Chapter 16: Glint and Glare

Preliminary Environmental Information Report

Volume 1

Steeple Renewables Project

Land at Sturton le Steeple, Nottinghamshire

16. Glint and Glare

16.1 Introduction

16.1.1 This Chapter presents the preliminary environmental information and a preliminary assessment of the effects of glint and glare during operation of the Proposed Development.

16.1.2 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.

16.1.3 Details of the lead author of this Chapter are set out in **Appendix 1.4 - 'EIA Statement of Competence'**.

16.2 Legislation and Planning Policy

16.2.1 There are no specific government guidelines setting out a particular methodological approach to delivering a glint and glare assessment.

16.2.2 For aviation activity specifically, guidelines for solar developments exist in the UK produced the Civil Aviation Authority (CAA) and in the USA produced by the Federal Aviation Administration (FAA). The guidance outlined by both aviation-governing bodies are high-level, and neither prescribes a formal methodology.

16.2.3 The CAA Interim Guidance recommends:

"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."

16.2.4 The Air Navigation Order[1] (ANO), also published by the CAA, outlines safeguarding concerns for aviation activity in the UK. The specific articles of the ANO state:

"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

[1] Civil Aviation Authority, Air Navigation Order 2016

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

…

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

16.2.5 The FAA guidance 'Technical Guidance for Evaluating Selected Solar Technologies on Airports'[2] is considered the most comprehensive guidelines available for the assessment of solar developments near aerodromes. Therefore, it is referred to as industry best practice pertaining to glint and glare, including for developments in the UK. The guidance states:

"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."

16.2.6 The glint and glare assessment has been carried out in accordance with the principles contained within the following appropriate policy and legislation:

- The Overarching National Policy Statement for Energy (EN-1)[3].
- National Policy Statement for Renewable Energy Infrastructure (EN-3)[4];
- Guidance for Renewable and Low Carbon Energy[5];
- Policy paper for UK Solar PV Strategy [6]; and
- The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

16.2.7 The National Policy Statement for Renewable Energy Infrastructure (EN-3) states in Sections 2.10.158 and 2.10.159:

[2]Federal Aviation Administration (FAA), (2013); 'Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports, Department of Transportation'.
[3] Department for Energy Security and Net Zero, (2023); 'Policy paper for Overarching National Policy Statement for energy (EN-1)'.
[4] Department for Energy Security & Net Zero, (2023); 'National Policy Statement for Renewable Energy Infrastructure (EN-3)'.
[5] Ministry of Housing, Communities and Local Government, Ministry of Housing, Communities & Local Government (2018 to 2021) and Department for Levelling Up, Housing and Communities, (2023); 'Guidance for Renewable and low carbon energy'.
[6] Department of Energy & Climate Change and The Rt Hon Gregory Barker, (2013); 'Policy paper for UK Solar PV Strategy'.

"Solar PV panels are designed to absorb, not reflect, irradiation. However, the Secretary of State should assess the potential impact of glint and glare on nearby homes, motorists, public rights of way, and aviation infrastructure (including aircraft departure and arrival flight paths)".

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

16.2.8 The guidance for Renewable and Low Carbon Energy 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."

16.3 Assessment Methodology

16.3.1 There is no formal planning guidance for the assessment of solar reflections from solar panels. Pager Power has however produced guidance[7] for glint and glare and solar photovoltaic developments, which was published in early 2017, with the fourth edition published in 2022. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, and aviation activity.

16.3.2 This preliminary assessment has geometrically modelled solar panels without the use of antireflective coating inclined at 16° above the horizontal and orientated to face the south (azimuth angle of 180°). A reflector point has been considered at the midpoint (2.58m) of the panels between the lowest (1.66m) and highest (3.50m) above ground level.

16.3.3 The parameters outlined above are indicative and will be confirmed in the subsequent ES. The receptors identified below and assessed are not subject to change and therefore any impacts would be comparable to those identified in this assessment.

16.3.4 **Table 16.1** below summarises how this preliminary glint and glare assessment has considered the feedback from the EIA Scoping Opinion (see **Appendix 1.2 – Steeple Renewables EIA Scoping Opinion**):

Table 16.1: Response to EIA Scoping Opinion

Feedback	Response within this Chapter
"The ES should justify the proposed assessment area of 1km as appropriate, explaining how elevated receptors which may overlook the site have been considered in the assessment. Receptors should include PRoWs and bridleways as well as residential and road users."	There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. The 1km assessment area is based on industry experience and best practice concerning ground-based receptors (roads and dwellings). Considerations to elevated observers (i.e. HGV drivers and residential properties with floors above ground level) are considered when determining the predicted impact.

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

Feedback	Response within this Chapter
	Public Rights of Way (PRoWs) and bridleways have been considered within this assessment, with further detail included in Section 16.7.
"The Scoping Report highlights that only railway receptors within 500m of the solar panel area will be included within the assessment based on a previous consultation with Network Rail. The ES should justify the study area, explaining why no significant effects would occur beyond 500m."	The assessment area is informed by previous consultation with Network Rail, and industry experience. No significant impacts beyond this distance would occur due to the fleeting nature of trains (i.e. train drivers) and reduced horizontal field-of-view for a train driver. Further detail is included in Section 16.7.
"The proposed assessment area should include river users on the River Trent, to ascertain whether the potential impact of glint and glare may give rise to LSEs. The Applicant's attention is directed to the comments from the Canal and River Trust in Appendix 2 on this matter."	The assessment has assessed the potential impact upon river users at a high-level without being geometrically modelled. Further detail is included in Section 16.7.
"The Applicant is advised to use the ZTV developed for the LVIA to identify sensitive receptors with potential views of the site that may be affected by glint and glare. Effort should be made to agree the sensitive receptors with relevant consultation bodies. The locations of the sensitive receptors should be shown on an accompanying plan."	The ZTV has been used to inform the assessment within this Chapter (**see Figure 6.4**).

