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Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Enviromena Project Management UK Ltd

Land north of Grimethorpe

December 2024





PLANNING SOLUTIONS FOR:

- Solar
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ADMINISTRATION PAGE

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11868A	24th January 2023	Initial issue (undertaken by Andrea Mariano)
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11868C	30th September 2024	Fifth Issue – Updated site layout plan and consideration of PROWs/Bridleways (undertaken by Waqar Qureshi)
11868C v2	4th November 2024	Sixth Issue – Updated site layout plan (undertaken by Waqar Qureshi)
11868C v3	13th December 2024	Seventh Issue – Updated site layout plan and landscape strategy plan (undertaken by Waqar Qureshi)

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development located east of Cudworth, South Yorkshire, England. The assessment pertains to the potential impact upon road safety, residential amenity, and aviation activity associated with YAA Nostell Helicopter Port, Walton Wood Airfield, Askern Airfield, Birds Edge Airstrip and Wentworth Private Airstrip. Public rights of way (PROWs) and bridleways have been considered at a high-level.

Conclusions

Mitigation is recommended for two dwellings due to the duration of effects, and the lack of sufficient mitigating factors. Further information is provided in Section 6.

There are no impacts requiring mitigation on surrounding road users, aviation activity, and PROWs/bridleways.

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. There is no existing planning guidance for the assessment of solar reflections from solar panels towards roads and nearby dwellings. Pager Power has however produced guidance for glint and glare and solar photovoltaic developments, which was published in early 2017, with the fourth edition published in 2022[1]. The guidance document sets out the methodology for assessing roads, dwellings, and aviation activity with respect to solar reflections from solar panels.

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[2].

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

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

Assessment Results

Roads

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.

No impacts are predicted on the assessed road section, because solar reflections are not geometrically possible, or there is significant screening in the form of existing vegetation, buildings, and/or terrain such that reflections would not be visible in practice.

Dwellings

No significant impacts are predicted on the dwellings within the assessment area subject to the implementation of the landscape strategy plan[3]. Where solar reflections are geometrically possible:

- There is significant existing and/or proposed screening such that reflections are not expected to be visible in practice; or
- the duration of effects received in practice is predicted to be less than 60 minutes on any given day and less than 3 months of the year; or
- there are significant factors that reduce the level of impact including:
    - A significant separation distance between observer and visible reflecting panels;
    - The position of the Sun beyond the reflecting panels – effects that coincide with direct sunlight appear less prominent than those that do not.

Further mitigation is not recommended.

Aviation

Considering the size of the proposed development, its location and distance relative to the identified airfields, the following is applicable:

- YAA Nostell Helicopter Port is a heliport located approximately 7.7km north of the proposed development. Helicopters can approach a heliport from any direction; however, it is predicted that, if solar reflections are possible, the impact of the proposed development upon these airfields' aviation operations will not be significant due to the low glare intensity (low impact for temporary after-image).
- Other airfields such as Walton Wood Airfield, Askern Airfield, Birds Edge Airstrip and Wentworth Private Airstrip are located at a greater distance (further than 10km from the proposed development). It is predicted that, if solar reflections are possible, the impact of the proposed development upon these airfields' aviation operations will not be significant due to the low glare intensity (low impact for temporary after-image).

[3] 11371-FPCR-ZZ-XX-DR-L-0001-0002-P14-Landscape Strategy Plan.pdf

Therefore, no significant impact is predicted for the aviation operation associated with the nearby airfields and no full modelling is recommended.

Public Rights of Way/Bridleways

In Pager Power's experience, significant impacts to pedestrians/equestrians using the surrounding public rights of way/bridleways are not possible due to glint and glare effects from PV developments. The reasoning is due to the sensitivity of the receptors (in terms of amenity and safety) being concluded to be of low significance. This is because:

- The typical density of pedestrians/horse riders located at these points is low in a rural environment;
- Any resultant effects are less serious than, for example, solar reflections experienced towards a road network whereby the resultant impacts of a solar reflection can be much more serious. Safety concerns are considered to a greater extent for horse riders and the possible event of being thrown by a scared animal, however the risk of this occurring due to glare from solar panels is considered to be small[4];
- Glint and glare effects towards an observer are transient, and time and location sensitive whereby a pedestrian/horse rider could move beyond the solar reflection zone with ease with little impact upon safety or amenity;
- Any observable solar reflection towards an observer/horse rider would be of similar intensity to those experienced whilst navigating the natural and built environment on a regular basis (e.g. bodies of water), and less intense than reflections from glass and other common outdoor surfaces.

