imagery and have therefore not been assessed. Network Rail has been contacted to confirm the location of any signals at these locations; however, no response has been received to date. Once a response has been received, the report can be updated.

Train Driver Receptors

The results of the analysis have shown that reflections from the proposed development are geometrically possible towards train drivers. Under the baseline scenario a significant impact (from Cottam 3b only) is predicted for train drivers travelling north-east for a section of 2.3km of assessed railway track for the tracking system and a section of 1.9km for the fixed system. However, the proposed screening is predicted to significantly reduce the visibility[7] of the reflective panel area from train driver receptors.

Therefore, a low impact is predicted at worst upon the identified train driver receptors, and no further mitigation is recommended.

9.7 Cumulative Assessment of Nearby Solar NSIP Projects

The cumulative glint and glare effect of West Burton Solar Project, Gate Burton Energy Park and Tillbridge Solar. Gate Burton Energy Park, West Burton 1 and Tillbridge Solar are sufficiently close to Cottam 1 to share multiple receptors, and this is also true for Tillbridge Solar and Cottam 2.

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[35] The ground floor is typically considered the main living space and has a greater significance with respect to residential amenity and views from the first floor have been considered within the results discussion where appropriate.

The shared receptors are as follows:

- Cottam, West Burton 1, 2 and 3 and Gate Burton Energy Park:
  - A section of B1241 near Gainsborough village (specifically road receptor 1 to 13).
  - Dwellings near and within Gainsborough village (specifically dwelling receptors 1 to 14, 15 to 17 and 19 to 34).
  - A section of Till Bridge Lane south of Cottam 1 (specifically road receptors 41 to 46).
- Cottam and Tillbridge Solar:
  - The A631 between Cottam 2 and Tillbridge Solar (specifically road receptor 1 to 27).
  - Dwellings between Cottam 1 and Tillbridge Solar (specifically dwelling receptors 135 to 138) and dwelling 49 between Cottam 2 and Tillbridge Solar.

However, under the baseline conditions, shared receptors are either unlikely to concurrently have visibility of multiple areas (Gate Burton Energy Park and West Burton 1) or, if visibility is possible, (Cottam 1 and 2 and Tillbridge Solar) no significant impact is predicted due to the presence of significant mitigating factors such as: the presence of partial screening reducing views of multiple developments, large separation distance between the receptors and the developments, the Sun being low at the horizon at the time of solar reflections. Therefore, no significant cumulative effects are possible.

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[36] (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.'

Draft National Policy Statement for Renewable Energy Infrastructure

The Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)[37] sets out the primary policy for decisions by the Secretary of State for nationally significant renewable energy infrastructure. Section 2.52 states:

'2.52.1 *Solar panels may reflect the sun's rays, causing glint and glare. Glint is defined as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is*

[36] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 08/12/2022.
[37] Draft National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Business, Energy & Industrial Strategy, date: September 2021, accessed on: 08/12/2022.

a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.

2.52.2 In some instances, it may be necessary to seek a glint and glare assessment as part of the application. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts. The potential for solar PV panels, frames and supports to have a combined reflective quality should be assessed. This assessment needs to consider the likely reflective capacity of all of the materials used[38] in the construction of the solar PV farm.

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

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

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

Consultation to determine whether EN-3 provides a suitable framework to support decision making for nationally significant energy infrastructure ended in November 2021. Pager Power is aware that aviation stakeholders were not consulted prior to the publication of the draft policy and understands that they will still request a glint and glare assessment on the basis that glare may lead to impact upon aviation safety. It is possible that the draft policy will change in light of the consultation responses from aviation stakeholders.

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

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare is 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[39] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

[38] In Pager Power's experience, the solar panels themselves are the overriding source of specular reflections which have the potential to cause significant impacts upon safety or amenity.
[39] Pager Power Glint and Glare Guidance, Fourth Edition (4.0), April 2022.

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[40] however the advice is still applicable[41] 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.

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[42], 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.

[40] Archived at Pager Power
[41] Reference email from the CAA dated 19/05/2014.
[42] Aerodrome Licence Holder.

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

FAA Guidance

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

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'[43], the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports*'[44], and the 2021 final policy is entitled '*Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports*'[45].

Key excerpts from the final policy are presented below:

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

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

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

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[43] Archived at Pager Power

[44] 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: 08/12/2021.

[45] Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports, Federal Aviation Administration, date: May 2021, accessed on: 08/12/2021.

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

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

In 2018, the FAA released the latest version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'[46]. Whilst the 2021 final policy also supersedes this guidance, many of the points are still relevant because aerodromes are still safeguarding against glint and glare irrespective of the FAA guidance. The key points are presented below for reference:

- *Reflectivity refers to light that is reflected off surfaces. The potential effects of reflectivity are glint (a momentary flash of bright light) and glare (a continuous source of bright light). These two effects are referred to hereinafter as "glare," which can cause a brief loss of vision, also known as flash blindness*[47].
- *The amount of light reflected off a solar panel surface depends on the amount of sunlight hitting the surface, its surface reflectivity, geographic location, time of year, cloud cover, and solar panel orientation.*
- *As illustrated on Figure 16*[48]*, flat, smooth surfaces reflect a more concentrated amount of sunlight back to the receiver, which is referred to as specular reflection. The more a surface is polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.*
- *Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:*
    - *A qualitative analysis of potential impact in consultation with the Control Tower, pilots and airport officials;*
    - *A demonstration field test with solar panels at the proposed site in coordination with FAA Tower personnel;*
    - *A geometric analysis to determine days and times when an impact is predicted.*

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[46] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.
[47] 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.
[48] First figure in Appendix B.

- *The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and system design.*
- ***1. Assessing Baseline Reflectivity Conditions** – Reflection in the form of glare is present in current aviation operations. The existing sources of glare come from glass windows, auto surface parking, rooftops, and water bodies. At airports, existing reflecting surfaces may include hangar roofs, surface parking, and glassy office buildings. To minimize unexpected glare, windows of air traffic control towers and airplane cockpits are coated with anti-reflective glazing. Operators also wear polarized eye wear. Potential glare from solar panels should be viewed in this context. Any airport considering a solar PV project should first review existing sources of glare at the airport and the effectiveness of measures used to mitigate that glare.*
- ***2. Tests in the Field** – Potential glare from solar panels can easily be viewed at the airport through a field test. A few airports have coordinated these tests with FAA Air Traffic Controllers to assess the significance of glare impacts. To conduct such a test, a sponsor can take a solar panel out to proposed location of the solar project, and tilt the panel in different directions to evaluate the potential for glare onto the air traffic control tower. For the two known cases where a field test was conducted, tower personnel determined the glare was not significant. If there is a significant glare impact, the project can be modified by ensuring panels are not directed in that direction.*
- ***3. Geometric Analysis** – Geometric studies are the most technical approach for reflectivity issues. They are conducted when glare is difficult to assess through other methods. Studies of glare can employ geometry and the known path of the sun to predict when sunlight will reflect off of a fixed surface (like a solar panel) and contact a fixed receptor (e.g., control tower). At any given site, the sun moves across the sky every day and its path in the sky changes throughout year. This in turn alters the destination of the resultant reflections since the angle of reflection for the solar panels will be the same as the angle at which the sun hits the panels. The larger the reflective surface, the greater the likelihood of glare impacts.*
- *Facilities placed in remote locations, like the desert, will be far from receptors and therefore potential impacts are limited to passing aircraft. Because the intensity of the light reflected from the solar panel decreases with increasing distance, an appropriate question is how far you need to be from a solar reflected surface to avoid flash blindness. It is known that this distance is directly proportional to the size of the array in question[49] but still requires further research to definitively answer.*
- ***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.*

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[49] 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.

Air Navigation Order (ANO) 2016

In some instances, an aviation stakeholder can refer to the ANO 2016[50] with regard to safeguarding. Key points from the document are presented below.

Lights liable to endanger

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

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

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

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

(a) to extinguish or screen the light; and

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

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

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

Lights which dazzle or distract

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

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

Endangering safety of an aircraft

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

Endangering safety of any person or property

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

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.

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

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'[51] which details the requirement for assessing glare towards railway signals.

Reflections and glare

Rationale

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

Guidance

A5 is present if direct glare or reflected light is directed into the eyes or into the lineside signalling asset that could make the asset appear to show a different aspect or indication to the one presented.

A5 is relevant to any lineside signalling asset that is capable of presenting a lit signal aspect or indication.

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

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

a) Disability glare, caused by scattering of light in the eye, can make it difficult to read a lit display.
b) Discomfort glare, which is often associated with disability glare. While being unpleasant, it does not affect the signal reading time directly, but may lead to distraction and fatigue.

Examples of the adverse effect of disability glare include:

a) When a colour light signal presenting a lit yellow aspect is viewed at night but the driver is unable to determine whether the aspect is a single yellow or a double yellow.
b) Where a colour light signal is positioned beneath a platform roof painted white and the light reflecting off the roof can make the signal difficult to read.

Options for militating against A5 include:

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

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[51] Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 12/12/2022.

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'[52] 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.

[52] 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 135° in the vertical plane and 200° 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°) to approximately 30° at each eye. The peripheral field extends from 30° 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.

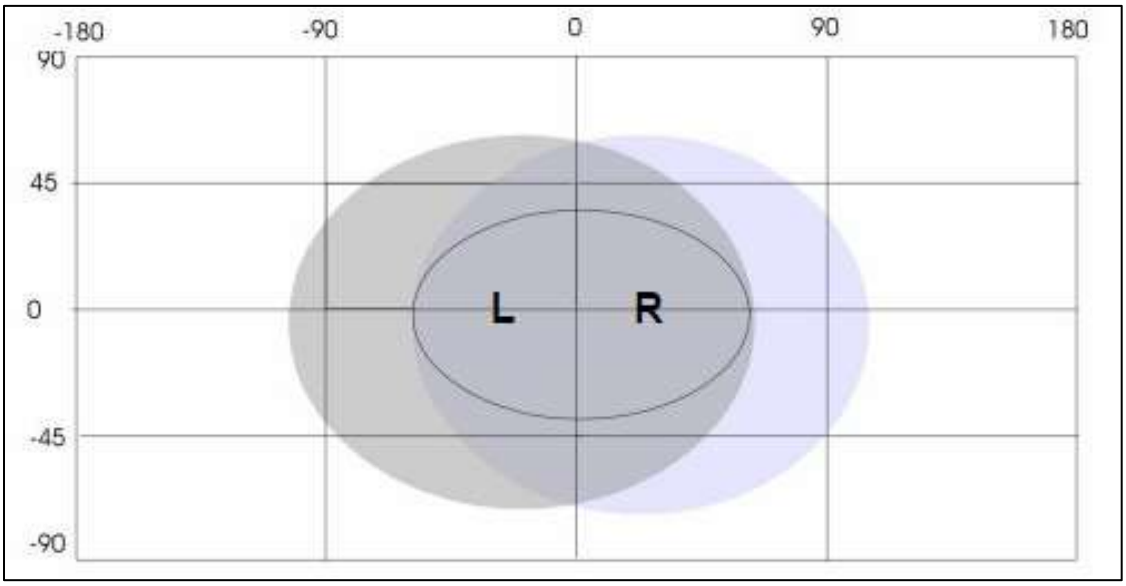


Figure G 21 - Field of view

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.

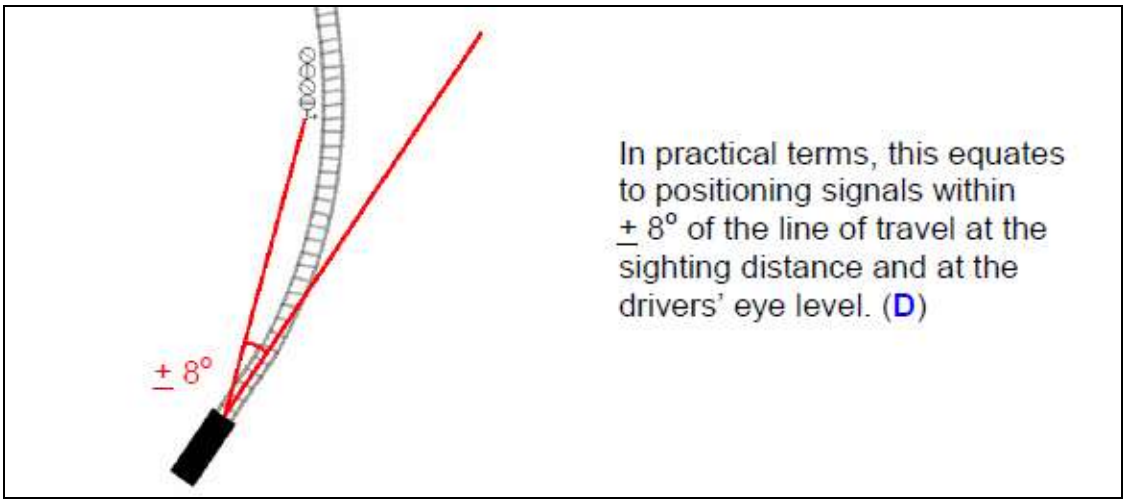


Figure G 22 - Signal positioning

'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 8° cone at 15.44 m in front of the driver*
16	*2.25*	-
17	*2.39*	-
18	*2.53*	*A stop aspect positioned 5.1 m above rail level and 0.9 m from the left hand rail is within the 8° cone at 17.93 m in front of the driver*
19	*2.67*	-
20	*2.81*	-
21	*2.95*	-
22	*3.09*	-
23	*3.23*	-
24	*3.37*	-
25	*3.51*	*A stop aspect positioned 3.3 m above rail level and 2.1 m from the right hand rail is within the 8° cone at 25.46 m in front of the driver*

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

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

Determining the Assessed Minimum Reading Time

The 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:

- An LED railway signal produces a more intense light making them more visible to approaching trains when compared to the traditional filament bulb technology[53];
- 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.

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

Many LED signal manufacturers[54] claim that LED signal lights significantly reduce or completely remove the likelihood of a phantom aspect illumination occurring.

[54] Source: Sun phantom LED traffic signal, Patrick Martineau, Siemens, date: 16/05/2002, Patent No.: US 2002/0186143 A1, (Last accessed 07.12.22).

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

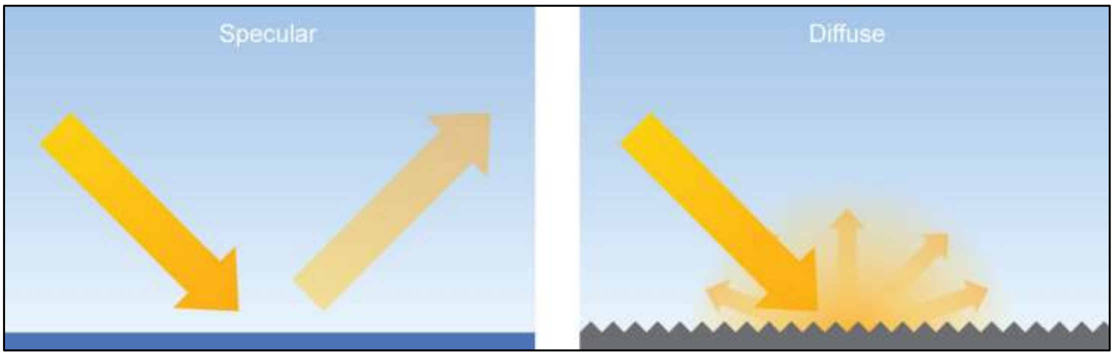
Overview

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

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

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse reflection will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[55], 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

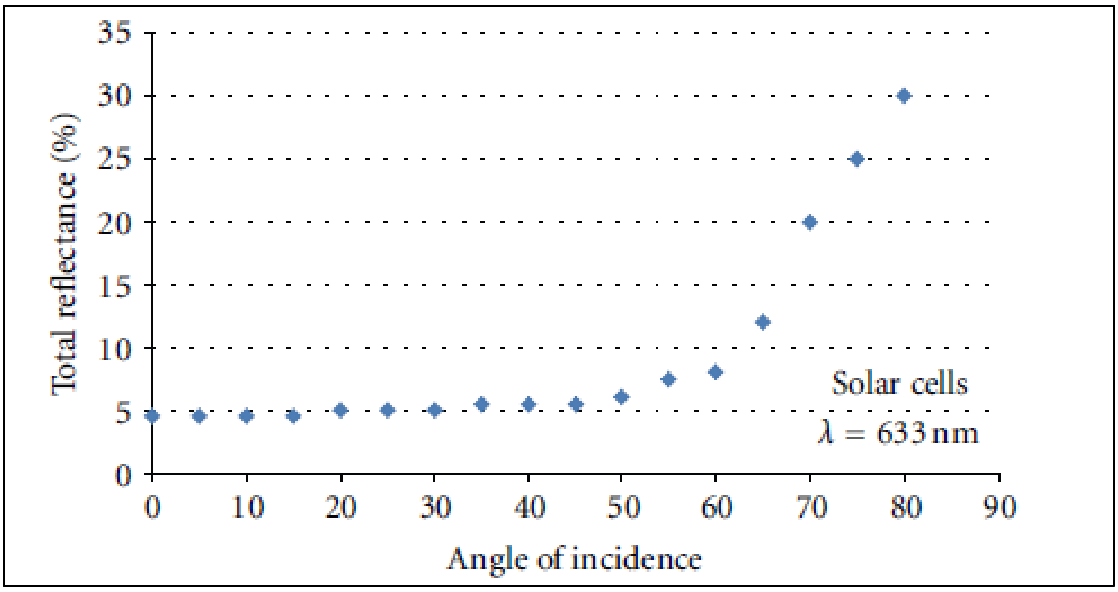
[55] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

Solar Reflection Studies

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

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

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[56]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;
- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[57]

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[56] 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

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

The 2010 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected[58]
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).

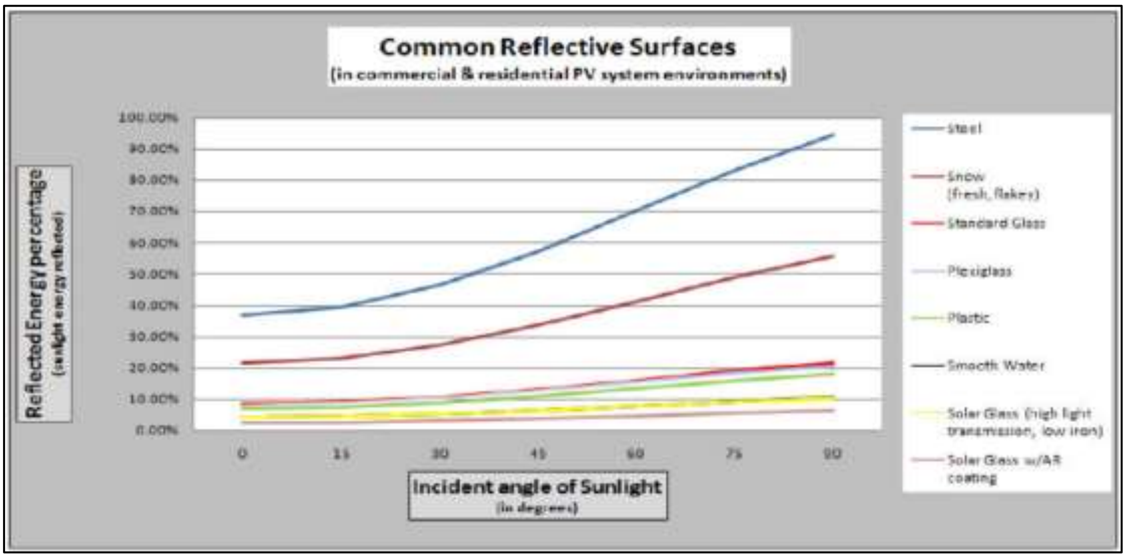
An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

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

SunPower Technical Notification (2009)

SunPower published a technical notification[59] to '*increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment*'.

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



Common reflective surfaces

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

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

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

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

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

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

- Time
- Date
- Latitude
- Longitude

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

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

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector.

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.

Receptor Sensitivity Definition

The table below presents the recommended definition of 'receptor sensitivity' in glint and glare terms and the type of receptor based on the sensitivity.

Sensitivity	Definition	Receptor
High	The receptor or resource has little ability to absorb the change without fundamentally altering its present character or it is of international or national importance.	None
Medium	The receptor or resource has moderate capacity to absorb the change without significantly altering its present character or is of high and more than local (but not national or international) importance.	Aviation Receptors (ATC Tower and Approach Paths), Railway Receptors (Train Drivers and Railway Signals), Roads (no local roads) and Dwellings.
Low	The receptor or resource is tolerant of change without detrimental effect, is of low or local importance.	Local Roads and Public Rights of Way

Receptors sensitivity definition

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.

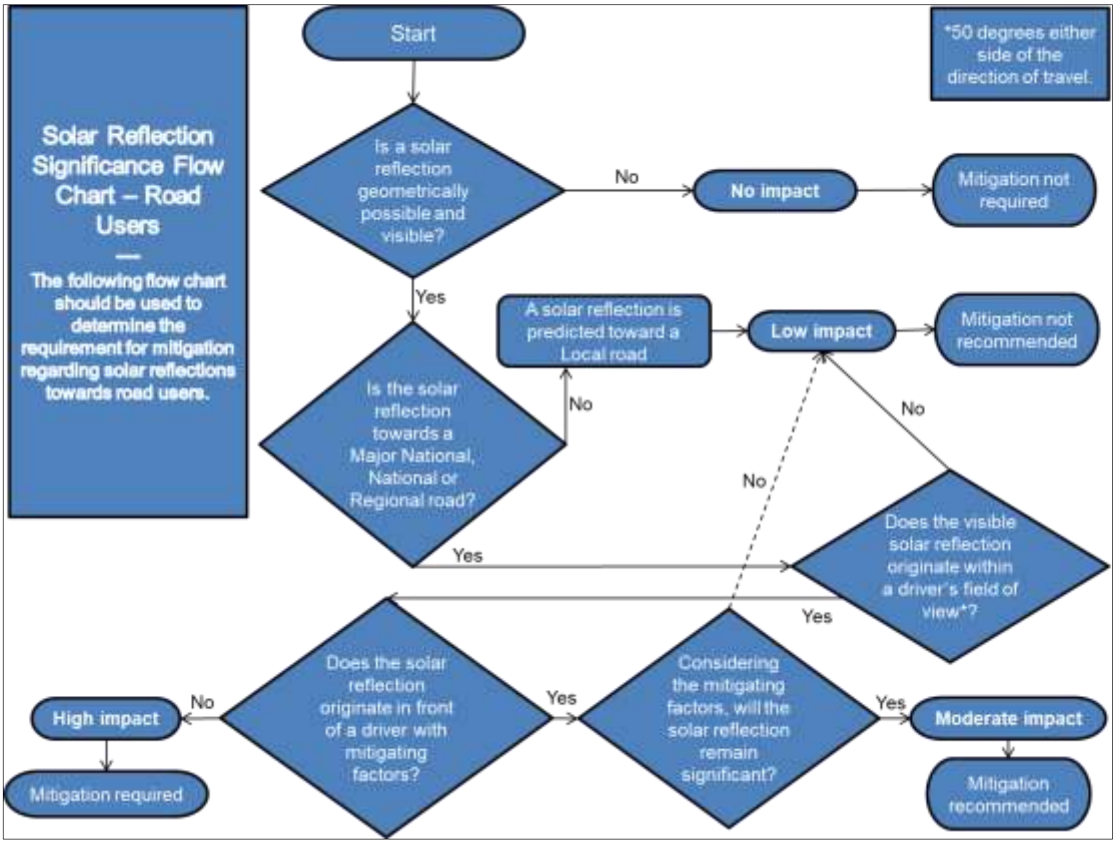
Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.

Impact Significance	Definition	Mitigation Requirement
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels significantly.	No mitigation recommended.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case given individual receptor criteria.	Mitigation recommended.
High	A solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria	Mitigation will be required if the proposed development is to proceed.

Impact significance definition

Impact Significance Determination for Road Receptors

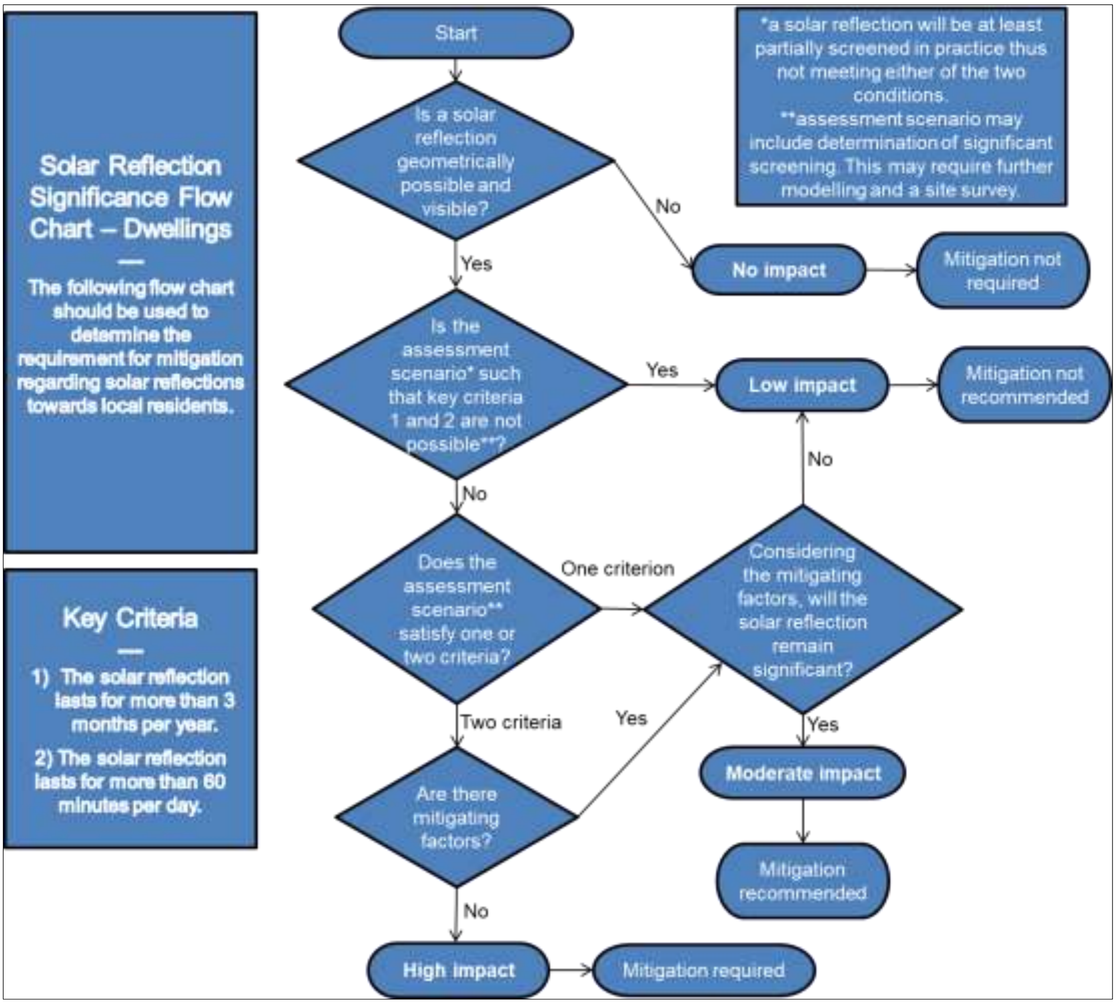
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road user impact significance flow chart

Impact Significance Determination for Dwelling Receptors

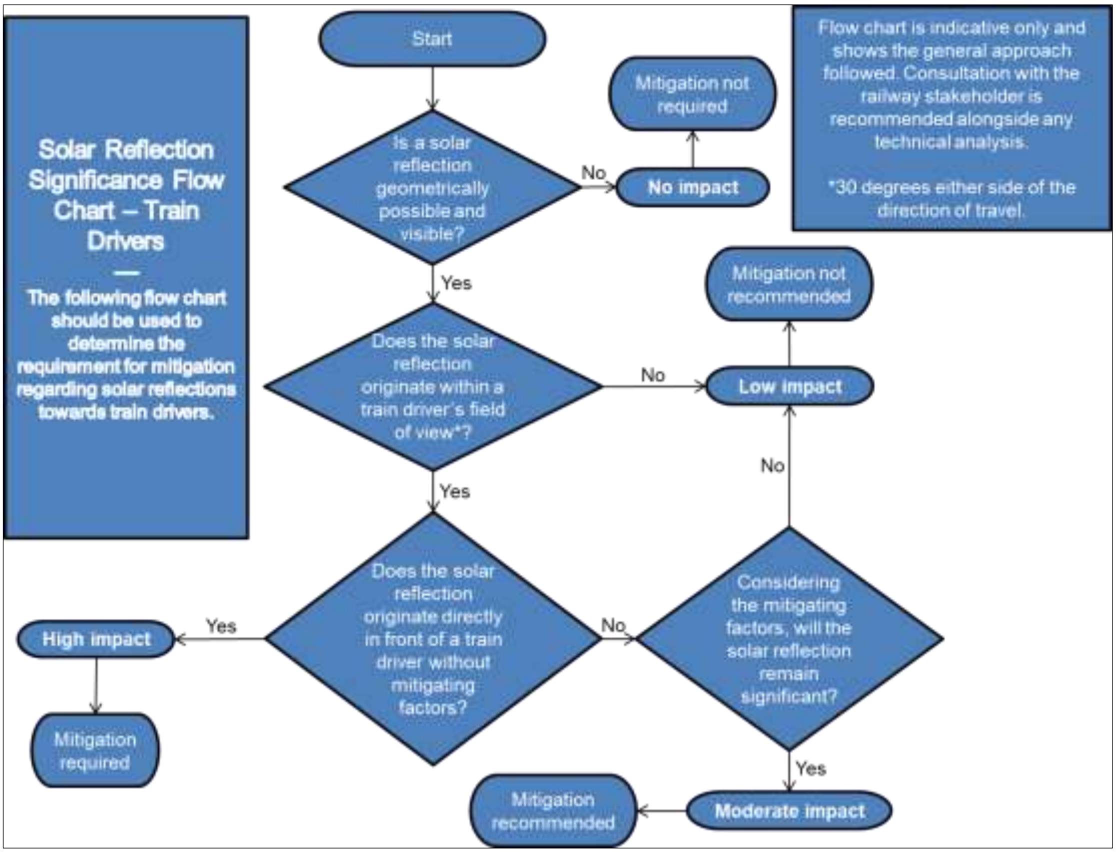
The flow chart presented below has been followed when determining the mitigation requirement for dwelling receptors.



