



# Hilfield Solar Farm and Battery Storage

## Environmental Statement Technical Appendices

on behalf of Elstree Green Limited

Prepared by Aardvark EM Limited | December 2020 | Document Reference: R008



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## Planning and Economic Development

Nick Leaney  
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Dear Mr Leaney

Our Ref: 20/1183/EI1  
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Date: 10 September 2020

### **TOWN AND COUNTRY PLANNING ACT 1990 ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS**

**Application Number:** 20/1183/EI1

**Site Location:** Land North Of Butterfly Lane, Land Surrounding Hilfield Farm, and Land East Of Hilfield Lane, Aldenham, Hertfordshire

**Description:** Request for a screening opinion (Environmental Impact Assessment) for a proposed solar farm and battery storage facility.

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I am writing in response to your application to the Council of 4<sup>th</sup> August 2020 (our reference for which is 20/1183/EI1) in which you asked for a Screening Opinion as to whether an Environmental Statement (ES) should be included with an application that you intend to submit seeking planning permission. You have written that you do not consider that an ES is necessary, but you are seeking our opinion on the matter as the Local Planning Authority. In the event that we disagree with you (i.e. in the event that we consider that an ES is indeed necessary) you have asked for our Scoping Opinion as to what topics it should cover.

#### **The proposal and the site**

The development for which you intend to seek planning permission would be a solar farm and battery storage facility. This would cover a total of 123 hectares of agricultural land in the vicinity of Elstree Aerodrome. The site is divided into two parcels, each of which is subdivided into several fields. The first parcel consists of Field 1 (between the A41 and Hilfield Lane) and Fields 2-5 (to the north, east and south of Hilfield Farm). The second parcel consists of Fields 6-20 which are located between Aldenham Road, Butterfly Lane and Watling Street.

#### **Pre-application advice**

You have not applied for pre-application advice (although I encourage you to do that) so the purpose of this letter is to address the question of whether an Environmental Statement is required (the *screening opinion*), and the question of what topics it must cover (the *scoping opinion*). The question of whether planning permission is likely to

be granted for the development will not be addressed in this letter, as that would more properly be addressed as a response to a request for pre-application advice.

### **Comments received from consultees**

The Council has notified relevant consultees of this application. The general public has not been consulted on this EIA screening request; although of course we will be consulting them when we receive an application for planning permission.

The comments that have been received are all published on our website, and I suggest that you read them because they will give you a good idea of the issues that are of concern to consultees. Some of the issues that are raised in those letters stray beyond the limited questions of whether an ES should accompany an application for planning permission and of what it should cover (which are all that concern us at this stage) but they are never the less worth considering because they will give you a good idea of what issues will be raised when you do submit an application for planning permission.

For instance the Council receives advice on matters pertaining to conservation of the historic environment from our consultants at Place Services, and they have submitted comments that you should consider. There are several heritage assets near the site that might be affected in terms of their settings. Similarly we take advice from Hertfordshire County Council on archaeological issues, and they have provided some useful comments that you should take account of.

Useful comments have been received on the subject of landscape, Green Belt matters and public rights of way from Hertfordshire County Council's Countryside and Rights of Way Officer, from the Campaign to Protect Rural England (CPRE), from the Ramblers, and from the Open Spaces Society.

Natural England and Cadent have also provided comments that may be of interest to you. Heathrow Airport have written to say that they have no objection; although curiously their comments relate mainly to wind turbines, which are not something that you are proposing to install.

### **Assessing whether an Environmental Statement is required**

In considering applications of this type, a Local Planning Authority must assess the proposal against the Town and Country Planning (Environmental Impact Assessment) Regulations 2017, schedules 1, 2 and 3. If a proposal is for development of a type that is listed in Schedule 1, then an Environmental Statement *must* be submitted with an application for planning permission. If a proposal is for development that is listed in Schedule 2 and the site is a "*sensitive area*" (as defined in the regulations) then an ES *must* be submitted (regardless of whether the threshold in the second column is exceeded). If the proposal is Schedule 2 development but the site is not a *sensitive area* then a decision must be made by the Local Planning Authority as to whether an ES is required, and in arriving at that decision the LPA should have regard to the principals that are set out in Schedule 3.

### **Is the proposal Schedule 1 development?**

There is no doubt that the proposed development would *not* be Schedule 1 development. That schedule covers development of facilities that might cause a

significant risk of environmental harm such as crude oil refineries, nuclear power stations, new motorways and so on, none of which would apply in this case.

Solar panels produce no pollution, they require no fuel (other than sunlight) and they emit no noise. They are not routinely staffed, and service and maintenance visits are infrequent. A solar farm does not constitute any of the types of development that are listed in Schedule 1.

### **Is this a “sensitive area”?**

The definition of a *sensitive area* is set out in regulation 2(1) of the EIA regulations. An application for planning permission for any development that is listed in the left column of the table in Schedule 2 *must* be accompanied by an Environmental Statement (regardless of whether the site’s area exceeds the threshold in the next column or not) if it is within a *sensitive area*.

The definition in Regulation 2(1) includes a site on which a *scheduled monument* is located. There is a scheduled monument very close to your site. It is the remains of a moated site within the grounds of Haberdasher Aske’s School, near Butterfly Lane. However my understanding is that the regulation refers to scheduled monuments that are *within* the site, not *nearby*, and therefore I consider that the site is not a *sensitive area* as defined by the EIA regulations.

### **Is the proposal Schedule 2 development that requires an ES?**

The proposed development would fall within *Category 3a: Industrial Installations For The Production Of Electricity* on a site exceeding the threshold of half a hectare (your site would total 123 hectares, so it would greatly exceed the threshold). As this would be a Schedule 2 development, the Council must consider, having regard to Schedule 3 of the EIA regulations, whether an Environmental Statement should be required in this case.

Schedule 3, part 1(f) states that:

*“The characteristics of the development must be considered with particular regard to... the risk of major accidents and / or disasters relevant to the development concerned.”*

Your proposal will be to install a large number of solar panels, extending over an extensive area (123 hectares in total). The panels would be angled upwards and they would be in close proximity to Elstree Aerodrome. Having visited the site, I have seen that small airplanes and helicopters take off and land here every few minutes. There are flying schools for trainee pilots of both airplanes and helicopters at the aerodrome – meaning that some of the pilots taking off and landing here may be inexperienced or not yet fully trained or qualified. The potential risk that pilots might be dazzled by the reflections from these upward facing solar panels is a matter that must be carefully assessed as part of the appraisal of your application for planning permission, so as to avoid any risk of accidents or disasters.

**Given that the proposed development would be an EIA development under Schedule 2 part 3a, and given that it might pose a risk of major accidents or disasters, as per Schedule 3 part 1f, the Council considers that your**

**application for planning permission should be accompanied by an Environmental Statement.**

This is not to say that the Council necessarily considers that the development would pose a danger to aircraft – only that it might have the potential to do so. This must be carefully considered. The onus will be on you to demonstrate its safety to our satisfaction.

I have seen the *Glint and Glare Report* that you have submitted – both the second issue which you submitted as Appendix 5 of your application and the more detailed fourth issue revision (dated 7<sup>th</sup> Sep 2020) which you have submitted this week, following our recent meeting and discussion at the site. It is encouraging to read in this report that there are methodologies that your consultants might employ to demonstrate that such a development could be safely installed near an airfield (I see that this has been done for a solar farm near Bristol Airport for instance). We will look forward to seeing these methodologies put into practice in the Environmental Statement that you will submit with your application for planning permission.

**Scoping opinion: topics to be addressed in the Environmental Statement**

The Council are mindful of paragraph 002 (ref ID 4-002-20140306) of the Planning Practice Guidance (PPG) in which the government states that:

*“Environmental Impact Assessments should not be a barrier to growth... The 2017 regulations should only apply to those projects which are likely to have significant effects on the environment... If required they should limit the scope of assessment to those aspects of the environment that are likely to be significantly affected.”*

It is because the site is located near an airfield that the Council is requiring the submission of an ES, and therefore **the only subject that must be included in the Environmental Statement is the issue of aviation safety.**

**Other topics**

However there are other subjects that we will need to consider in assessing your application for planning permission, and the Council will expect to see plans and documents on these issues. They may be included as chapters within your Environmental Statement, or else they may be submitted as separate supporting documents – as you prefer.

The fact that these topics could be covered by supporting documents that are not part of an Environmental Statement does not mean that they are less important. Planning permission would be likely to be refused unless an application could demonstrate that it would not be harmful to the interests that are listed below (or, in some cases, unless it can be demonstrated that any such harm would be outweighed by other significant benefits).

Those subjects are:

- Impact on the landscape (including views from public rights of way) and on the open character of the Green Belt (including the question of whether “*very special*”

*circumstances*” can be demonstrated that might justify an inappropriate development in the Green Belt).

- An assessment of the value of the agricultural land.
- Consideration of alternative sites.
- Impact on heritage assets and their settings. You might find our pre-application advice service (which can include advice from our heritage consultant at Place Services) helpful in this regard, as there are several heritage assets nearby whose settings might be affected. Incidentally I have walked the site this week with our heritage consultant, and I can tell you that he is worried about the idea of installing solar panels in the southern part of Field 5 (where the setting of Hilfield Castle might be threatened), and in proximity to Slades Farm, and the gates of Haberdasher Aske’s School on Butterfly Lane, and the scheduled monument that lies within the school’s grounds. He recommends that in locations where you are relying on screening by trees you should take photographs now while the trees are in leaf, and again when the leaves have fallen (from the same positions and angles) and include those photographs side by side in the report that you submit.
- Impact on archaeologically sensitive areas. I suggest that you propose shallow pad bases for the frames in those sensitive areas, rather than piles.
- Wildlife, habitats, trees and biodiversity (I note that evidence has been found of Great Crested Newts, which are a protected species, in two ponds on the site).
- Impacts on the highway network

### **Conclusion**

Your planning application will need to be supported by an Environmental Statement to demonstrate that your development would not pose a threat to the safety of aircraft using Elstree Aerodrome.

As with any major application for planning permission, there are several other issues that the Council will expect to see covered by supporting technical documents. Those can be included as chapters within your Environmental Statement, or else they could be supporting documents in their own right - as you prefer.