Overall, no significant impact on observers/equestrians using the surrounding public rights of way/bridleways is predicted and therefore mitigation is not required.

[4] This is supported by the 'Advice on Solar Farms' document published by the British Horse Society in April 2024, which states: *"They [standard photovoltaic panels] are designed to absorb rather than reflect light for efficiency (reflected light is wasted energy) and although the amount of reflection varies with the component materials and the angle, the incidence of glare or dazzle is very low compared with glass and will not be uniform throughout a period of sunlight, assuming that the panel is static. Any reflection is unlikely to be a direct problem to horses, riders or carriage-drivers because of the angles and distances involved."*

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 60 countries internationally.

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

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems.

Over the years, the company has expanded into numerous fields including:

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

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

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

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development located east of Cudworth, South Yorkshire, England. The assessment pertains to the potential impact upon road safety, residential amenity, and aviation activity associated with YAA Nostell Helicopter Port, Walton Wood Airfield, Askern Airfield, Birds Edge Airstrip and Wentworth Private Airstrip. Public rights of way (PROWs) and bridleways have been considered at a high-level.

This report contains the following:

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

Following this, a summary of findings and overall conclusions and recommendations from the desk-based analysis is presented.

1.2 Pager Power's Experience

Pager Power has undertaken over 1,400 Glint and Glare assessments in the UK and internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

1.3 Glint and Glare Definition

The definition of glint and glare is as follows:

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

These definitions are aligned with those presented within the National Policy Statement for Renewable Energy Infrastructure (EN-3)[5] and with those used by the Federal Aviation Administration in the USA. The term ‘solar reflection’ is used in this report to refer to both reflection types.

[5] Published by the Department for Energy Security and Net Zero in November 2023 and last updated on 17 January 2024

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Solar PV Areas

Figure 1 on the following page shows the latest proposed solar panel layout[6]. The blue horizontal rectangles denote the solar panel locations.

Figure 2 shows the modelled solar panel layout[7]. The modelling and analysis in this report were undertaken based on this layout.

There are some minor changes to panel boundaries, however these are not expected to significantly alter the impacts predicted in this report.

[6] Source: P007033-11-PlanningLayout-RevG.pdf (cropped)
[7] Source: P.Grimethorpe_11_PlanningLayout.RevA.pdf (cropped)

Figure 1 – *Proposed solar panel layout*

Figure 2 – *Modelled solar panel layout*

2.2 Photovoltaic Panel Mounting Arrangements and Orientation

The solar panel details as assessed within this report are as follows:

- Assessed panel height: 1.545m[8] above ground level (agl);
- Tilt: 15 degrees above the horizontal;
- Azimuth: 180 degrees (south facing).

2.3 Reflector Areas

A resolution of 20m has been chosen for this assessment. This means that a geometric calculation is undertaken for each identified receptor from a point every 20m from within the defined areas. This resolution is sufficiently high to maximise the accuracy of the results; increasing the resolution further would not significantly change the modelling output. The number of modelled reflector points is determined by the size of the reflector areas and the assessment resolution. The bounding coordinates for the proposed solar development have been extrapolated from the site plans. The data can be provided on request.

Figure 3 – *Reflector Areas*

[8] This is the centre point of the panel calculated considering the max height (2.490m) and the min height (0.600m): ((2.490-0.600)/2)+0.600.

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Overview

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

3.2 Guidance and Studies

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

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

3.3 Background

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

3.4 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, studies and Pager Power's practical experience. The methodology for this glint and glare assessment is as follows:

- Identify receptors in the area surrounding the proposed development;
- Consider direct solar reflections from the proposed development towards the identified receptors by undertaking geometric calculations;
- Consider the visibility of the reflectors from the receptor's location. If the reflectors 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 proposed 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 Appendix D.