Dwelling impact significance flow chart

Impact Significance Determination for Railway Receptors – Train Drivers

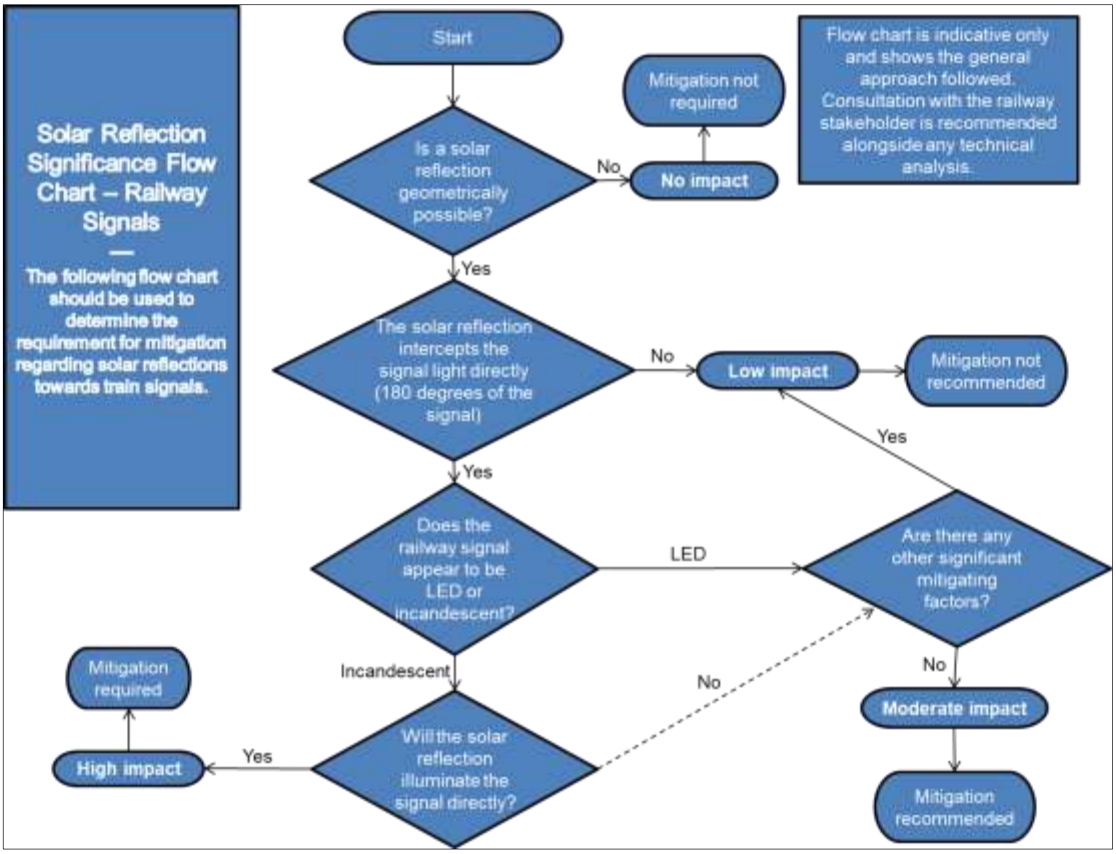
The flow chart presented below has been followed when determining the mitigation requirement for train drivers.



Train driver impact significance flow chart

Impact Significance Determination for Railway Receptors – Railway Signals

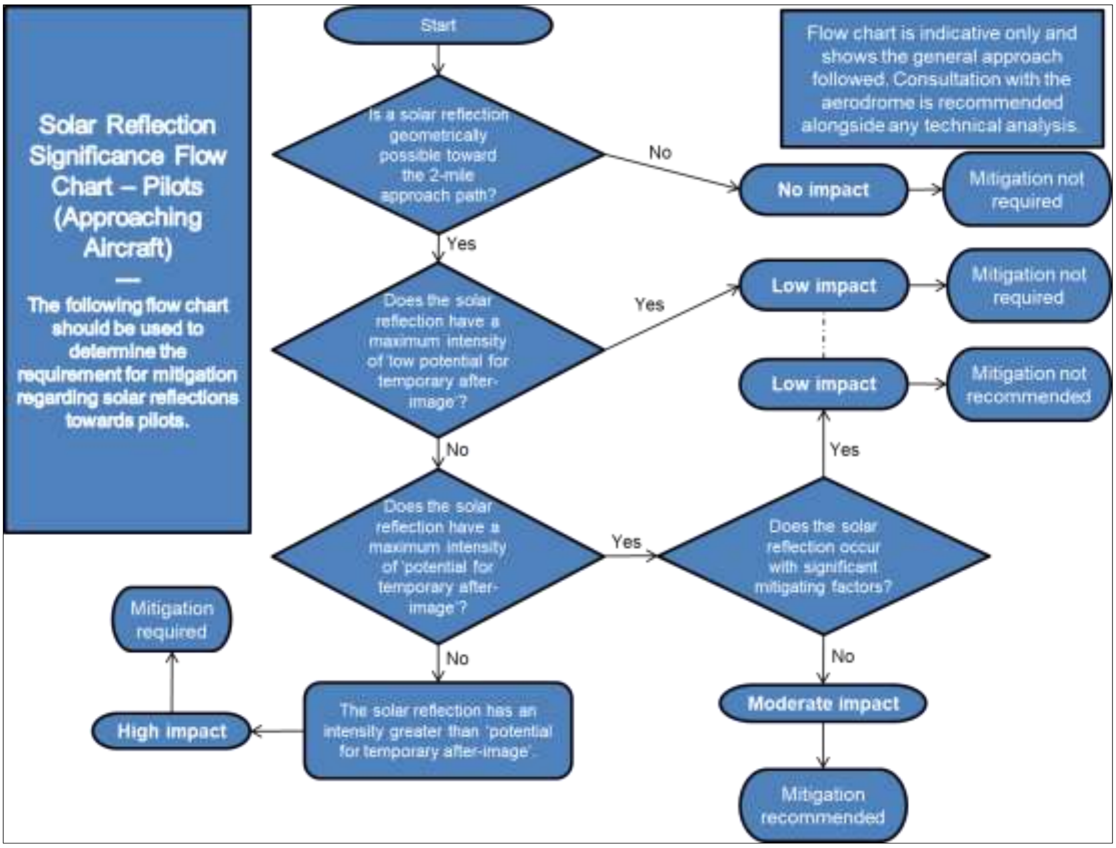
The flow chart presented below has been followed when determining the mitigation requirement for railway signals.



Railway signals impact significance flow chart

Impact Significance Determination for Aviation Receptors – Approaching Aircrafts

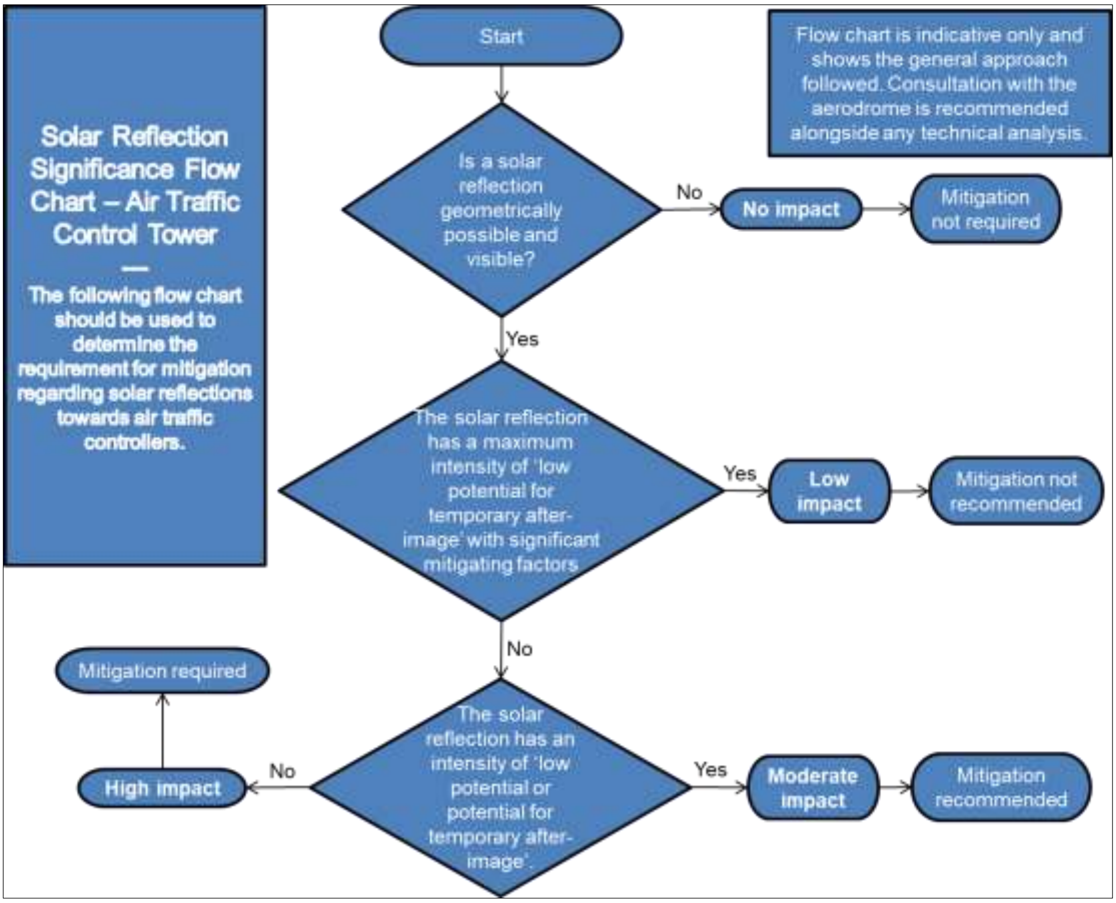
The flow chart presented below has been followed when determining the mitigation requirement for approaching aircrafts.



Approaching Aircrafts impact significance flow chart

Impact Significance Determination for Aviation Receptors – ATC Tower

The flow chart presented below has been followed when determining the mitigation requirement for ATC Tower.



ATC Tower impact significance flow chart

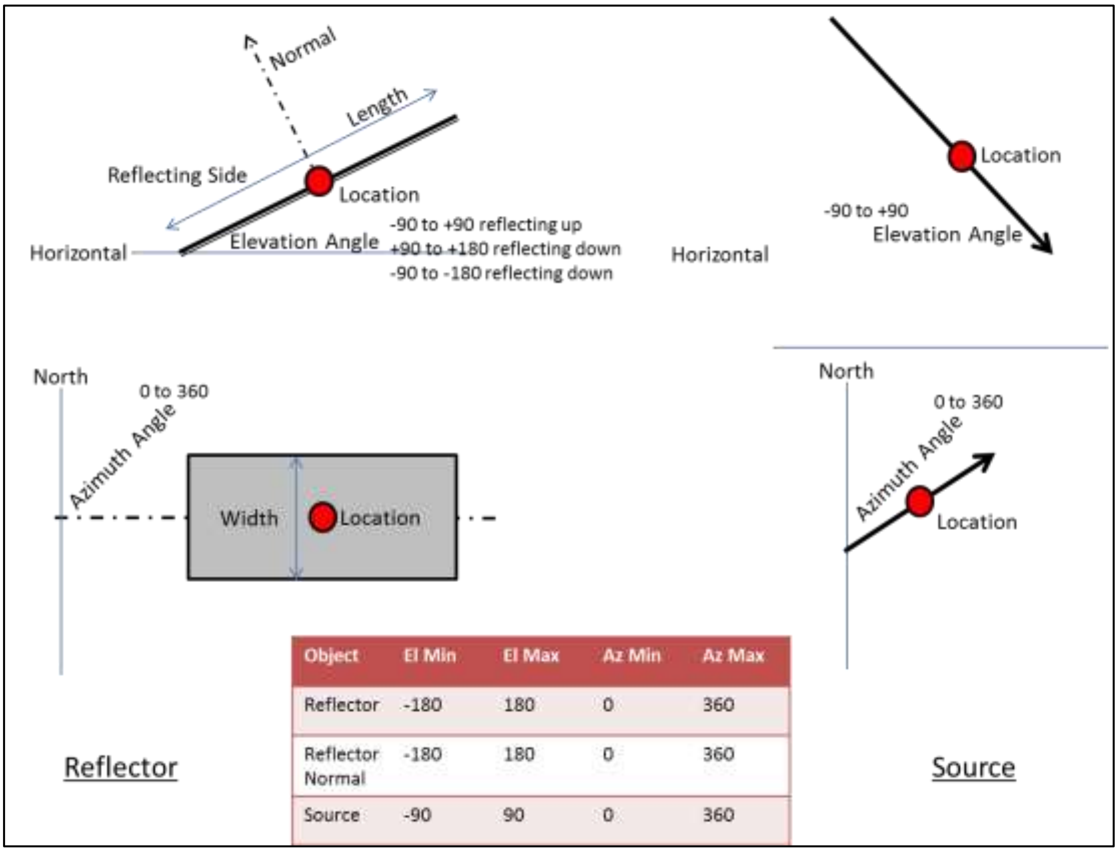
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

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

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



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

Reflection calculation process

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

- Use the Latitude and Longitude of reflector as the reference for calculation purposes;
- Calculate the Azimuth and Elevation of the normal to the reflector;
- Calculate the 3D angle between the source and the normal;

- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
    - The angle between source and normal is equal to angle between normal and reflection;
    - Source, Normal and Reflection are in the same plane.

Pager Power's Model

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

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

The model considers terrain between the reflecting solar panels and the visible horizon (where the sun may be obstructed from view of the panels)[60].

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

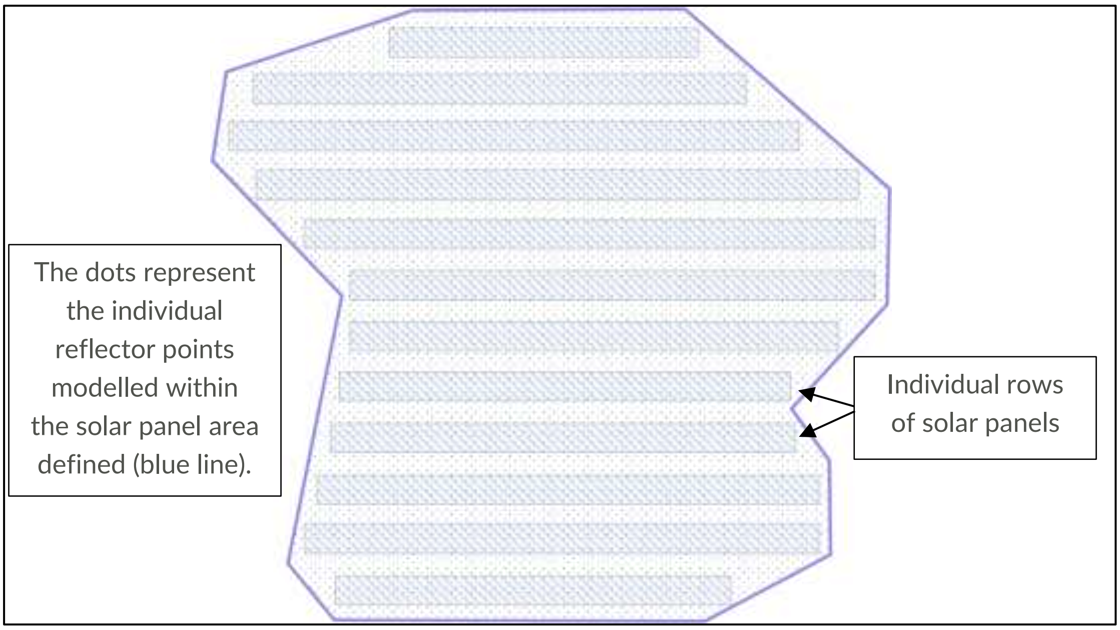
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

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

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

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

[60] UK only.



Solar panel area modelling overview

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

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

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

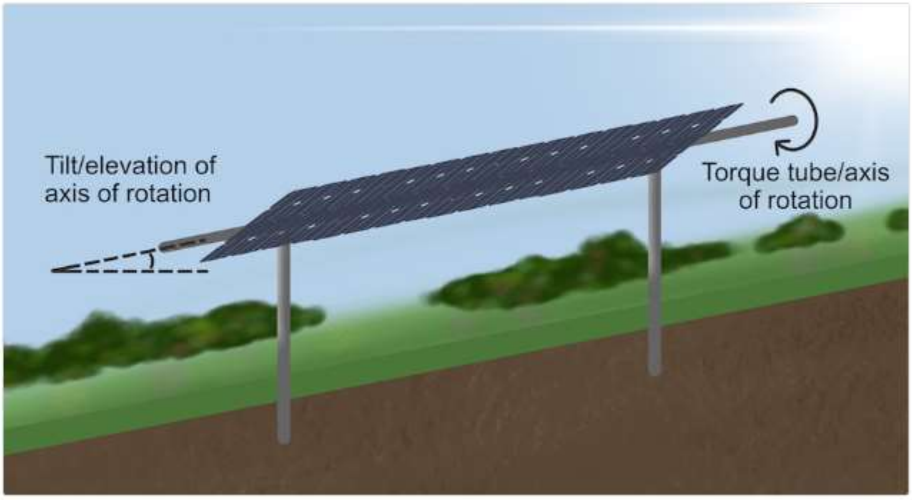
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Forge Reflection Calculations Methodology

Extracts taken from the Forge Solar Model.

Tracking System Parameters

Single-axis module tracking systems are described by a unique set of parameters. These angular inputs model the tracking axis, rotation range and backtracking behavior. Dual-axis module tracking systems are assumed to track the sun at all times.



Single-axis tracking system with torque tube tilted due to geography

Tilt of tracking axis (°)
Tilt above flat ground of axis over which panels rotate (e.g. torque tube). System on flat, level ground would have axis tilt of 0°.

Orientation of tracking axis (°)
Azimuthal angle of axis over which panels rotate. Angle represents the facing of the axis and system. For example, typical tracking system in northern hemisphere has tracking axis oriented north-south with an orientation of 180°, allowing panels to rotate east-west with potential south-facing tilt. Typical tracking system in southern hemisphere runs south-north with axis orientation of 0°, yielding east-west rotation with potential north-facing tilt.

Offset angle of module (°)
Additional tilt angle of PV module elevated above tracking axis/torque tube. Offset angle is measured from the torque tube.

Maximum tracking angle (°)
Maximum angle of rotation of tracking system in one direction. For example, a typical system with a 120° range of rotation has a *max tracking angle* of 60° (east/west).

Resting angle (°)
Angle of rotation of panels when sun is outside tracking range. Used to model backtracking. Panels will revert to the position described by this rotation angle at all times when the sun is outside the rotation range. Setting this equal to the *maximum tracking angle* implies the panels do not backtrack.

ForgeSolar utilizes a simplified model of backtracking which assumes panels instantaneously revert to the *resting angle* whenever the sun is outside the rotation range. For example, panels with *max tracking angle* of 60° and *resting angle* of 0° would lie flat from sunrise until the sun enters the rotation range, and immediately after the sun leaves the rotation range until sunset daily.

Tracking System Parameters

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Dwelling Receptor Details

The dwelling receptors details are presented in the tables below.

Cottam 1

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.68346	53.35268	87	-0.66427	53.31790
2	-0.68318	53.35213	88	-0.66420	53.31777
3	-0.68343	53.35204	89	-0.66413	53.31763
4	-0.68350	53.35190	90	-0.66395	53.31751
5	-0.68336	53.35172	91	-0.66383	53.31737
6	-0.68352	53.35155	92	-0.66376	53.31723
7	-0.68345	53.35125	93	-0.66368	53.31713
8	-0.68228	53.35076	94	-0.66361	53.31699
9	-0.68314	53.35038	95	-0.66346	53.31684
10	-0.68303	53.35022	96	-0.66343	53.31672
11	-0.68295	53.35007	97	-0.66340	53.31655
12	-0.68283	53.34995	98	-0.66281	53.31637
13	-0.68220	53.34967	99	-0.66253	53.31648
14	-0.68014	53.34936	100	-0.66218	53.31655
15	-0.68255	53.34959	101	-0.66195	53.31662
16	-0.68303	53.34955	102	-0.66159	53.31660
17	-0.68227	53.34848	103	-0.66142	53.31641
18	-0.67983	53.34837	104	-0.66131	53.31623
19	-0.68244	53.34800	105	-0.66150	53.31606
20	-0.68297	53.34795	106	-0.66180	53.31607

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
21	-0.68354	53.34772	107	-0.66028	53.31408
22	-0.68405	53.34773	108	-0.64885	53.31285
23	-0.68473	53.34778	109	-0.64896	53.31257
24	-0.68536	53.34775	110	-0.64925	53.31216
25	-0.68580	53.34756	111	-0.64951	53.31185
26	-0.68556	53.34717	112	-0.64964	53.31151
27	-0.68539	53.34681	113	-0.64977	53.31122
28	-0.68393	53.34428	114	-0.64983	53.31115
29	-0.68404	53.34404	115	-0.65318	53.31034
30	-0.68376	53.34392	116	-0.65287	53.31037
31	-0.68305	53.34394	117	-0.65241	53.31022
32	-0.68292	53.34377	118	-0.65209	53.31007
33	-0.68027	53.34053	119	-0.65098	53.30981
34	-0.67623	53.33804	120	-0.65169	53.30964
35	-0.67672	53.33712	121	-0.65127	53.30959
36	-0.67660	53.33665	122	-0.64565	53.30922
37	-0.67525	53.33457	123	-0.63218	53.31512
38	-0.67493	53.33462	124	-0.63242	53.31446
39	-0.67832	53.33149	125	-0.63074	53.31509
40	-0.67307	53.33238	126	-0.63157	53.31390
41	-0.67794	53.33012	127	-0.62667	53.31505
42	-0.67729	53.32986	128	-0.60714	53.31618
43	-0.67717	53.32959	129	-0.60186	53.33835
44	-0.67686	53.32915	130	-0.60215	53.33943
45	-0.67674	53.32871	131	-0.60313	53.35565

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
46	-0.67677	53.32857	132	-0.60189	53.35618
47	-0.67611	53.32813	133	-0.60168	53.36172
48	-0.67587	53.32815	134	-0.58161	53.36143
49	-0.67567	53.32817	135	-0.60947	53.37367
50	-0.67549	53.32818	136	-0.61171	53.37342
51	-0.67522	53.32816	137	-0.61803	53.37376
52	-0.67466	53.32849	138	-0.61857	53.37284
53	-0.67469	53.32820	139	-0.61994	53.35971
54	-0.67457	53.32774	140	-0.63297	53.35668
55	-0.67410	53.32780	141	-0.63210	53.35685
56	-0.67309	53.32789	142	-0.62433	53.35429
57	-0.67245	53.32810	143	-0.62924	53.34086
58	-0.67192	53.32817	144	-0.63692	53.33772
59	-0.67068	53.32841	145	-0.63701	53.33699
60	-0.66876	53.32849	146	-0.63759	53.33700
61	-0.66665	53.32865	147	-0.64034	53.33717
62	-0.66571	53.32884	148	-0.63747	53.33108
63	-0.67132	53.32768	149	-0.64814	53.33040
64	-0.67330	53.32743	150	-0.65268	53.33015
65	-0.67372	53.32729	151	-0.65400	53.32985
66	-0.67313	53.32716	152	-0.65618	53.32969
67	-0.67282	53.32701	153	-0.65704	53.32962
68	-0.67221	53.32650	154	-0.65746	53.32958
69	-0.66735	53.32233	155	-0.63574	53.32685
70	-0.66684	53.32233	156	-0.65127	53.34753

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
71	-0.66652	53.32213	157	-0.65138	53.34932
72	-0.66656	53.32184	158	-0.64670	53.35534
73	-0.66648	53.32171	159	-0.64730	53.35523
74	-0.66638	53.32155	160	-0.64964	53.35252
75	-0.66629	53.32136	161	-0.64966	53.35281
76	-0.66610	53.32090	162	-0.65140	53.35501
77	-0.66591	53.32039	163	-0.65181	53.35499
78	-0.66591	53.32028	164	-0.65206	53.35497
79	-0.66584	53.32014	165	-0.65869	53.35609
80	-0.66585	53.32000	166	-0.65633	53.35447
81	-0.66591	53.31984	167	-0.66014	53.35365
82	-0.66585	53.31968	168	-0.66874	53.35233
83	-0.66474	53.31848	169	-0.66957	53.35179
84	-0.66458	53.31829	170	-0.67316	53.35137
85	-0.66449	53.31815	171	-0.67480	53.34760
86	-0.66445	53.31799			

Cottam 1: receptor (dwellings) locations

Cottam 2

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.68822	53.42650	28	-0.69107	53.41248
2	-0.68792	53.42651	29	-0.69118	53.41235
3	-0.68766	53.42628	30	-0.69135	53.41215
4	-0.68701	53.42612	31	-0.69125	53.41199
5	-0.68711	53.42591	32	-0.69126	53.41188
6	-0.68780	53.42570	33	-0.69151	53.41167

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
7	-0.68612	53.41804	34	-0.69155	53.41147
8	-0.67687	53.41890	35	-0.69162	53.41131
9	-0.67670	53.41612	36	-0.69174	53.41113
10	-0.68762	53.41684	37	-0.69187	53.41087
11	-0.69091	53.41519	38	-0.69195	53.41074
12	-0.68822	53.41477	39	-0.69189	53.41060
13	-0.68813	53.41455	40	-0.69185	53.41043
14	-0.68798	53.41443	41	-0.69197	53.41033
15	-0.68761	53.41437	42	-0.69239	53.41012
16	-0.68713	53.41433	43	-0.69183	53.40983
17	-0.68646	53.41411	44	-0.69173	53.40971
18	-0.68656	53.41377	45	-0.69163	53.40956
19	-0.68694	53.41376	46	-0.69170	53.40944
20	-0.68729	53.41372	47	-0.69162	53.40928
21	-0.68771	53.41373	48	-0.69098	53.40891
22	-0.68814	53.41374	49	-0.65326	53.40663
23	-0.68847	53.41375	50	-0.65443	53.41679
24	-0.68895	53.41369	51	-0.65336	53.41666
25	-0.68931	53.41369	52	-0.65152	53.41693
26	-0.69051	53.41333	53	-0.65097	53.41808
27	-0.69095	53.41264			

Cottam 2: receptor (dwellings) locations

Cottam 3a

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.70948	53.45360	30	-0.70699	53.44576
2	-0.70977	53.45312	31	-0.70679	53.44578
3	-0.70331	53.45354	32	-0.70660	53.44582
4	-0.71061	53.45260	33	-0.70641	53.44584
5	-0.70926	53.44808	34	-0.70623	53.44587
6	-0.70951	53.44803	35	-0.70597	53.44588
7	-0.70914	53.44785	36	-0.70533	53.44549
8	-0.70906	53.44773	37	-0.70563	53.44550
9	-0.70870	53.44784	38	-0.70592	53.44549
10	-0.70855	53.44771	39	-0.70616	53.44545
11	-0.70843	53.44763	40	-0.70633	53.44535
12	-0.70813	53.44788	41	-0.70653	53.44535
13	-0.70805	53.44777	42	-0.70671	53.44542
14	-0.70777	53.44783	43	-0.70684	53.44541
15	-0.70759	53.44777	44	-0.70711	53.44541
16	-0.70734	53.44769	45	-0.70709	53.44520
17	-0.70738	53.44752	46	-0.70713	53.44500
18	-0.70753	53.44739	47	-0.70717	53.44484
19	-0.70766	53.44727	48	-0.70726	53.44463
20	-0.70732	53.44707	49	-0.70530	53.44027
21	-0.70736	53.44690	50	-0.70512	53.44010
22	-0.70738	53.44669	51	-0.69786	53.44349
23	-0.70750	53.44659	52	-0.69651	53.44517
24	-0.70817	53.44634	53	-0.69655	53.44581

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
25	-0.70813	53.44613	54	-0.68467	53.44331
26	-0.70796	53.44591	55	-0.67555	53.44655
27	-0.70785	53.44586	56	-0.66797	53.44633
28	-0.70760	53.44582	57	-0.67184	53.45457
29	-0.70741	53.44580	58	-0.67059	53.46228
30	-0.70723	53.44577			

Cottam 3a: receptor (dwellings) locations

Cottam 3b

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.70819	53.44611	32	-0.70522	53.43856
2	-0.70801	53.44592	33	-0.69930	53.43744
3	-0.70782	53.44587	34	-0.69920	53.43554
4	-0.70756	53.44582	35	-0.70121	53.43486
5	-0.70739	53.44578	36	-0.70186	53.43485
6	-0.70721	53.44577	37	-0.70176	53.43510
7	-0.70701	53.44576	38	-0.70208	53.43516
8	-0.70681	53.44573	39	-0.70258	53.43521
9	-0.70660	53.44581	40	-0.70316	53.43521
10	-0.70643	53.44584	41	-0.70280	53.43502
11	-0.70622	53.44587	42	-0.70264	53.43491
12	-0.70602	53.44586	43	-0.70269	53.43477
13	-0.70727	53.44466	44	-0.70305	53.43463
14	-0.70719	53.44484	45	-0.70216	53.43455
15	-0.70719	53.44502	46	-0.70317	53.43420
16	-0.70711	53.44519	47	-0.70439	53.43409

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
17	-0.70724	53.44541	48	-0.70431	53.43377
18	-0.70689	53.44542	49	-0.70404	53.43351
19	-0.70671	53.44542	50	-0.70243	53.43363
20	-0.70654	53.44535	51	-0.70295	53.43374
21	-0.70633	53.44536	52	-0.70338	53.43371
22	-0.70619	53.44544	53	-0.70272	53.43348
23	-0.70590	53.44547	54	-0.70349	53.43344
24	-0.70565	53.44549	55	-0.70424	53.43305
25	-0.70535	53.44549	56	-0.70264	53.43092
26	-0.69655	53.44585	57	-0.70139	53.42948
27	-0.69646	53.44517	58	-0.67636	53.43538
28	-0.69779	53.44345	59	-0.67588	53.43535
29	-0.70536	53.44021	60	-0.67552	53.44656
30	-0.70511	53.44008	61	-0.68467	53.44330
31	-0.70208	53.43967			

Cottam 3b: receptor (dwellings) locations

Road Receptor Details

The road receptors details are presented in the tables below.