Study Areas and Receptor Identification

16.3.5 The location of the Proposed Development is rural, surrounded by roads, dwellings, railway operations and infrastructure, and aerodromes. The key receptors are outlined in the following sections.

Ground-based Receptors

16.3.6 There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. From a technical perspective, there is no maximum distance for potential reflections. However, the significance of a solar reflection decreases with distance. This is because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance

increases. In most instances, terrain and shielding by vegetation are also more likely to obstruct an observer's view at greater distances.

16.3.7 A 1km assessment area surrounding the Proposed Development is considered appropriate for glint and glare effects on roads and dwellings, based on industry experience. The following receptors have been identified:

- Local roads (i.e. Main Street, Leverton Road and Wheatley Road);
- Regional roads (200m section of A156/Gainsborough Road); and
- Residential dwellings.

16.3.8 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 not be considered significant in the worst-case, in accordance with the guidance outlined in Paragraph 16.3.1.

16.3.9 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.

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

16.3.11 In total, 212 receptors have been geometrically assessed to model residential properties within 1km of the Proposed Development, as shown in **Figure 16.1**. The pink shaded areas on the below Figures indicate the boundary of the Site for diagrammatic purposes only, and do not accurately represent **Figure 2.2 – 'Operational Phase Parameter Plan'**.

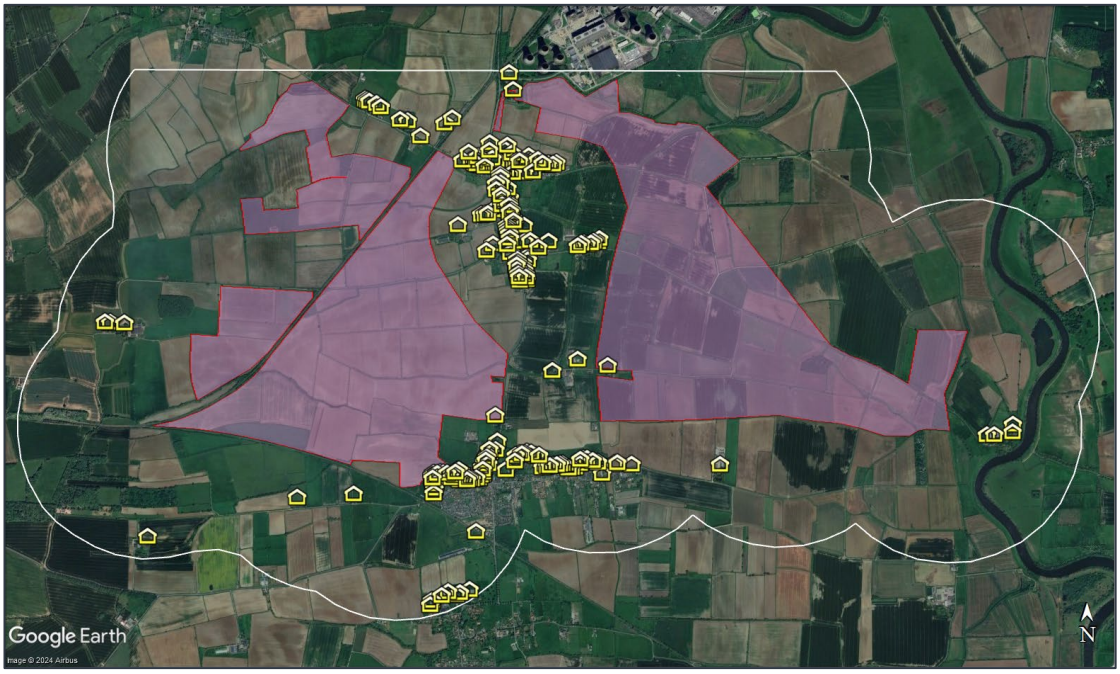

Figure 16.1 Overview of assessed dwelling receptors

16.3.12 Reflections towards ground-based receptors located further north than the parameters set out in **Figure 2.2 'Operational Phase Parameter Plan'** are highly unlikely for south-facing panels, such as the configuration of the Proposed Development. Therefore, receptors north of the Site have not been modelled, and the study area has been designed accordingly as a 1km study area, excluding the area to the north of the northern-most areas of the Site.

Railway Receptors

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

16.3.14 A 500m assessment area surrounding the Proposed Development is considered appropriate for glint and glare effects on railway infrastructure and operations, based on industry experience. The following receptors have been identified:

- Separate 4.70km and 3.45km sections of the Network Rail Eastern Region – North and East Route respectively;
- Five trackside, two ground-mounted and two cantilever railway signals.

16.3.15 **Figure 16.2** below shows the section of railway (highlighted blue) and the locations of the signals (white markers) identified. At the time of writing this chapter, the

eastern section of railway is understood to be disused; however, it been included in this assessment in the event that it is used again in the future.