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

3.5 Assessment Methodology and Limitations

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

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

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

The above parameters and extensive experience over a significant number of glint and glare assessments undertaken show that consideration of receptors within 1km of solar PV module areas is appropriate for glint and glare effects on roads and dwellings. Therefore, the study area has been designed accordingly as a 1km boundary from solar PV module areas. The panels are fixed south facing and solar reflections at ground level towards the north at this latitude are highly unlikely. Therefore, the area to the north of the northern-most solar panels has been excluded.

Potential receptors are identified based on mapping and aerial photography of the region. The initial judgement is made based on a 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 DTM data. Receptor details can be found in Appendix G.

4.2 Road Receptors

4.2.1 Overview

Road types can generally be categorised as:

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

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 considered any major national, national, and regional roads that:

- are within the one-kilometre study area; and
- have a potential view of the panels.

4.2.2 Identification

The assessed road receptor points along approximately 3km of the A628 (receptors 1-31) are shown in Figure 4 below. A height of 1.5 metres above ground level has been taken as typical eye level for a road user. The distance between road receptors is approximately 100m.

Other roads are located within the study area (indicated by the yellow text in Figure 4) have not been taken forwards for the full assessment since visibility of the proposed development is extremely unlikely due to existing screening such as vegetation, residential areas and terrain.

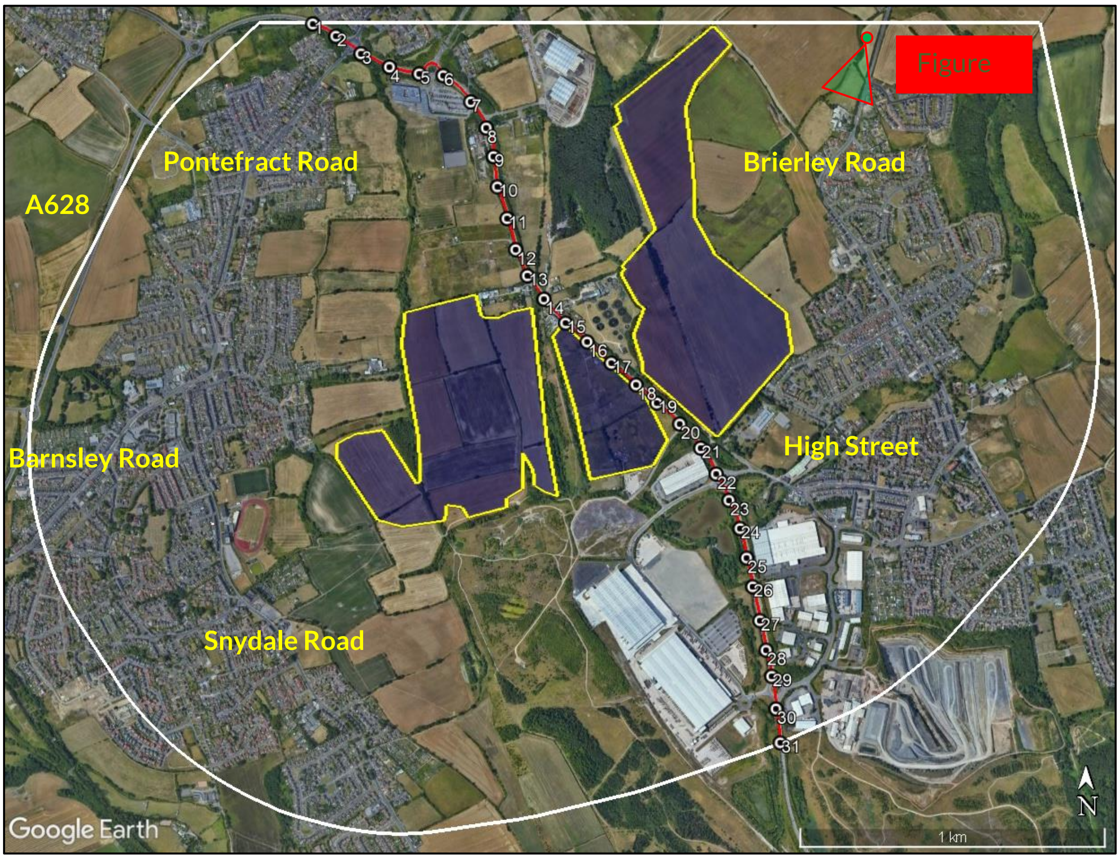

Figure 4 – *Assessed road receptors and other nearby roads*

Figure 5 – *Level of screening on Brierley Road*

4.3 Dwelling Receptors

4.3.1 Overview

The analysis has considered dwellings that:

- are within the one-kilometre study area; and
- have a potential view of the panels.