Cottam 1

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.68576	53.34783	24	-0.67543	53.32901
2	-0.68521	53.34701	25	-0.67236	53.32183
3	-0.68475	53.34615	26	-0.67103	53.32142
4	-0.68425	53.34529	27	-0.66965	53.32106
5	-0.68372	53.34444	28	-0.66861	53.32044
6	-0.68314	53.34360	29	-0.66768	53.31974

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
7	-0.68250	53.34280	30	-0.66698	53.31895
8	-0.68184	53.34199	31	-0.65601	53.31073
9	-0.68119	53.34117	32	-0.65458	53.31042
10	-0.68056	53.34039	33	-0.65320	53.31011
11	-0.67987	53.33958	34	-0.65176	53.30979
12	-0.67916	53.33883	35	-0.65035	53.30948
13	-0.67802	53.33826	36	-0.64897	53.30918
14	-0.67696	53.33762	37	-0.64755	53.30886
15	-0.67647	53.33677	38	-0.64614	53.30855
16	-0.67619	53.33588	39	-0.64474	53.30824
17	-0.67608	53.33500	40	-0.64334	53.30793
18	-0.67586	53.33399	41	-0.64191	53.30762
19	-0.67563	53.33316	42	-0.64049	53.30730
20	-0.67566	53.33228	43	-0.63910	53.30700
21	-0.67632	53.33155	44	-0.63768	53.30668
22	-0.67589	53.33071	45	-0.63626	53.30637
23	-0.67600	53.32981	46	-0.63508	53.30611

Cottam 1: Assessed road receptor locations (B1241 receptors 1 to 30 and Till Bridge Lane receptros 31 to 46)

Cottam 2

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.69156	53.40880	15	-0.67115	53.40640
2	-0.69019	53.40874	16	-0.66968	53.40627
3	-0.68870	53.40872	17	-0.66811	53.40627
4	-0.68713	53.40872	18	-0.66665	53.40627
5	-0.68569	53.40861	19	-0.66504	53.40630
6	-0.68419	53.40844	20	-0.66359	53.40633
7	-0.68270	53.40822	21	-0.66218	53.40635

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
8	-0.68129	53.40801	22	-0.66065	53.40639
9	-0.67979	53.40781	23	-0.65908	53.40644
10	-0.67833	53.40763	24	-0.65755	53.40648
11	-0.67687	53.40744	25	-0.65602	53.40645
12	-0.67537	53.40724	26	-0.65461	53.40641
13	-0.67398	53.40688	27	-0.65308	53.40636
14	-0.67249	53.40658			

Cottam 2: Assessed road receptor locations (A631 receptors 1 to 27)

Cottam 3a

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.70653	53.46305	32	-0.68692	53.44659
2	-0.70632	53.46215	33	-0.68536	53.44667
3	-0.70612	53.46128	34	-0.68391	53.44675
4	-0.70591	53.46037	35	-0.68230	53.44683
5	-0.70577	53.45948	36	-0.68085	53.44690
6	-0.70566	53.45858	37	-0.67930	53.44698
7	-0.70558	53.45770	38	-0.67779	53.44705
8	-0.70553	53.45678	39	-0.67640	53.44712
9	-0.70588	53.45591	40	-0.67511	53.44751
10	-0.70668	53.45509	41	-0.67479	53.44832
11	-0.70763	53.45442	42	-0.67469	53.44922
12	-0.70857	53.45378	43	-0.67527	53.45008
13	-0.70957	53.45302	44	-0.67531	53.45091
14	-0.71021	53.45225	45	-0.67508	53.45185
15	-0.71046	53.45135	46	-0.67411	53.45258
16	-0.71057	53.45051	47	-0.67317	53.45328
17	-0.71068	53.44965	48	-0.67229	53.45393

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
18	-0.71081	53.44866	49	-0.67114	53.45450
19	-0.70647	53.44561	50	-0.66969	53.45452
20	-0.70496	53.44568	51	-0.66807	53.45457
21	-0.70346	53.44576	52	-0.66668	53.45462
22	-0.70196	53.44583	53	-0.66522	53.45467
23	-0.70045	53.44591	54	-0.66366	53.45473
24	-0.69895	53.44599	55	-0.70747	53.44551
25	-0.69744	53.44606	56	-0.70750	53.44460
26	-0.69600	53.44614	57	-0.70714	53.44375
27	-0.69444	53.44621	58	-0.70675	53.44287
28	-0.69293	53.44629	59	-0.70652	53.44198
29	-0.69143	53.44637	60	-0.70612	53.44112
30	-0.68987	53.44644	61	-0.70562	53.44028
31	-0.68832	53.44652			

Cottam 3a: Assessed road receptor locations (Laughton Road receptors 1 to 18, Kirton Road receptors 19 to 54 and Station Road receptors 55 to 61)

Cottam 3b

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.70853	53.44584	26	-0.69985	53.44593
2	-0.70751	53.44537	27	-0.69833	53.44601
3	-0.70750	53.44447	28	-0.69681	53.44609
4	-0.70710	53.44359	29	-0.69534	53.44617
5	-0.70673	53.44274	30	-0.69382	53.44624
6	-0.70649	53.44184	31	-0.69230	53.44632
7	-0.70604	53.44100	32	-0.69074	53.44640
8	-0.70555	53.44015	33	-0.68939	53.44647
9	-0.70500	53.43932	34	-0.68783	53.44655

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
10	-0.70462	53.43845	35	-0.68626	53.44663
11	-0.70449	53.43755	36	-0.68487	53.44670
12	-0.70436	53.43665	37	-0.68331	53.44678
13	-0.70423	53.43572	38	-0.68183	53.44686
14	-0.70413	53.43480	39	-0.68023	53.44694
15	-0.70388	53.43392	40	-0.67875	53.44702
16	-0.70370	53.43308	41	-0.67736	53.44709
17	-0.70338	53.43218	42	-0.67584	53.44716
18	-0.70305	53.43128	43	-0.67497	53.44781
19	-0.70275	53.43045	44	-0.67474	53.44863
20	-0.70243	53.42955	45	-0.67485	53.44950
21	-0.70732	53.44555	46	-0.67530	53.45038
22	-0.70580	53.44563	47	-0.67527	53.45126
23	-0.70436	53.44570	48	-0.67477	53.45207
24	-0.70285	53.44578	49	-0.67378	53.45280
25	-0.70133	53.44586			

Cottam 3b: Assessed road receptor locations (Station Road receptors 1 to 19 and Kirton Road receptors 20 to 49)

Modelled Reflector Data – PV Areas

Cottam 1

Site 1

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.59501	53.36526	9	-0.60816	53.36891
2	-0.59641	53.36654	10	-0.60875	53.36878
3	-0.59870	53.36995	11	-0.60926	53.36773
4	-0.59971	53.36986	12	-0.60762	53.36583
5	-0.60048	53.36970	13	-0.60601	53.36369
6	-0.60212	53.36933	14	-0.60631	53.36312
7	-0.60267	53.36925	15	-0.59501	53.36526
8	-0.60678	53.36905			

Cottam 1 – Site 1: Modelled Reflector Data

Site 2

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.60601	53.36369	7	-0.60210	53.36933
2	-0.60926	53.36773	8	-0.59970	53.36986
3	-0.60876	53.36878	9	-0.59870	53.36995
4	-0.60815	53.36891	10	-0.59642	53.36655
5	-0.60678	53.36904	11	-0.59501	53.36526
6	-0.60267	53.36925	12	-0.60631	53.36312

Cottam 1 – Site 2: Modelled Reflector Data

Site 3

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.64105	53.34841	25	-0.60597	53.34959
2	-0.63935	53.34872	26	-0.60611	53.35038
3	-0.63639	53.34976	27	-0.60508	53.35114
4	-0.63463	53.35023	28	-0.60265	53.35138
5	-0.63301	53.35042	29	-0.60048	53.35120

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
6	-0.62795	53.35159	30	-0.59767	53.34985
7	-0.62490	53.35186	31	-0.59728	53.34987
8	-0.62325	53.34847	32	-0.59878	53.35505
9	-0.62074	53.34875	33	-0.60553	53.35482
10	-0.61981	53.34611	34	-0.60586	53.35588
11	-0.61799	53.34674	35	-0.61435	53.35571
12	-0.61619	53.34719	36	-0.61456	53.35582
13	-0.61302	53.34743	37	-0.61590	53.35789
14	-0.61340	53.34140	38	-0.61620	53.35794
15	-0.61004	53.34138	39	-0.62694	53.35645
16	-0.61015	53.34231	40	-0.63055	53.36068
17	-0.60929	53.34336	41	-0.63630	53.35986
18	-0.60833	53.34596	42	-0.64250	53.35818
19	-0.60778	53.34647	43	-0.64170	53.35650
20	-0.60778	53.34684	44	-0.64199	53.35596
21	-0.60758	53.34710	45	-0.64425	53.35563
22	-0.60759	53.34787	46	-0.64356	53.35433
23	-0.60719	53.34804	47	-0.64668	53.34800
24	-0.60647	53.34957	48	-0.64105	53.34841

Cottam 1 – Site 3: Modelled Reflector Data

Site 4

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.66860	53.34606	5	-0.66639	53.34893
2	-0.66533	53.34881	6	-0.67292	53.34840
3	-0.66603	53.34871	7	-0.67152	53.34588
4	-0.66641	53.34872	8	-0.66860	53.34606

Cottam 1 – Site 4: Modelled Reflector Data

Site 5

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.65052	53.34368	10	-0.66004	53.34655
2	-0.65062	53.34500	11	-0.66025	53.34634
3	-0.65115	53.34503	12	-0.66075	53.34614
4	-0.65131	53.34663	13	-0.66096	53.34555
5	-0.65304	53.34729	14	-0.65967	53.34332
6	-0.65394	53.34962	15	-0.65911	53.34276
7	-0.66030	53.34897	16	-0.65489	53.34336
8	-0.66175	53.34709	17	-0.65052	53.34368
9	-0.66162	53.34645			

Cottam 1 – Site 5: Modelled Reflector Data

Site 6

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.67112	53.33775	7	-0.66210	53.33712
2	-0.66828	53.33721	8	-0.66288	53.33822
3	-0.66659	53.33725	9	-0.66718	53.33785
4	-0.66580	53.33691	10	-0.66909	53.34060
5	-0.66477	53.33680	11	-0.67213	53.34032
6	-0.66407	53.33714	12	-0.67112	53.33775

Cottam 1 – Site 6: Modelled Reflector Data

Site 7

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.65123	53.33245	4	-0.65170	53.33361
2	-0.64653	53.33313	5	-0.65123	53.33245
3	-0.64749	53.33415			

Cottam 1 – Site 7: Modelled Reflector Data

Site 8

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.65257	53.32692	4	-0.65295	53.32826
2	-0.64272	53.32821	5	-0.65257	53.32692
3	-0.64387	53.32919			

Cottam 1 – Site 8: Modelled Reflector Data

Site 9

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.64801	53.32137	26	-0.60009	53.32965
2	-0.64582	53.32161	27	-0.60025	53.33060
3	-0.64563	53.31953	28	-0.60725	53.33102
4	-0.64174	53.31951	29	-0.60737	53.33188
5	-0.64303	53.31781	30	-0.61074	53.33100
6	-0.64230	53.31517	31	-0.61249	53.33081
7	-0.63593	53.31511	32	-0.61525	53.33077
8	-0.63573	53.31650	33	-0.61668	53.32998
9	-0.63019	53.31655	34	-0.61806	53.32943
10	-0.63011	53.31603	35	-0.61971	53.32926
11	-0.62899	53.31601	36	-0.61960	53.32884
12	-0.62741	53.31667	37	-0.62596	53.32838
13	-0.62744	53.31724	38	-0.62472	53.32402
14	-0.62282	53.31731	39	-0.61950	53.32399
15	-0.62290	53.31585	40	-0.61859	53.32148
16	-0.62340	53.31484	41	-0.61885	53.32084
17	-0.61941	53.31473	42	-0.63412	53.32074
18	-0.61551	53.31793	43	-0.63420	53.32222
19	-0.61468	53.32370	44	-0.63963	53.32204
20	-0.60659	53.32353	45	-0.63966	53.32311

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
21	-0.60673	53.32578	46	-0.64032	53.32458
22	-0.60540	53.32575	47	-0.64808	53.32357
23	-0.60410	53.32812	48	-0.65122	53.32354
24	-0.60063	53.32813	49	-0.64801	53.32137
25	-0.60086	53.32935			

Cottam 1 – Site 9: Modelled Reflector Data

Cottam 2

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	53.41538	-0.68108	13	53.42159	-0.66392
2	53.41860	-0.68160	14	53.41942	-0.66263
3	53.42075	-0.67727	15	53.41885	-0.66267
4	53.42494	-0.67400	16	53.41745	-0.66173
5	53.42507	-0.66967	17	53.41604	-0.66160
6	53.42578	-0.66945	18	53.41394	-0.66890
7	53.42622	-0.66890	19	53.41059	-0.66654
8	53.42640	-0.66765	20	53.41046	-0.66692
9	53.42443	-0.66718	21	53.41238	-0.67018
10	53.42428	-0.66877	22	53.41402	-0.67542
11	53.42351	-0.66770	23	53.41387	-0.67911
12	53.42256	-0.66538	24	53.41558	-0.67975

Cottam 2: Modelled Reflector Data

Cottam 3a

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.70362	53.45039	39	-0.68521	53.45433
2	-0.70340	53.44583	40	-0.68513	53.45353
3	-0.70000	53.44603	41	-0.68665	53.45304
4	-0.70050	53.44980	42	-0.68541	53.45211

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
5	-0.69834	53.44991	43	-0.68372	53.45165
6	-0.69652	53.44615	44	-0.68318	53.45124
7	-0.68305	53.44688	45	-0.68288	53.45025
8	-0.68335	53.44843	46	-0.68367	53.45016
9	-0.67968	53.44899	47	-0.68339	53.44886
10	-0.67977	53.44932	48	-0.68665	53.44856
11	-0.67840	53.44948	49	-0.68921	53.45002
12	-0.67833	53.44914	50	-0.68921	53.45056
13	-0.67773	53.44919	51	-0.68467	53.45089
14	-0.67791	53.45085	52	-0.68462	53.45121
15	-0.67743	53.45157	53	-0.68667	53.45199
16	-0.67749	53.45263	54	-0.68936	53.45407
17	-0.67797	53.45362	55	-0.68986	53.45582
18	-0.67921	53.45432	56	-0.68926	53.45835
19	-0.68037	53.45429	57	-0.69075	53.45842
20	-0.68079	53.45532	58	-0.69403	53.45372
21	-0.68199	53.45608	59	-0.69508	53.45355
22	-0.68272	53.45725	60	-0.69747	53.45492
23	-0.68288	53.45812	61	-0.69794	53.45430
24	-0.68020	53.46013	62	-0.70011	53.45478
25	-0.67997	53.46089	63	-0.70278	53.45439
26	-0.68216	53.46089	64	-0.70242	53.45152
27	-0.68251	53.46207	65	-0.70202	53.45086
28	-0.68593	53.46155	66	-0.70148	53.45048
29	-0.68583	53.46111	67	-0.70285	53.45043
30	-0.68612	53.46079	68	-0.70315	53.45189

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
31	-0.68685	53.46053	69	-0.70528	53.45170
32	-0.68751	53.46045	70	-0.70587	53.45364
33	-0.68774	53.45941	71	-0.70773	53.45311
34	-0.68726	53.45933	72	-0.70918	53.45294
35	-0.68691	53.45909	73	-0.71018	53.45137
36	-0.68684	53.45878	74	-0.71026	53.45004
37	-0.68562	53.45878	75	-0.70362	53.45039
38	-0.68547	53.45464			

Cottam 3a: Modelled Reflector Data

Cottam 3a

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.69092	53.43804	11	-0.67633	53.43869
2	-0.69054	53.43632	12	-0.67671	53.43961
3	-0.68898	53.43645	13	-0.67699	53.44150
4	-0.68811	53.43634	14	-0.67694	53.44171
5	-0.68813	53.43621	15	-0.67648	53.44289
6	-0.68576	53.43637	16	-0.67634	53.44394
7	-0.68312	53.43638	17	-0.69681	53.44037
8	-0.68320	53.43816	18	-0.69666	53.43753
9	-0.68044	53.43817	19	-0.69092	53.43804
10	-0.67811	53.43842			

Cottam 3b: Modelled Reflector Data

APPENDIX H – DETAILED MODELLING RESULTS

Model Output Charts

Each Forge chart shows:

- The reflection date/time graph – top left image. The chart shows the time at which glare at the corresponding intensities can occur;
- Duration of glare – top right image. The chart shows the duration for the corresponding glare intensities;
- The reflecting areas – bottom left image. Indicative only;
- Glare intensity graph – bottom right image. Shows you the intensity of glare produced and the categorisation it falls within.

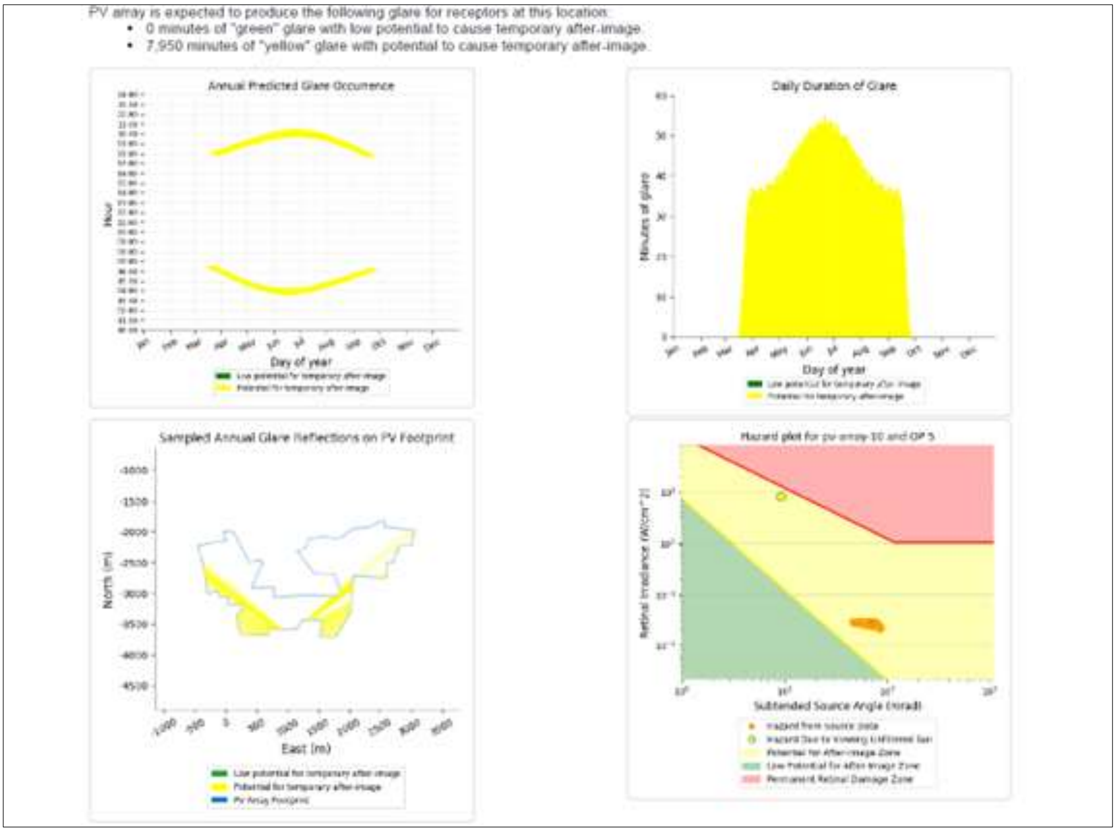
The Pager Power charts for the receptors are shown on the following pages. Each chart shows:

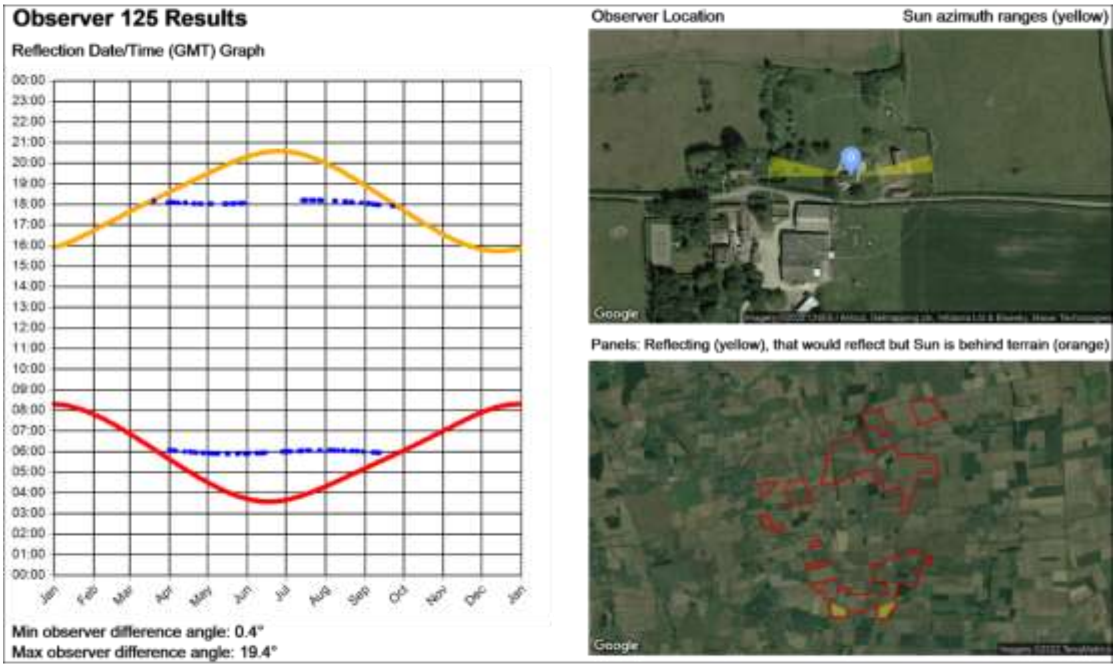
- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of the report;
- The reflecting areas – 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 reflector area from view are considered separately within the analysis;
- The reflection date/time graph – left hand side of the page. The blue line indicates the dates and times at which geometric reflections are possible. This relates to reflections from the yellow areas only.

Dwelling Receptors

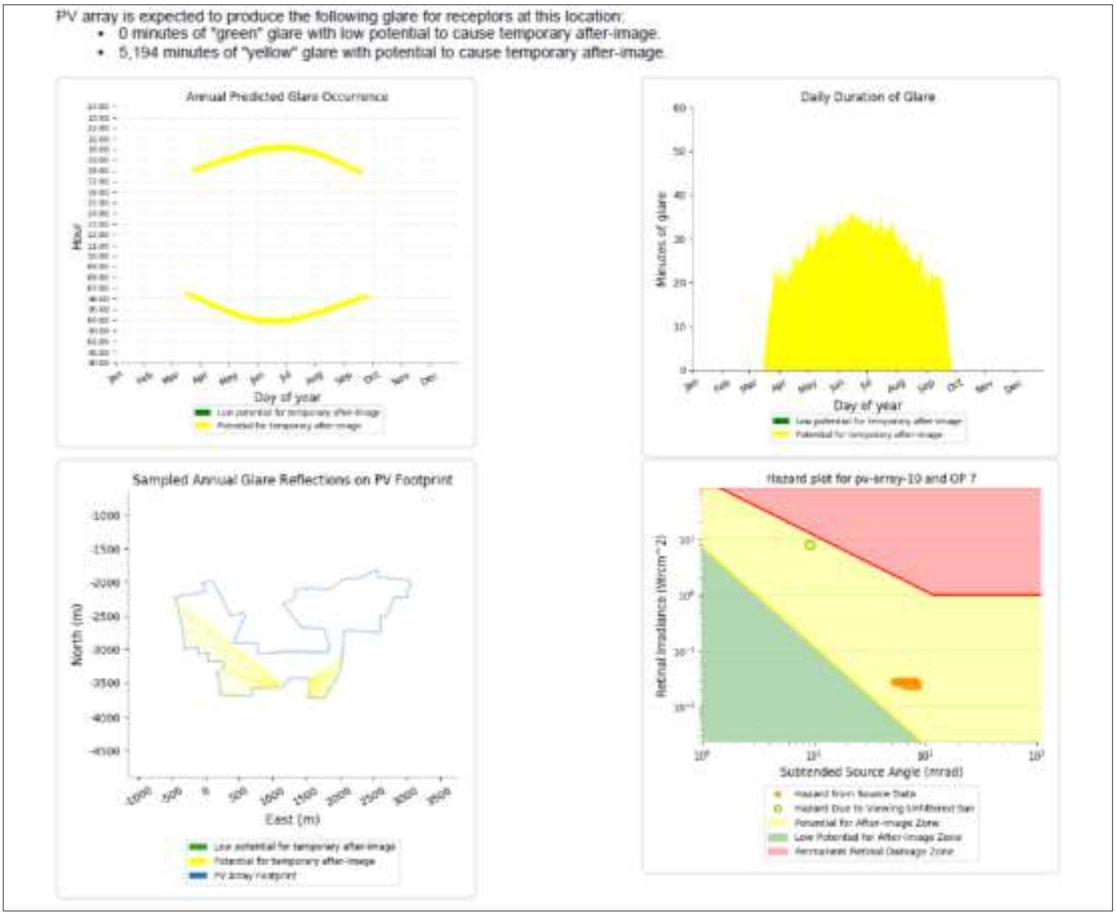
Only the chart for the closest reflective area is shown below.

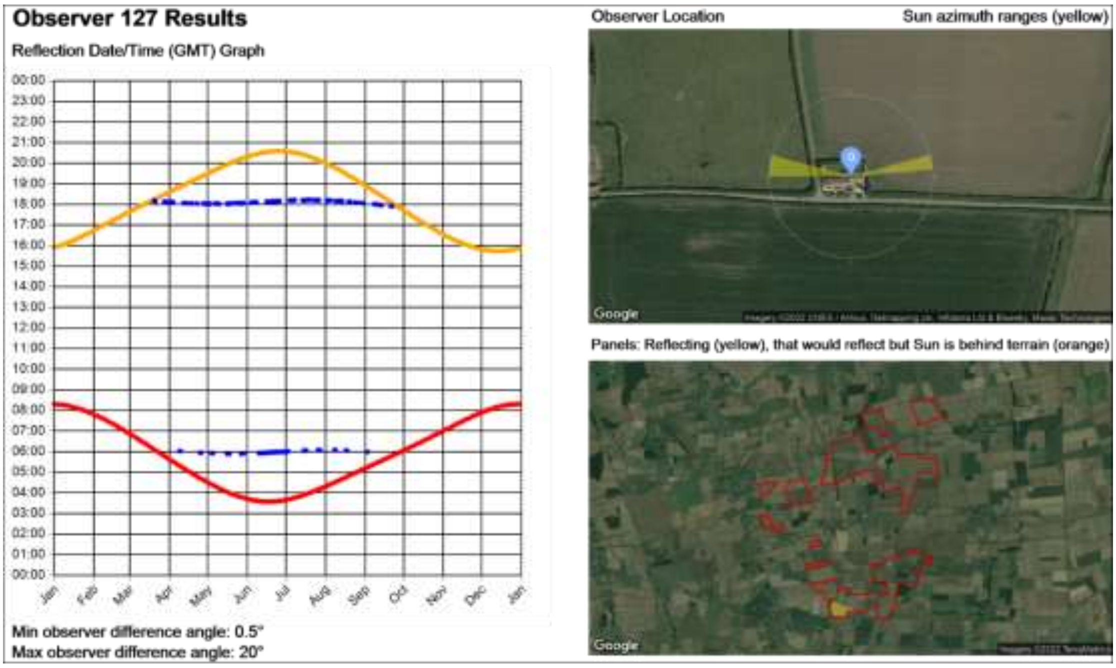
Dwelling 125 – Cottam 1



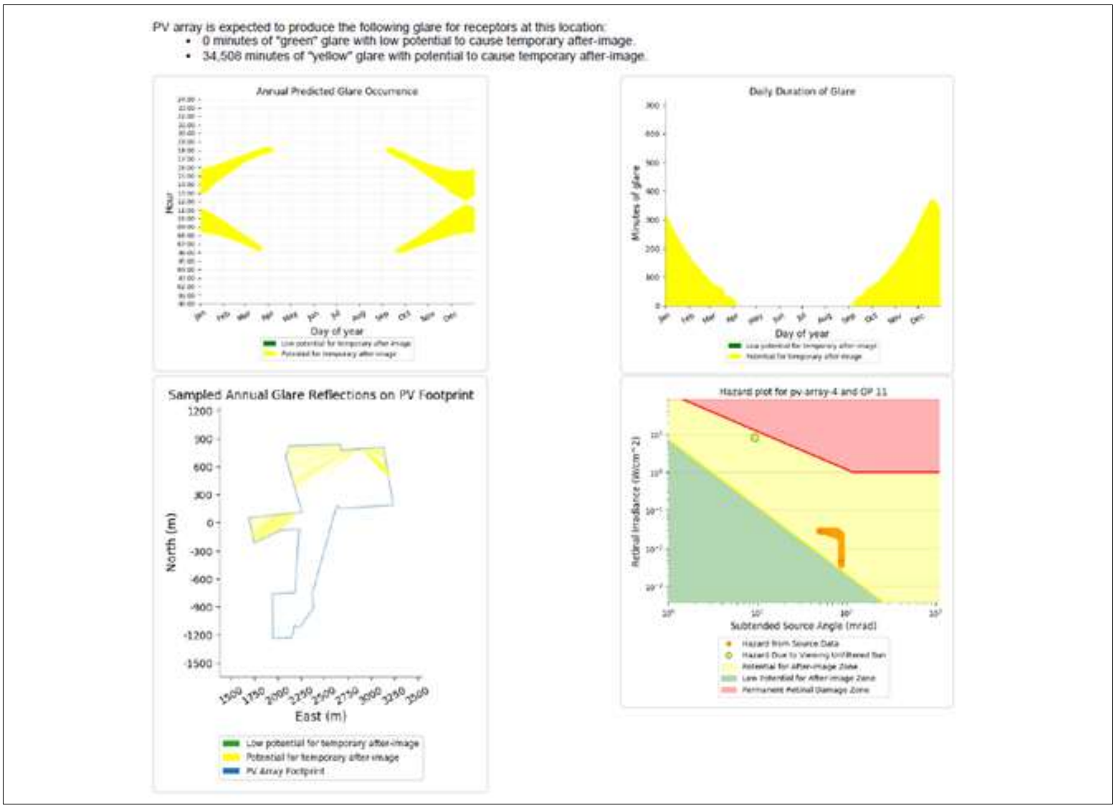


Dwelling 127 – Cottam 1





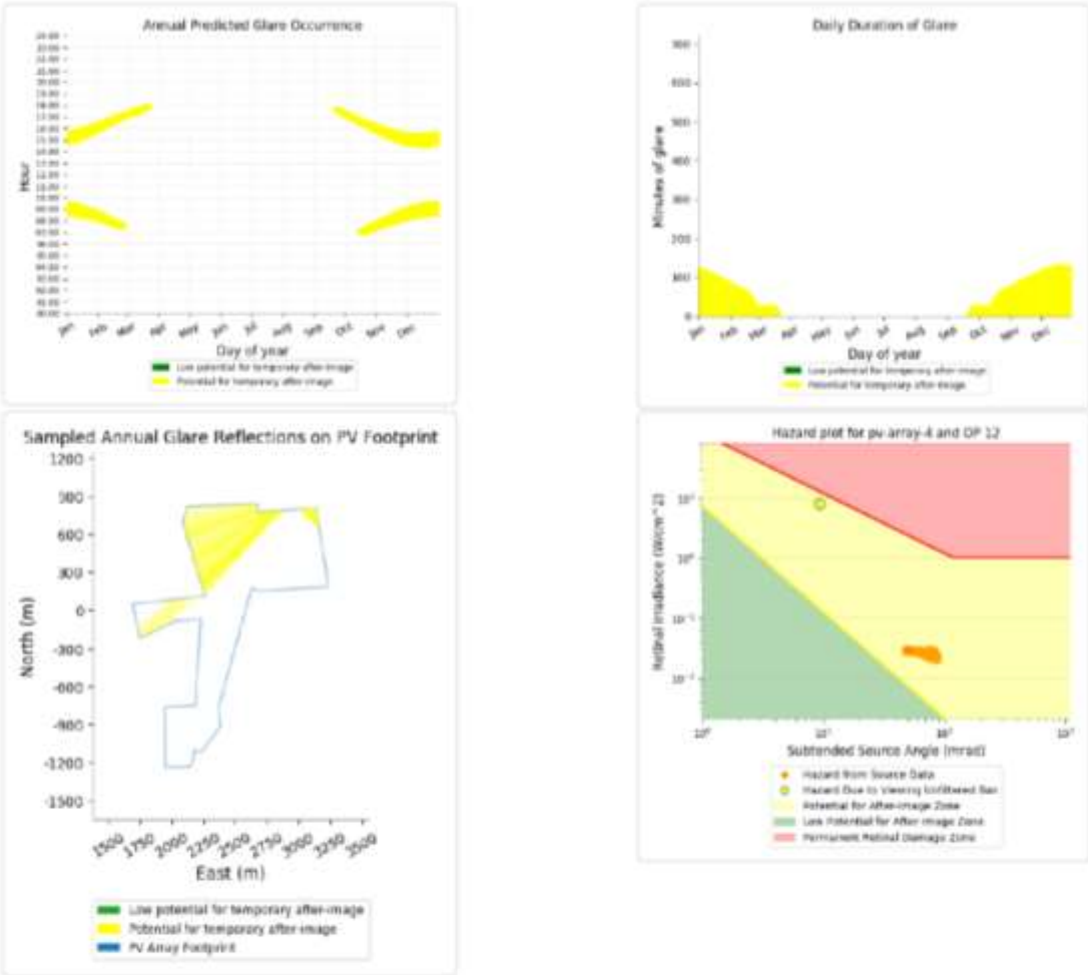
Dwelling 131 – Cottam 1



Dwelling 132 – Cottam 1

PV array is expected to produce the following glare for receptors at this location:

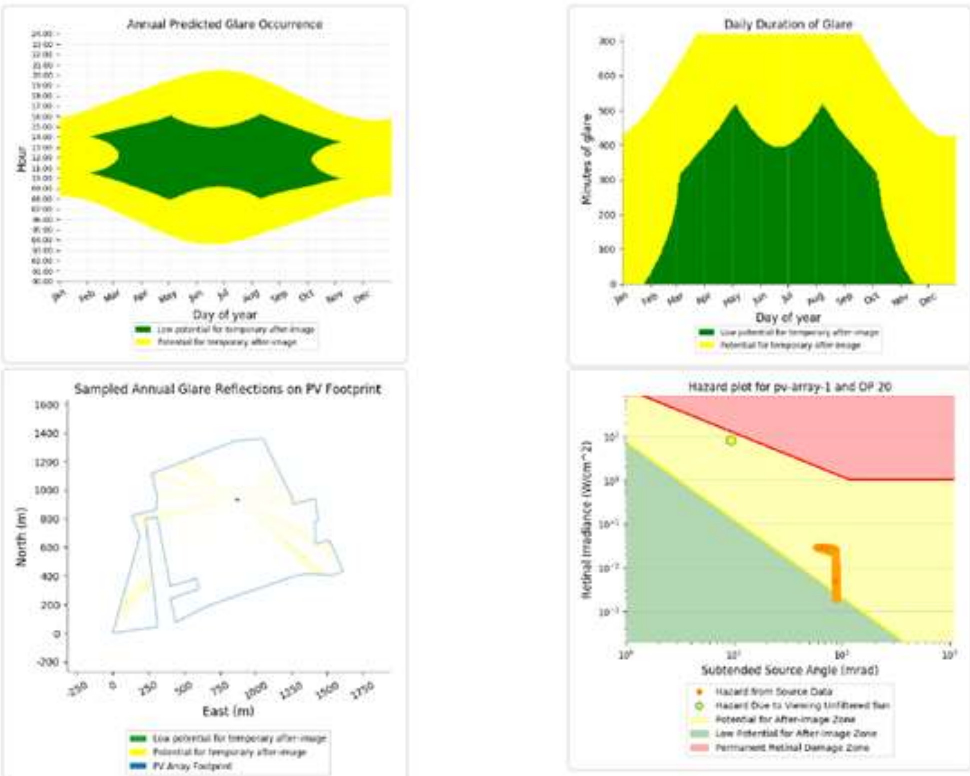
- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 14,671 minutes of "yellow" glare with potential to cause temporary after-image.