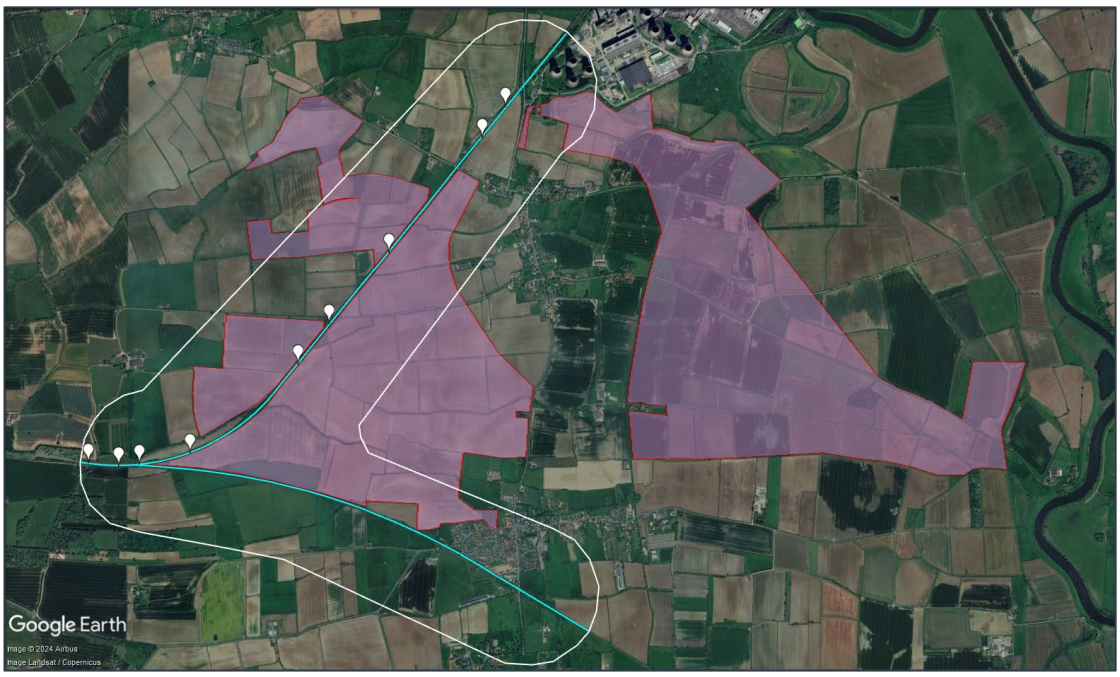

Figure 16.2: Section of Railway with 500m buffer included for the Glint and Glare Assessment

Aviation Receptors

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

16.3.17 A 15km assessment area surrounding the Proposed Development is considered appropriate for glint and glare effects on aviation activity. The following aerodromes have been identified:

- Carr Farm Airfield.
- Darlton Gliding Club.
- Forwood Farm Airfield.
- Grove Farm Airfield.

- Headon Airfield.
- Retford Gamson Airport.
- Stow Airfield.
- Sturgate Airfield.
- West Burton Airfield.
- Willow Farm Airfield.
- RAF Scampton.

16.3.18 **Figure 16.3** on the following page shows identified aerodromes in relation to the Site.

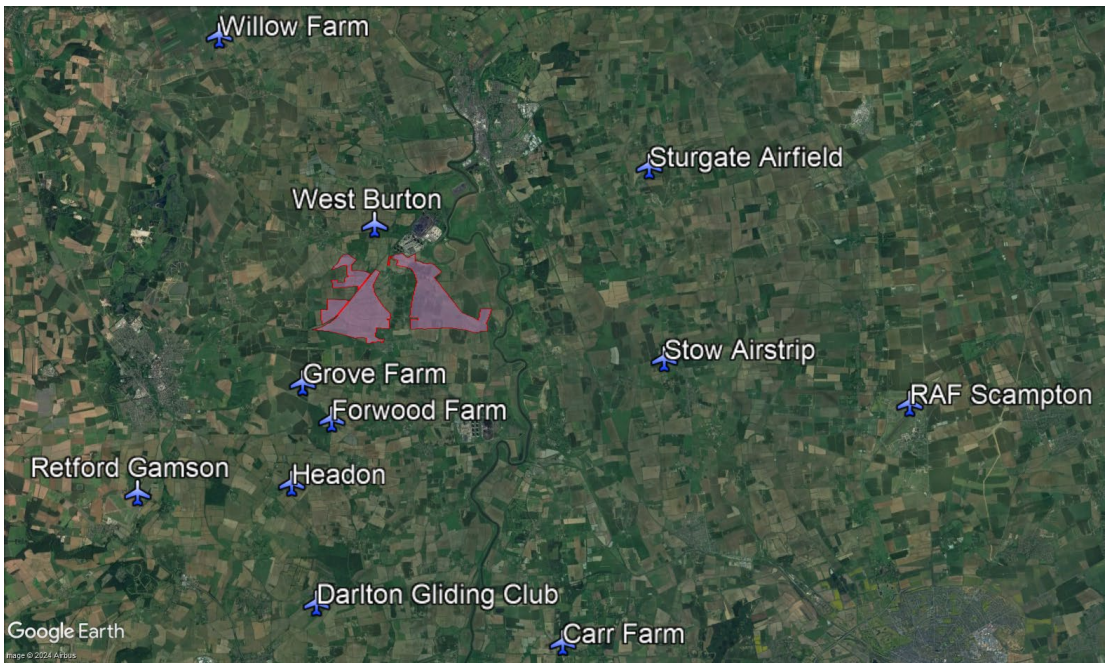

Figure 16.3 Aerodromes identified for inclusion within the Glint and Glare assessment

Sensitivity of Receptors

Road Users

16.3.19 Roads can generally be categorised as:

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

- Regional – Typically a single carriageway with a maximum speed limit of up to 60mph. The speed of vehicles will vary with a typical traffic density of low to moderate.
- Local – Typically roads and lanes with the lowest traffic densities. Speed limits vary.

16.3.20 Local roads would be considered as 'Low' sensitivity. Regional, National, and Major National roads would be considered of 'Medium' sensitivity.

16.3.21 The magnitude of effect upon road user receptors is dependent on the following factors:

- Whether a solar reflection is predicted to be experienced in practice.
- The type of road – in the context of traffic speeds and likely densities.
- The location of the reflecting panels relative to a road user's field-of-view, which is defined as 50 degrees either side relative to the direction of travel.
- The distance between the receptor and the panel area.

16.3.22 A 'Negligible' magnitude would occur if solar reflections were not geometrically possible or are not predicted to be experienced by a road user.