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

In some cases, one physical structure is split into multiple separate addresses. In such cases, the results for the assessed location will be applicable to all associated addresses. The sampling resolution is sufficiently high to capture the level of effect for all potentially affected dwellings. 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 since this is typically the most occupied floor of a dwelling throughout the day[9].

4.3.2 Identification

In total, 286 dwellings were identified for assessment, as shown in Figure 6 on the following page. These receptors are shown in more detail in Figure 7 to Figure 226 on the following pages.

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

Figure 6 – *Overview of dwelling receptors – aerial image*

Figure 7 *Assessed dwelling receptors 1 to 19 – aerial image*

Figure 8 *Assessed dwelling receptors 20 to 42 – aerial image*

Figure 9 *Assessed dwelling receptors 43 to 53 – aerial image*

Figure 10 *Assessed dwelling receptors 54 to 71 – aerial image*

Figure 11 *Assessed dwelling receptors 72 to 92 – aerial image*

Figure 12 *Assessed dwelling receptors 93 to 104 – aerial image*

Figure 13 *Assessed dwelling receptors 105 to 113 – aerial image*

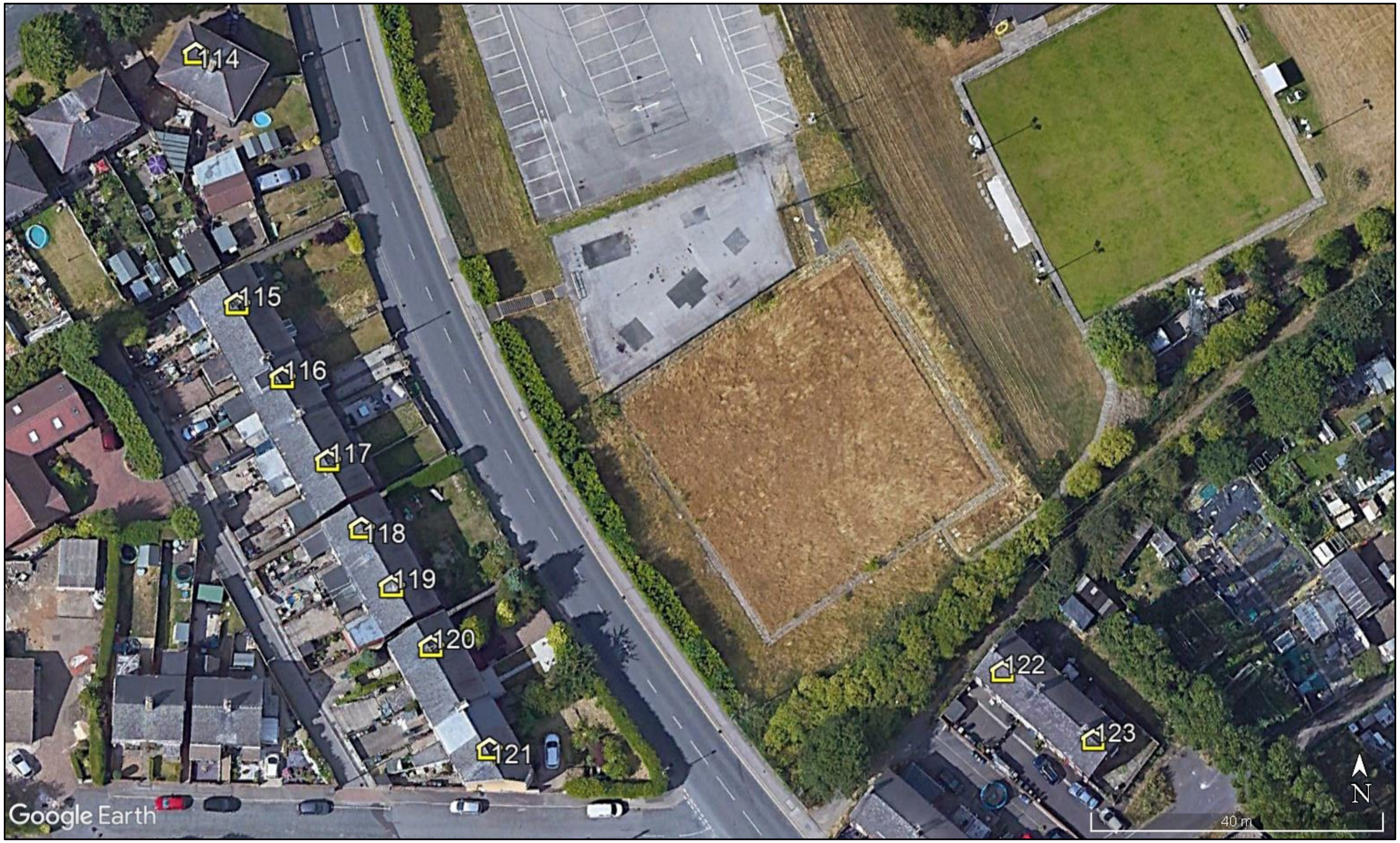

Figure 14 *Assessed dwelling receptors 114 to 123 – aerial image*

Figure 15 *Assessed dwelling receptors 124 to 147 – aerial image*

Figure 16 *Assessed dwelling receptors 148 to 159 – aerial image*

Figure 17 *Assessed dwelling receptors 160 to 165 – aerial image*

Figure 18 *Assessed dwelling receptors 166 to 178 – aerial image*

Figure 19 *Assessed dwelling receptors 179 to 181 – aerial image*

Figure 20 *Assessed dwelling receptors 182 to 189 – aerial image*

Figure 21 *Assessed dwelling receptors 190 to 201 – aerial image*

Figure 22 *Assessed dwelling receptors 201 to 220 – aerial image*

Figure 23 *Assessed dwelling receptors 221 to 228 – aerial image*