Dwelling 140 – Cottam 1

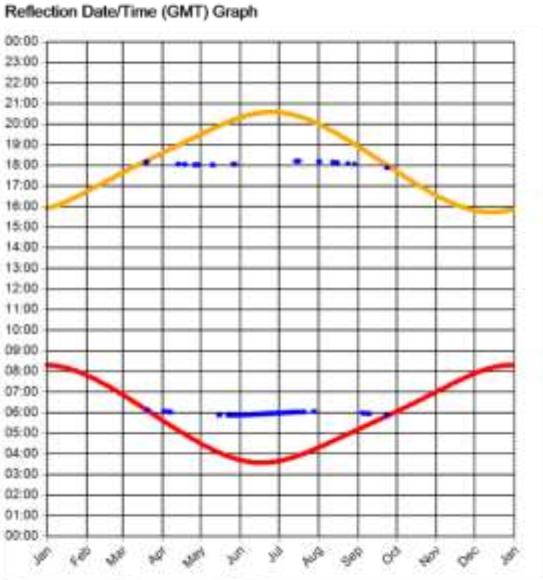
PV array is expected to produce the following glare for receptors at this location:

- 100,237 minutes of "green" glare with low potential to cause temporary after-image.
- 159,691 minutes of "yellow" glare with potential to cause temporary after-image.



Observer 140 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 19.3°

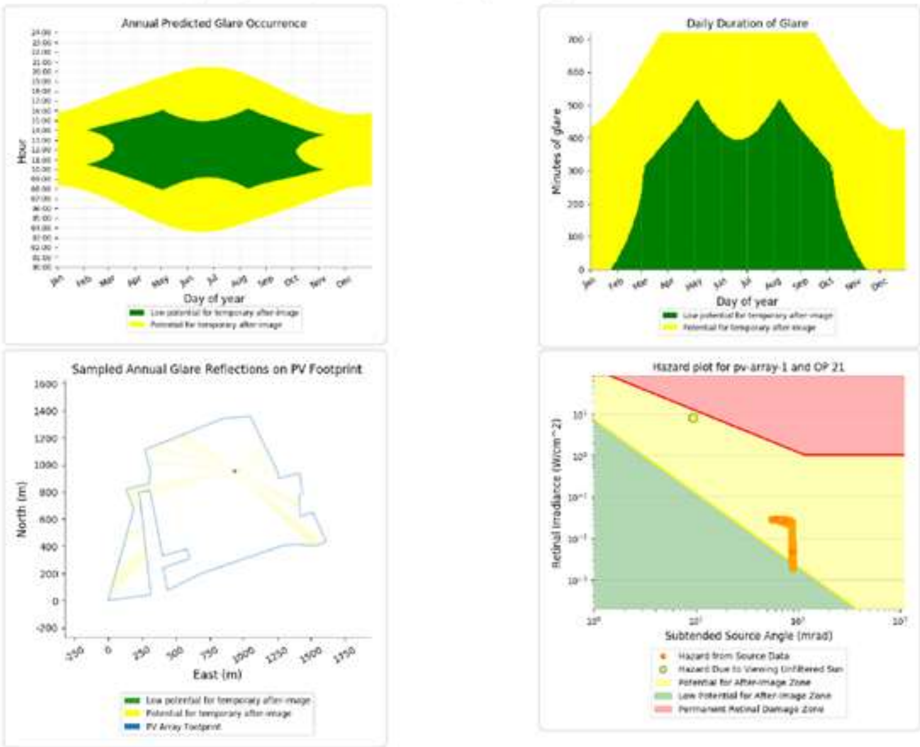
Observer Location | Sun azimuth ranges (yellow)

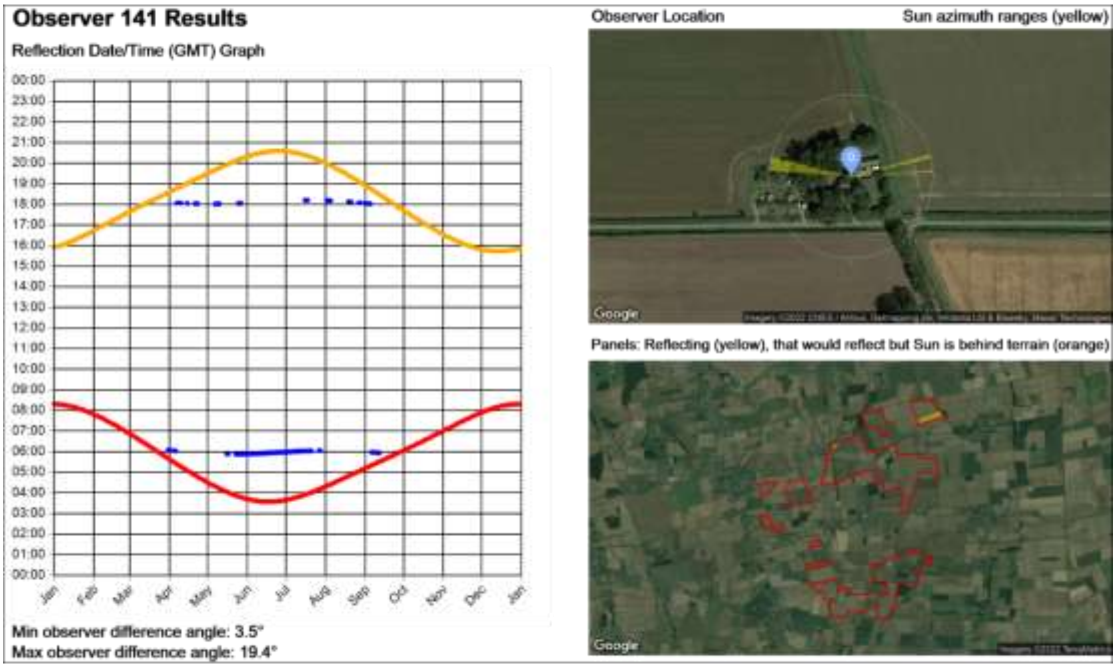
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Dwelling 141 – Cottam 1

PV array is expected to produce the following glare for receptors at this location:

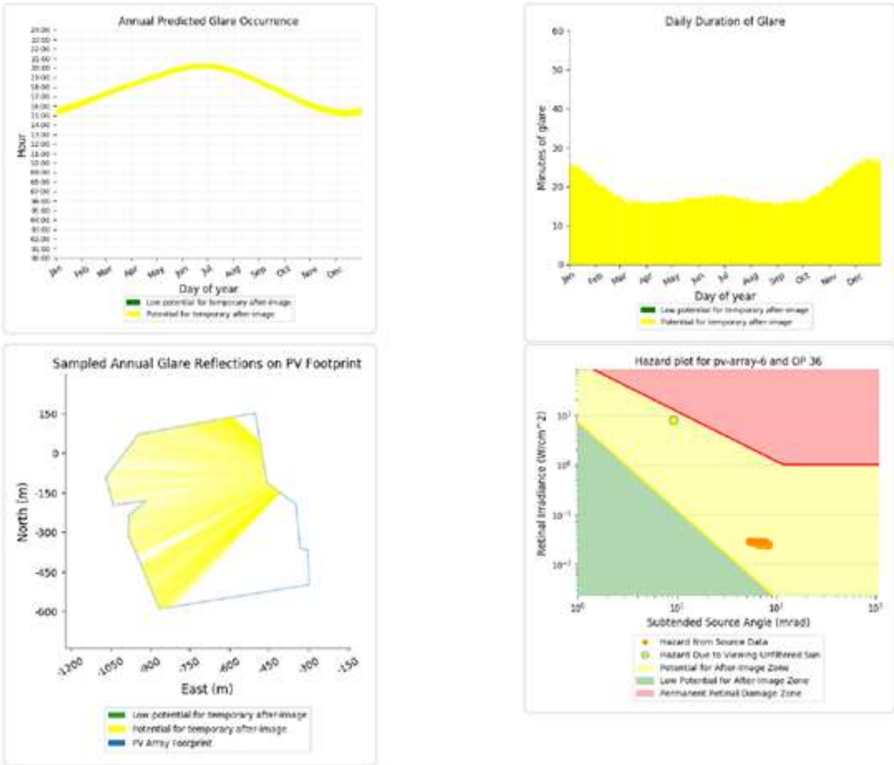
- 100,287 minutes of "green" glare with low potential to cause temporary after-image.
- 159,641 minutes of "yellow" glare with potential to cause temporary after-image.





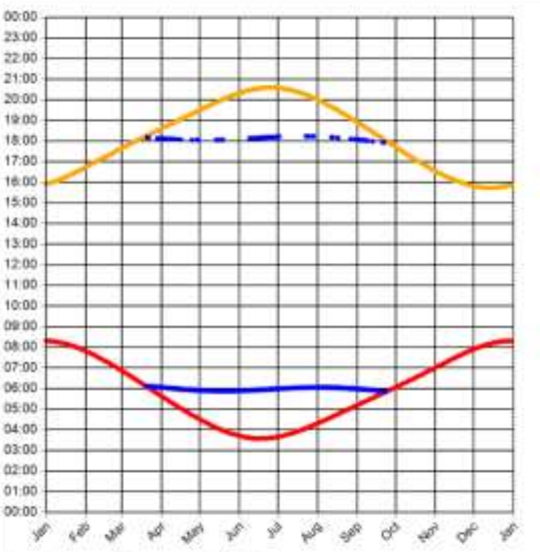
Dwelling 156 – Cottam 1

PV array is expected to produce the following glare for receptors at this location:
- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 6,892 minutes of "yellow" glare with potential to cause temporary after-image.



Observer 156 Results

Reflection Date/Time (GMT) Graph

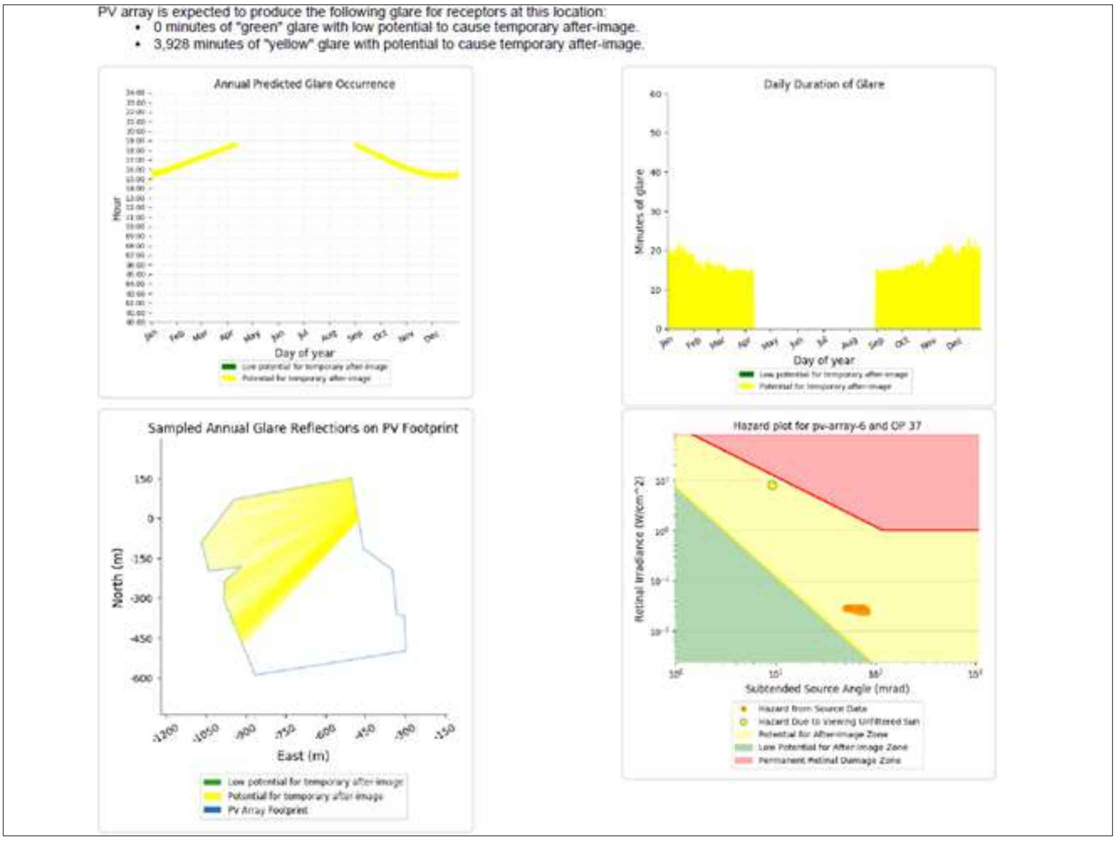


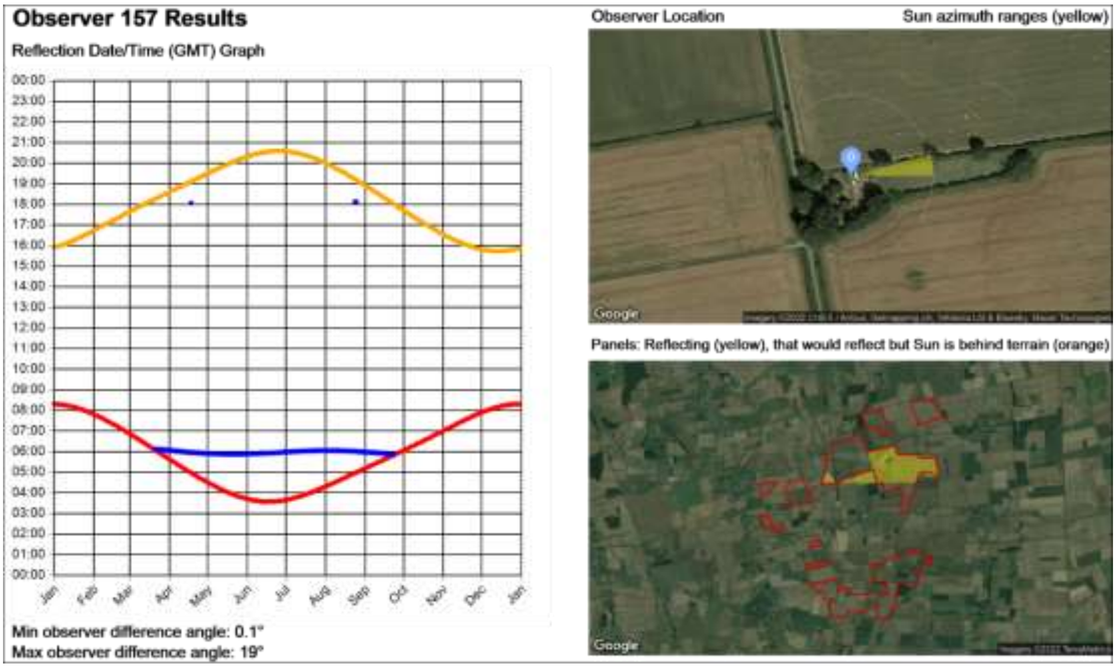
Min observer difference angle: 0.2°
Max observer difference angle: 19.2°

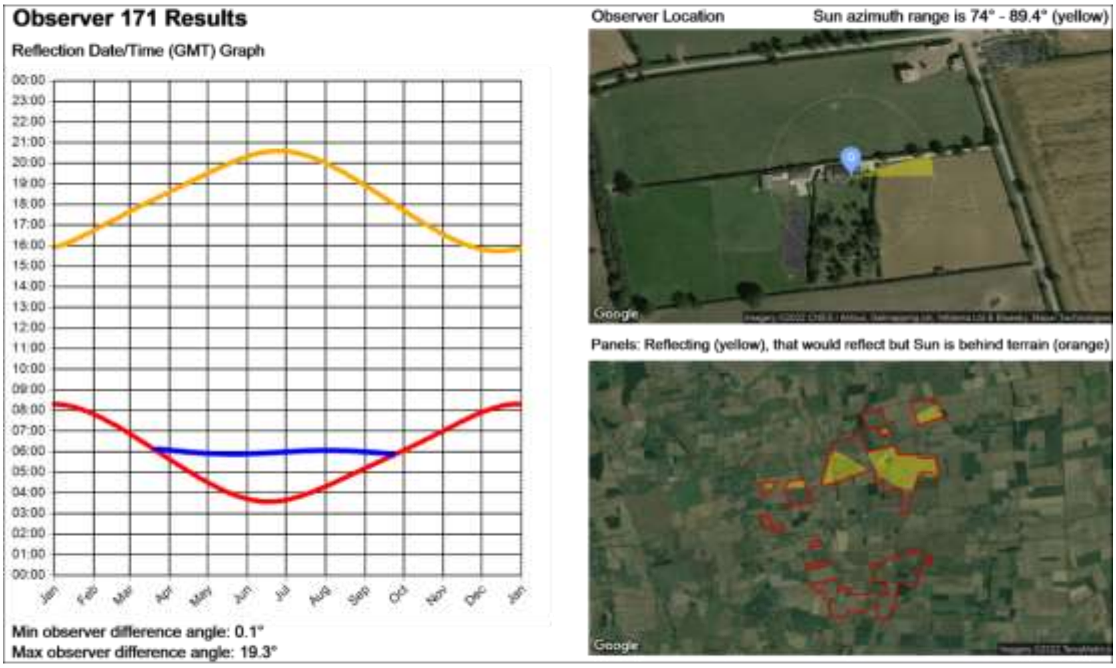
Observer Location　　Sun azimuth ranges (yellow)

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

Dwelling 157 – Cottam 1



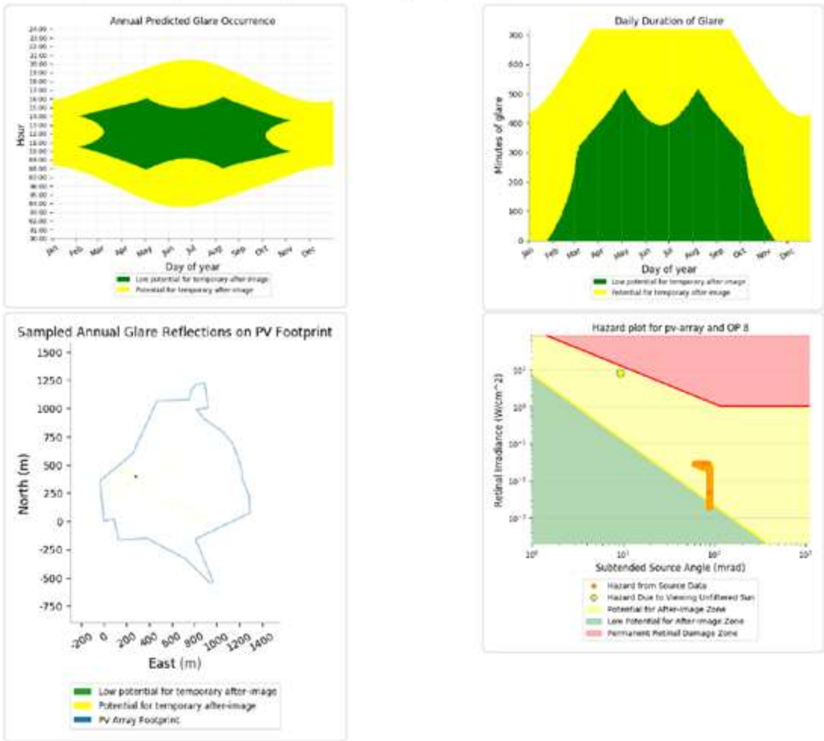


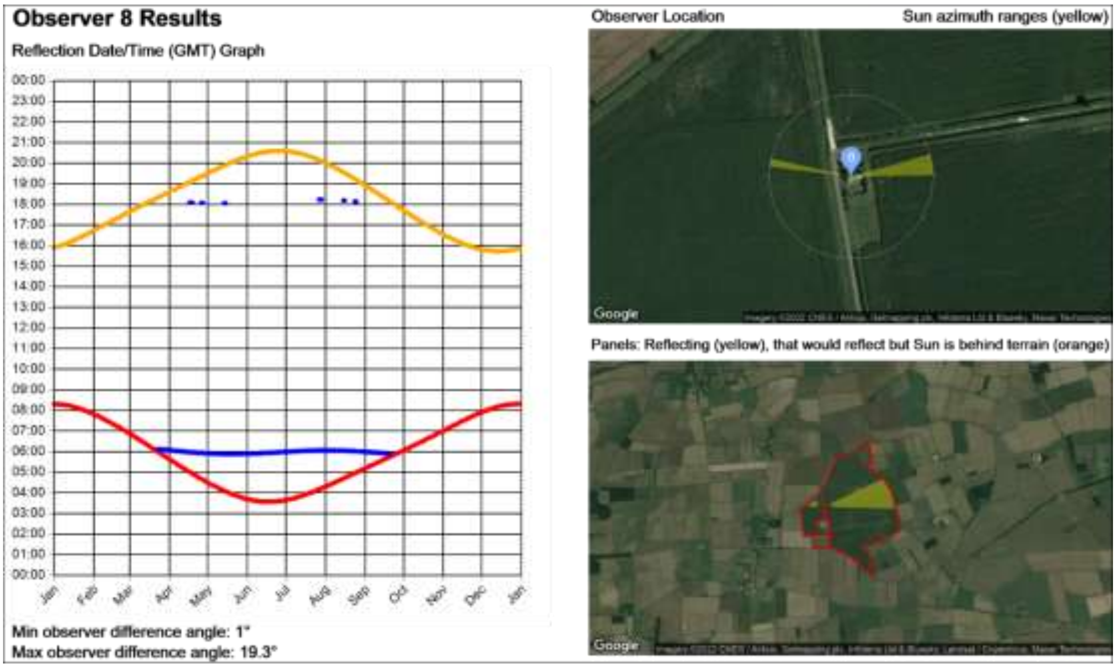

Observer 171 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 0.1°
Max observer difference angle: 19.3°
Observer Location
Sun azimuth range is 74° - 89.4° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Dwelling 8 – Cottam 2

PV array is expected to produce the following glare for receptors at this location:

- 99,958 minutes of "green" glare with low potential to cause temporary after-image.
- 159,894 minutes of "yellow" glare with potential to cause temporary after-image.

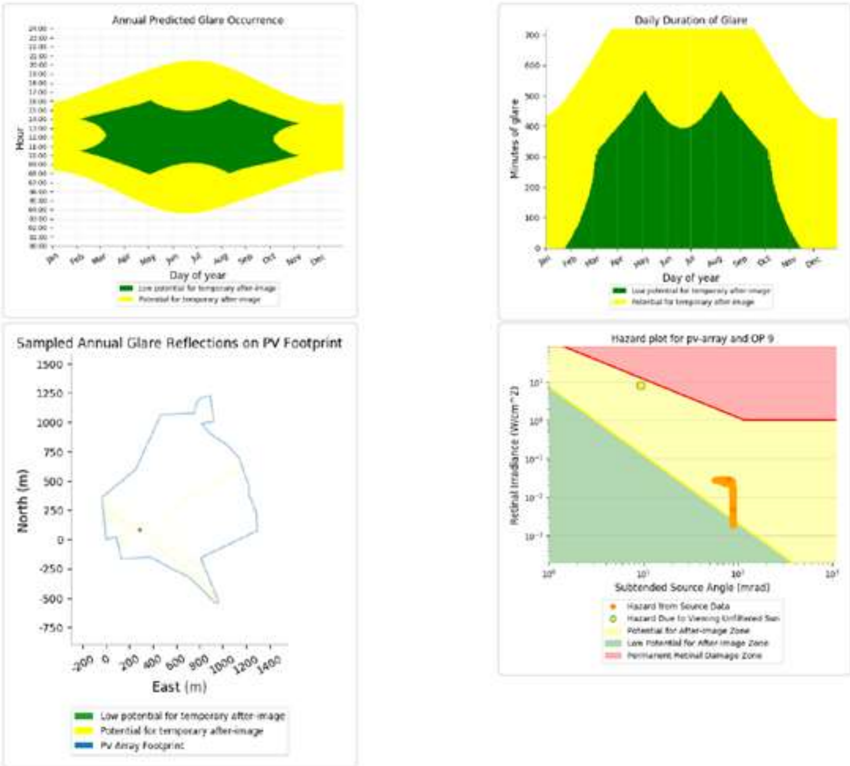


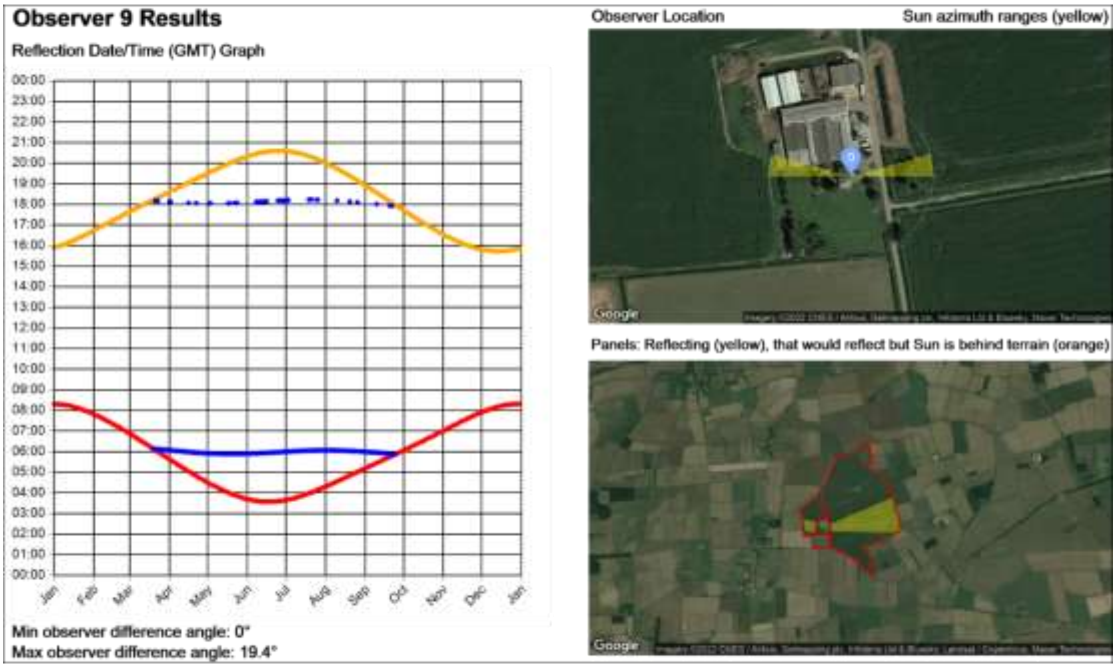


Dwelling 9 – Cottam 2

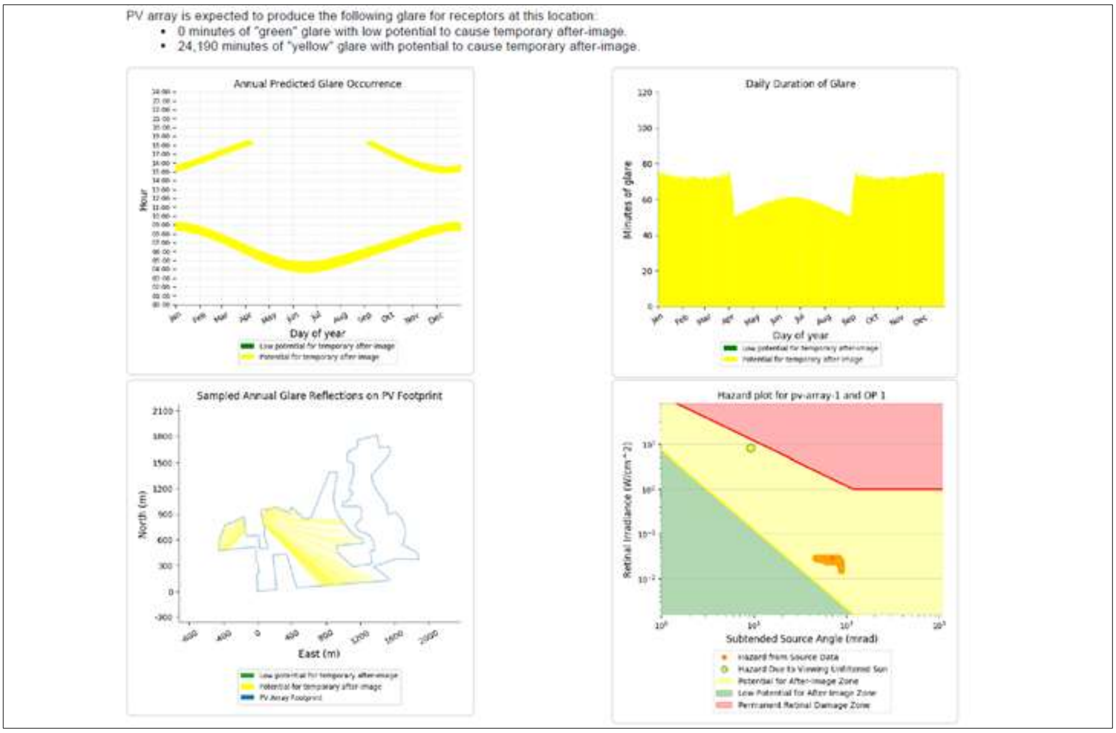
PV array is expected to produce the following glare for receptors at this location:

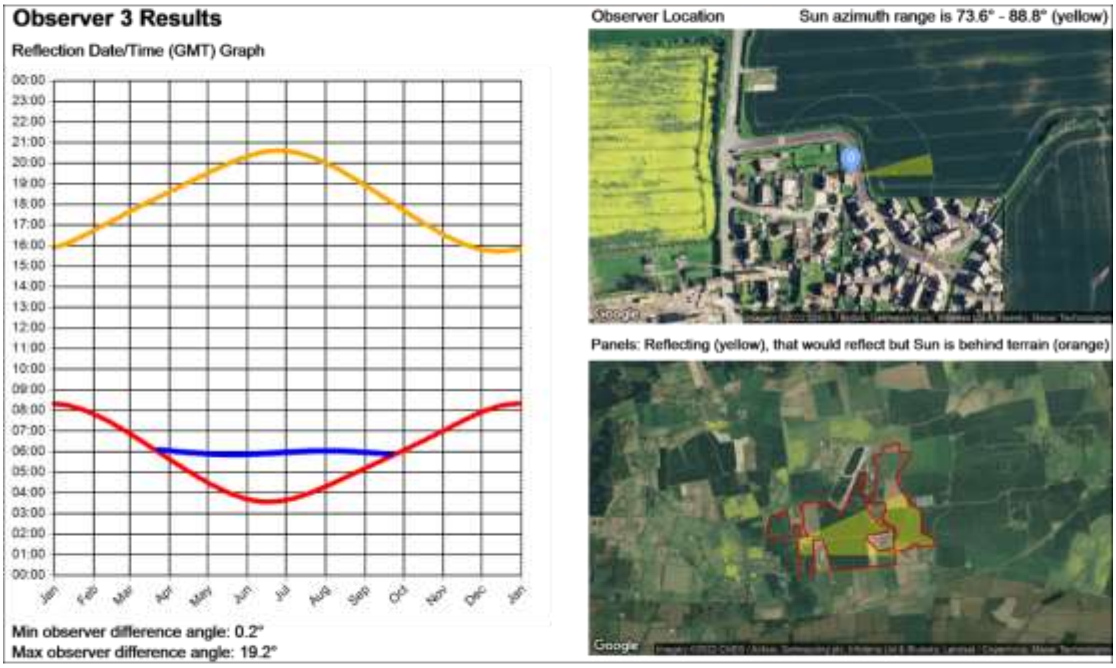
- 99,996 minutes of "green" glare with low potential to cause temporary after-image.
- 159,856 minutes of "yellow" glare with potential to cause temporary after-image.