Yours sincerely



**Max Sanders**  
Senior Planning Officer

## Appendix 2 EIA Project Team Qualifications & Experience

This Appendix provides information necessary to demonstrate compliance with Regulation 18 of the EIA Regulations 2017 which requires:

- Developers to “ensure that the environmental statement is prepared by competent experts”, and
- The Environmental Statement (ES) to be accompanied by a statement from the developer “outlining the relevant expertise or qualifications of such experts”.

**Table 1 Individual Profiles**

Company	Individual	Profile	Role
Aardvark EM	Nick Leaney	<p><u>Qualifications:</u>            BSc Hons Real Estate Management            MRICS (from 1996 to date)</p> <p><u>Relevant Experience and Expertise:</u>            26 years commercial planning and development experience of which the last 16 years has been in project managing and advising on large scale energy and waste management planning applications, appeals and environmental impact assessment.</p>	EIA Co-ordinator
Aardvark EM	Rachel Ness	<p><u>Qualifications:</u>            BSc Hons Town and Regional Planning            MRTPI from 1995 - 2003</p> <p><u>Relevant Experience and Expertise:</u>            27 years experience advising on major infrastructure planning applications and EIA development including for large scale energy projects and project managing multi-disciplinary teams in the preparation of the necessary planning and environmental assessment reports. Experience includes DCO NSIPs including preliminary environmental impact reporting and EIA and Welsh DNS applications and EIAs.</p>	EIA Technical Reviewer
Pager Power	Andrea Mariano	<p><u>Qualifications</u>            MEng Hons Renewable Energy</p> <p><u>Relevant Experience and Expertise:</u>            2 years of experience on Glint and Glare assessment towards different types of receptors, such as: dwelling, roads, railway and aviation. The experience on aviation includes visual approach path and ATC Tower.</p>	Aviation Safety – Glint & Glare
Pager Power	Danny Scrivener	<p><u>Qualifications</u>            BSc Hons Environmental Science</p> <p><u>Relevant Experience and Expertise:</u>            8 years of experience on Glint and Glare assessment towards different types of receptors, such as: dwelling, roads, railway and aviation. The experience on aviation includes visual approach path and ATC Tower.</p>	Aviation Safety – Glint & Glare Technical Review





# Hilfield Solar Farm and Battery Storage

## Glint & Glare Assessment on behalf of Elstree Green Limited

Prepared by Pager Power Limited | December 2020 | Document Reference: R012



# Glint & Glare Assessment

Hilfield Solar Farm and Battery Storage

Elstree Green Limited

December, 2020



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## ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	19 <sup>th</sup> November, 2020	Initial issue
2	23 <sup>rd</sup> November, 2020	Second issue – minor amendments
3	16 <sup>th</sup> December, 2020	Third issue – railway high-level assessment, initial consultation with Elstree Aerodrome manager and general amendments.
4	18 <sup>th</sup> December, 2020	Forth issue – minor amendments

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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 Farm and Battery Storage development on land to the North East and West of Elstree Aerodrome, Hertfordshire.

This assessment pertains to the possible effects upon surrounding road users and dwellings as well as aviation activity associated with Elstree Aerodrome.

### Assessment Results – Overall Conclusion

The glint and glare assessment has shown that:

- For all aviation receptors, the maximum impact is low and no mitigation is required. However, the airport's position regarding this potential glare should be confirmed (further information can be found in Sections 9.2, 9.3 and 9.4). Mitigation strategies are not recommended.
- For only four dwelling receptors, the impact is moderate under the current baseline conditions and mitigation is required. However, the developer has proposed screening at these locations which should be sufficient to remove all views of the reflective areas (further information can be found in Section 9.5). Therefore, no impact is expected.
- For only four road receptors the impact is categorised as moderate under the current baseline scenario. However, the developer has proposed screening which will be sufficient to remove all views of the reflective areas (further information can be found in Section 9.6).

### Assessment Results – Aviation

#### ATC Tower

The analysis has shown that solar reflections from the proposed solar development towards the ATC Tower are geometrically possible. However, a review of available imagery and on-site survey have shown that visibility of the reflective area is not possible due to intervening terrain.

Therefore, no impact is expected, and no mitigation is required.

#### Aviation Receptors – Approach 08

The Pager Power model indicates that solar reflections are possible towards the entire runway 08 approach path. Forge predicts that at a distance of 1.1 miles from the threshold, the intensity of reflections is expected to have a potential for temporary after-image meanwhile for the rest of the approach path the intensity of reflections is expected to have a low potential for temporary after-image.

Solar reflections with potential for temporary after-image will occur at circa 6:50 GMT at the beginning of March and at circa 6:20 GMT at the beginning of October. In total solar reflections with potential for temporary after-image are predicted to for a maximum of 3 minutes per year.

While glare with potential for temporary after-image has been predicted, impacts upon pilots approaching runway 08 are judged to be not significant. This because the amount of glare where

potential for after-image is possible per year is minimal (only 0.001% of daylight time per year) and the glare produced by the panels and sunlight will generate from approximately the same point in space.

#### **Aviation Receptors – Approach 26**

The Pager Power model indicates that solar reflections are possible towards the entire runway 26 approach path. Forge predicts solar reflection with potential for after-image between threshold and 0.2 miles, at 0.8 miles from the threshold and between 1.0 mile and 1.2 miles from the threshold. At all other locations, the intensity of reflections is expected to have low potential for temporary after-image.

A review of the available imagery shows that the reflective area located west of the airport is significantly obstructed from view of a pilot by terrain and vegetation for aircrafts travelling between 0.2 miles and the threshold. Therefore, at these locations, any glare with potential for after-image will be sufficiently screened and pilots approaching runway 26 will not be affected.

Solar reflections with potential for temporary after-image will occur at circa 17:30 from the end of April to the end of end of May and from mid-July to mid-August and at circa 18:00 from the end of May until mid-July. In total solar reflections with potential for temporary after-image are predicted to for a maximum of 172 minutes per year.

While glare with potential with potential for temporary after-image has been predicted, impacts upon pilots approaching runway 26 are judged to be not significant. This because the amount of glare where potential for after-image is possible per year is minimal (only 0.065% of daylight time per year) and the glare will not generate near the threshold.

#### **Assessment Results - Dwellings**

While the results of the analysis have shown that reflections from the proposed development are possible towards 85 of 108 identified dwelling receptors, the review of available imagery showed that screening in form of vegetation or other buildings will block all views of the reflective areas from 81 out of 85 dwelling receptors. For these 81 dwellings no impact is expected.

Four dwelling receptors located immediately east of the proposed development will concurrently experience reflections for more than 3 months per year but for less than 1 hour per day and be only partially screened under baseline conditions. The developer has subsequently proposed screening at these locations which will be sufficient to remove all views of the reflective areas. Therefore, no impact is expected, and no mitigation is required.

#### **Assessment Results - Roads**

While the results of the analysis have shown that the solar reflections from the proposed development are geometrically possible towards 57 out of the 69 identified road receptors, the review of available imagery showed that existing screening in form of vegetation will block all views of the reflective area for 53 of those road receptors. The remaining four receptors are located on Butterfly Lane where some existing screening, which will partially screen the proposed development, has been identified. The developer has however proposed further screening which will fully block all views of the proposed development. Therefore, no impact is expected and therefore further mitigation is not required.

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## ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 48 countries within South Africa, Europe, 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.

With regards to aviation glint and glare assessment Pager Power has extensive experience in assessing solar developments, including those located near aerodromes for which “visual approach” is the only available approach type.

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 Farm and Battery Storage development on land to the North East and West of Elstree Aerodrome, Hertfordshire.

This assessment pertains to the possible effects upon surrounding road users and dwellings as well as aviation activity associated with Elstree Aerodrome. This report therefore contains the following:

- Details of the proposed solar development;
- Explanation of glint and glare;
- Overview of relevant guidance;
- Overview of relevant studies;
- Identification of aviation concerns and receptors;
- Assessment methodology;
- Glint and glare assessment for:
  - Road user locations;
  - Dwelling locations;
  - Air Traffic Control (ATC) Tower;
  - Locations on the approach paths.
- Results discussion;

The relevant technical analysis is presented in each section. Following the assessment, conclusions and recommendations are made.

This report is solely desk based and no site visit has taken place.

### 1.2 Pager Power's Experience

Pager Power has undertaken over 550 Glint and Glare assessments internationally. The studies have included assessment civil and military Airports, railway infrastructure and other ground-based receptors including roads and dwellings. With regards to aviation glint and glare assessment Pager Power has extensive experience in assessing solar developments located near aerodromes, including those for which "visual approach" is the only available approach type. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders including airports and aviation regulators.

### 1.3 Glint and Glare Definition

The definition of glint and glare can vary however, the definition used by Pager Power 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 of the Federal Aviation Administration (FAA) in the United States of America. The term 'solar reflection' is used in this report to refer to both reflection types i.e. glint and glare.

## 2 PROPOSED DEVELOPMENT LOCATION AND DETAILS

### 2.1 Proposed Development Location

The layout of the proposed development is shown in Figure 1<sup>1</sup> below. A closer view of the development is shown in Figure 2<sup>2</sup> and Figure 3<sup>3</sup> on pages 15 and 16 respectively), the areas considered for the assessment are shown in Figure 4<sup>4</sup> (yellow lines) on page 17.