Figure 24 *Assessed dwelling receptors 229 to 244 – aerial image*

Figure 25 *Assessed dwelling receptors 245 to 261 – aerial image*

Figure 26 *Assessed dwelling receptors 262 to 276 – aerial image*

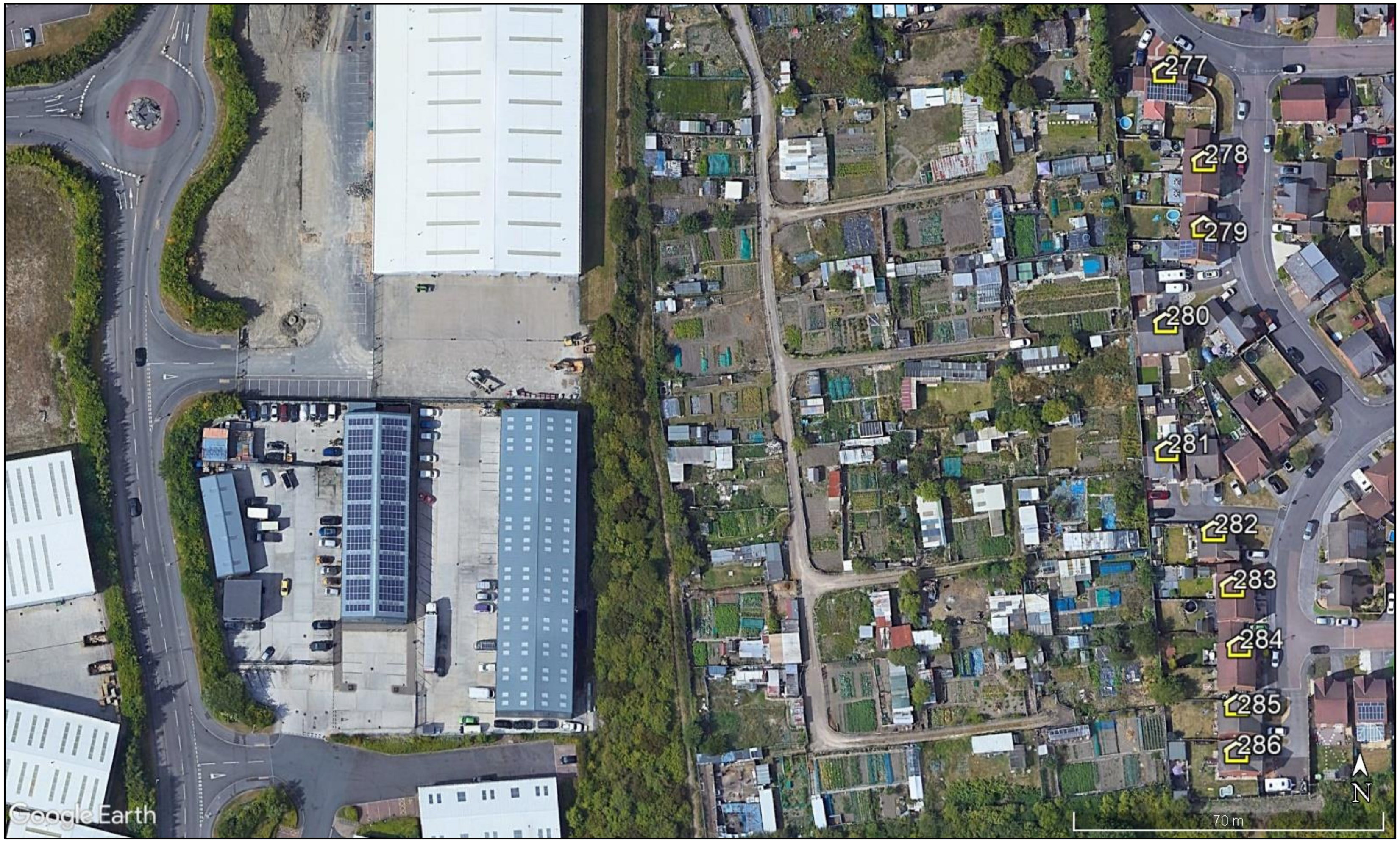

Figure 27 *Assessed dwelling receptors 277 to 286 – aerial image*

5 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

5.1 Overview

The following sub-sections present the modelling results as well as the significance of any predicted impact in the context of existing screening, and the relevant criteria set out in the next subsection. The criteria are determined by the assessment process for each receptor, which are set out in Appendix D.

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

The modelling output showing the precise predicted times and the reflecting panel areas can be provided on request.

5.2 Roads

5.2.1 Impact Significance Methodology

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

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

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

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

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

- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side;
- Whether visibility is likely for elevated drivers (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;
- 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.

If following consideration of the relevant factors, the solar reflections do not remain significant, the impact significance is low, and mitigation is not recommended.

If following consideration of the relevant factors, the solar reflections remain significant, then the impact significance is moderate, and mitigation is recommended.

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

5.2.2 Geometric Modelling Results

The modelling results[10] for road receptors are presented in Table 1 on the following page.