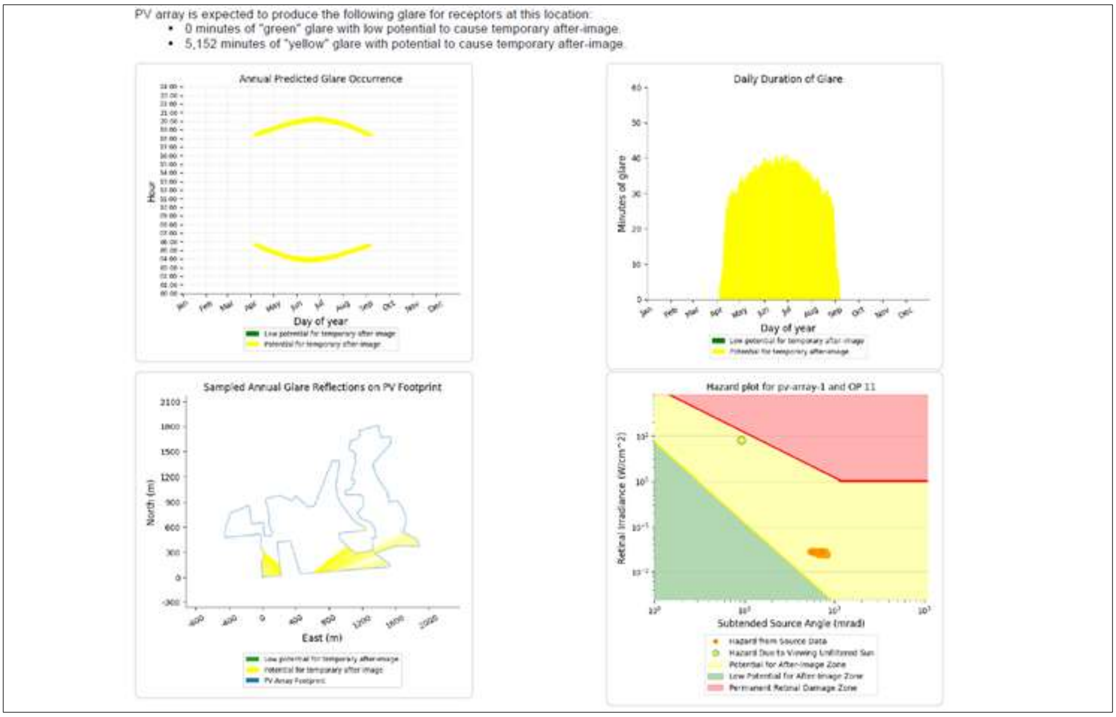


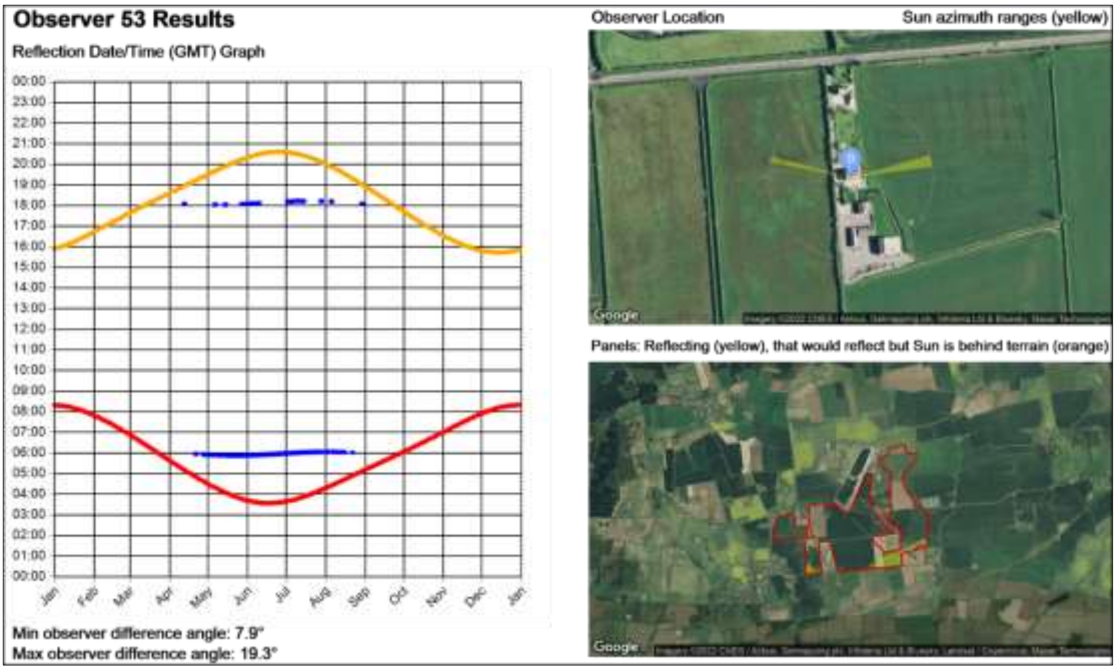
Dwelling 1 – Cottam 3



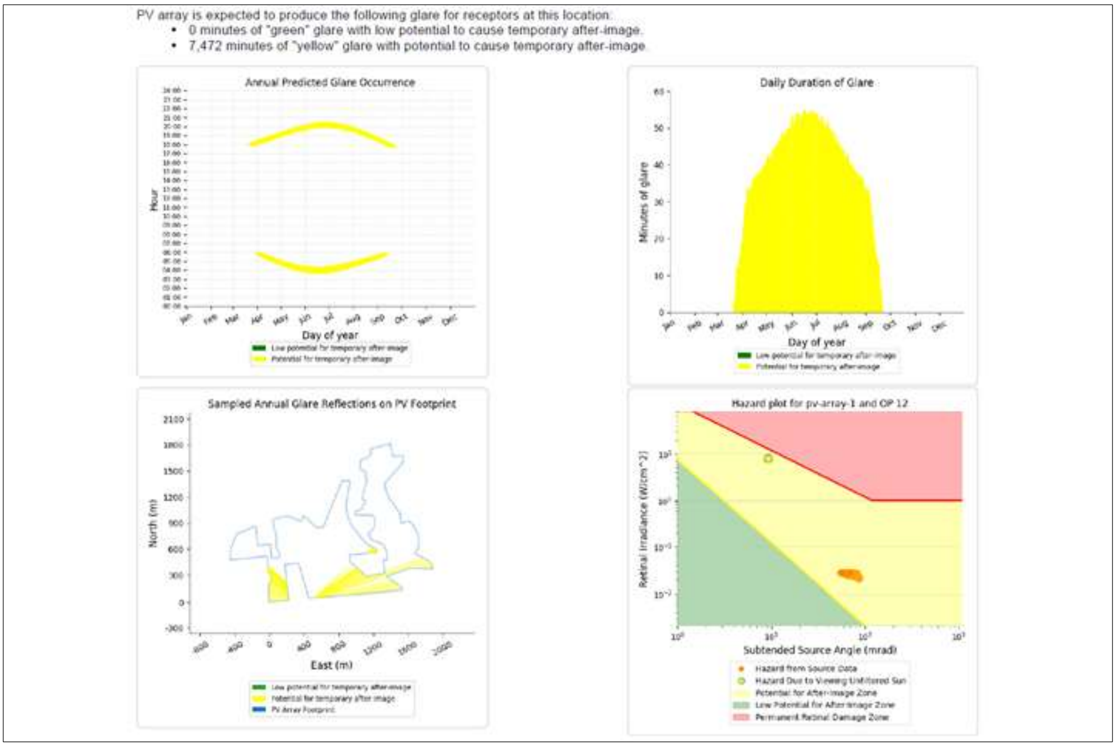


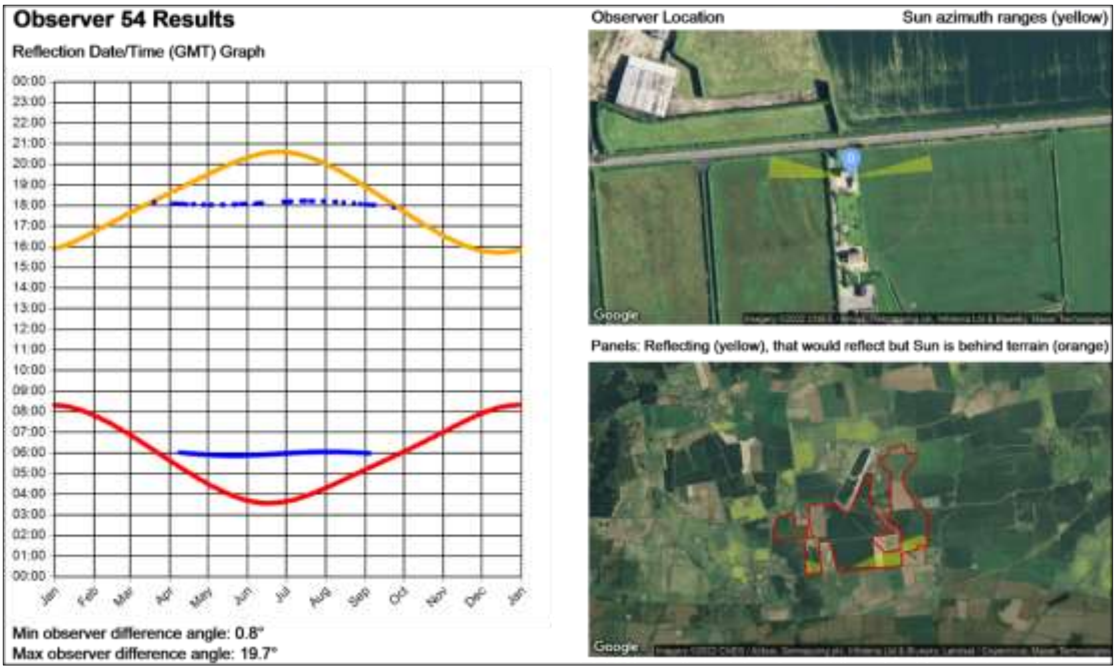
Dwelling 53 – Cottam 3





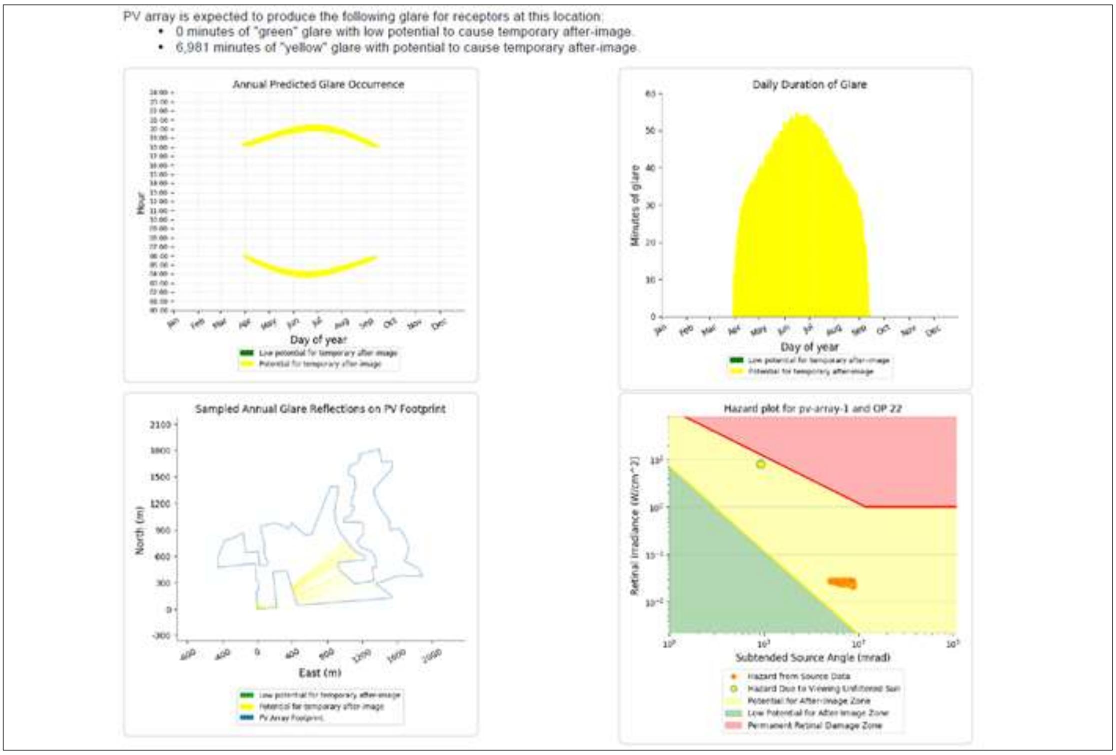
Dwelling 54 – Cottam 3

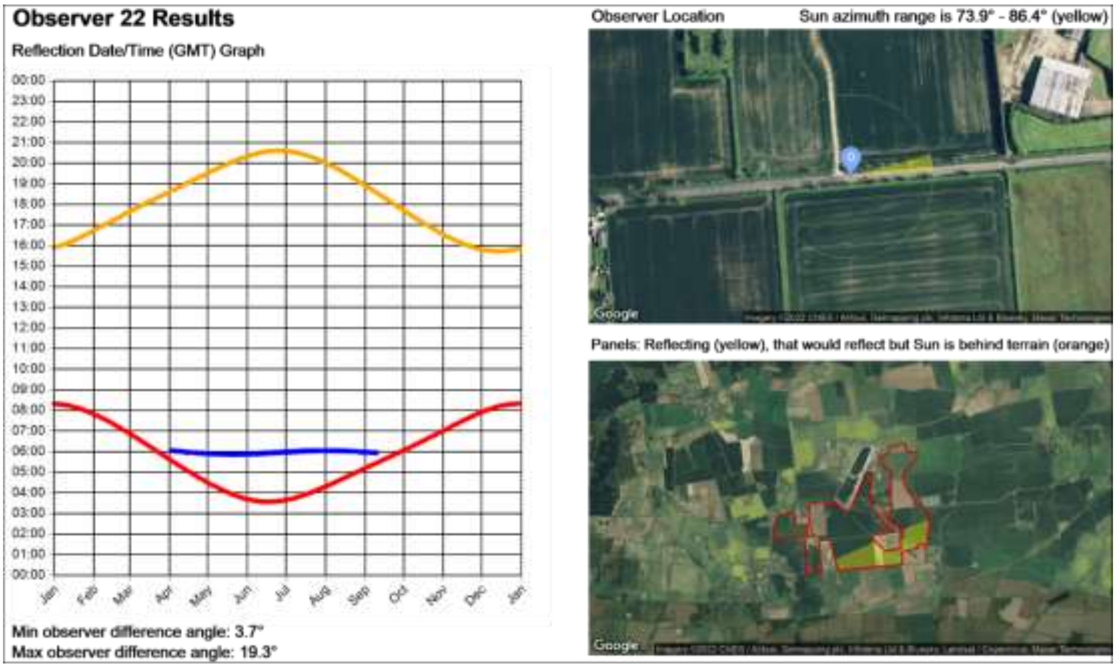




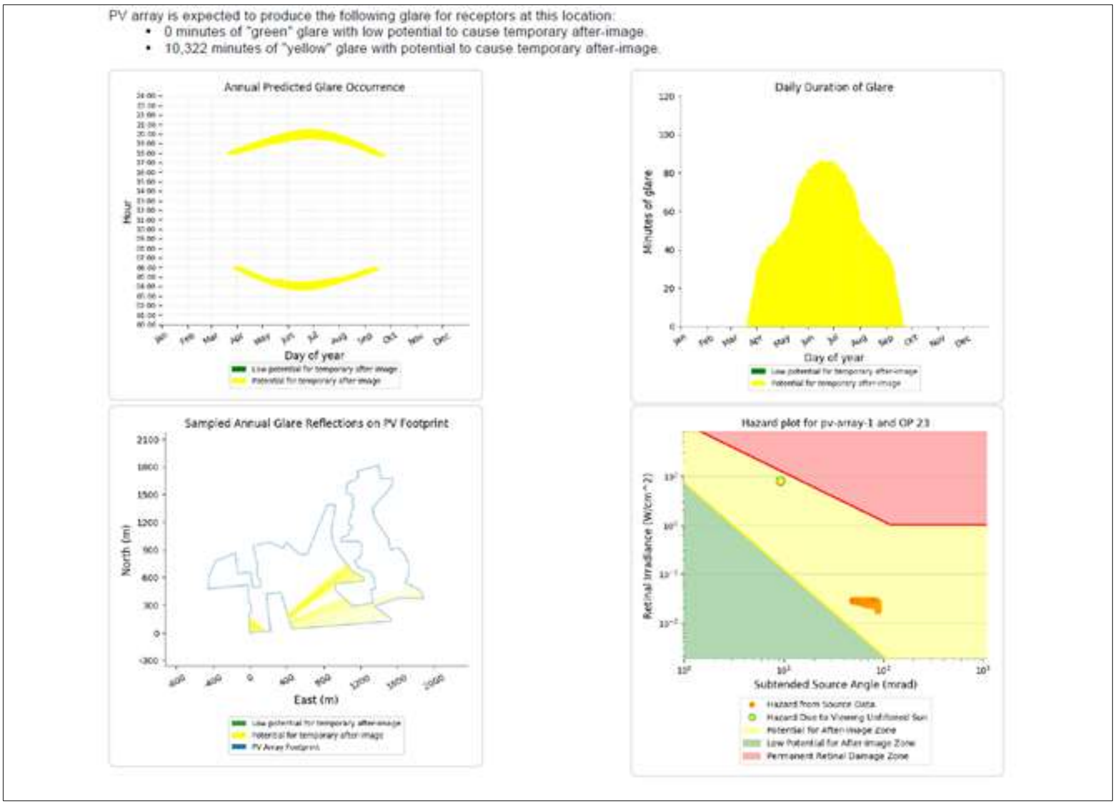
Road Receptors

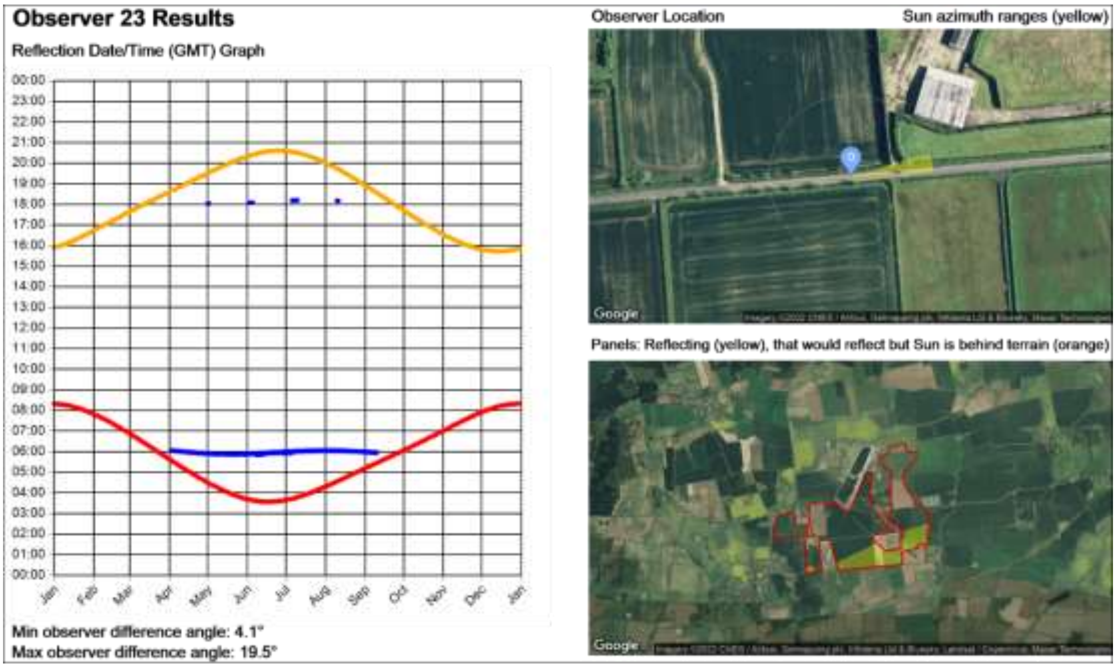
Receptor 22 – Cottam 3





Receptor 23 – Cottam 3



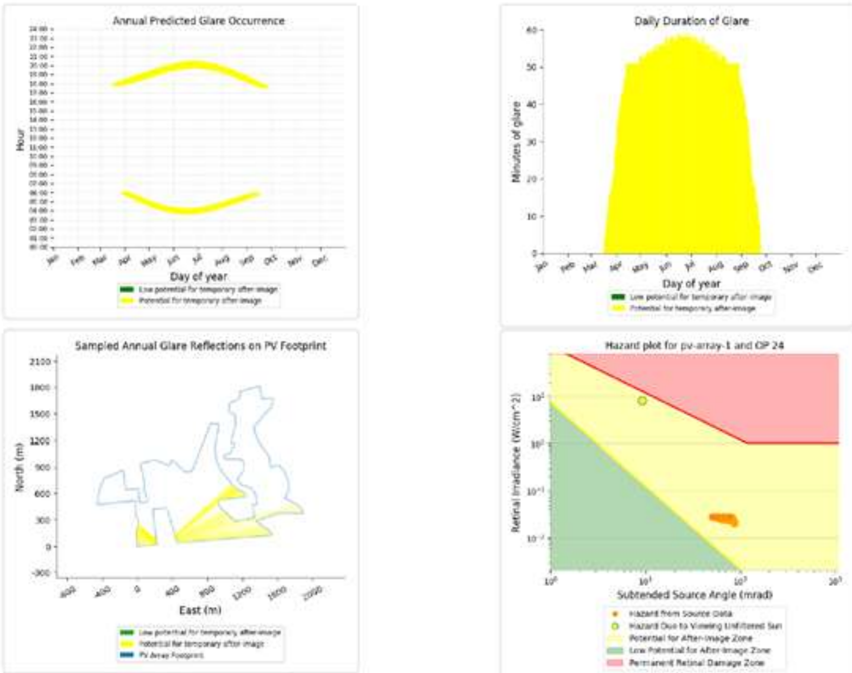


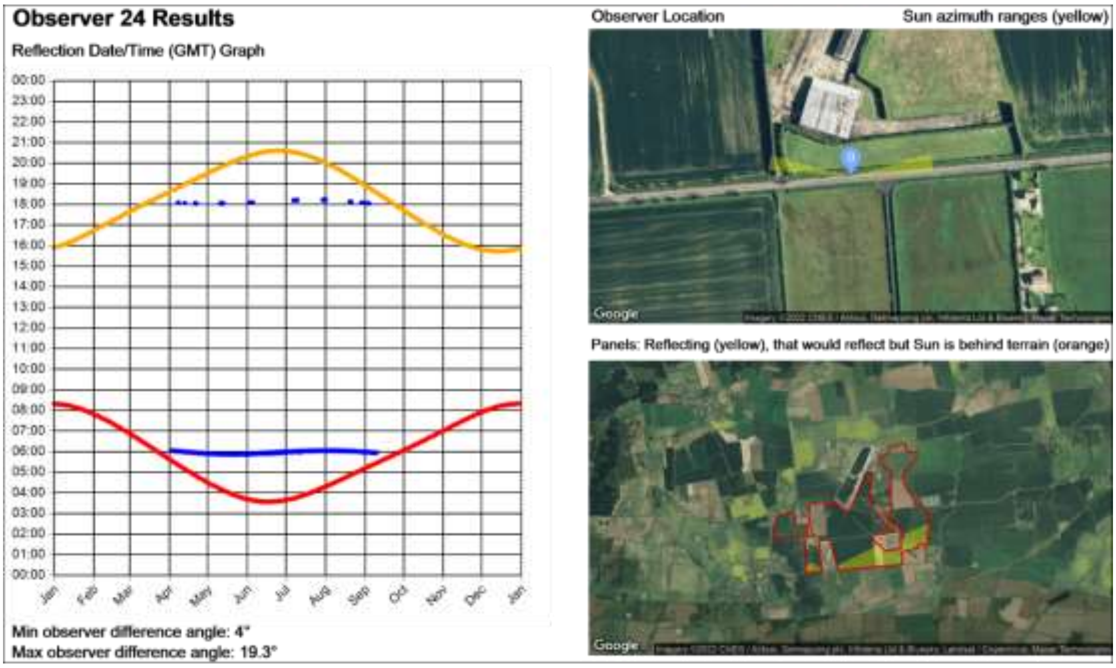
Receptor 24 – Cottam 3

PV array 1 - OP Receptor (OP 24)

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 9,065 minutes of "yellow" glare with potential to cause temporary after-image.