16.3.23 A 'Low' magnitude would occur if solar reflections would all originate from outside a road user's main field of view. Reflections originating within a road user's main field of view can be of 'Low' magnitude based on consideration of the following mitigating factors:

- Whether the solar reflection originates with a road user's field-of-view.
- Whether visibility is likely for elevated drivers (relevant to dual carriageways and motorways).
- The separation distance to the panel area - larger separation distances reduce the proportion of an observer's field of view that is affected by glare.
- Whether a solar reflection is fleeting in nature - small gap/s in screening, e.g. an access point to the site, may not result in a sustained reflection for a road user.
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not.

16.3.24 A 'Medium' magnitude would occur if solar reflections were experienced from within a driver's main field of view and there are insufficient mitigating factors.

16.3.25 A 'High' magnitude would occur if solar reflections were experienced from directly in front of a road user's direction of travel with no mitigating factors

Residential Dwellings

16.3.26 Residential dwellings would be considered as 'Low' sensitivity as they are of local importance.

16.3.27 The magnitude of effect upon residential dwelling receptors is dependent on the following factors:

- Whether a solar reflection is predicted to be experienced in practice.
- The duration of effects, relative to the thresholds of three months per year and sixty minutes per day.
- The distance between the receptor and the panel area.

16.3.28 A 'Negligible' magnitude would occur if solar reflections were not geometrically possible or are not predicted to be experienced by an observer within a residential dwelling.

16.3.29 A 'Low' magnitude would occur if solar reflections would be experienced for less than three months per year and for less than sixty minutes per day, or outside of these limits based on consideration of the following mitigating factors:

- Whether visibility is likely from all storeys – the ground floor is typically considered the main living space and has a greater significance with respect to residential amenity.
- Whether the dwelling appears to have windows facing the reflecting area – factors that restrict potential views of a reflecting area reduce the level of impact. 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 distance between the receptor and the panel area.
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not.

16.3.30 A 'Medium' magnitude would occur if solar reflections were experienced for more than three months per year or for more than sixty minutes per day and there are insufficient mitigating factors.

16.3.31 A 'High' magnitude would occur if solar reflections were experienced for more than three months per year and for more than sixty minutes per day with no mitigating factors.

Public Rights of Way (ProW) and Waterways

16.3.32 Significant effects from glint and glare are not possible upon pedestrians/observers along PRoWs and waterways. The reasoning is due to the sensitivity of the receptors (in terms of amenity and safety) being concluded to be of low significance due to:

- The typical density of pedestrians at these locations is usually low.
- 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 the safety of road users.
- Glint and glare effects towards receptors on PRoWs and waterways 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. Any observable solar reflection to users of the PRoW would be of similar intensity to those experienced whilst navigating the natural and built environment on a regular basis.

Railway Operations and Infrastructure

16.3.33 Railway operations and infrastructure are considered to be of 'Medium' sensitivity because they are of regional to national importance with a low to moderate capacity to absorb change.

16.3.34 The magnitude of impact is dependent on the following factors:

- Whether a solar reflection is predicted to be experienced in practice.
- The location of the reflecting panels relative to a train drivers' main field-of-view; defined as 30 degrees either side of the railway line with respect to the direction of travel.

- The contrast of sensitivity.
- Significance of location relative to switch points, stations, signals and pedestrian crossing points.
- The duration of solar reflections.
- Whether the solar development is in keeping with the surrounding environment.

16.3.35 A 'Negligible' magnitude would occur if solar reflections were not geometrically possible or are not predicted to be experienced by a train driver.

16.3.36 A 'Low' magnitude would occur if solar reflections would all originate from outside a train drivers' main field-of-view. Reflections originating within a train drivers' main field of view can be of 'Low' magnitude based on consideration of the following mitigating factors:

- 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.

16.3.37 A 'Medium' magnitude would occur if solar reflections were experienced from within a train drivers' main field of view and there are insufficient mitigating factors.

16.3.38 A 'High' magnitude would occur if solar reflections were experienced from directly in front of a train drivers' direction of travel with no mitigating factors.

Aviation Activity

16.3.39 Aviation receptors are typically considered to be of 'Medium' sensitivity because they are of regional to national importance with a 'low' to 'moderate' capacity to absorb change. The interim CAA guidance does not specifically address glint and glare.

16.3.40 The magnitude of effect depends on the type of aviation receptor and the glare intensity.

16.3.41 Aviation receptors include airborne receptors such as approach paths and circuits, and receptors used to consider views from the Air Traffic Control (ATC) Tower. Additional sensitive viewpoints can also be considered, as are specifically defined by the aerodrome.

16.3.42 Glare intensity can generally be categorised as solar reflections having a:

- 'Low potential for temporary after-image' referred to as 'green' glare
- 'Potential for temporary after-image' referred to as 'yellow' glare
- 'Potential for permanent eye damage' referred to as 'red' glare

Air Traffic Control (ATC) Towers

16.3.43 Solar reflections of any kind towards ATC Towers were formerly not permissible under the interim guidance provided by the FAA. This FAA guidance from 2013 has since been superseded by the FAA guidance in 2021, whereby airports are tasked with determining safety requirements themselves. This guidance is considered industry best practice, and is applicable for solar developments in the UK.

16.3.44 For ATC Towers, the magnitude of effect is dependent on the following factors:

- Whether a solar reflection is predicted to be experienced in practice.
- Proportion of an observer's field-of-view (relative to a 210-degree azimuth range) that is taken up by the reflecting area.
- The glare intensity and duration - a reflection of greater intensities and prolonged time periods have a higher impact upon ATC Tower personnel.
- Glare location relative to key operational areas – a solar reflection originating near sensitive areas such s the runway threshold will have a higher impact upon the ATC Tower personnel.