[10] Only considering reflections from solar panels within 1km of the receptor. Reflections outside of 1km are not considered to be significant.

Receptor	Geometric modelling results from panel areas within 1km (without consideration of screening) All times in GMT	Identified screening and predicted visibility (desk-based review)	Relevant Factors	Predicted Impact Classification	Further Mitigation Recommended/Required?
1 – 3	Solar reflections are not geometrically possible	N/A	N/A	None	No
4 – 7	Solar reflections predicted to originate from **inside** of a road user's primary horizontal field of view 05:30-06:30 in March-May and August-September	Existing vegetation, buildings, and/or terrain screening Views of reflecting panels are not expected to be possible in practice	N/A	None	No
8 – 14	Solar reflections predicted to originate from **outside** of a road user's primary horizontal field of view 05:00-06:00 in March-September	Existing vegetation, buildings, and/or terrain screening Views of reflecting panels are not expected to be possible in practice	N/A	None	No

Receptor	Geometric modelling results from panel areas within 1km (without consideration of screening) All times in GMT	Identified screening and predicted visibility (desk-based review)	Relevant Factors	Predicted Impact Classification	Further Mitigation Recommended/Required?
15 – 20	Solar reflections predicted to originate from **inside** of a road user's primary horizontal field of view 05:00-06:15 and 18:00-19:15 in March-September	Existing vegetation, buildings, and/or terrain screening Views of reflecting panels are not expected to be possible in practice	N/A	None	No
21 - 27	Solar reflections predicted to originate from **outside** of a road user's primary horizontal field of view 18:00-19:15 in March-September	Existing vegetation, buildings, and/or terrain screening Views of reflecting panels are not expected to be possible in practice	N/A	None	No
28 – 31	Solar reflections are not geometrically possible	N/A	N/A	None	No