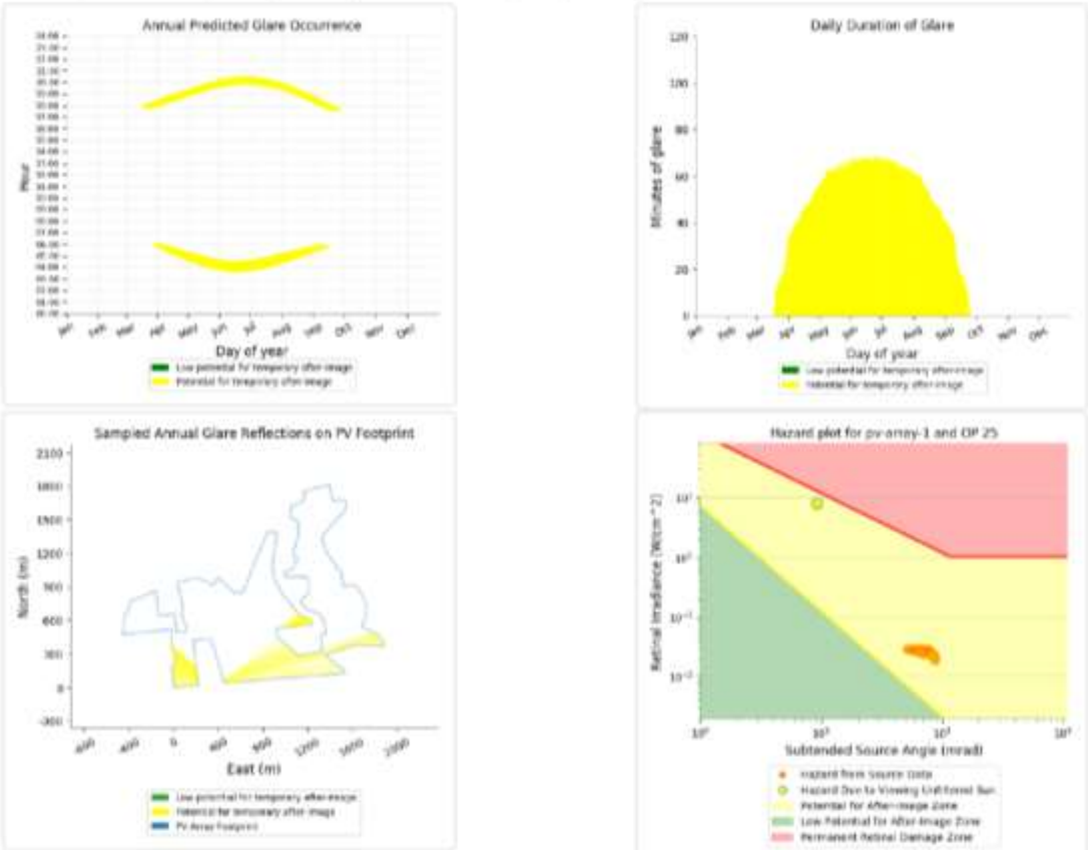


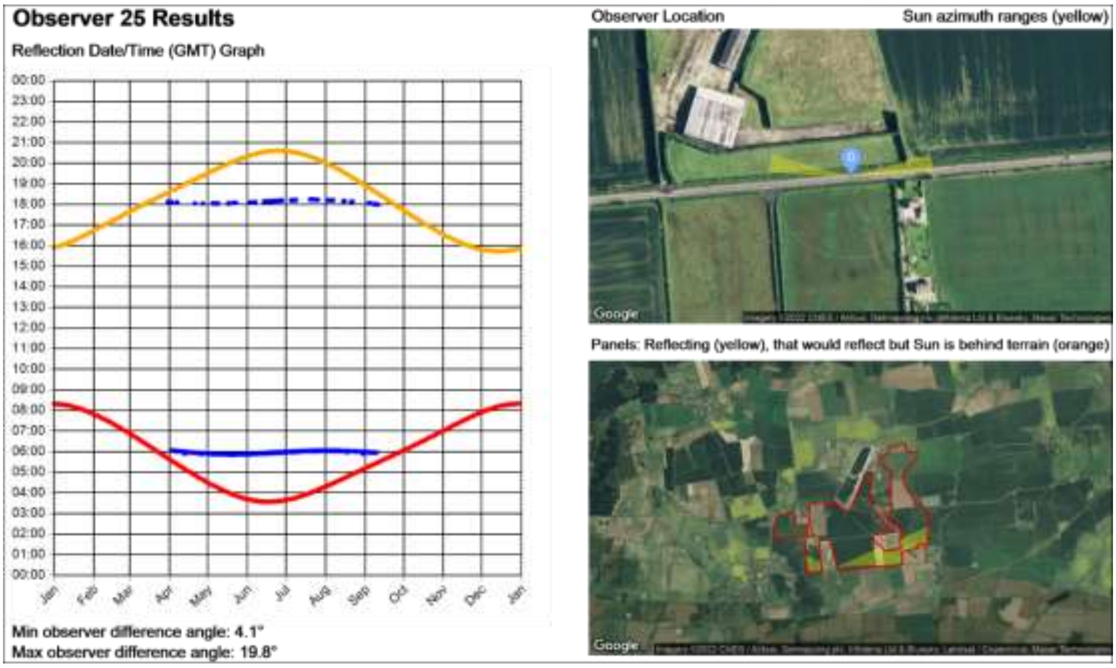


Receptor 25 – Cottam 3

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 9,828 minutes of "yellow" glare with potential to cause temporary after-image.

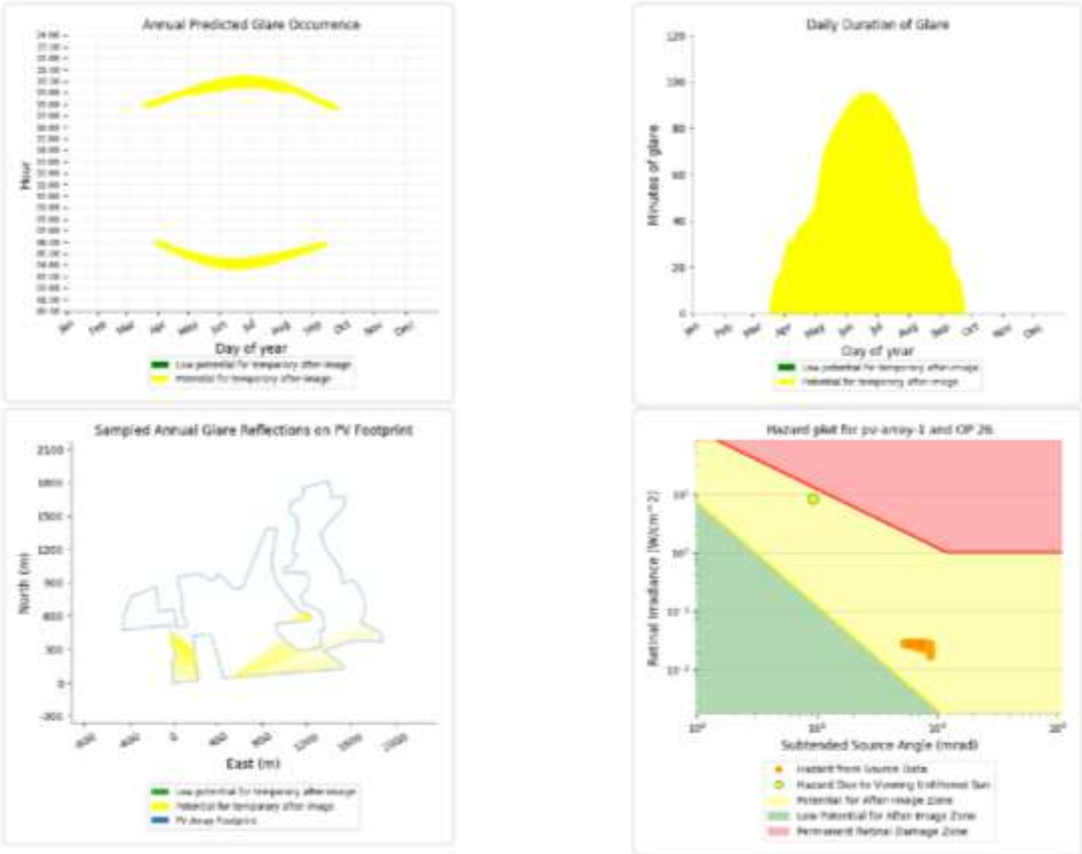




Receptor 26 – Cottam 3

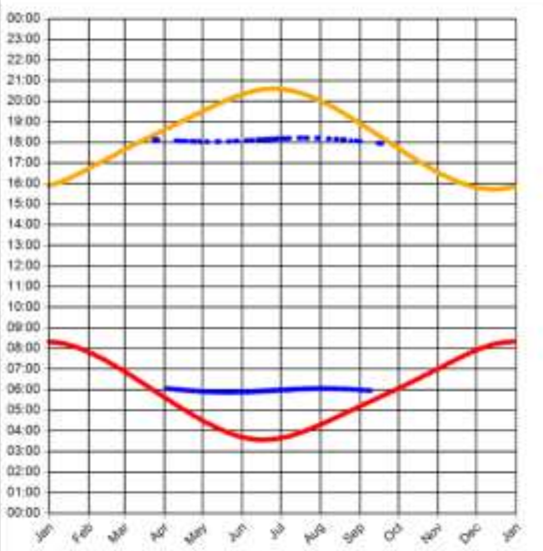
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 11,075 minutes of "yellow" glare with potential to cause temporary after-image.



Observer 26 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 2.1°
Max observer difference angle: 19.9°

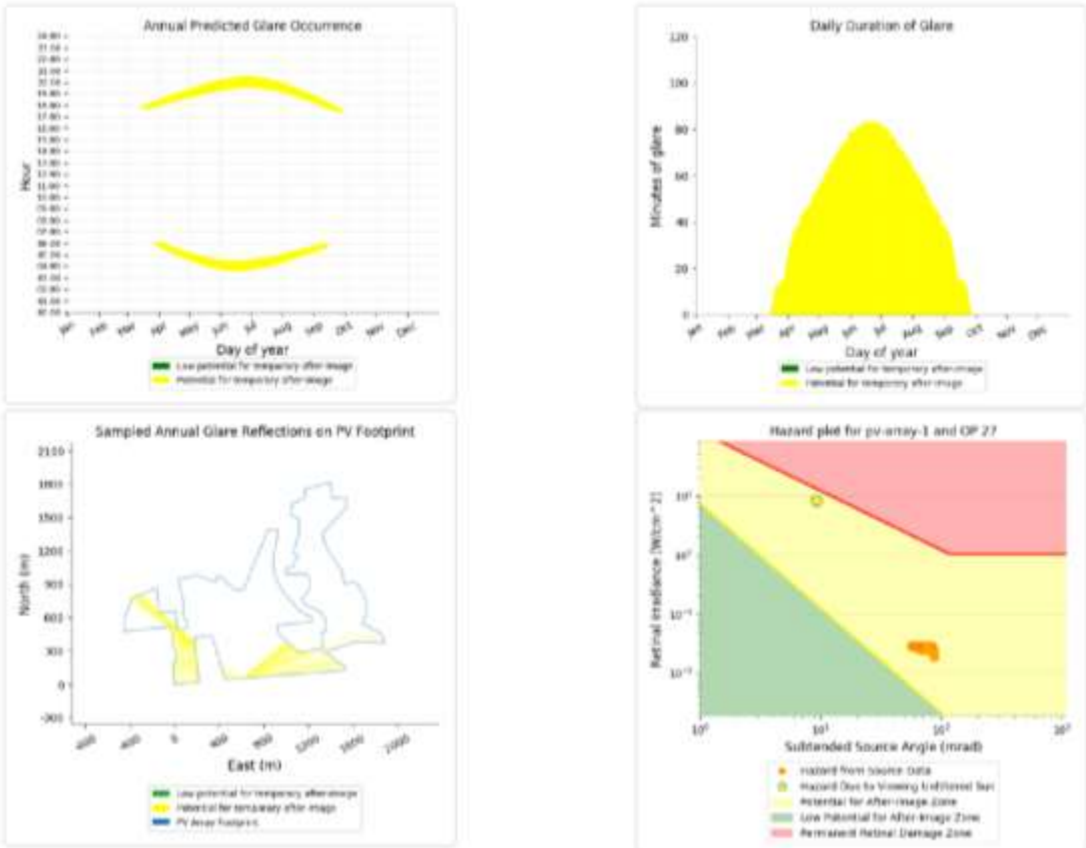
Observer Location | Sun azimuth ranges (yellow)

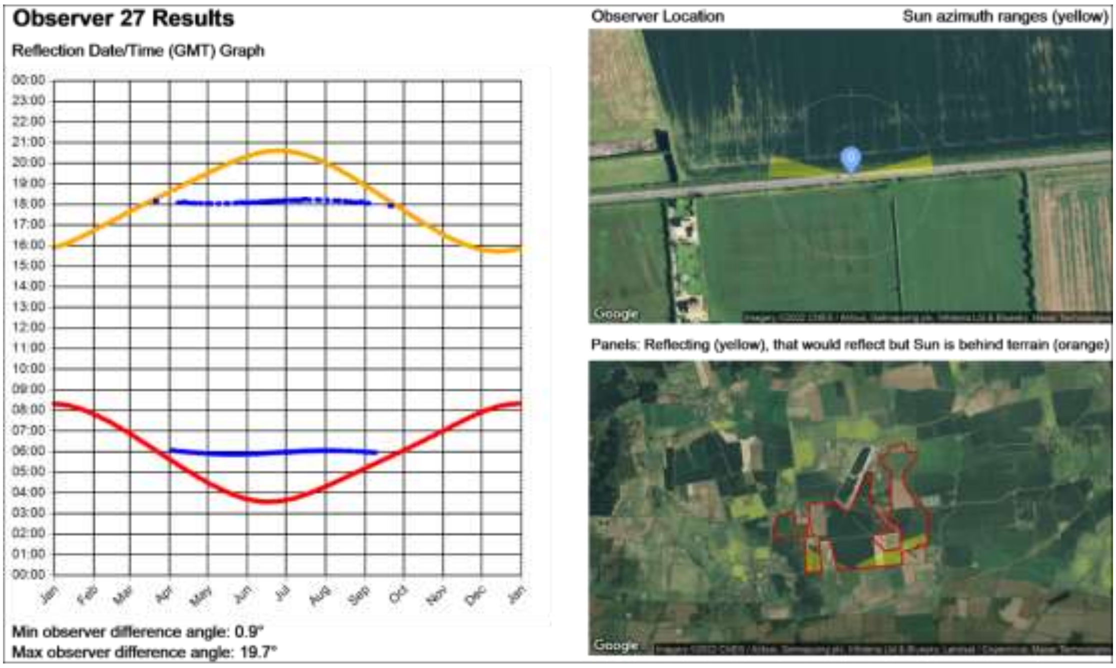
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Receptor 27 – Cottam 3

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 10,506 minutes of "yellow" glare with potential to cause temporary after-image.

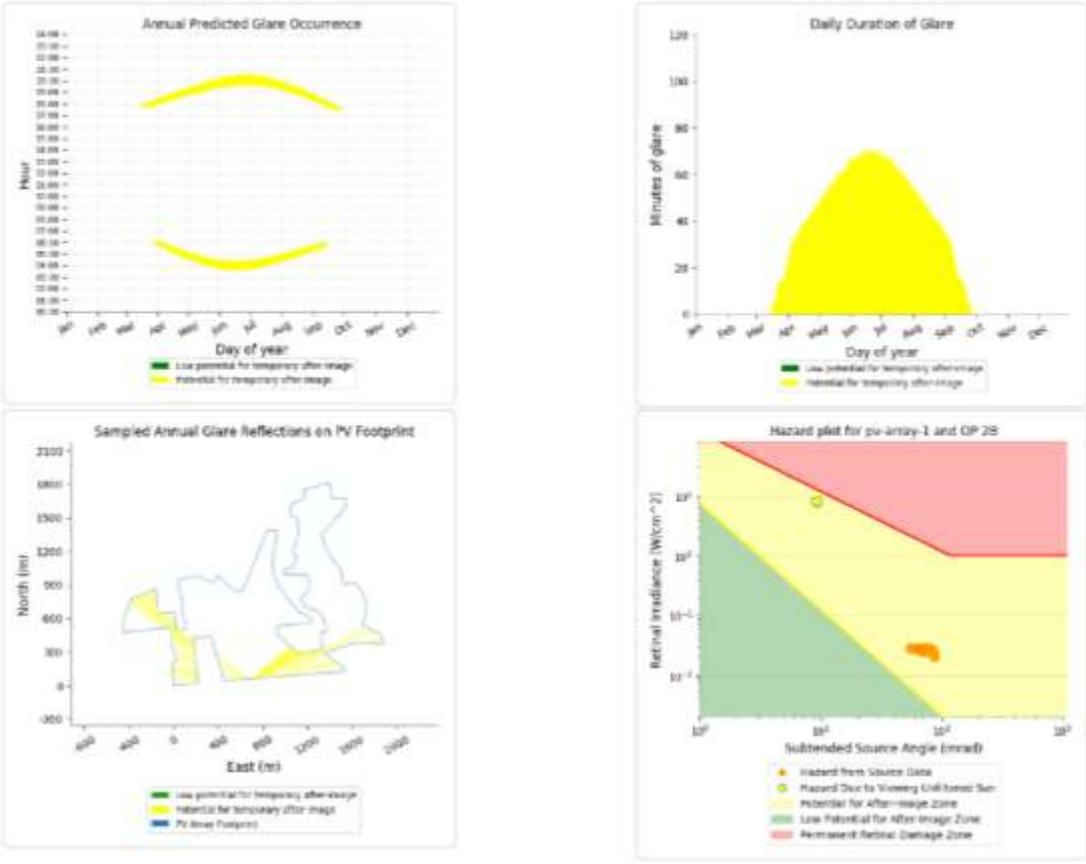




Receptor 28 – Cottam 3

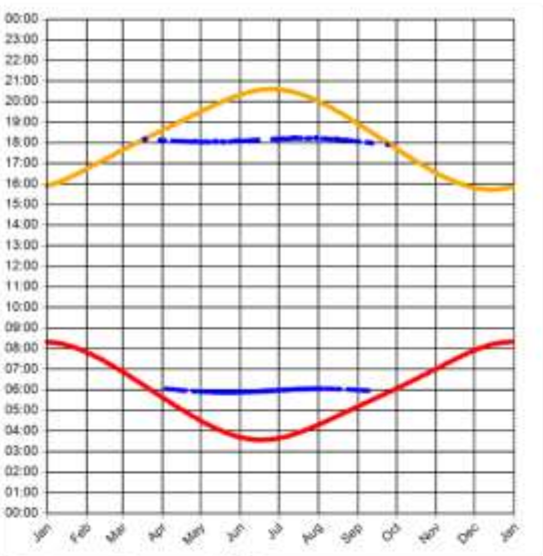
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 9,026 minutes of "yellow" glare with potential to cause temporary after-image.



Observer 28 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.3°
Max observer difference angle: 19.7°

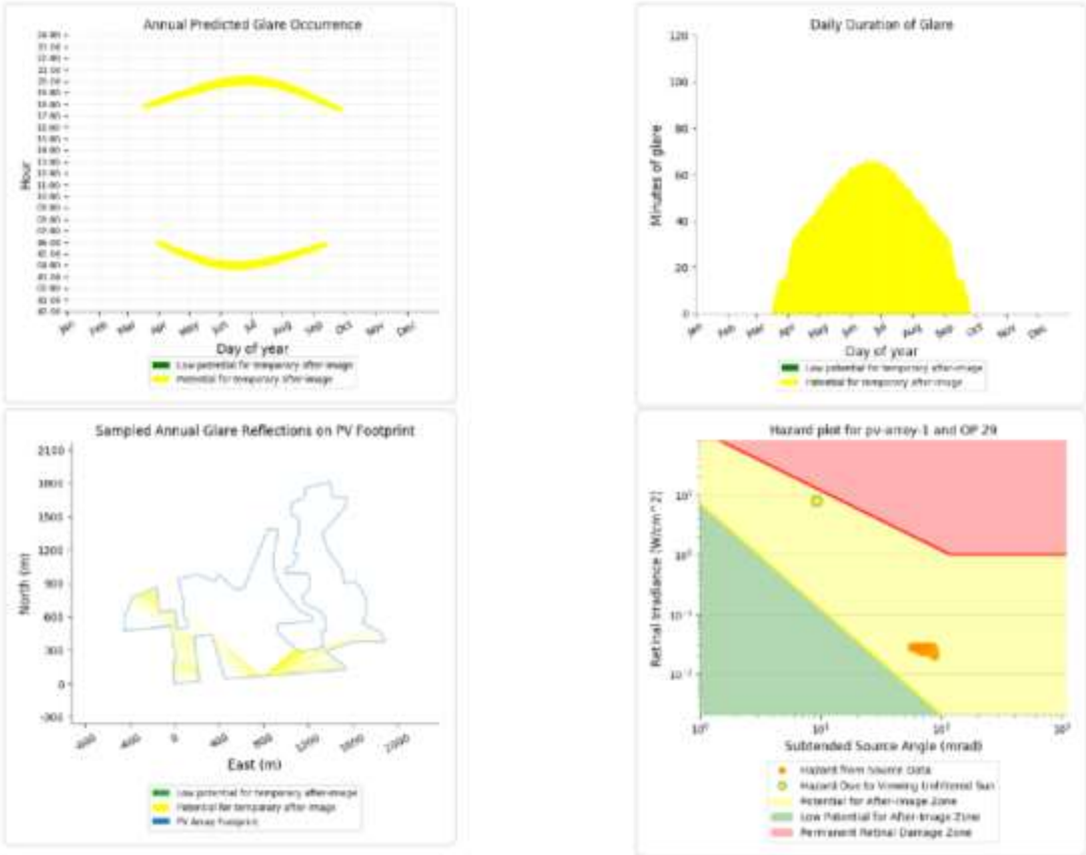
Observer Location | Sun azimuth ranges (yellow)

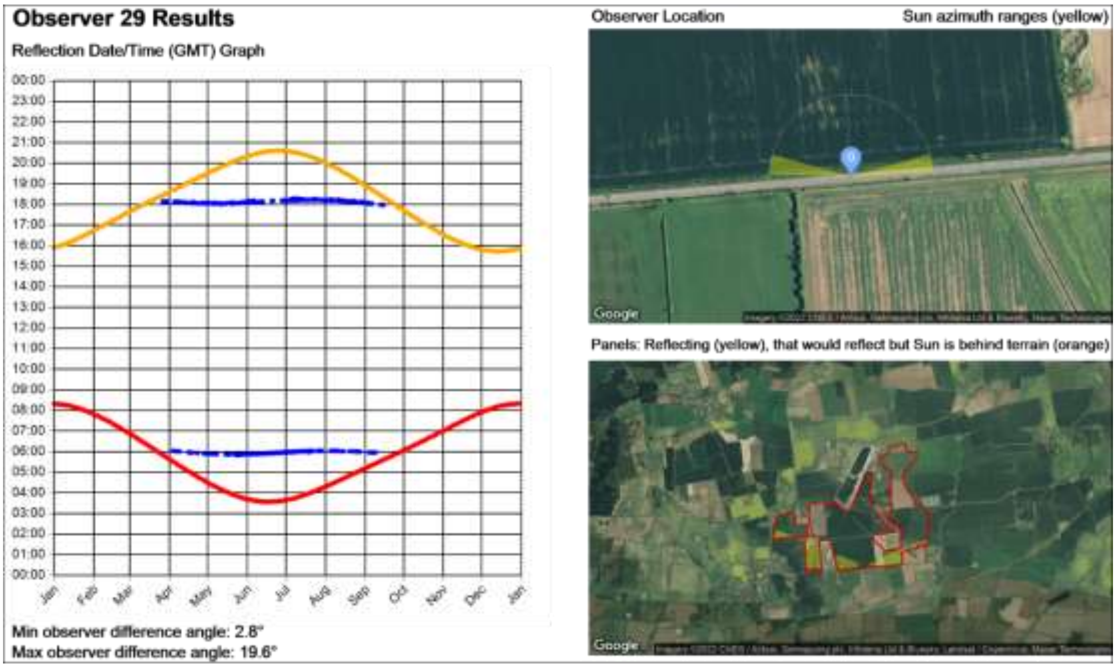
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Receptor 29 – Cottam 3

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 8,606 minutes of "yellow" glare with potential to cause temporary after-image.

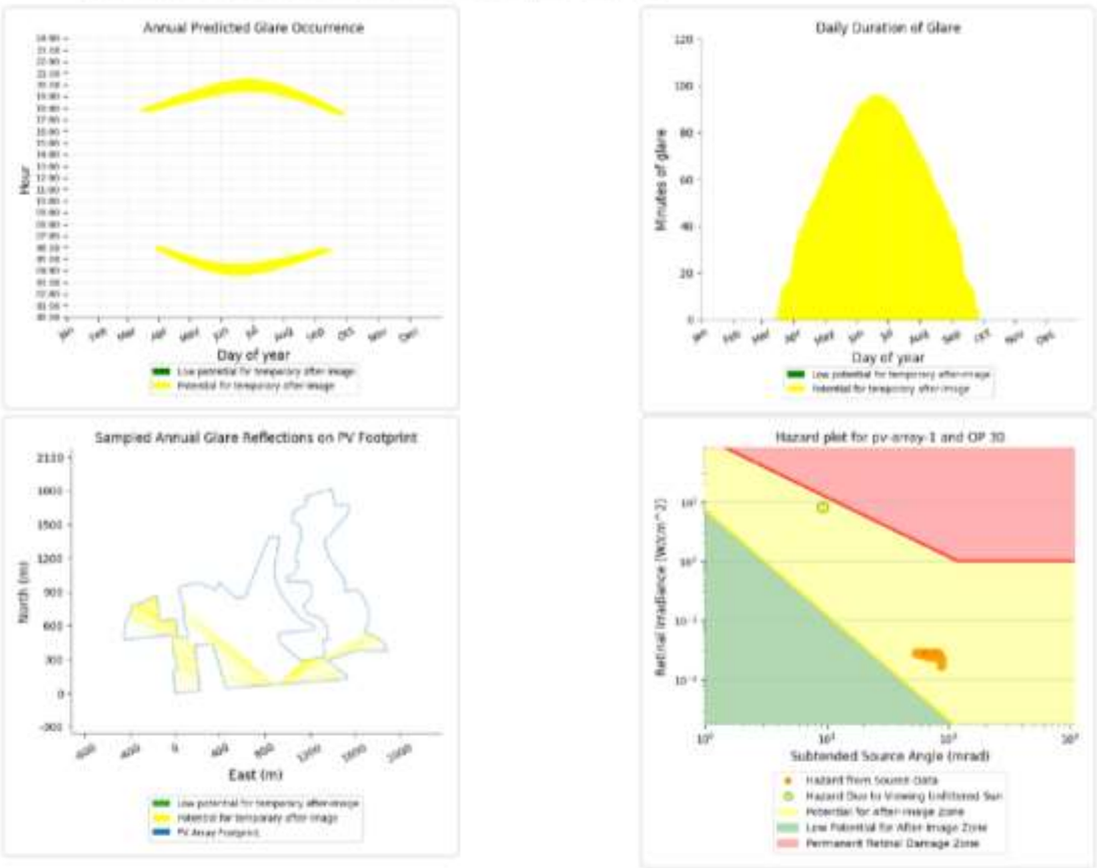


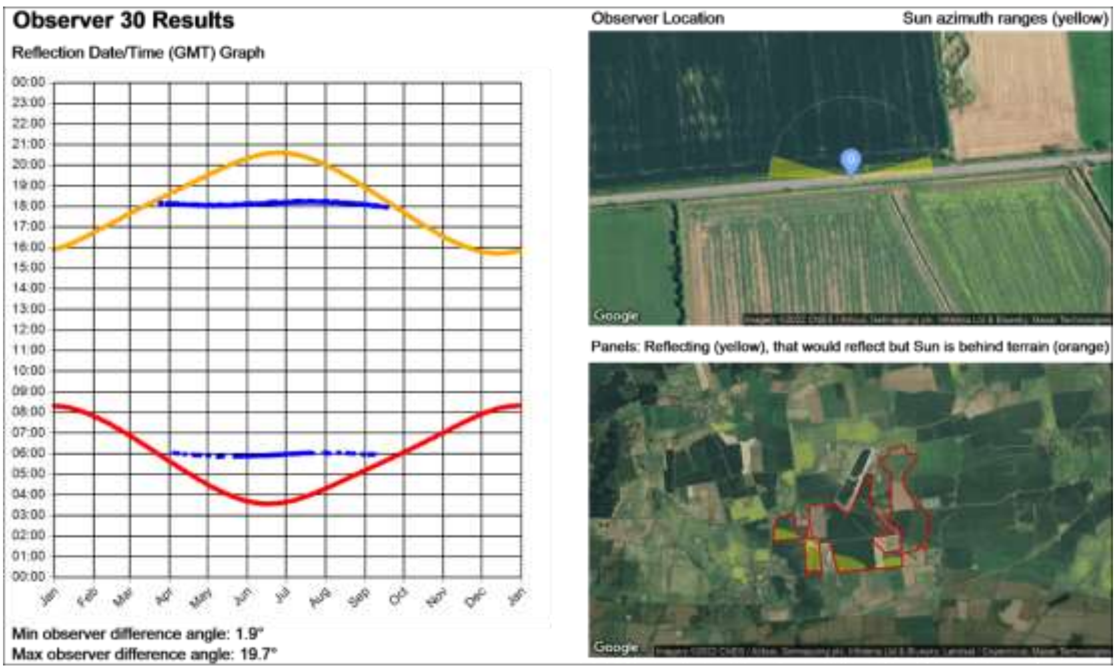


Receptor 30 – Cottam 3

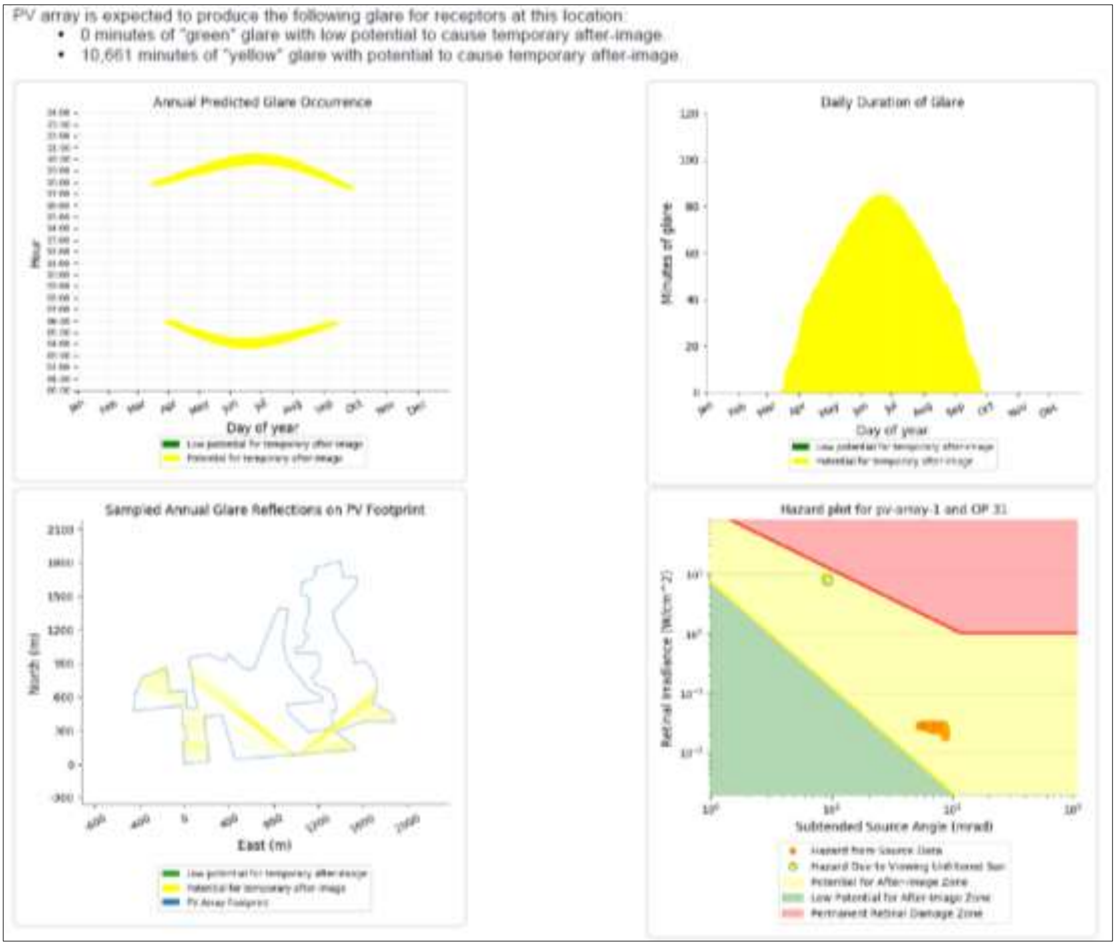
PV array is expected to produce the following glare for receptors at this location:

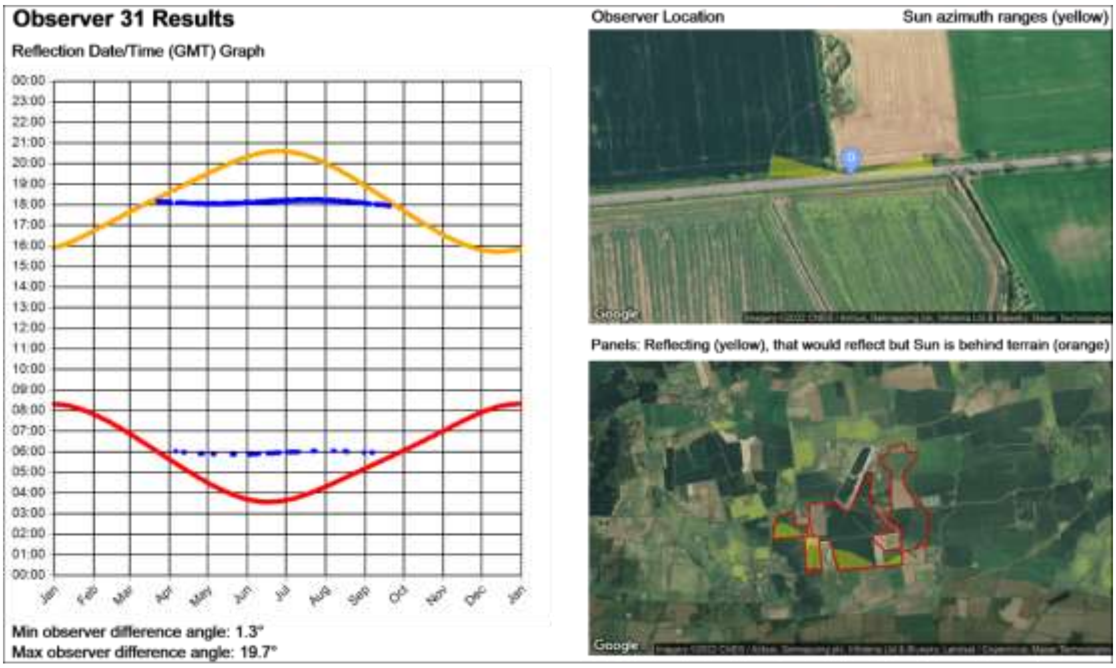
- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 11,886 minutes of "yellow" glare with potential to cause temporary after-image.