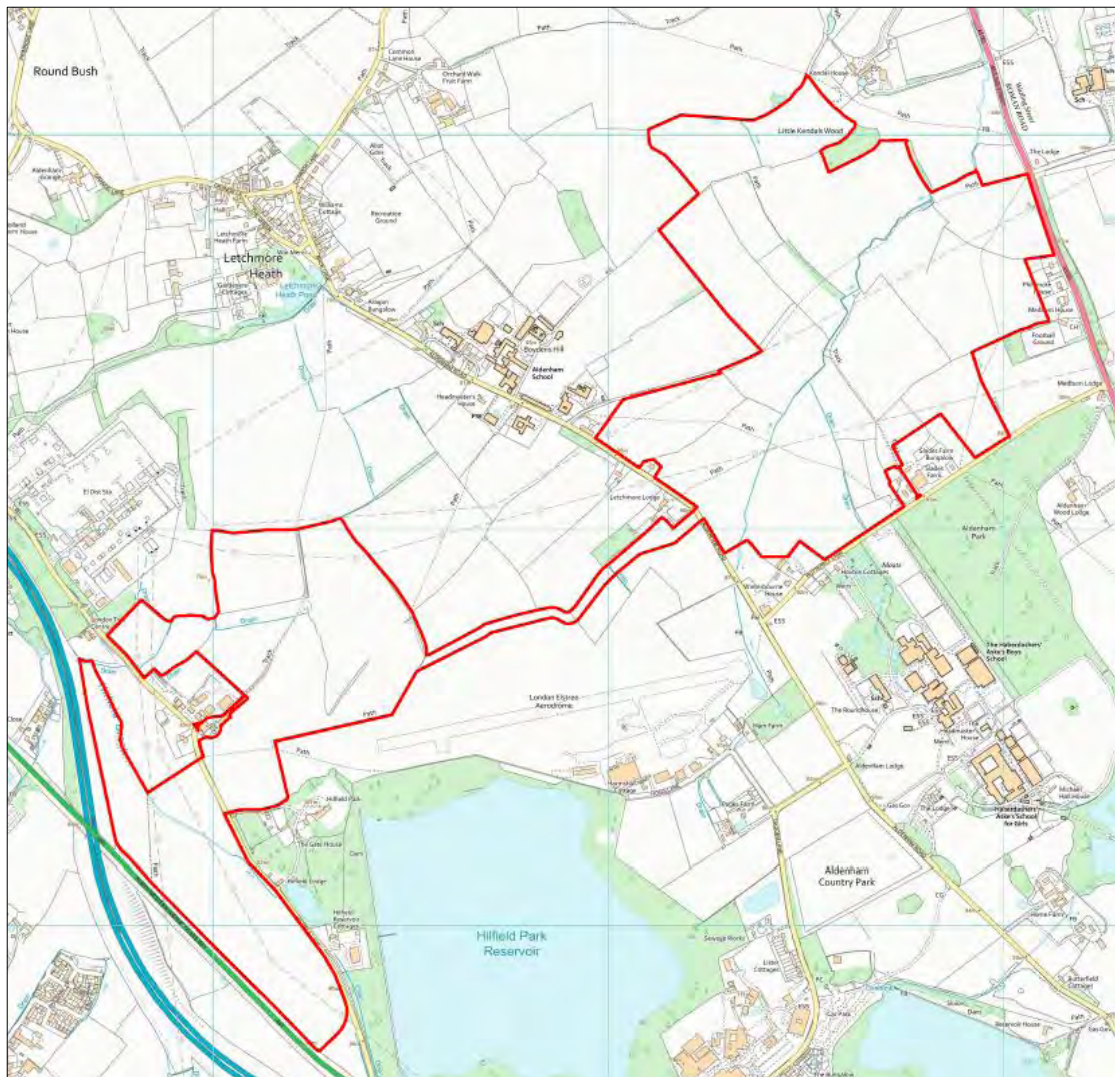


Figure 1 – Proposed development

<sup>1</sup> HILFIELD SOLAR FARM AND BATTERY STORAGE, LDA Design, date: 19/11/2020, DRAWING No.: 7533\_012, cropped.

<sup>2</sup> Hilfield Solar Farm, aardvark, Site Layout Plan 2, Drawing No.: HF 2.2, date: 15/12/2020, cropped.

<sup>3</sup> Hilfield Solar Farm, aardvark, Site Layout Plan 1, Drawing No.: HF 2.1, date: 15/12/2020, cropped.

<sup>4</sup> Source: Copyright © 2020 Google.