16.3.45 A 'Negligible' magnitude would occur if solar reflections were not geometrically possible, or are not predicted to be experienced by ATC personnel.

16.3.46 A 'Low' magnitude would occur if solar reflections were experienced by ATC personnel but there are sufficient mitigating factors, or the aerodrome have confirmed the glare scenario is operationally accommodatable, or the level of glare is accommodatable.

16.3.47 A 'Medium' magnitude would occur if solar reflections were experienced by ATC personnel and effects occasionally and marginally affected the safeguarding operations.

16.3.48 A 'High' magnitude would occur if solar reflections were experienced by ATC personnel and the safeguarding operations were regularly and substantially affected.

Approach Path

16.3.49 The magnitude of effect upon aircraft approaching a runway (referred to as an approach path) is dependent of the following factors:

- Whether a solar reflection is predicted to be experienced in practice.
- The location of the reflecting panels relative to a pilot's main field-of-view, which is defined as 50 degrees either side of the approach bearing.
- The likely traffic volumes and level of safeguarding at the aerodrome – licensed aerodromes typically have higher traffic volumes and are formally safeguarded;
- The time of day at which glare is predicted and whether the aerodrome will be operational such that pilots can be on the approach at these times;
- The duration of any predicted glare – glare that occurs for low durations throughout the year is less likely to be experienced than glare that occurs for longer durations throughout the year;
- The location of the source of glare relative to the position of the Sun at the times and dates in which solar reflections are geometrically possible – effects that coincide with direct sunlight appear less prominent than those that do not;
- The level of predicted effect relative to existing sources of glare – a solar reflection is less noticeable by pilots when there are existing reflective surfaces in the surrounding environment.

16.3.50 A 'Negligible' magnitude would occur if solar reflections were not geometrically possible.

16.3.51 A 'Low' magnitude would occur under the following scenarios:

- Solar reflections originate from outside a pilot's main field-of-view.
- Solar reflections have a 'low potential for temporary after-image'.
- Solar reflections have 'potential for temporary after-image' with sufficient mitigating factors.
- The aerodrome has confirmed the glare scenario is acceptable.

16.3.52 A 'Medium' magnitude would occur if solar reflections have 'potential for temporary after-image' without sufficient mitigating main factors.

16.3.53 A 'High' magnitude would occur if solar reflections have 'potential for permanent eye damage'.

16.3.54 The descriptions of the sensitivity of the receptor is presented in **Table 16.2** below.

Table 16.2: Sensitivity of Receptor

Sensitivity	Description
High	The receptor has little ability to absorb change without fundamentally altering its present character or is of international or national importance.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character or is of high importance.
Low	The receptor is tolerant of change without detriment to its character or is of low or local importance.
Negligible	The receptor has little ability to absorb change without fundamentally altering its present character or is of negligible importance.

Magnitude of Effects

16.3.55 The classifications of magnitude of effect are presented in **Table 16.3** below.

Table 16.3 Magnitude of Change

Magnitude of Effect	Criteria
High	Total loss or substantial alteration to key features of the baseline conditions such that receptor attributes will be funda-mentally changed.
Medium	Loss or alteration to one or more key features of the baseline conditions such that receptor attributes will be materially changed.
Low	A minor shift away from baseline conditions. Change arising from the alteration will be discernible but not material. The underlying attributes of the baseline condition will be largely unchanged.

Magnitude of Effect	Criteria
Negligible	Very little change from baseline conditions. Change barely distinguishable, approximating to a 'no change' situation.

Impact Significance for Environmental Effects

16.3.56 The impact significance for environmental effects is presented in **Table 16.4** below. An impact of 'Moderate' and greater is considered to be of significance.

Table 16.4: Impact Significance of Environmental Effects

Magnitude of Effect	Sensitivity of Receptor			
	High	**Medium**	**Low**	**Negligible**
High	Major Adverse	Major Adverse	Minor Adverse	Negligible
Medium	Moderate Adverse	Moderate Adverse	Minor Adverse	Negligible
Low	Moderate Adverse	Minor Adverse	Minor Adverse	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Assessment Methodology

16.3.57 The glint and glare assessment is carried out in accordance with the principles contained within the following documents:

- Guidance for Renewable and Low Carbon Energy,
- Pager Power Glint and Glare Guidance (herein referred to as 'the Glint and Glare Guidance')[8].

16.3.58 Guidance for glint and glare and solar photovoltaic developments has been adopted for this assessment, which was first published in early 2017, with the fourth edition produced in 2022. This guidance document sets out the methodology for assessing road safety, residential amenity, and aviation safety, with respect to solar reflections from solar panels. This guidance document has also been adopted for previous assessments. Pager Power has undertaken over 1,300 glint and glare assessments in the UK, Europe and internationally. The company's own glint and

[8] Pager Power, (2022); 'Solar Photovoltaic and Building Development – Glint and Glare Guidance: Fourth Edition'.

glare guidance is based on industry experience and extensive consultation with industry stakeholders, including airports and aviation regulators.

16.3.59 The methodology for the glint and glare assessment is outlined within the Glint and Glare Guidance, and the assessment within this chapter is as follows:

- Identify the key receptors in the study area surrounding the Proposed Development, which have been outlined in Sections 16.3.5 – 16.3.15.
- Consider direct solar reflections from the Proposed Development towards the identified receptors by undertaking geometric calculations.
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur.
- Consider the solar reflection with respect to the published studies and guidance - including intensity calculations where appropriate.
- Determine whether the potential for a significant impact is possible, without consideration of screening. This has been presented as the 'Likely Significant Effects' in this chapter.
- The glare scenario takes into account of any screening or mitigating factors that reduce any significant impact identified. This has been presented as the Residual Effects in this chapter.
- Potential effects are classified based on duration, location, relative to an observer's field of view and intensity as appropriate. Receptor sensitivity and magnitude of impact is evaluated differently for different observer types.