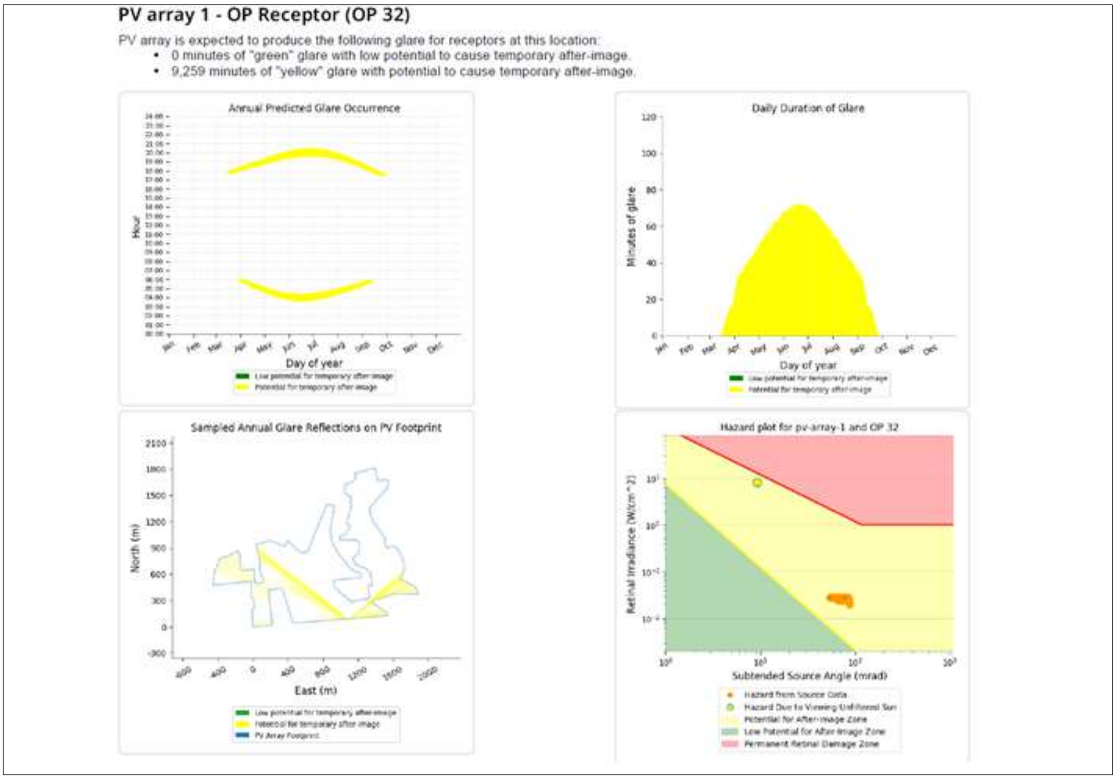


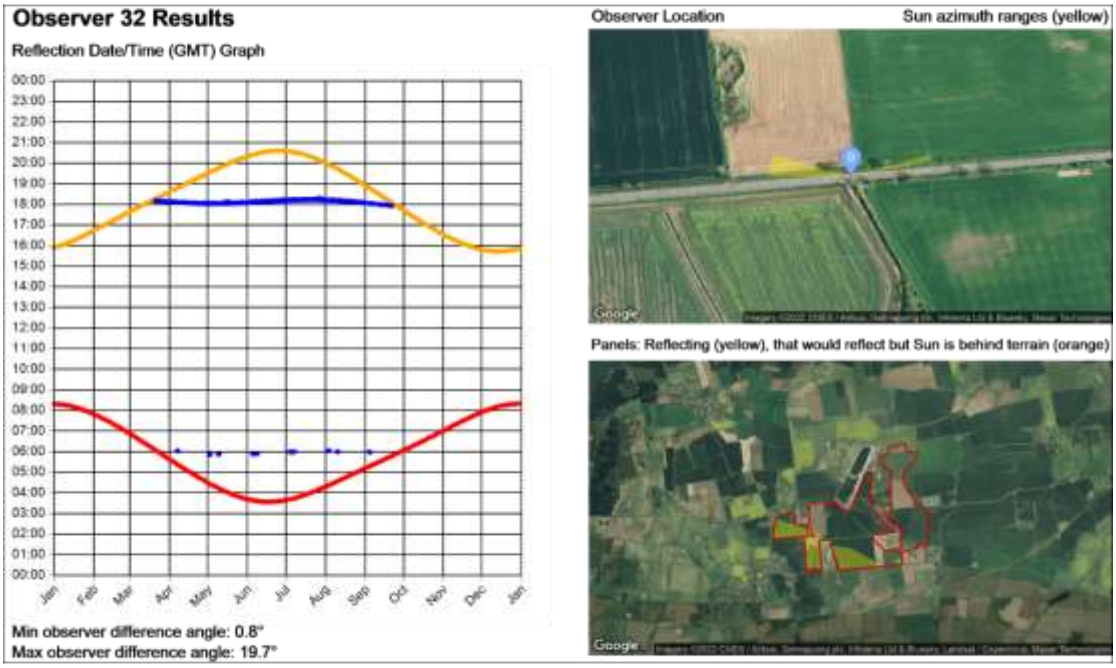
Receptor 31 – Cottam 3





Receptor 32 – Cottam 3





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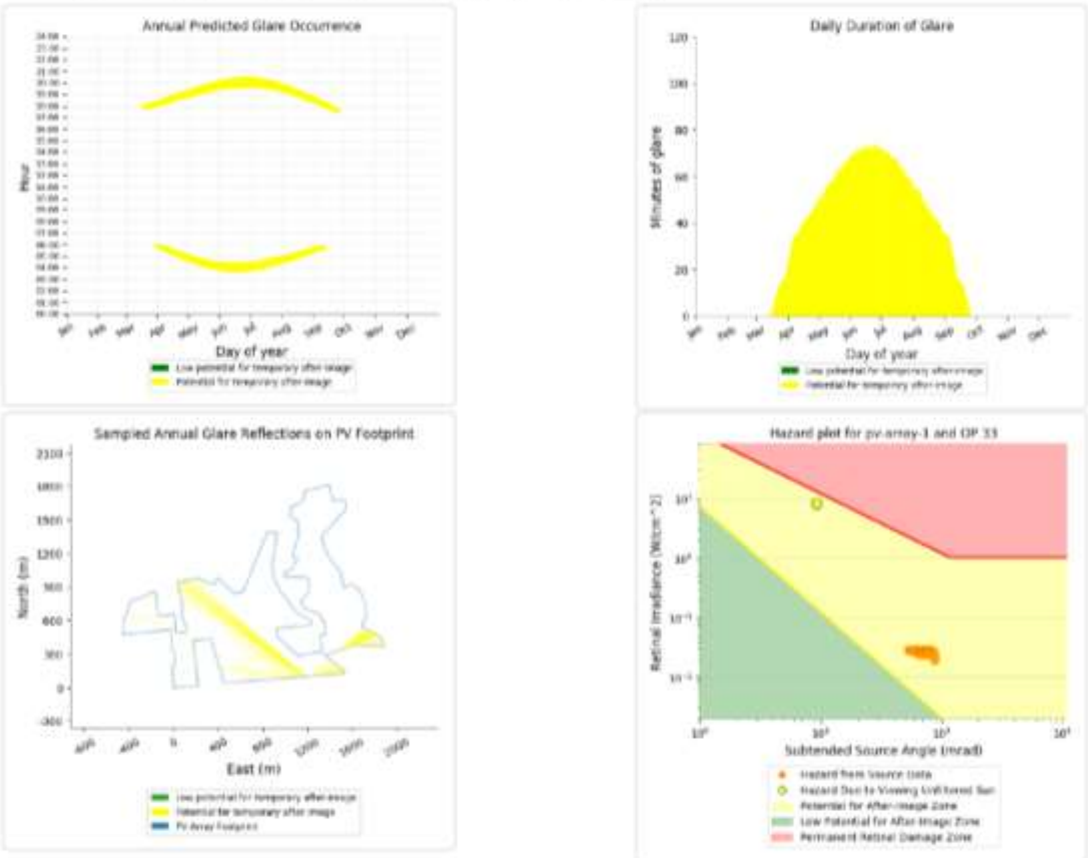
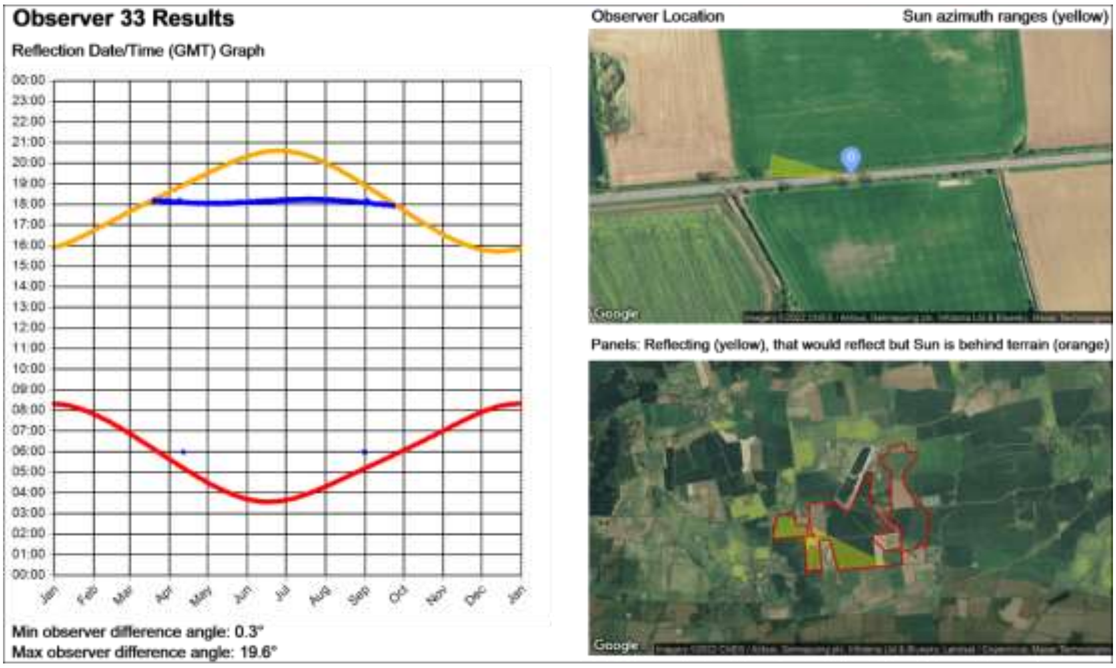
Receptor 33 – Cottam 3

PV array is expected to produce the following glare for receptors at this location:
- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 9,364 minutes of "yellow" glare with potential to cause temporary after-image.

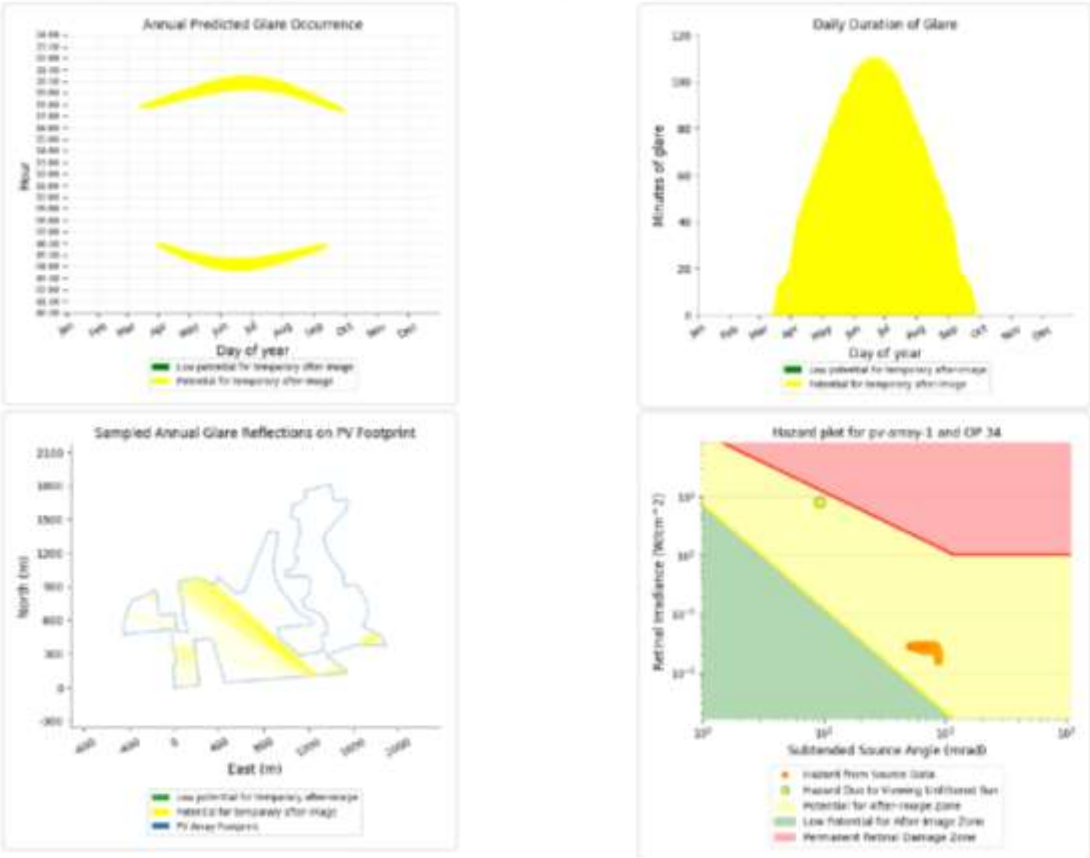




Receptor 34 – Cottam 3

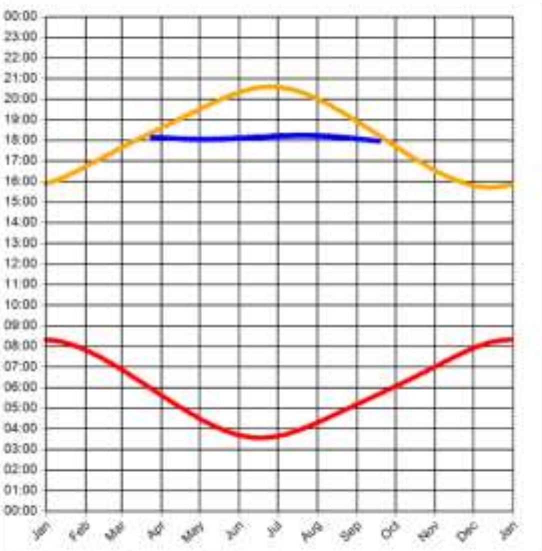
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 13,455 minutes of "yellow" glare with potential to cause temporary after-image.



Observer 34 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 2°
Max observer difference angle: 19.6°

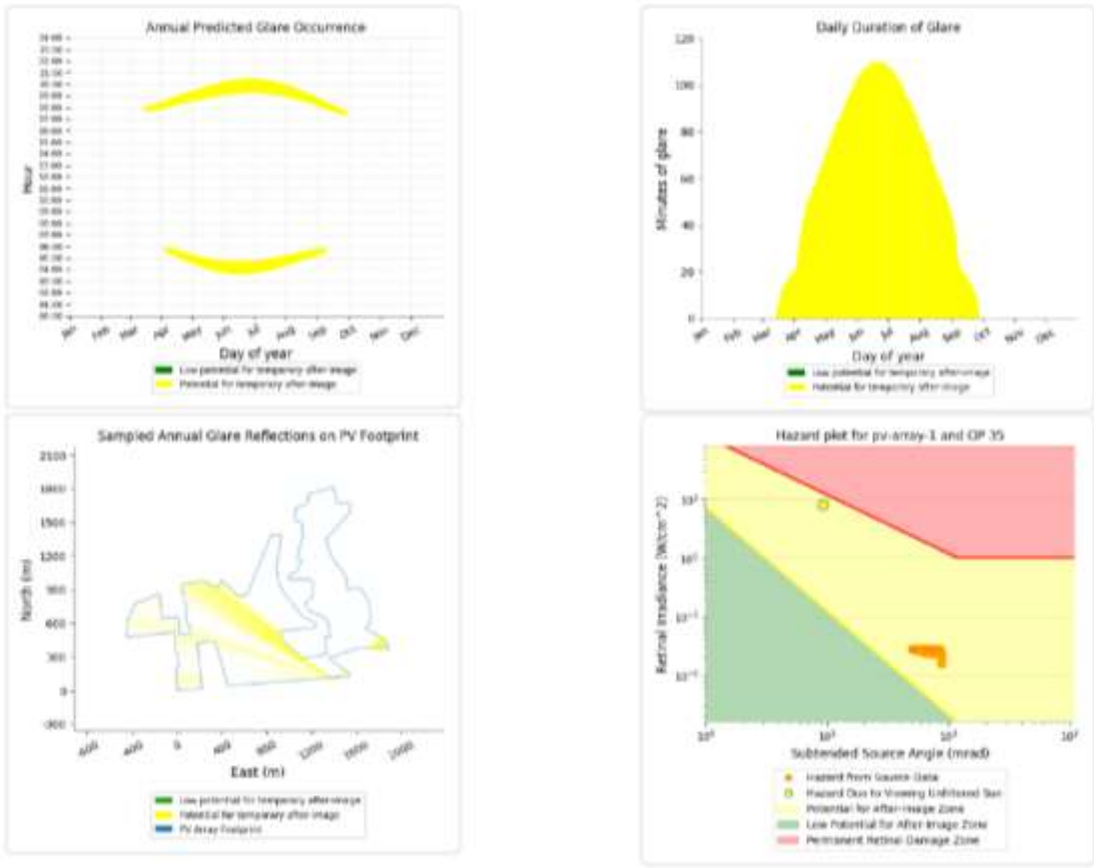
Observer Location — Sun azimuth range is 271.1° - 285.9° (yellow)

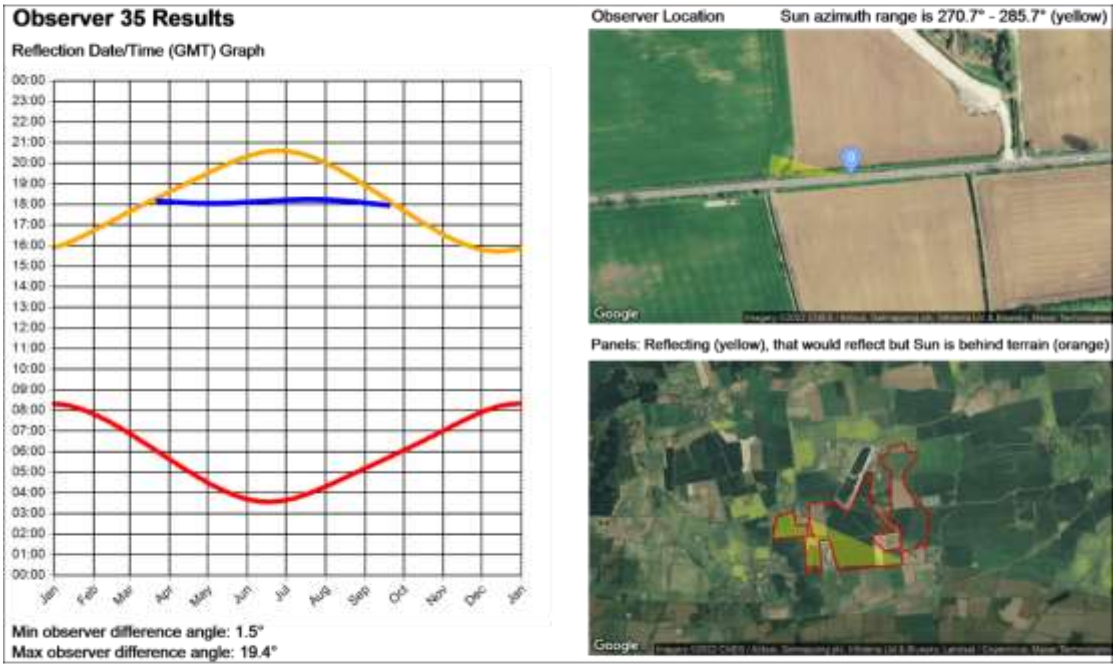
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Receptor 35 – Cottam 3

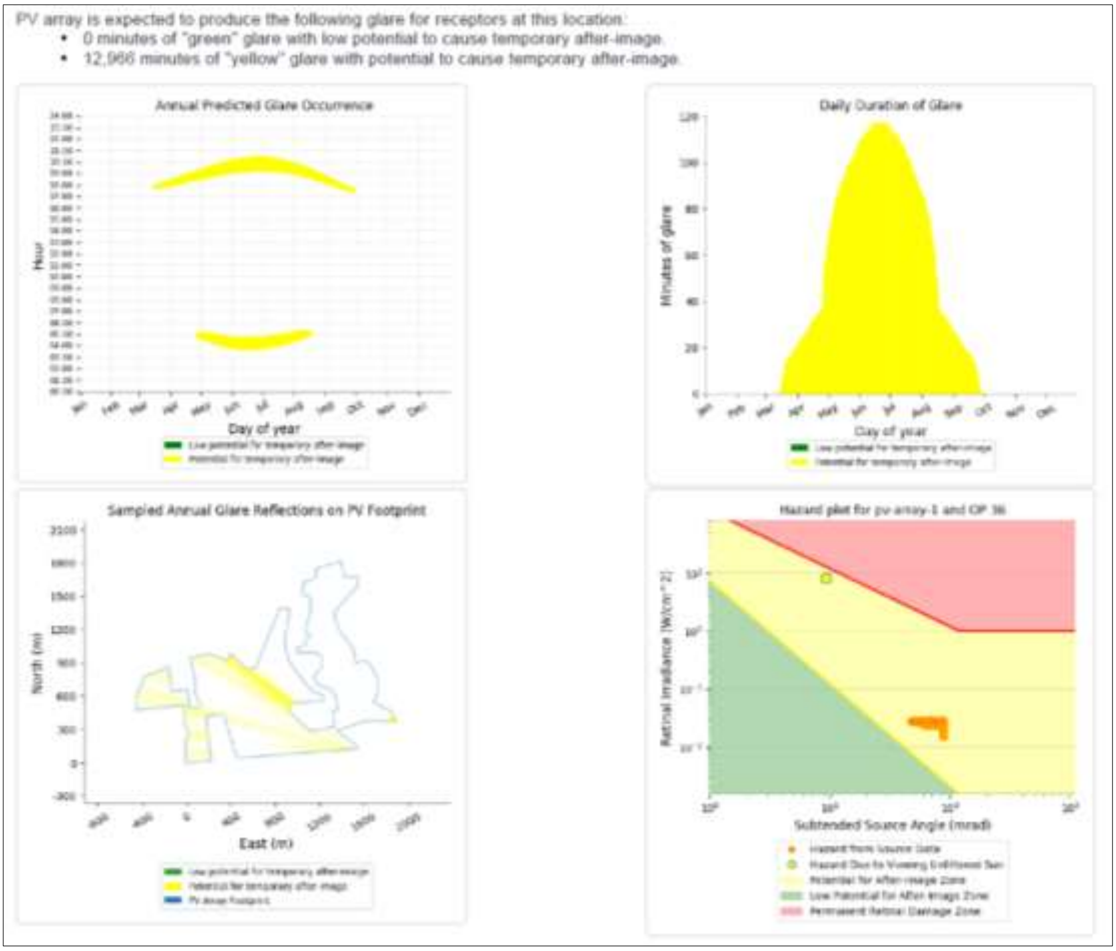
PV array is expected to produce the following glare for receptors at this location:

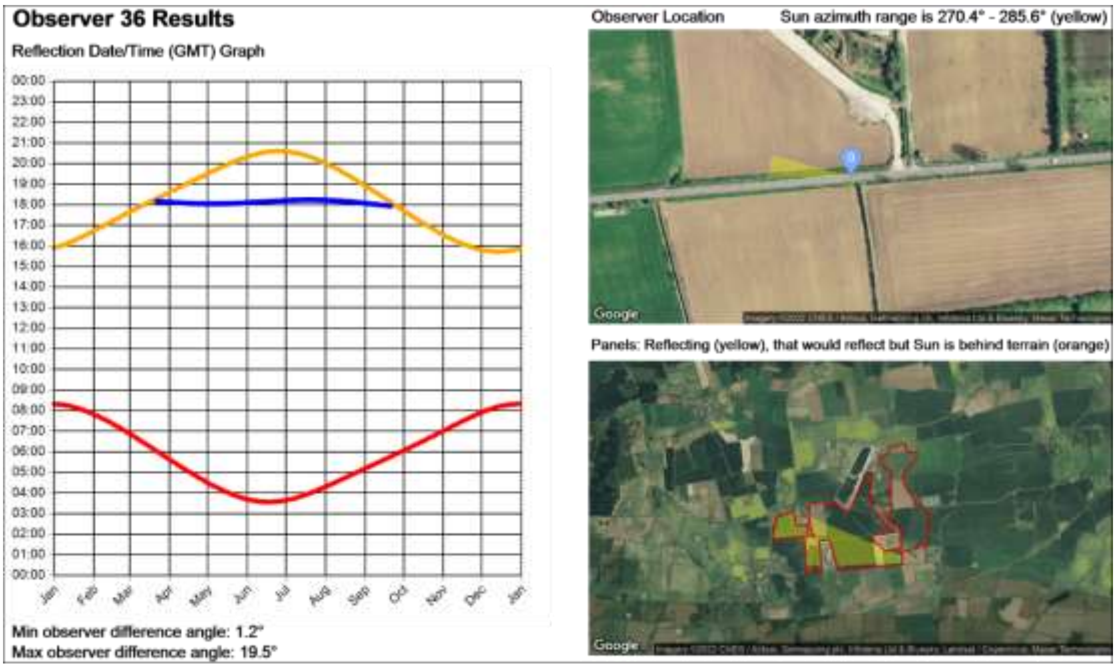
- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 13,230 minutes of "yellow" glare with potential to cause temporary after-image.





Receptor 36 – Cottam 3



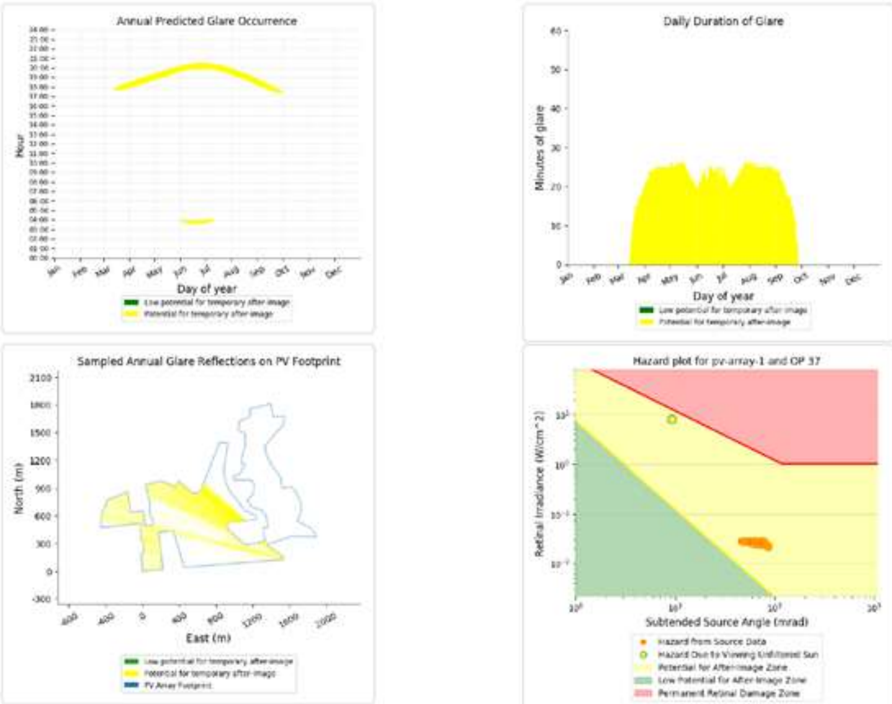


Receptor 37 – Cottam 3

PV array 1 - OP Receptor (OP 37)

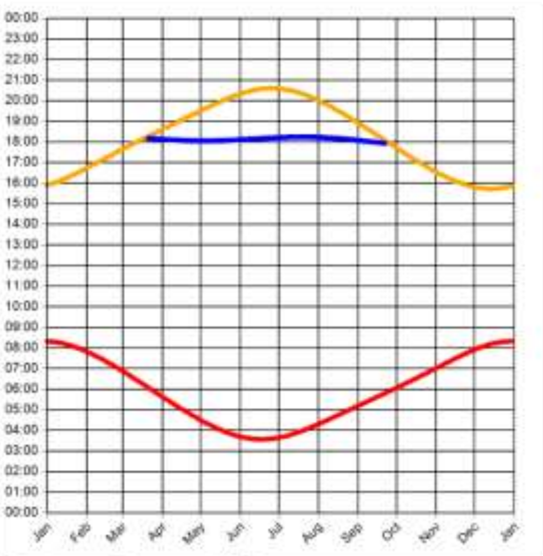
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 4,397 minutes of "yellow" glare with potential to cause temporary after-image.