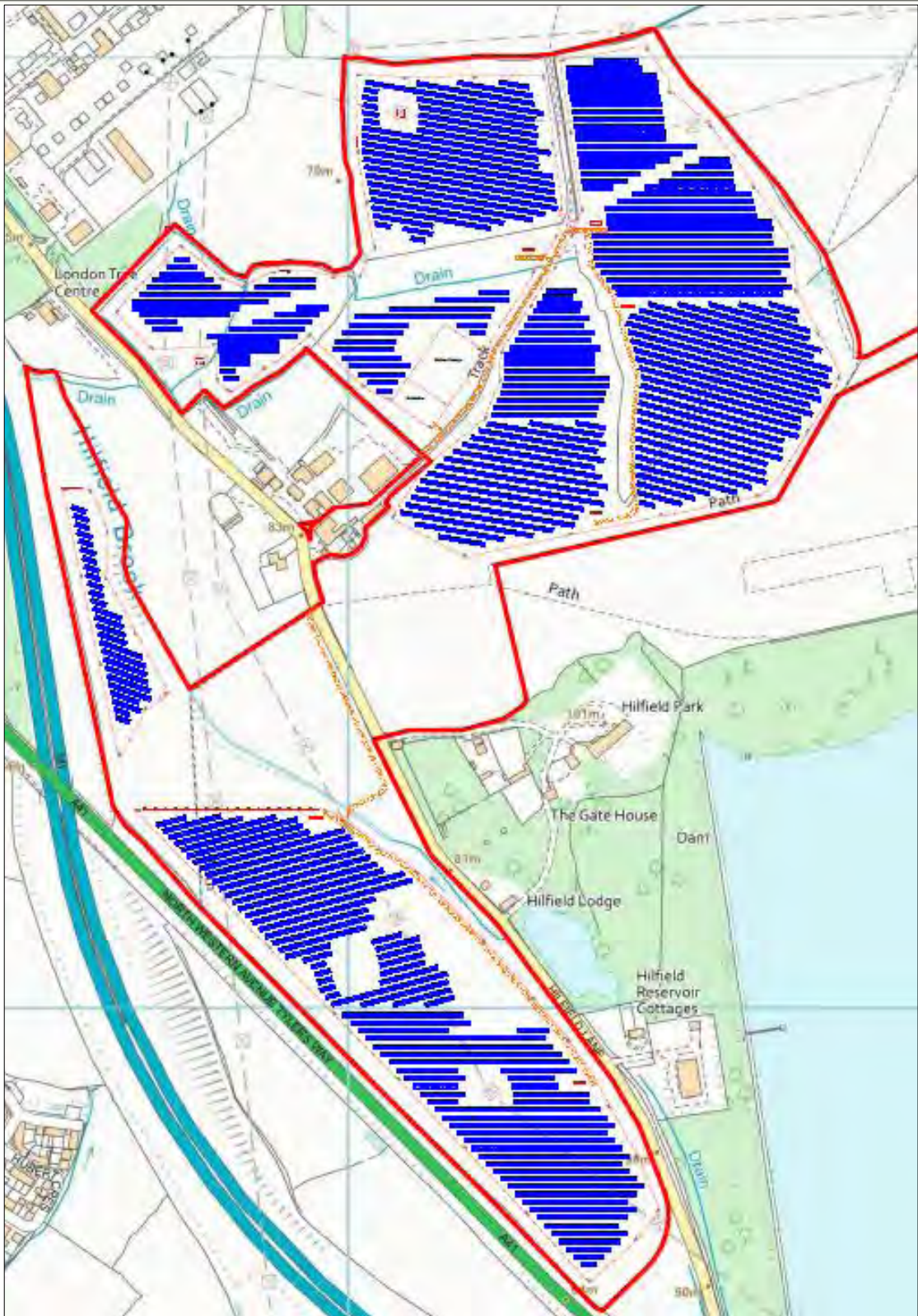


Figure 2 - Closed Up view of the area located south west



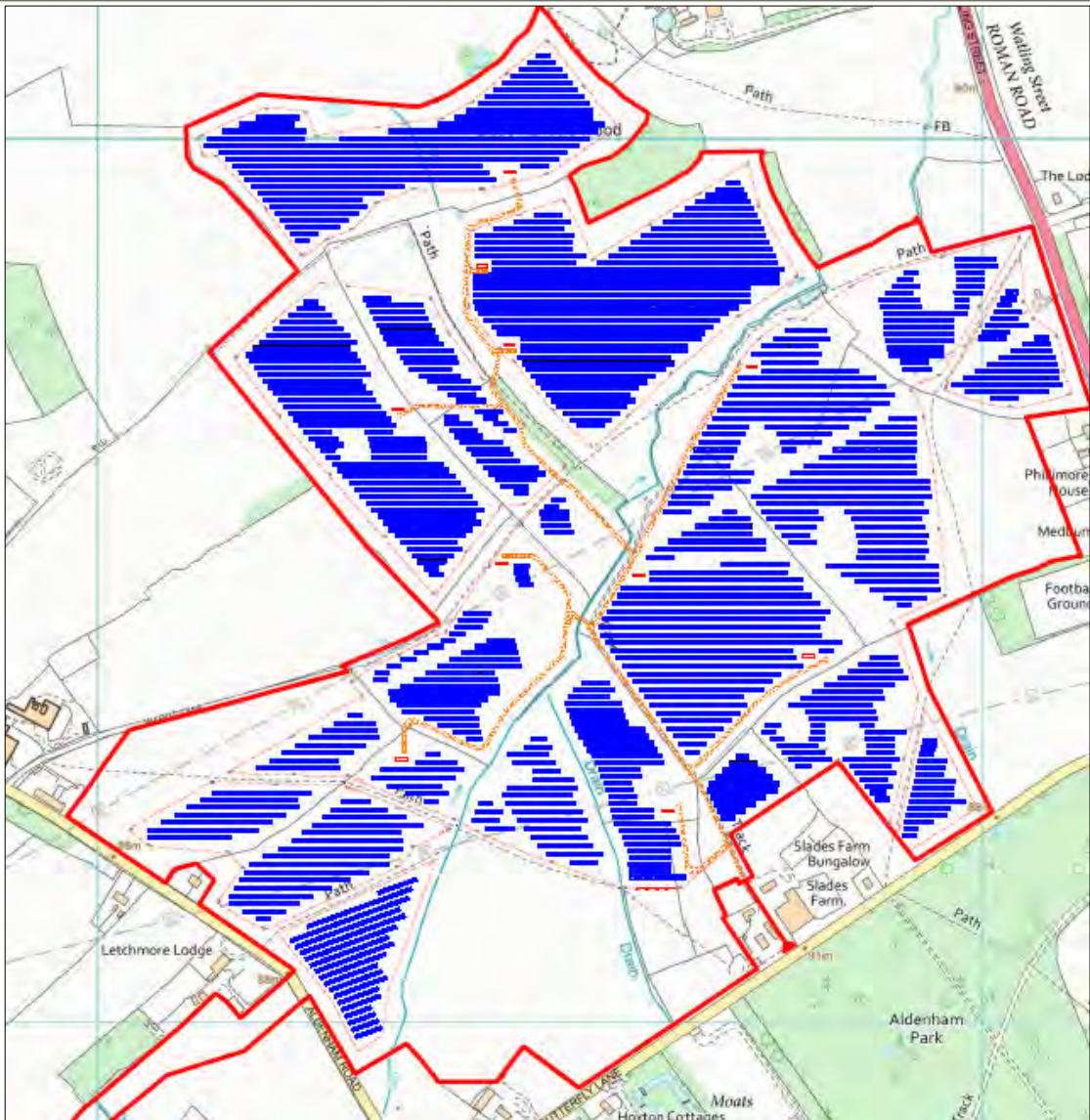


Figure 3 – Closed up view of the area located north west

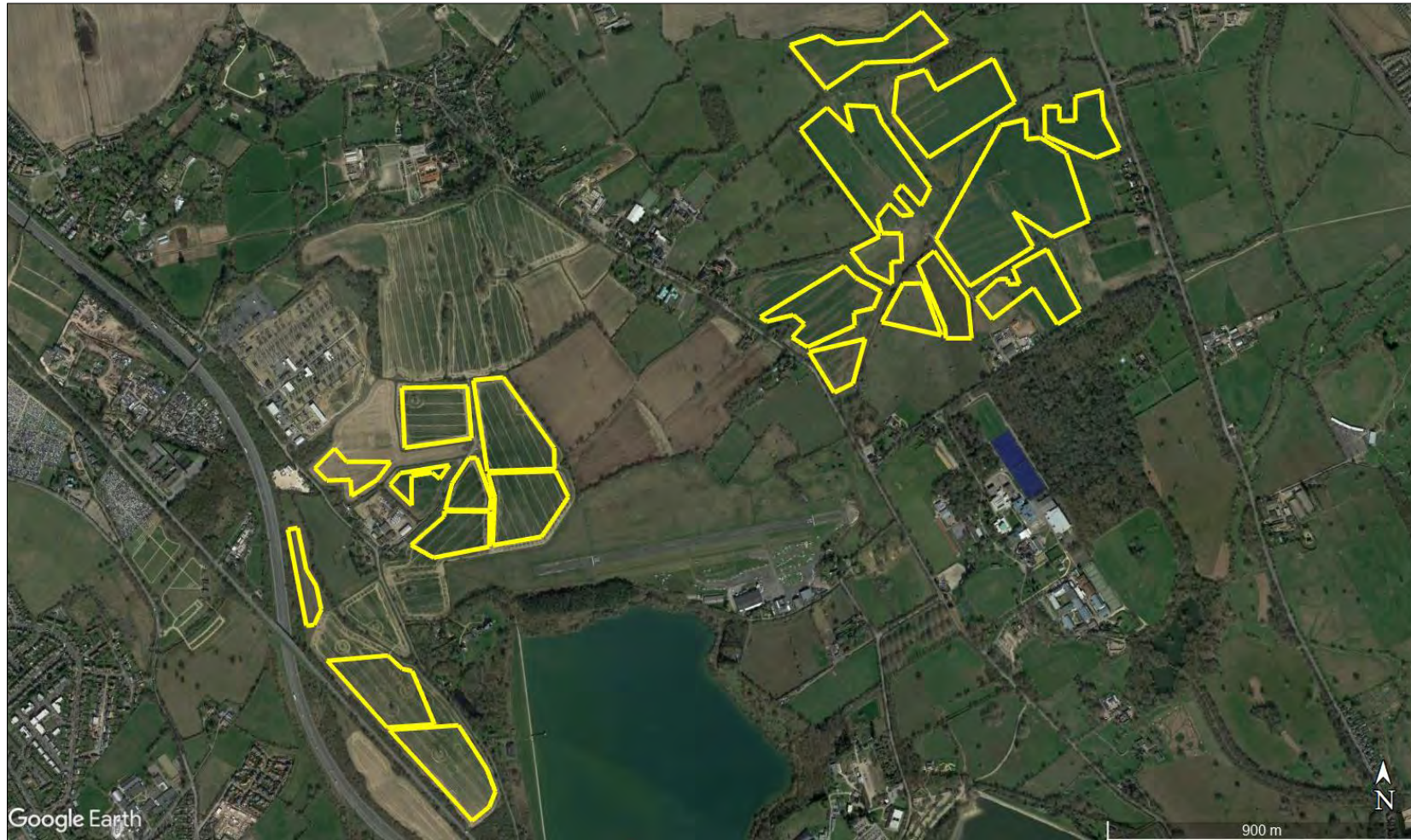


Figure 4 - Proposed solar development location



Figure 5 - Close up image of both areas

## 2.2 Consultation with Elstree Aerodrome

Pager Power has consulted with Elstree Aerodrome to understand their concerns regarding the proposed development. Following the consultation, a layout optimisation has been carried out. The aim of this task was to avoid unacceptable glare towards aviation receptors at Elstree Aerodrome and to minimise impacts overall.

This has been achieved by changing panel characteristics such as tilt and orientation. The findings of the layout optimisation have informed the design team and are shown in Table 1 below.

## 2.3 Proposed Solar Panel Characteristics

Different “sites” have different panel’s characteristics; however they all share the same height above ground. This is shown in Figure 6<sup>5</sup> on the following page.

The solar panels have the following characteristics (see Table 1 below):

Site	Tilt (°)	Orientation (°)	Mid Height (m) (agl)
Site 1	20	180	<p>1.9m</p> <p>The mid height of the panel has been considered for the assessment (see red circle in Figure 6 on the following page)</p>
Site 2	20	165	
Site 3	20	200	
Site 4	20	180	
Site 5	30	180	
Site 6	30	190	
Site 7	20	180	
Site 8	30	195	
Site 9	20	180	
Site 10	30	190	
Site 11	20	180	
Site 12	20	180	
Site 13	30	180	
Site 14	20	180	
Site 15	20	180	

<sup>5</sup> PV Elevations, Blueleaf, Date: 22/09/2020, Project Name: Elstree Solar PV and Battery, Drawing No.: ET3.0 cropped.

Site	Tilt (°)	Orientation (°)	Mid Height (m) (agl)
Site 16	20	180	1.9m The mid height of the panel has been considered for the assessment (see red circle in Figure 6 below)
Site 17	30	180	
Site 18	30	160	
Site 19	30	180	
Site 20	20	180	

Table 1 - Panel characteristics per each site

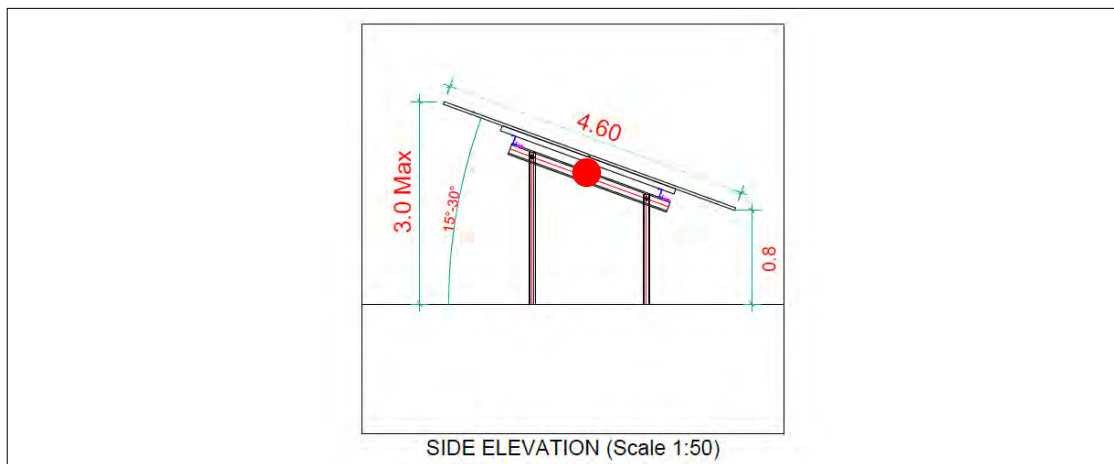


Figure 6 – Solar panel characteristics

## 3 ELSTREE AERODROME DETAILS

### 3.1 Overview

The following section presents general details regarding Elstree Aerodrome.

### 3.2 Airport Information

Elstree Aerodrome is a licenced Airport.

### 3.3 Runway Details

Elstree Aerodrome<sup>6</sup> has one operational runway. The runway details are presented below:

1. 08/26 measuring 651m by 20m.

### 3.4 Air Traffic Control Tower

The ATC Tower is located south of the runway centre point (green circle in Figure 7<sup>7</sup> on the following page). Further details are presented in Section 5.2 of this report.