16.3.60 Each effect is assessed based on its magnitude of change and the sensitivity of the affected receptor.

16.3.61 The guidance also presents 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.

16.3.62 Published guidance[9] 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.

16.3.63 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.

16.3.64 The methodology for the glint and glare assessment within this chapter is as follows:

- Identify the key receptors in the study area surrounding the Proposed Development, which have been outlined in Sections 16.3.5 – 16.3.15.
- Consider direct solar reflections from the Proposed Development towards the identified receptors by undertaking geometric calculations.
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur.
- Consider the solar reflection with respect to the published studies and guidance - including intensity calculations where appropriate.
- Determine whether the potential for a significant impact is possible, without consideration of screening. This has been presented as the 'Likely Significant Effects' in this chapter.
- The glare scenario takes into account of any screening or mitigating factors that reduce any significant impact identified. This has been presented as the Residual Effects in this chapter.
- Potential effects are classified based on duration, location, relative to an observer's field of view and intensity as appropriate. Receptor sensitivity and magnitude of impact is evaluated differently for different observer types.
- Each effect is assessed based on its magnitude of change and the sensitivity of the affected receptor.

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

16.4 Assessment Assumptions and Limitations

16.4.1 The glint and glare assessment considers the operation phase of the Proposed Development, which is considered to be the worst-case for glint and glare. There would be no impacts during the construction phase that would not occur during the operational phase.

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

16.4.3 Only a reflection from the face of the panel will be considered. The frame supporting the panels, or the back of solar panels, has not been considered.

16.4.4 The geometric model has assumed panels within the entirety of the indicated areas of the parameter plan. In actual practice, rows and arrays of solar panels are likely to include a break in-between panels to decrease the effects of shadowing upon neighbouring panels. Therefore, the model assumes a highly conservative number of panels and presents a worse-case geometric result.

16.4.5 The model assumes that a receptor can view the face of every panel (i.e. 'point', defined in the following paragraph) within the Site 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.

16.4.6 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 Proposed 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 Site, rather a single point is defined every 10 metres (based on this assessment resolution) with the geometric characteristics of the panel. A panel area is however defined to encapsulate all possible panel locations.

16.4.7 The assessment does not account for any existing screening in the form of vegetation and buildings that could obstruct views of reflecting panels. Therefore, the assessment of likely significant effects portrays the 'worst-case scenario' for the Proposed Development during the operational phase.

16.5 Stakeholder Engagement

16.5.1 Consultation has begun with the relevant stakeholders, including West Burton Airfield, Grove Farm Airfield and Forwood Farm Airfield. A detailed record of stakeholder engagement will be provided in the subsequent ES.

16.5.2 Network Rail have been contacted via their Asset Protection and Optimisation (ASPRO) portal for further information regarding signals and assets to include in the glint and glare assessment.

16.6 Baseline Conditions

16.6.1 The surrounding area includes existing vegetation, intervening terrain and existing non-residential buildings, that provide a level of mitigation for reflecting panels, and therefore reduce the level of impact upon identified receptors.

16.7 Assessment of Likely Significant Effects

16.7.1 The following sections provide an assessment of the identified receptors based on the geometric modelling result.

Road Safety

16.7.2 Solar reflections are geometrically possible towards a 200m section of the A156/Gainsborough Road. Solar reflections occur within a road user's main field-of-view. Based on the geometric result (i.e. no existing screening), the resulting impact significance of effect would be a 'moderate adverse' due to the 'medium' sensitivity of the receptor. This is considered to be significant before the baseline conditions of the Site (e.g., existing vegetation) are taken into account.

Residential Amenity

16.7.3 A 'medium' magnitude of effect is geometrically possible towards 212 residential dwelling receptors. This is due to solar reflections occurring for more than three months per year but less than sixty minutes on any given day. Based on the geometric result, the resulting impact significance would be 'minor adverse' due to the 'low' sensitivity of the receptor. This is considered to be significant before the baseline conditions of the Site (e.g., existing vegetation and built form on and around the Site) are taken into account.

16.7.4 Considering the baseline conditions of the Site, screening in the form of existing vegetation, non-residential buildings and intervening terrain is predicted to obstruct views of reflecting panels for all residential dwellings included for

assessment, such that effects arising from the Proposed Development would be 'negligible', which is not significant.

Railway Operations and Infrastructure

16.7.5 A 'medium' magnitude of effect upon the section of railway (see Figure 16.4 below) is geometrically possible due to solar reflections occurring within a train driver's main field-of-view. Based on the geometric result, the resulting impact significance of effect would be 'moderate adverse' due to the 'medium' sensitivity of the receptor. This is considered to be significant before the baseline conditions of the Site (e.g., existing vegetation and built form on and around the Site) are taken into account.