Observer 37 Results

Reflection Date/Time (GMT) Graph

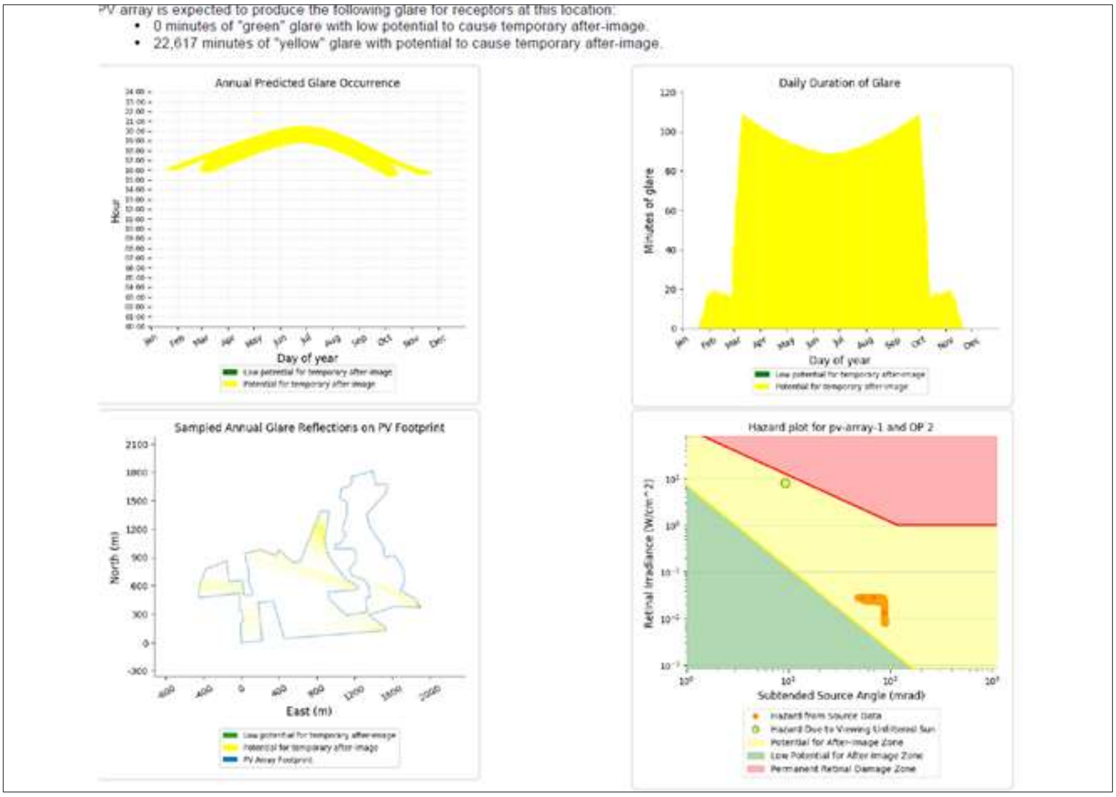


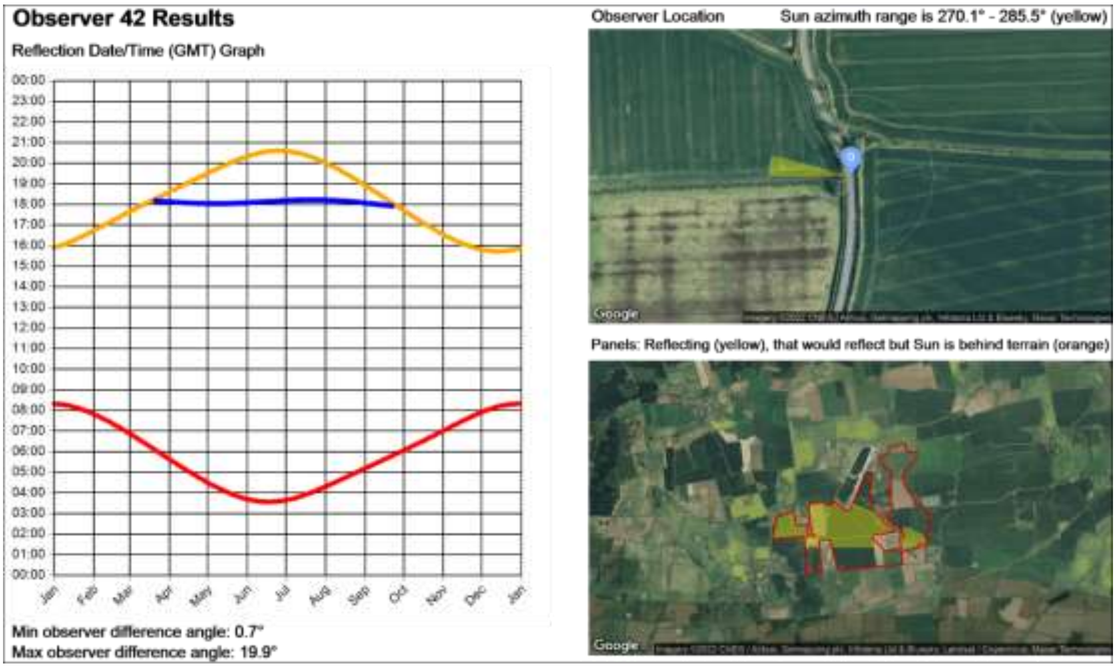
Min observer difference angle: 0.8°
Max observer difference angle: 19.4°

Observer Location — Sun azimuth range is 270.2° - 285.8° (yellow)

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

Receptor 42 – Cottam 3

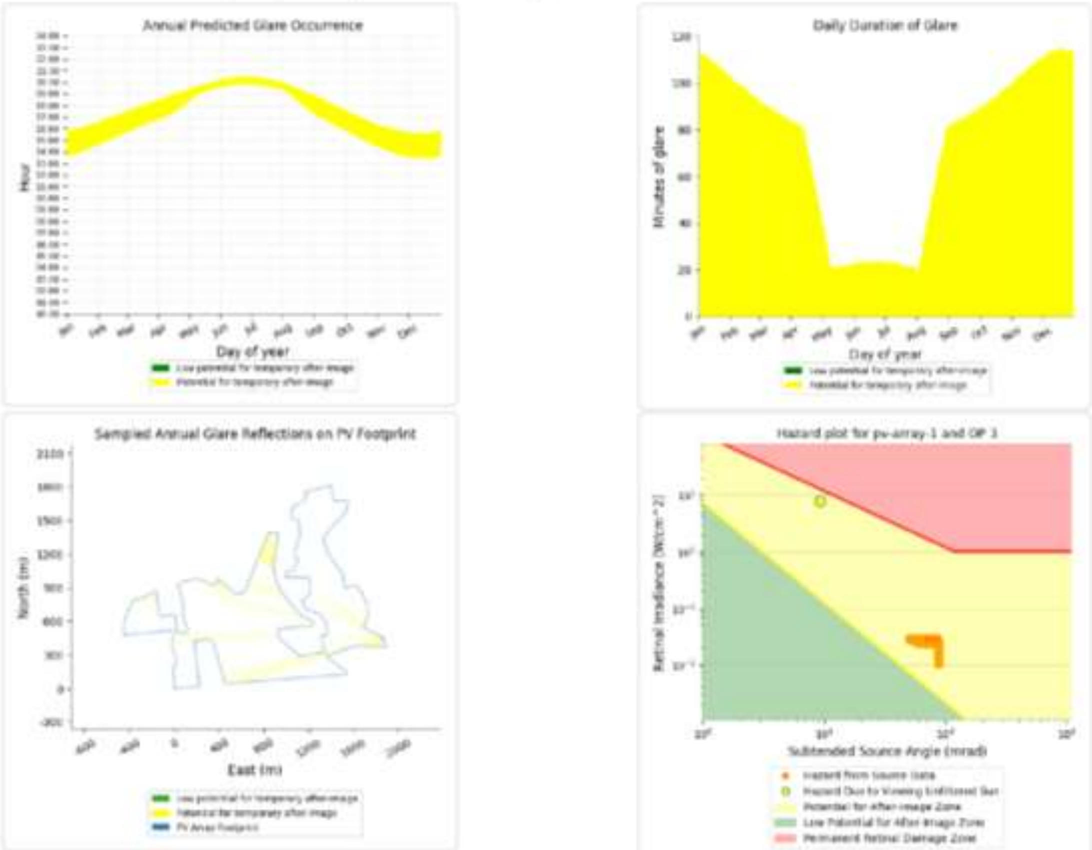




Receptor 43 – Cottam 3

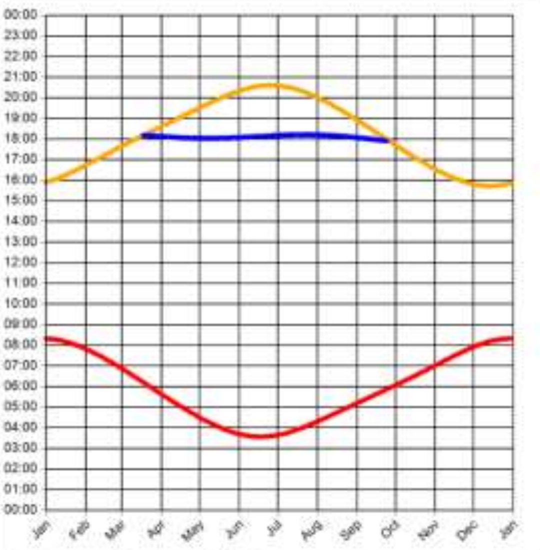
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 26,868 minutes of "yellow" glare with potential to cause temporary after-image.



Observer 43 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.4°
Max observer difference angle: 20.2°

Observer Location

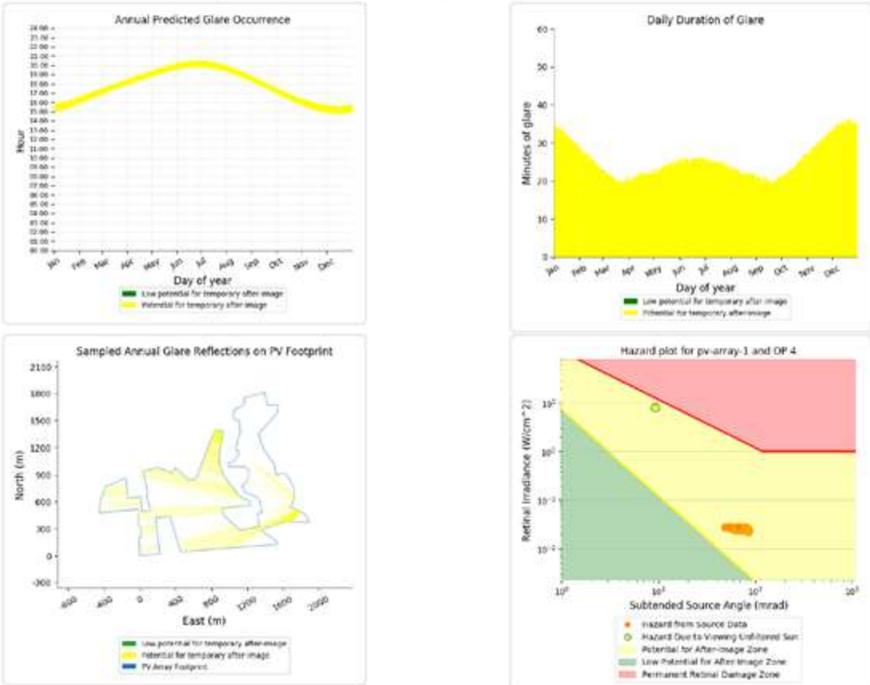
Sun azimuth range is 269.5° - 285.3° (yellow)

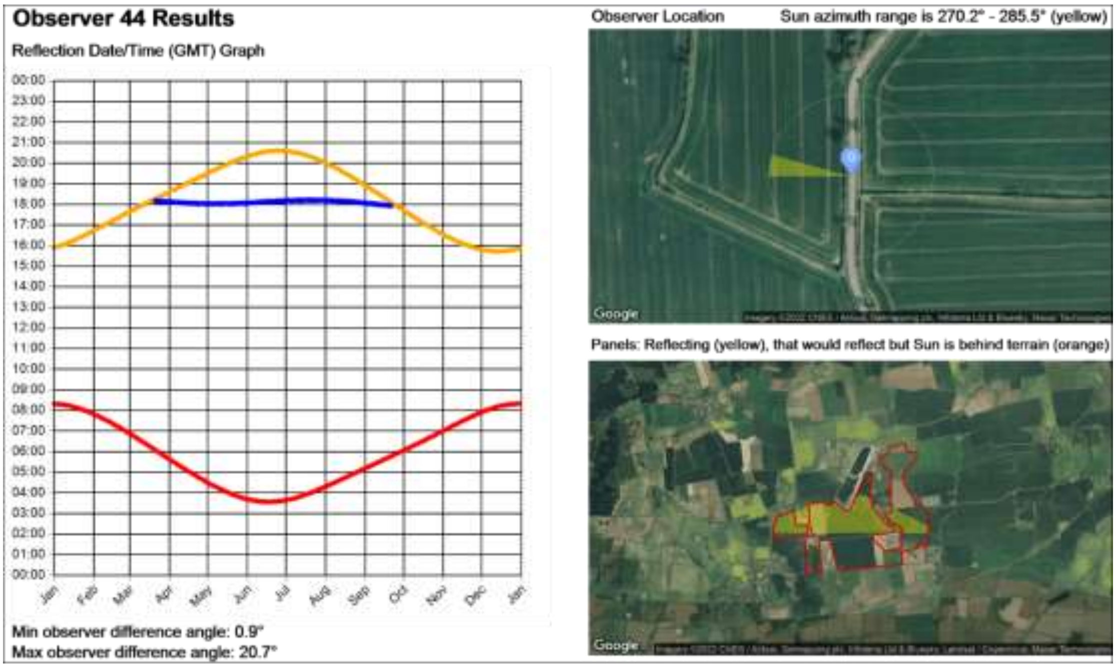
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Receptor 44 – Cottam 3

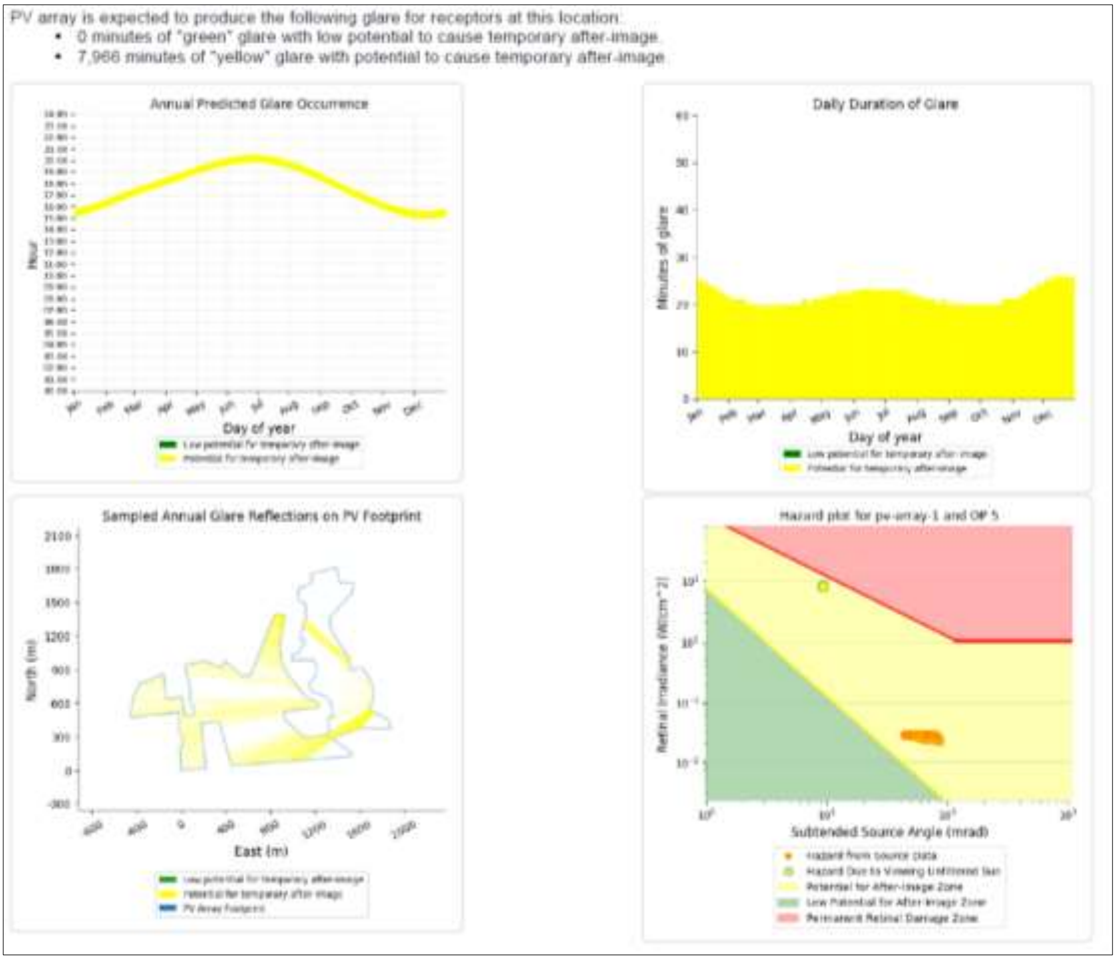
PV array is expected to produce the following glare for receptors at this location:

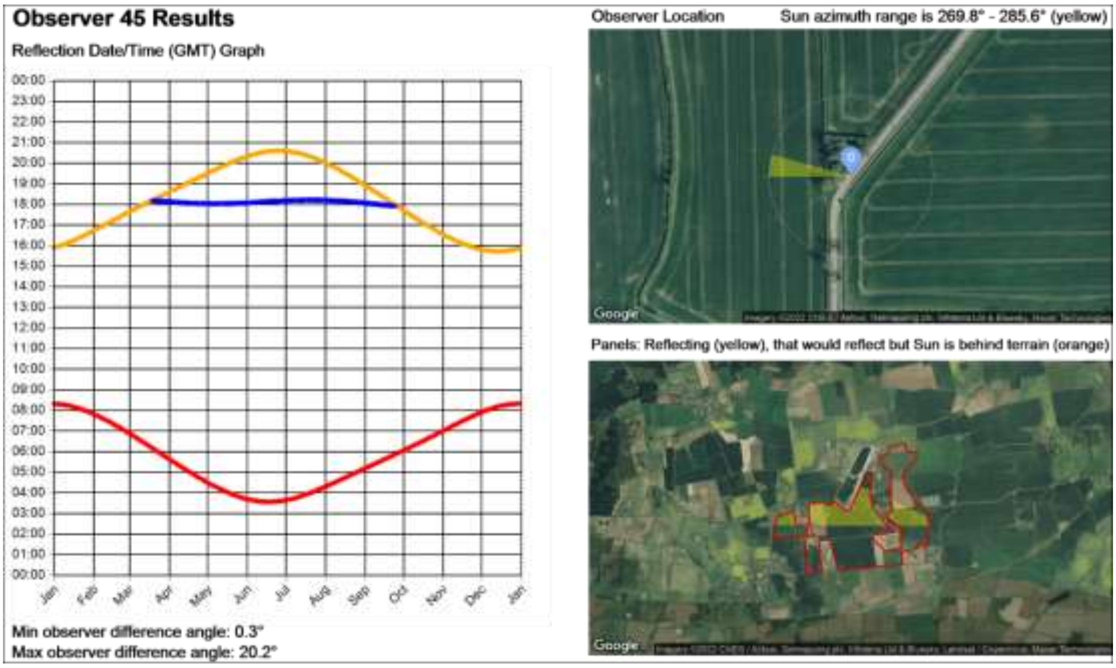
- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 9,343 minutes of "yellow" glare with potential to cause temporary after-image.





Receptor 45 – Cottam 3

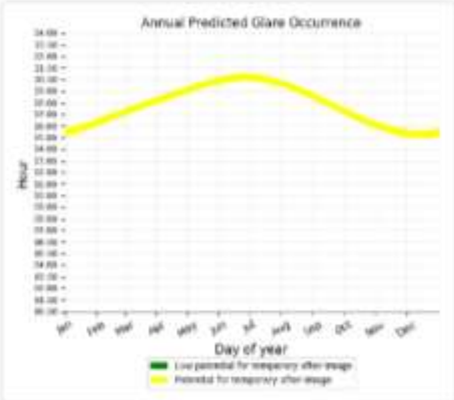


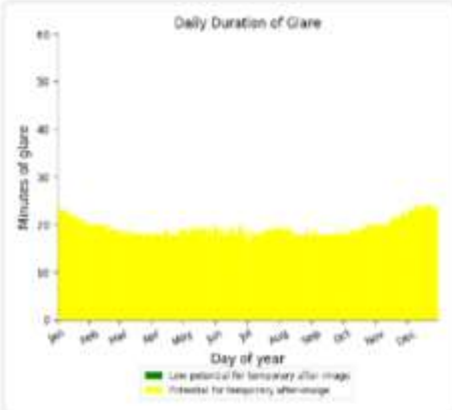


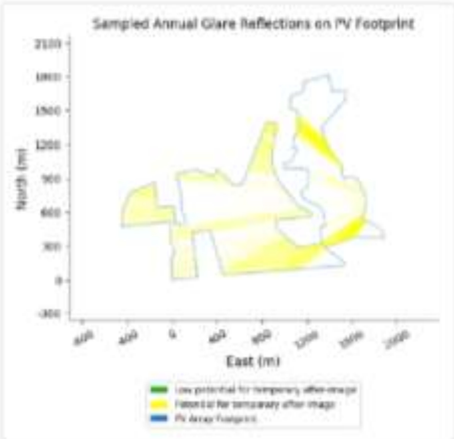
Receptor 46 – Cottam 3

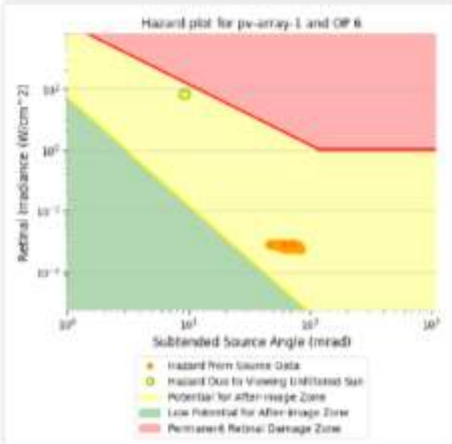
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 7,134 minutes of "yellow" glare with potential to cause temporary after-image.



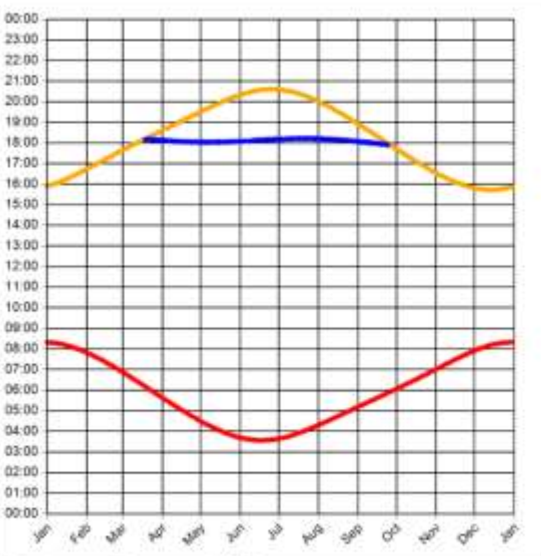






Observer 46 Results

Reflection Date/Time (GMT) Graph



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

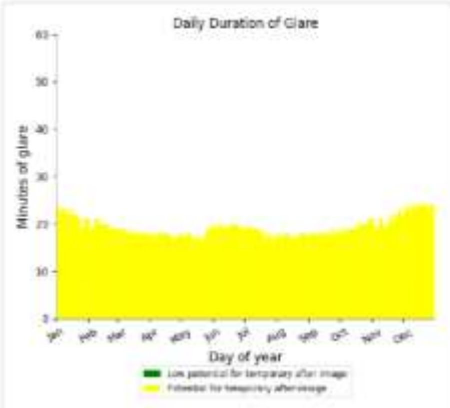
Observer Location | Sun azimuth range is 269.5° - 285.4° (yellow)

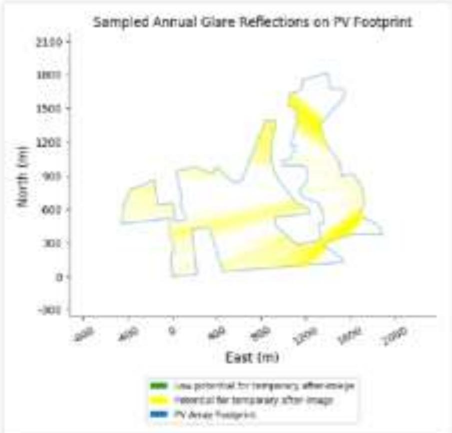
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

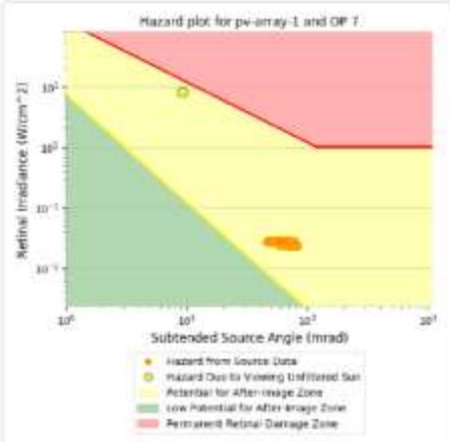
Receptor 47 – Cottam 3

PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 7,087 minutes of "yellow" glare with potential to cause temporary after-image.

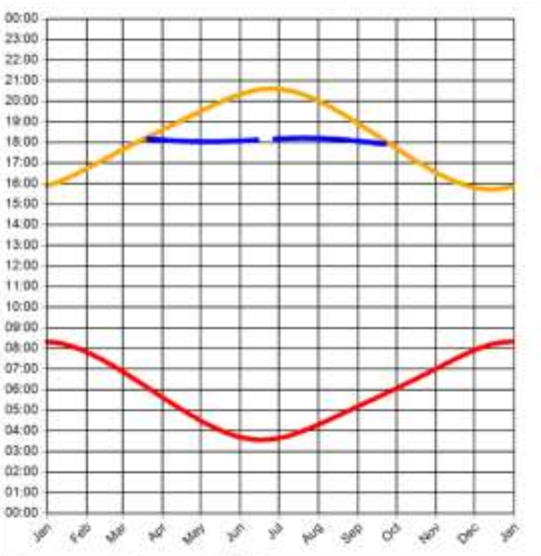






Observer 47 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.6°

Max observer difference angle: 19.8°

Observer Location

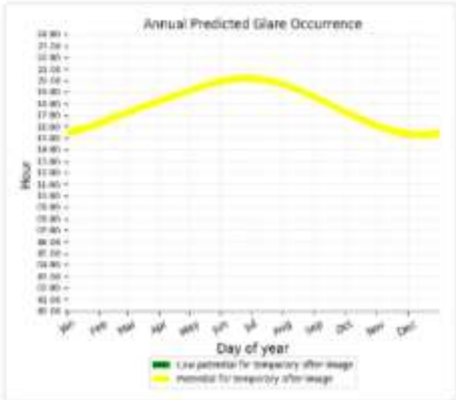
Sun azimuth range is 270.2° - 285.3° (yellow)

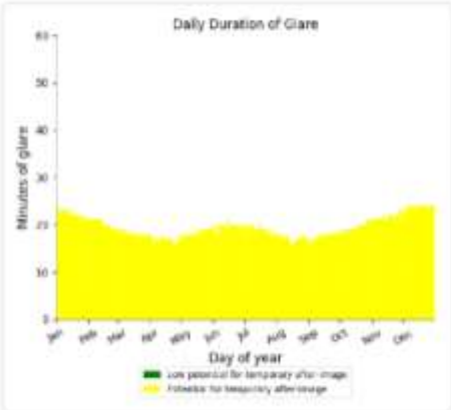
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

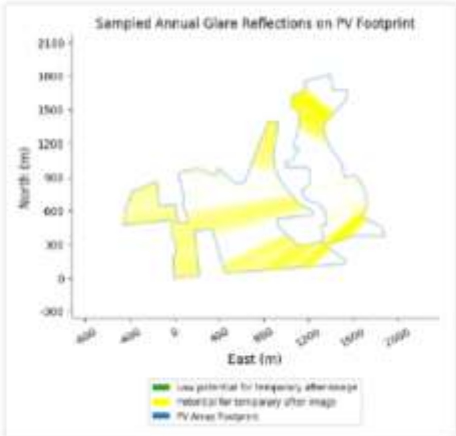
Receptor 48 – Cottam 3

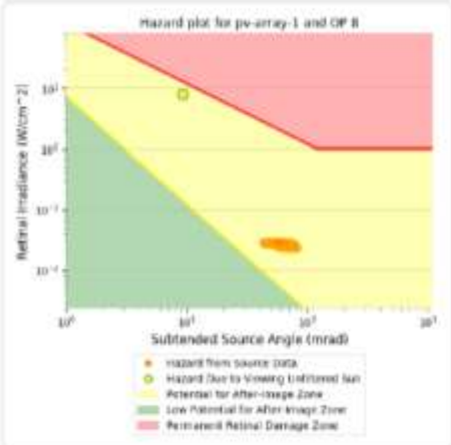
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 7,140 minutes of "yellow" glare with potential to cause temporary after-image.



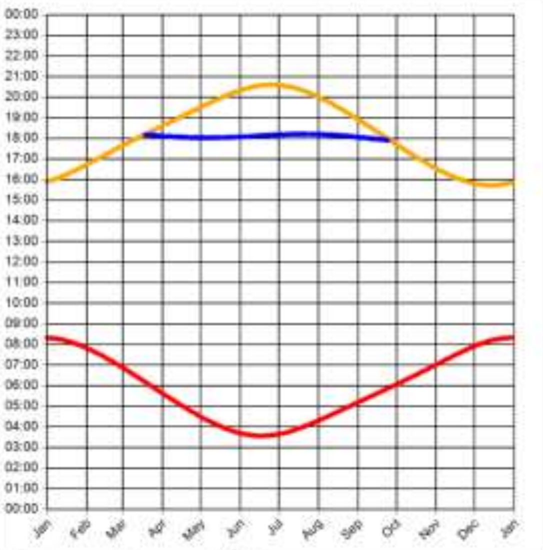






Observer 48 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.3°
Max observer difference angle: 20°

Observer Location

Sun azimuth range is 269.6° - 285.3° (yellow)

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

PAGERPOWER
Urban & Renewables

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

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