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<sup>6</sup> Source: EGTR – ELSTREE, EGTR AD 2.12 RUNWAY PHYSICAL CHARACTERISTICS

<sup>7</sup> EGTR – ELSTREE, AD 2-EGTR-2-1, AERO INFO DATE 26/11/18

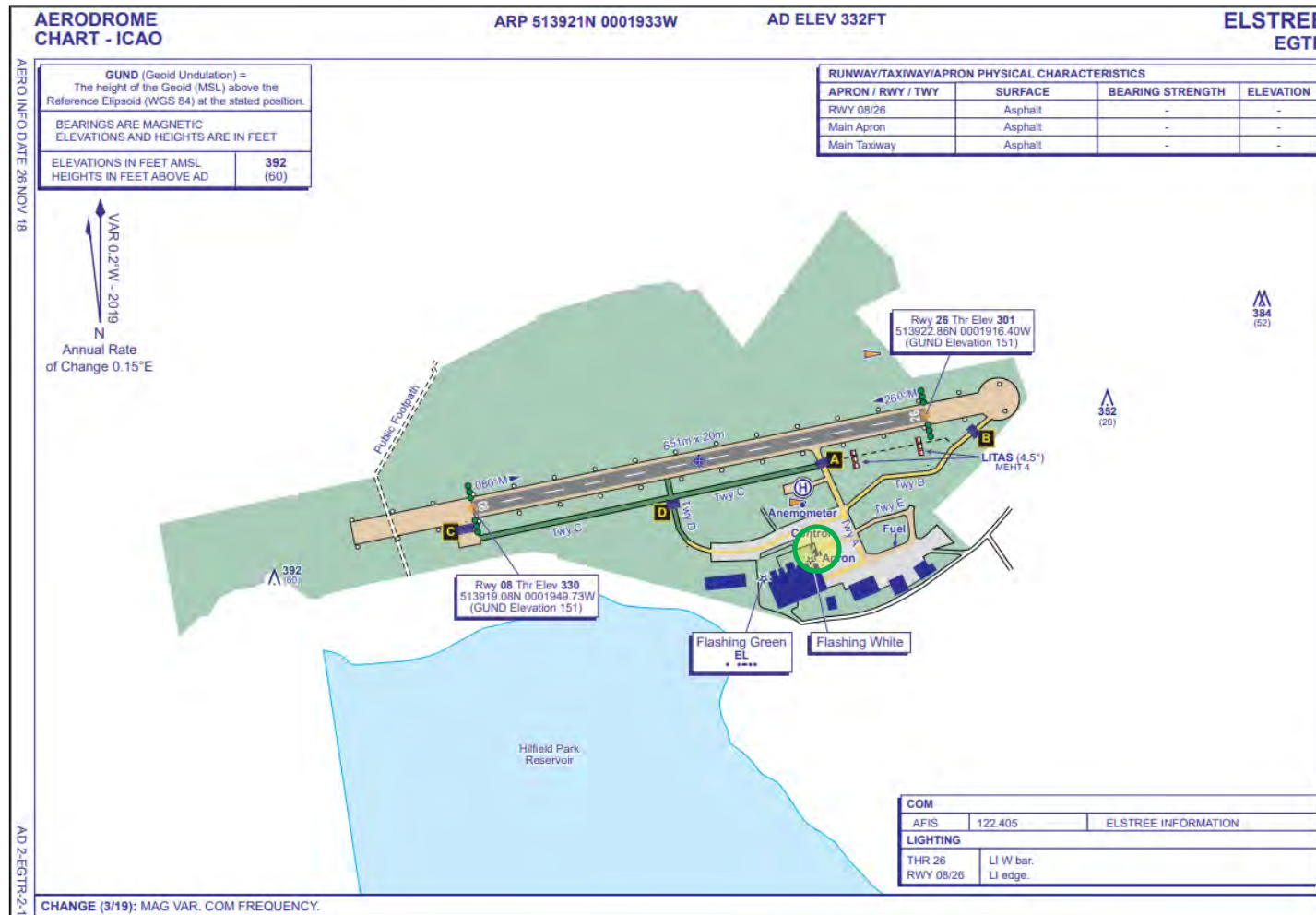


Figure 7 - Elstree Aerodrome (Aerodrome Chart - ICAO)

## 4 GLINT AND GLARE ASSESSMENT METHODOLOGY

### 4.1 Overview

The following sub-sections provides a general overview with respect to the guidance studies and methodology which informs this report.

### 4.2 Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority – CAA) and in the USA (produced by the Federal Aviation Administration – FAA) with respect to solar developments and aviation activity, however a specific methodology for aviation assessments in the UK, especially regarding UK civil aerodromes, has not been produced to date. The same is true for the assessment upon road safety and residential amenity. Therefore, Pager Power has reviewed existing guidelines and the available studies (discussed below) in the process of defining its own glint and glare assessment guidance. Pager Power guidance document<sup>8</sup> defines the process for determining the impact upon aviation activity. Pager Power’s approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, undertake solar intensity calculations in line with the Sandia National Laboratories’ FAA methodology (aviation only). The scenario in which a solar reflection can occur is identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

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

- Specular reflections of the Sun from solar panels and glass 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 and similar to those from glass. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces, which are common in an outdoor environment.

### 4.3 Background

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

### 4.4 Methodology

The assessment methodology is based on guidance, studies, previous discussions with stakeholders and Pager Power’s practical experience. Information regarding the methodology of Pager Power’s and Sandia National Laboratories’ methodology is presented below.

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<sup>8</sup> Pager Power’s Glint and Glare Assessment Guidance, Second Edition.



#### 4.4.1 Pager Power's 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. The methodology for aviation, dwelling and road receptors 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 the solar reflection intensity, if appropriate (only for aviation);
- 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.

Where a solar reflection is identified for an aviation approach path receptor, intensity calculations are completed in line with the Sandia National Laboratories methodology (discussed in the following section).

#### 4.4.2 Sandia National Laboratories' Methodology

Sandia National Laboratories developed the Solar Glare Hazard Analysis Tool (SGHAT) which is no longer available. Pager Power has since reviewed the Sandia National Laboratories model and is developing its own intensity calculation model in line with Sandia National Laboratories' methodology. Whilst strictly applicable in the USA and to solar Photovoltaic developments only, the methodology and associated guidance is widely used by UK aviation stakeholders. The following text is taken from the SGHAT model methodology.

*'This tool determines when and where solar glare can occur throughout the year from a user-specified PV array as viewed from user-prescribed observation points. The potential ocular impact from the observed glare is also determined, along with a prediction of the annual energy production.'*

The result was a chart that states whether a reflection can occur, the duration and predicted intensity for aviation receptors.

Pager Power has undertaken many aviation glint and glare assessments with both models (SGHAT and Pager Power's) producing similar results. Therefore, where the Pager Power geometrical analysis indicates that a solar reflection is geometrically possible, an intensity calculation in line with Sandia National Laboratories' methodology has also been completed<sup>9</sup>.

#### **4.5 Assessment Methodology and Limitations**

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

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<sup>9</sup> Currently using the Forge Solar model, based on the Sandia methodology.

## 5 HIGH-LEVEL RAILWAY CONSIDERATIONS

### 5.1 Overview

There is no formal buffer distance within which railway effects must be modelled. However, in practice, concerns are most often raised for developments within 200m of a railway line. A high-level railway assessment has been undertaken considering the nearby railway line.

### 5.2 High-Level Assessment

The railway line is located circa 660m<sup>10</sup> (at its closest point) north east of the proposed development (see Figure 8<sup>11</sup> below).



Figure 8 – Railway line location relative to the proposed development

It is expected that either terrain or other ground-based obstruction such as existing vegetation or buildings will screen the proposed development. Furthermore, any solar reflection will generate outside the train driver's field of focus such that the impact would be categorised as low in the worst case. Therefore, no significant impact is possible towards train drivers travelling on both direction of the identified stretch of railway.

<sup>10</sup> Furthermore, it is unlikely that at this distance Network Rail will raise a concern.

<sup>11</sup> Source: Google Earth Copyright © 2020.

## 6 IDENTIFICATION OF RECEPTORS

### 6.1 Overview

The following section presents the relevant receptors assessed within this report.

### 6.2 Air Traffic Control Tower

It is important to determine whether a solar reflection can be experienced by personnel within the ATC Tower. The ATC Tower is located approximately 0.6km south-east of the proposed development (at its closest point).

ATC Tower co-ordinates have been extrapolated from available imagery. The ground elevation has been taken from OSGB36 terrain data, with the height of the ATC Tower being assessed as 5m<sup>12</sup> above ground level (agl). The ATC tower can be seen in a photograph presented in Figure 9<sup>13</sup> below. Full details are presented in Appendix G.



Figure 9 – ATC Tower at Elstree Aerodrome

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<sup>12</sup> This is the height at which the ATC Tower personnel are expected to be. The actual height of the ATC Tower is predicted to be more than 5m..

<sup>13</sup> Airfield Site. Control Tower, Richard E Flagg, 19/01/2019.

### 6.3 Approaching Aircraft

It is Pager Power's methodology to assess whether a solar reflection can be experienced on the approach paths for the associated runways. Elstree Aerodrome has two approach paths associated with its runway (08/26).

A geometric glint and glare assessment has been undertaken for all aircraft approach paths. This is considered to be the most critical stage of the flight. The Pager Power approach for determining receptor (aircraft) locations on the approach path is to select locations along the extended runway centre line from 15.24 metres above the runway threshold out to a distance of 2 miles. The height of the aircraft is determined by using a 3-degree descent path relative to the runway threshold height. The receptor details for each runway approach are presented in Appendix G. Figure 10<sup>14</sup> on the following page shows the assessed aircraft receptor locations.

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<sup>14</sup> Source: Aerial imagery copyright © 2020 Google.



Figure 10 - Approach and ATC Tower receptor locations

## 6.4 Dwellings

The analysis has considered dwellings that:

- Are within, or close to one kilometre of the proposed development; and
- Have a potential view of the panels.

An overview of the assessed dwellings relative to the proposed development is shown in Figure 11<sup>15</sup> on the following page. A height above ground level of 1.8 metres has been taken as the typical eye level for an observer on the ground floor of each dwelling. In total 108 dwelling receptors points<sup>16</sup> have been identified for the assessment. A clearer view of the dwellings considered for the assessment are shown from Figure 12 to Figure 18 on the following pages.

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<sup>15</sup> Source: Copyright © 2020 Google.

<sup>16</sup> The co-ordinates of the dwelling receptor points are presented in Appendix G.