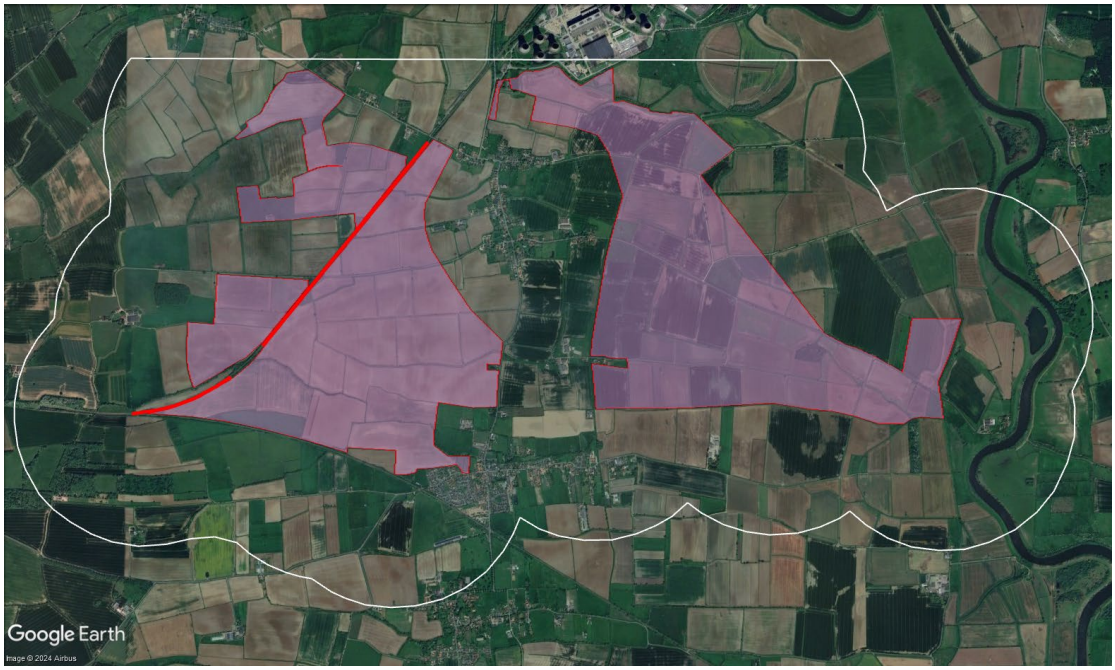

Figure 1645: Sections of Railway where solar reflections are modelled within a train driver's main field of view.

16.7.6 Considering the baseline conditions of the Site, screening in the form of existing vegetation and intervening terrain is predicted to obstruct views of reflecting panels for a separate 2.60km (North) and 3.45km (East) sections, such that effects arising from the Proposed Development would be 'negligible', which is not significant.

16.7.7 For the remaining 2.10km (North) section, a minor adverse impact is predicted when considering the baseline conditions, and railway-specific assessment criteria, which is not considered significant.

Aviation Activity

16.7.8 Solar reflections towards West Burton Airfield, Grove Farm Airfield, and Forwood Farm Airfield have glare intensities with 'potential for temporary after-image' (i.e.,

'yellow' glare). The glare intensity is greater than the acceptable limits. Based on the geometric result, the resulting impact significance of effect would be 'moderate adverse' due to the 'medium' sensitivity of the receptor. This is considered to be significant. As such, the Applicant has begun to engage with the relevant stakeholders to determine if the effects would be 'significant' in the context of their own operations. .

16.7.9 Solar reflections towards Carr Farm Airfield, Darlington Gliding Club, Headon Airfield, Retford Gamson Airfield, Stow Airfield, Sturgate Airfield, Willow Farm Airfield and RAF Scampton have solar reflections of intensities of 'low potential for temporary after-image' ('green' glare). The glare intensity is considered acceptable in accordance with industry best practice. Based on the geometric result, the resulting impact significance of effect would be 'minor adverse' due to the 'medium' sensitivity of the receptor. This is not considered to be significant.

16.7.10 Solar reflections towards the ATC Tower at RAF Scampton will be obstructed by existing vegetation, buildings and intervening terrain. Therefore, impacts are not predicted to be experienced by personnel. The resulting impact significance would be 'negligible' and not significant.

PRoW and Waterways

16.7.11 Solar reflections, and therefore any impact upon PRoW and waterways are not considered to be significant, due to the 'low' sensitivity. Any impact would be considered 'minor adverse' and not require mitigation. This is justified by Paragraph 16.3.31 of this chapter that sets out that, for example, glint and glare effects towards receptors on PRoWs and waterways are transient, and time and location sensitive, whereby a pedestrian could move beyond the solar reflection zone with ease. Additionally, screening in the form of existing vegetation, buildings and intervening terrain will reduce the visibility of reflecting panels towards these receptors and therefore further mitigate any impact.

16.8 Mitigation and Enhancement

16.8.1 'Moderate' impacts and greater upon ground-based receptors such as roads and residential dwellings, and railway operations and infrastructure can be reduced to a lower impact by various mitigation strategies – the most common being, for example, the provision of screening along the boundary of the Proposed Development to obstruct views of potentially reflecting panels.

16.8.2 The iterative design of the Proposed Development will consider what mitigation will be implemented for the relevant receptors above, for example the appropriate management of existing and new planting on the Site, in order to minimise the potential for significant effects and ensure a satisfactory level of environmental protection. Further, as previously set out, the Applicant is engaging stakeholders that have been identified to incur likely significant effects arising from the Proposed Development, to ascertain if the effects would actually be 'significant' in the context of their operations, which would identify any mitigation (if required).

16.9 Residual Effects

16.9.1 The iterative design of the Proposed Development, stakeholder engagement, and the incorporation of any required mitigation, such as the retention of and appropriate management of existing vegetation (where feasible) and the provision of new planting on the Site, will be such that any residual effects will not be significant and ensure a satisfactory level of environmental protection during the operational phase.

16.10 Cumulative and In-combination Effects

16.10.1 Cumulative and in-combination effects are considered with the consented[10] 'Land North West And South Of Field Farm Wood Lane Sturton Le Steeple Nottinghamshire' solar development, located adjacent west to Site.

16.10.2 No in-combination effects, in the context of glint and glare, are considered significant for the Proposed Development at this stage. Further detail considering in-combination effects with the landscape and visual impact will be considered within the ES.

16.10.3 Cumulative impacts upon the A156/Gainsborough Road are not predicted, as no impact is predicted from the consented development.