Table 1 *Geometric modelling results, assessment of impact significance, and mitigation recommendation/requirement – road receptors*

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5.2.3 Screening Review

Figure 28 *Screening for road section 4-7 (white polygons) and reflecting points (yellow icons)*

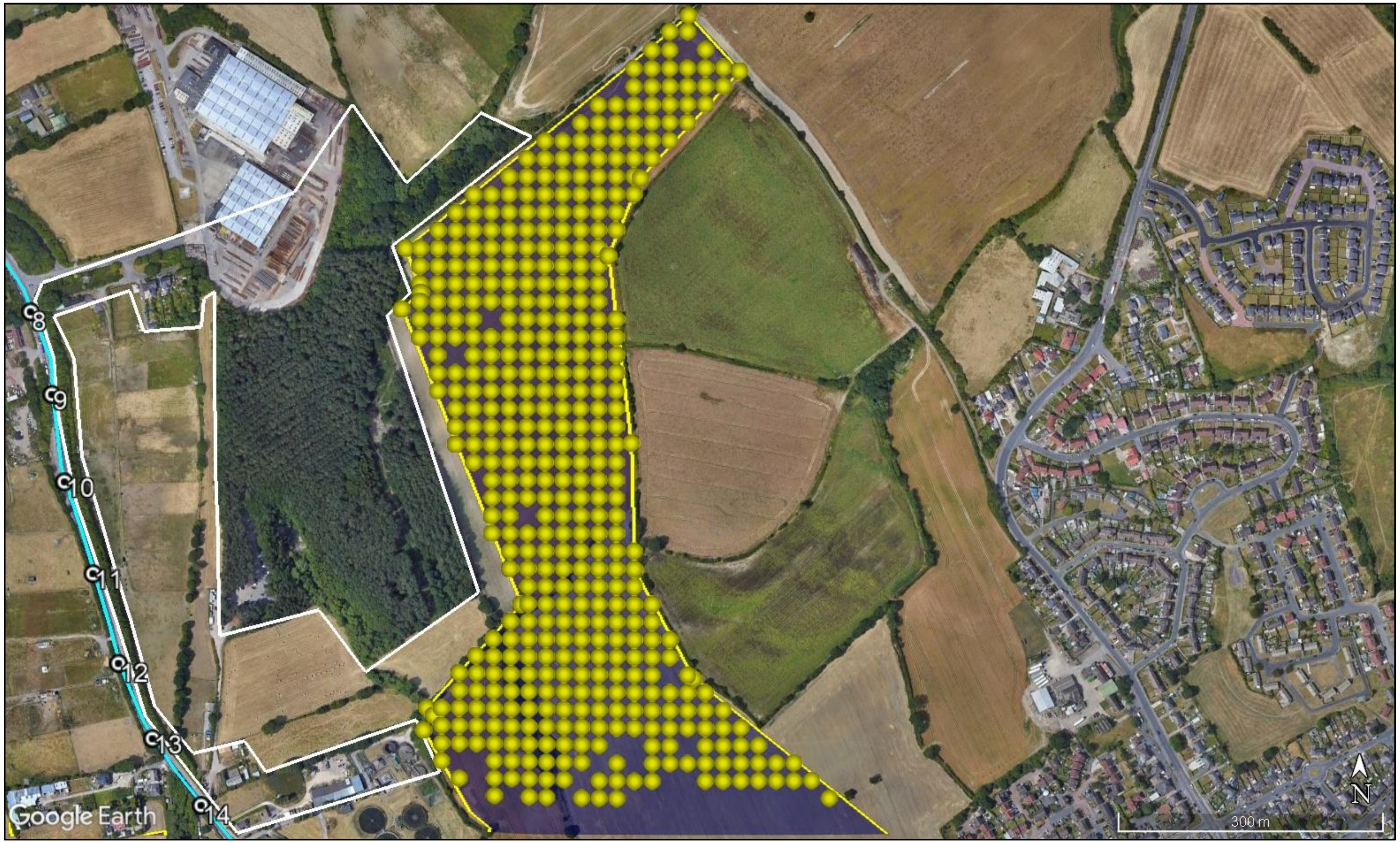

Figure 29 *Screening for road section 8-14 (white polygons) and reflecting points (yellow icons)*