Figure 11 - Assessed dwellings receptors



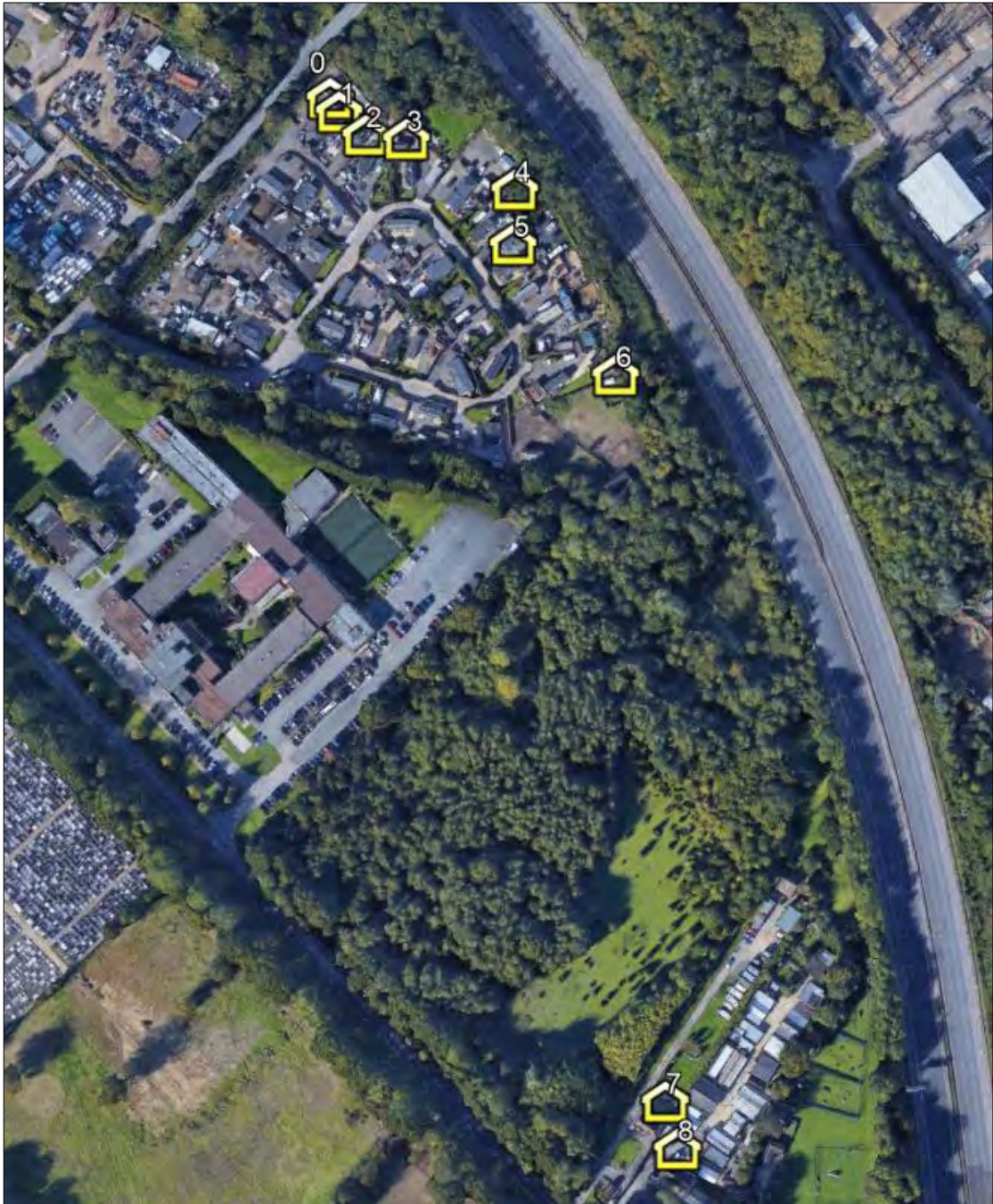


Figure 12 – Assessed dwellings receptors (dwellings 0 to 8)



Figure 13 – Assessed dwellings receptors (dwellings 9 to 22)



Figure 14 - Assessed dwellings receptors (dwellings 23 to 28)



Figure 15 – Assessed dwellings receptors (dwellings 29 to 59)



Figure 16 - Assessed dwellings receptors (dwellings 60 to 80)



Figure 17 - Assessed dwellings receptors (dwellings 81 to 94 and 97 - 98)



Figure 18 – Assessed dwellings receptors (dwellings 99 to 107)

## 6.5 Roads

The analysis has considered through-roads that:

- Are within, or close to one kilometre of the proposed development;
- Have a potential view of the panels.

The assessed road receptor points are shown as white icons in Figure 19<sup>17</sup> on the following page. The stretch of road assessed includes six roads:

- M1 (0 to 17 – light-blue line);
- A41 (18 to 27 – purple line);
- Hilfield Lane (28 to 39 – green line);
- Aldenham Road (40 to 50 – yellow line);
- Butterfly Lane (51 to 58 – red line); and
- A5183 (59 to 68 – dark-blue line).

A height above ground level of 1.5 metres has been taken as typical eye level for a road user for all roads. In total, 69 road receptor points<sup>18</sup> have been identified for the assessment.

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<sup>17</sup> Source: Copyright © 2020 Google.

<sup>18</sup> The co-ordinates of the road receptor points are presented in Appendix G.





Figure 19 - Assessed roads receptors

## 7 ASSESSED REFLECTOR AREAS

### 7.1 Overview

The following section presents the modelled reflector areas.

### 7.2 Reflector Areas

The solar development contains 20 areas of reflective panels.

The number of modelled reflector points being determined by the size of the reflector area and the assessment resolution. The bounding co-ordinates for the proposed solar development have been extrapolated from the site plans. All ground heights have been based on OSGB36 terrain data and the panel elevation data has been provided by the client. The data can be found in Appendix G. A resolution of 20m has been chosen for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 20m within the defined area. This resolution is sufficiently high to maximise the accuracy of the results – increasing the resolution further would not significantly change the modelling output. If a reflection is experienced from an assessed panel location, then it is likely that a reflection will be viewable from similarly located panels within the proposed solar development. The reflector areas assessed are shown in Figure 20<sup>19</sup> below (blue highlighted area).



Figure 20 – Assessed Reflector Areas

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<sup>19</sup> Source: Aerial image copyright © 2020 Google.

## 8 GLINT AND GLARE ASSESSMENT RESULTS

### 8.1 Overview

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

The Pager Power model has been used initially. Where solar reflections have been predicted, intensity calculations in line with Sandia National Laboratories' methodology have been undertaken.

The intensity model calculates the expected intensity of a reflection with respect to the potential for an after-image (or worse) occurring. The designation used by the model is presented in Table 2 below along with the associated colour coding.





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

Table 2 – Glare intensity designation

This coding has been used in the table where a reflection has been calculated and is in accordance with Sandia National Laboratories' methodology. The relative width of the colour band is related to the estimated percentage of each type of glare<sup>20</sup>.

In addition, the intensity model allows for assessment of a variety of solar panel surface materials. In the first instance, a surface material of 'smooth glass without an anti-reflective coating' is assessed. This is the most reflective surface and allows for a 'worst case' assessment. Other surfaces that could be modelled include:

- Smooth glass with an anti-reflective coating;
- Light textured glass without an anti-reflective coating;
- Light textured glass with an anti-reflective coating; or
- Deeply textured glass.

If significant glare is predicted, modelling of less reflective surfaces could be undertaken.

<sup>20</sup> Where two or more glare intensities are predicted for a particular receptor throughout the year.

The tables in the following subsections summarise the months and times during which a solar reflection could be experienced by a receptor.

This does not mean that reflections would occur continuously between the times shown.

The range of times at which reflections are geometrically possible is generally greater than the length of time for any particular day. This is because the times of day at which reflections could start and stop vary throughout the days/months.

The results of the analysis are presented in the following sections. Appendix H presents the results charts.

## 8.2 Geometric Calculation Results Overview – ATC Tower

The results of the geometric calculation for the ATC Tower is presented in Table 3 below.

Receptor	Pager Power Results		Glare Type	Comment
	Reflection possible toward the ATC Tower? <sup>21</sup> (GMT)			
	am	pm		
ATC Tower	None.	Between 17:23 and 17:26 from mid-February to early March. Between 17:41 and 18:50 from the end of March to mid-September. Between 16:53 and 17:04 from early October to late October.	"Yellow Glare" glare with potential for after-image <sup>22</sup>	Reflections are geometrically possible. However, the reflective area is not visible from an observer located in the ATC Tower.  No impact expected. No mitigation required. Discussed in Section 9.2.

Table 3 – Geometric analysis results for the ATC Tower

<sup>21</sup> This column reports the dates and times at which reflections are theoretically possible. This does not mean that glare will occur continuously throughout this time range in practice.

<sup>22</sup> "Yellow Glare" with potential for after-image is the worst-case scenario predicted by Forge. However, it is not expected to occur at all times.

### 8.3 Geometric Calculation Results Overview – Approach for Runway 08

The results of the geometric calculations for the approach towards runway 08 are presented in Table 4 below.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
Threshold	None.	Between 17:30 and 18:32 from late March to mid- September.	"Green Glare" with low potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.
0.1 miles	Between 05:09 and 05:16 from early June to early July.	Between 17:34 and 18:11 from the beginning of April to the end of May. Between 17:41 and 18:08 from early June to the beginning of July. Between 17:42 and 18:07 from mid- July to mid- September.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.

<sup>23</sup> This column reports the dates and times at which reflections are theoretically possible. This does not mean that glare will occur continuously throughout this time range in practice.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
0.2 miles	Between 05:06 and 05:17 from mid- May to late July.	Between 18:42 and 18:43 during early April. Between 17:16 and 17:31 during mid- May. Between 17:15 and 17:27 during the end of May. At circa 17:29 during mid- July. Between 17:33 and 17:41 during late July. Between 18:38 and 18:41 during the beginning of September.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.
0.3 miles	Between 05:05 and 05:52 from mid- May to the beginning of August.	Between 18:26 and 18:29 from late March to mid- April. Between 18:31 and 18:34 during early May. Between 18:35 and 18:43 from the end of July to mid- August. Between 18:15 and 18:26 from the end of August to mid- September.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
0.4 miles	Between 05:05 and 05:54 from early May to early August.	At circa 17:23 during mid-February. At circa 17:43 during the beginning of March. Between 17:36 and 17:44 during mid-March. Between 17:37 and 17:45 during the end of March. Between 17:36 and 18:02 from mid-April to late May. At circa 18:11 during the beginning of June. At circa 18:18 during early July. Between 18:04 and 18:11 during late July. Between 17:30 and 17:55 from mid-August to mid-September. Between 17:19 and 17:26 during late September. At circa 17:18 during mid-October. At circa 16:54 during late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.



Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
0.5 miles	Between 05:05 and 07:31 from the end of April to mid- August.	Between 13:48 and 14:40 during late January. Between 13:54 and 14:45 during late February. Between 13:54 and 14:47 during the beginning of April. At circa 12:57 during late April. At circa 14:51 during early May. At circa 13:59 during late May. At circa 14:09 during late July. Between 13:28 and 14:17 during mid-October. Between 13:20 and 14:13 during mid- November.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
0.6 miles	Between 08:56 and 09:17 during early April. Between 05:05 and 09:06 from late April to mid-May. Between 05:12 and 09:10 from late May to mid- August. At circa 08:54 during the beginning of September.	None.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.
0.7 miles	Between 05:05 and 08:01 from late April to late August.	None.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
0.8 miles	Between 05:05 and 07:39 from late April to late August.	None.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.
0.9 miles	Between 05:05 and 07:32 from mid- April to late August.	None.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.
1.0 mile	Between 05:05 and 07:31 from mid- April to late August.	None.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.1 miles	Between 06:37 and 06:39 during the beginning of March. Between 05:05 and 05:06 during mid-April. Between 05:48 and 07:30 from early May to early August. Between 05:06 and 05:12 from mid- August to the end of August. Between 06:12 and 06:14 during mid-October.	None.	“Yellow Glare” with potential for after-image <sup>24</sup>	Reflections are geometrically possible. Discussed in Section 9.3

<sup>24</sup> “Yellow Glare” with potential for after-image is the worst-case scenario predicted by Forge. However, it is not expected to occur at all times.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.2 miles	<p>Between 06:33 and 06:38 during early March.</p> <p>Between 05:05 and 05:06 during mid- April.</p> <p>Between 05:48 and 07:29 from early May to early August. Between 05:06 and 05:11 during late August. Between 06:10 and 06:13 during early October.</p>	None.	<p><b>"Green Glare" with no potential for after-image</b></p>	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.3 miles	<p>Between 06:31 and 06:36 from the beginning of March to mid- March.</p> <p>Between 05:05 and 05:06 during mid- April.</p> <p>Between 05:49 and 07:29 from early May to early August. Between 05:05 and 05:10 during late August. Between 06:09 and 06:13 during early October.</p>	None.	<p><b>"Green Glare"</b> with no potential for after-image</p>	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.4 miles	<p>Between 06:29 and 06:35 from early March to mid-March. At circa 05:06 during mid- April.</p> <p>Between 05:49 and 07:28 from early May to early August. Between 05:05 and 05:09 during late August. Between 06:09 and 06:13 from the end of September to early October.</p>	None.	<p><b>"Green Glare" with no potential for after-image</b></p>	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.5 miles	Between 06:26 and 06:33 from early March to mid-March. At circa 05:06 during mid- April. Between 05:49 and 07:28 from early May to early August. Between 05:05 and 05:09 during the end of August. Between 06:08 and 06:12 from late September to early October.	None.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.  Low impact expected. No mitigation required. Discussed in Section 9.3.



Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.6 miles	<p>Between 06:25 and 06:32 from early March to late March. At circa 05:06 during mid- April.</p> <p>Between 05:49 and 07:28 from the beginning of May to mid- August.</p> <p>Between 05:06 and 05:08 during the end of August.</p> <p>Between 06:07 and 06:12 from late September to early October.</p>	None.	<p><b>"Green Glare" with no potential for after-image</b></p>	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.7 miles	<p>Between 06:23 and 06:31 from early March to late March. At circa 05:06 during mid- April.</p> <p>Between 05:49 and 07:27 from the beginning of May to mid- August.</p> <p>Between 05:05 and 05:07 during the end of August.</p> <p>Between 06:07 and 06:11 from late September to early October.</p>	None.	<p><b>"Green Glare" with no potential for after-image</b></p>	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.8 miles	<p>Between 06:22 and 06:30 from early March to late March. At circa 05:06 during mid- April.</p> <p>Between 05:49 and 07:27 from the beginning of May to mid- August.</p> <p>Between 05:05 and 05:07 during the end of August.</p> <p>Between 06:07 and 06:11 from mid- September to early October.</p>	None.	<p><b>"Green Glare" with no potential for after-image</b></p>	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
1.9 miles	<p>Between 06:21 and 06:28 from mid- March to late March. At circa 05:06 during mid- April.</p> <p>Between 05:49 and 07:27 from the beginning of May to mid- August.</p> <p>Between 05:05 and 05:06 during the end of August.</p> <p>Between 06:07 and 06:11 from mid- September to the beginning of October.</p>	None.	<p><b>"Green Glare" with no potential for after-image</b></p>	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 08 Approach? <sup>23</sup> (GMT)			
	am	pm		
2.0 miles	<p>Between 06:21 and 06:28 from mid- March to late March. At circa 05:06 during mid- April.</p> <p>Between 05:49 and 07:27 from the end of April to mid- August. Between 06:07 and 06:10 from mid- September to the beginning of October.</p>	None.	"Green Glare" with no potential for after-image	<p>Reflections are geometrically possible. However, the glare intensity will have low potential for after-image.</p> <p>Low impact expected. No mitigation required. Discussed in Section 9.3.</p>

Table 4 – Geometric analysis results for the Runway 08 Approach

## 8.4 Geometric Calculation Results Overview – Approach for Runway 26

The results of the geometric calculations for the approach towards runway 26 are presented in Table 5 below.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
Threshold	None.	Between 17:22 and 17:24 during mid- February. Between 17:49 and 18:31 from late March to mid- September. Between 16:52 and 16:55 during late October.	“Yellow Glare” with potential for after- image <sup>26</sup>	Reflections are geometrically possible. However, the reflective area is not visible from pilots travelling across this receptor point. No impact expected. No mitigation required. Discussed in Section 9.4.
0.1 miles	None.	Between 17:21 and 17:23 during mid- February. Between 17:54 and 18:33 from late March to mid- May. Between 17:48 and 18:28 from late July to late September. Between 16:51 and 16:55 during late October.	“Yellow Glare” with potential for after- image <sup>27</sup>	Reflections are geometrically possible. However, the reflective area is not visible from pilots travelling across this receptor point. No impact expected. No mitigation required. Discussed in Section 9.4.

<sup>25</sup> This column reports the dates and times at which reflections are theoretically possible. This does not mean that glare will occur continuously throughout this time range in practice.

<sup>26</sup> “Yellow Glare” with potential for after-image is the worst-case scenario predicted by Forge. However, it is not expected to occur at all times.

<sup>27</sup> “Yellow Glare” with potential for after-image is the worst-case scenario predicted by Forge. However, it is not expected to occur at all times.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
0.2 miles	None.	Between 17:20 and 17:22 from mid- February to late February. Between 17:57 and 18:33 from mid- March to early May. Between 17:48 and 18:26 from early August to late September. Between 16:50 and 16:54 during late October.	"Yellow Glare" with potential for after-image <sup>28</sup>	Reflections are geometrically possible. However, the reflective area is not visible from pilots travelling across this receptor point. No impact expected. No mitigation required. Discussed in Section 9.4.
0.3 miles	None.	Between 17:20 and 17:22 from mid- February to late February. Between 17:58 and 18:34 from mid- March to late April. Between 17:45 and 18:25 from mid- August to late September. Between 16:49 and 16:55 from mid- October to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.

<sup>28</sup> "Yellow Glare" with potential for after-image is the worst-case scenario predicted by Forge. However, it is not expected to occur at all times.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
0.4 miles	None.	Between 17:19 and 17:22 from mid- February to late February. Between 18:00 and 18:33 from mid- March to mid- April. Between 17:43 and 18:24 from late August to the end of September. Between 16:49 and 16:55 from mid- October to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.
0.5 miles	None.	Between 17:19 and 17:22 from mid- February to late February. Between 18:00 and 18:05 from mid- March to mid- April. Between 17:29 and 17:32 from mid- June to late June. At circa 17:33 during the beginning of July. Between 17:42 and 18:01 from the end of August to the beginning of October. Between 16:48 and 16:54 from mid- October to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.



Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
0.6 miles	None.	Between 17:18 and 17:21 from mid- February to the end of February. Between 18:00 and 18:05 from mid- March to early April. Between 16:18 and 17:41 from mid- May to the beginning of August. Between 17:41 and 17:59 from the beginning of September to the beginning of October. Between 16:48 and 16:54 from mid- October to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.
0.7 miles	None.	Between 17:18 and 17:21 from mid- February to the end of February. Between 18:00 and 18:05 from mid- March to early April. Between 16:19 and 17:43 from late April to mid- August. Between 16:48 and 17:56 from early September to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
0.8 miles	None.	Between 17:18 and 17:21 from mid- February to the end of February. Between 18:00 and 18:05 from mid- March to the beginning of April. Between 16:20 and 18:03 from mid- April to late August. Between 16:47 and 17:54 from early September to late October.	"Yellow Glare" with potential for after-image <sup>29</sup>	Reflections are geometrically possible. However, the glare intensity will have potential for after-image. Discussed in Section 9.4.
0.9 miles	None.	Between 17:18 and 18:05 from mid- February to the end of March. Between 16:21 and 18:09 from mid- April to the end of August. Between 16:47 and 17:52 from mid- September to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.

<sup>29</sup> "Yellow Glare" with potential for after-image is the worst-case scenario predicted by Forge. However, it is not expected to occur at all times.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
1.0 mile	None.	Between 16:23 and 18:08 from mid- February to the beginning of September. Between 16:48 and 17:50 from mid- September to late October.	"Yellow Glare" with potential for after-image <sup>30</sup>	Reflections are geometrically possible. However, the glare intensity will have potential for after-image.  Discussed in Section 9.4.
1.1 miles	None.	Between 16:25 and 18:11 from mid- February to late October.	"Yellow Glare" with potential for after-image <sup>26</sup>	Reflections are geometrically possible. However, the glare intensity will have potential for after-image.  Discussed in Section 9.4.
1.2 miles	None.	Between 16:27 and 18:12 from mid- February to late October.	"Yellow Glare" with potential for after-image <sup>26</sup>	Reflections are geometrically possible. However, the glare intensity will have potential for after-image.  Discussed in Section 9.4.