16.10.4 Cumulative impacts upon residential dwellings, and railway infrastructure and operations are considered possible. Solar reflections from the consented scheme coincide with the Proposed Development, and therefore does not increase the

[10] 20/00117/FUL - Installation and operation of a solar farm comprising an array of ground mounted solar PV panels with associated infrastructure including housing for inverters a substation compound, point of connection mast, fencing, security cameras, cabling, access tracks and a temporary construction compound. Application Approved August 2020.

duration of effects. As such, the impact significance is not predicted to change (i.e. worsen) than the Proposed Development in isolation.

16.10.5 Cumulative impacts upon aerodromes are considered possible. Solar reflections from the consented scheme coincide with the Proposed Development, and therefore the glare intensity does not increase. As such, the impact significance is not predicted to change (i.e. worsen) than the proposed Site in isolation.

16.11 Summary

16.11.1 The Proposed Development is predicted to have a 'moderate adverse' significance of effect concerning glint and glare, when considering the worst-case; the model having not included the baseline conditions of the Site (e.g., existing vegetation, and built form); and without implementing mitigation. The prediction of significant effects at this stage is based on receptors having 'medium' sensitivity (for all but local dwellings, and users of PRoWs and waterways, which comprise 'low' sensitivity). A 'Moderate adverse' (significant) effect is predicted for surrounding road users, 35 residential dwellings, three aerodromes, and railway receptors. The iterative design of the Proposed Development will consider any required mitigation to ensure a satisfactory level of environmental protection.

Table 16.4: Summary of Effects, Mitigation and Residual Effects

Receptor/ Receiving Environment	Description of Effect	Nature of Effect *	Sensitivity Value **	Magnitude of Effect **	Geographical Importance ***	Significance of Effects ****	Mitigation/ Enhancement Measures	Residual Effects ****
Operation								
Users of Local Roads (i.e., Main Street, Leverton Road and Wheatley Road) and Regional Roads (200m section of A156 / Gainsborough Road)	Solar reflection upon vehicle drivers on roads	Permanent Direct	Medium	Medium	District	Moderate adverse	The retention of and appropriate management of existing vegetation around the Site (where feasible), and provision of screening (vegetation) along the boundary of the Site to obstruct views of potentially	Negligible

Receptor/ Receiving Environment	Description of Effect	Nature of Effect *	Sensitivity Value **	Magnitude of Effect **	Geographical Importance ***	Significance of Effects ****	Mitigation/ Enhancement Measures	Residual Effects ****
							reflecting panels.	
Residential Dwellings	Reflection of sunlight from panels in array. Nuisance caused by glint reflections visible from inside of house.	Permanent Direct	Low	Medium	Local	Moderate adverse (significant)	The retention of and appropriate management of existing vegetation around the Site (where feasible), and provision of screening (vegetation) along the boundary of the Site to obstruct views of potentially reflecting	Negligible

Receptor/ Receiving Environment	Description of Effect	Nature of Effect *	Sensitivity Value **	Magnitude of Effect **	Geographical Importance ***	Significance of Effects ****	Mitigation/ Enhancement Measures	Residual Effects ****
							panels, where required.	
Railway receptor (train drivers operating trains within the railway inside of / adjacent to the western portion of the Site)	Reflection of sunlight from panels in array. Potential issue from driver dazzle.	Permanent direct	Medium	Medium	Regional	Minor adverse (for the eastern section of the railway only – see Paragraph 16.7.7)	The retention of and appropriate management of existing vegetation (where feasible), and provision of screening (vegetation) to obstruct views of potentially reflecting panels towards train operators.	Minor adverse (for the eastern section of the railway only – see Paragraph 16.7.7)
Aviation Receptors (West Burton	Reflection of sunlight from panels in array.	Permanent Direct	Medium	'Potential for temporary after-image'	National	Moderate Adverse (significant)	The Applicant has begun to engage with	Any mitigation measures (if required) would

Receptor/ Receiving Environment	Description of Effect	Nature of Effect *	Sensitivity Value **	Magnitude of Effect **	Geographical Importance ***	Significance of Effects ****	Mitigation/ Enhancement Measures	Residual Effects ****
Airfield, Grove Farm Airfield, and Forward Farm Airfield)	Potential safety issue from pilot dazzle or air traffic control dazzle.			referred to as 'yellow' glare			the relevant stakeholders to identify mitigation measures (if required).	ensure a satisfactory level of protection and be such that any residual effects would not be significant.
Aviation Receptors (Carr Farm Airfield, Darlington Glint Club, Headon Airfield, Retford Gamson Airfield, ow Airfield, Sturgate Airfield, Willow Farm Airfield	Reflection of sunlight from panels in array. Potential safety issue from pilot dazzle or air traffic control dazzle.	Permanent Direct	Medium	'Low potential for temporary after image' referred to as 'green' glare.	National	Minor Adverse	N/A	Minor Adverse

Receptor/ Receiving Environment	Description of Effect	Nature of Effect *	Sensitivity Value **	Magnitude of Effect **	Geographical Importance ***	Significance of Effects ****	Mitigation/ Enhancement Measures	Residual Effects ****
and RAF Scampton)								
Aviation Receptors (ATC Tower at RAF Scampton)	Reflection of sunlight from panels in array. Potential safety issue from pilot dazzle or air traffic control dazzle.	Permanent Direct	Medium	'Low potential for temporary after-image' referred to as 'green' glare	National	Negligible	N/A	Negligible
Public Rights of Way and Waterways	Reflection of sunlight from panels in array. Nuisance caused by reflections / potential safety issue to those navigating on	Permanent Direct	Low	Low	Local	Minor Adverse	The retention of and appropriate management of existing vegetation (where feasible) and the provision of new planting	Negligible

Receptor/ Receiving Environment	Description of Effect	Nature of Effect *	Sensitivity Value **	Magnitude of Effect **	Geographical Importance ***	Significance of Effects ****	Mitigation/ Enhancement Measures	Residual Effects ****
	waterways in the vicinity of the Site							
Cumulative and In Combination								
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A