<sup>30</sup> "Yellow Glare" with potential for after-image is the worst-case scenario predicted by Forge. However, it is not expected to occur at all times.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
1.3 miles	None.	Between 16:29 and 18:11 from mid- February to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.
1.4 miles	None.	Between 16:30 and 18:11 from late February to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.
1.5 miles	None.	Between 16:32 and 18:12 from late February to late October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
1.6 miles	None.	Between 16:32 and 18:11 from late February to mid- October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.
1.7 miles	None.	Between 16:34 and 18:04 from late February to early June. Between 16:32 and 18:10 from early July to mid- October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.
1.8 miles	None.	Between 16:35 and 18:00 from late February to late May. Between 16:32 and 18:10 from mid- July to mid- October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.

Receptor	Pager Power Results		Glare Type	Reflection Expected
	Reflection possible toward the Runway 26 Approach? <sup>25</sup> (GMT)			
	am	pm		
1.9 miles	None.	Between 16:36 and 18:00 from late February to mid- May. Between 16:32 and 18:08 from late July to mid- October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.
2.0 miles	None.	Between 16:37 and 18:00 from late February to mid- May. Between 16:32 and 18:07 from the beginning of August to mid- October.	"Green Glare" with no potential for after-image	Reflections are geometrically possible. However, the glare intensity will have low potential for after-image. Low impact expected. No mitigation required. Discussed in Section 9.4.

Table 5 – Geometric analysis results for the Runway 26 Approach

## 8.5 Geometric Calculation Results Overview – Dwellings

The results of the geometric calculations towards identified dwellings receptors are presented in Table 6 below.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
0	Between 05:37 and 06:57 from the beginning of March to mid- June. Between 05:41 and 06:33 from the end of June to mid- October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.
1	Between 05:37 and 06:57 from the end of February to mid- October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.
2	Between 05:37 and 06:57 from the beginning of March to mid- October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
3	Between 05:37 and 06:57 from the end of February to mid- October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.
4	Between 05:37 and 06:57 from the beginning of March to mid- October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.
5	Between 05:37 and 06:57 from the end of February to mid- October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.
6	Between 05:37 and 06:57 from the beginning of March to mid- October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.



Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
7	<p>Between 07:13 and 07:17 from mid- February to late February. At circa 07:06 during mid- March.</p> <p>Between 05:36 and 07:08 from late March to late September. At circa 06:45 during the beginning of October. Between 06:46 and 06:47 from mid- October to late October.</p>	None.	<p>Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.</p> <p>No impact expected. Discussed in Section 9.5.</p>

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
8	Between 07:12 and 07:18 from mid- February to the end of February. Between 05:36 and 07:08 from mid- March to mid- September. At circa 06:46 during the end of September. Between 06:46 and 06:48 from mid- October to late October.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation or buildings has been identified.  No impact expected. Discussed in Section 9.5.
9	Between 04:58 and 05:21 from early April to early September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
10	Between 05:03 and 06:09 from mid- March to mid-June. Between 05:07 and 05:56 from late June to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
11	Between 05:02 and 06:08 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
12	Between 05:00 and 06:07 from late March to early June. Between 05:06 and 05:56 from early July to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
13	Between 05:00 and 06:04 from late March to mid-June. Between 05:04 and 05:08 during the beginning of July. Between 05:09 and 05:56 from mid- July to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
14	Between 04:59 and 06:06 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
15	Between 04:58 and 06:05 from late March to early June. Between 05:05 and 05:55 from early July to mid- September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
16	Between 04:59 and 06:06 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
17	Between 05:00 and 06:06 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
18	Between 05:02 and 06:06 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
19	Between 05:02 and 06:05 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
20	Between 05:03 and 06:03 from late March to mid-September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
21	Between 05:02 and 06:03 from the end of March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
22	Between 05:41 and 06:02 from the end of March to mid-September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
23	None.	<p>At circa 18:05 during mid-March. Between 17:31 and 18:10 from late March to mid-April. Between 17:26 and 19:11 from the end of April to early June. Between 17:42 and 17:44 during late June.</p> <p>Between 17:33 and 19:17 from early July to mid-September. Between 17:46 and 17:47 during late September.</p>	<p>Reflections from the proposed development are possible. Some existing screening has been identified. The developer has proposed further screening in the form of vegetation.</p> <p>No impact expected. Discussed in Section 9.5.</p>

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
24	None.	<p>Between 17:30 and 17:34 from the beginning of March to late March. Between 17:29 and 17:33 during the beginning of April. Between 17:30 and 19:14 from mid- April to early June. Between 19:18 and 19:19 during late June. Between 17:24 and 19:20 from early July to early September. Between 17:04 and 17:18 from late September to early October.</p>	<p>Reflections from the proposed development are possible. Some existing screening has been identified. The developer has proposed further screening in the form of vegetation.</p> <p>Low impact expected. Discussed in Section 9.5.</p>



Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
25	None.	Between 17:16 and 17:25 from mid- February to mid- March. Between 18:59 and 19:09 from mid- April to early June. Between 19:01 and 19:16 from early July to the end of August. Between 16:45 and 17:07 from late September to late October.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
26	None.	Between 17:15 and 17:23 from mid- February to early March. Between 18:59 and 19:11 from mid- April to early June. Between 19:02 and 19:16 from the beginning of July to late August. Between 16:46 and 17:04 from the beginning of October to late October.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
27	Between 04:54 and 07:05 from mid- April to the end of August.	Between 19:03 and 19:04 during the end of April. At circa 19:15 during early August. At circa 19:10 during mid- August.	Reflections from the proposed development are possible. Some existing screening has been identified.  Low impact expected. Discussed in Section 9.5.
28	Between 04:54 and 07:04 from early April to early September. At circa 06:18 during late September.	None.	Reflections from the proposed development are possible. Some existing screening has been identified.  Low impact expected. Discussed in Section 9.5.
29	Between 05:03 and 05:59 from early April to early September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
30	Between 05:41 and 05:56 from mid- April to the end of August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
31	Between 05:41 and 05:55 from late April to late August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
32	Between 05:41 and 05:55 from late April to late August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
33	Between 05:41 and 05:55 from the end of April to mid- August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
34	Between 05:41 and 05:55 from late April to mid- August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
35	Between 05:41 and 05:54 from the beginning of May to early August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
36	Between 05:41 and 05:54 from early May to the beginning of August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
37	Between 05:41 and 05:54 from mid- May to the beginning of August.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
38	Between 05:42 and 05:43 from mid- May to mid- June. At circa 05:44 during late June. Between 05:47 and 05:53 from the beginning of July to the end of July.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
39	Between 05:42 and 05:52 from late May to late July.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
40	At circa 05:42 during early June. At circa 05:44 during late June. At circa 05:48 during early July.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
41 – 60	None.	None.	None.
61	Between 06:00 and 06:08 from mid- March to the beginning of April. Between 05:51 and 05:53 from mid- September to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
62	Between 05:58 and 06:08 from mid- March to early April. Between 05:51 and 05:53 from early September to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
63	Between 05:56 and 06:07 from late March to early April. Between 05:51 and 05:53 from early September to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
64	Between 05:55 and 06:07 from mid- March to mid- April. Between 05:51 and 05:53 from the beginning of September to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
65	Between 05:53 and 06:07 from mid- March to mid- April. Between 05:50 and 05:53 from the end of August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
66	Between 05:52 and 06:07 from mid- March to mid- April. Between 05:50 and 05:53 from the end of August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
67	Between 05:51 and 06:07 from mid- March to mid- April. Between 05:50 and 05:53 from late August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
68	Between 05:49 and 06:07 from late March to late April. Between 05:51 and 05:53 from late August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
69	Between 05:47 and 06:07 from late March to late April. Between 05:51 and 05:53 from late August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
70	Between 05:46 and 06:06 from late March to late April. Between 05:50 and 05:53 from mid- August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.



Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
71	Between 05:44 and 06:07 from late March to the end of April. Between 05:49 and 05:53 from mid- August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
72	Between 05:41 and 06:07 from late March to early May. Between 05:49 and 05:54 from early August to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
73	Between 05:38 and 06:07 from late March to mid-May. Between 05:48 and 05:57 from late July to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
74	Between 05:37 and 06:07 from late March to the beginning of June. Between 05:45 and 05:59 from mid- July to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
75	Between 05:37 and 06:07 from late March to mid-June. Between 05:41 and 06:01 from late June to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
76	Between 05:37 and 06:07 from late March to mid-June. Between 05:42 and 06:01 from the end of June to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
77	Between 05:37 and 06:07 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
78	Between 05:37 and 06:07 from late March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
79	Between 05:36 and 06:08 from late March to late May. At circa 05:39 during mid- June. Between 05:41 and 05:44 from late June to the end of June. Between 05:46 and 06:09 from mid- July to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
80	Between 05:37 and 06:13 from mid- March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
81	Between 05:40 and 06:18 from mid- March to the end of September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
82	Between 05:40 and 06:22 from mid- March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
83	Between 05:40 and 06:22 from mid- March to the end of September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
84	Between 05:41 and 06:23 from mid- March to the end of September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
85	Between 05:41 and 06:23 from mid- March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
86	Between 05:41 and 06:23 from mid- March to the end of September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
87	Between 05:41 and 06:23 from mid- March to late September.	None.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
88	Between 05:41 and 06:23 from mid- March to late September.	None.	Reflections from the proposed development are possible. Some screening in the form of existing vegetation has been identified. Furthermore, the developer has proposed screening to block all view of the proposed development.  No impact expected. Discussed in Section 9.5.
89	Between 05:42 and 06:24 from mid- March to late September.	None.	Reflections from the proposed development are possible. Some screening in the form of existing vegetation and other buildings has been identified.  Low impact expected. Discussed in Section 9.5.
90	Between 05:41 and 06:25 from mid- March to late September.	None.	Reflections from the proposed development are possible. Some screening in the form of existing vegetation has been identified.  Low impact expected. Discussed in Section 9.5.
91	Between 04:58 and 06:22 from mid- April to the end of August.	None.	Reflections from the proposed development are possible. Some screening in the form of existing vegetation and other buildings has been identified.  Low impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
92	None.	Between 18:08 and 18:10 from mid- March to early April. Between 17:55 and 18:06 from early September to late September.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
93	None.	Between 18:08 and 18:10 from mid- March to early April. Between 17:54 and 18:08 from the end of August to late September.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
94	None.	Between 18:08 and 18:36 from mid- March to mid- April. Between 17:51 and 18:31 from late August to late September.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
95	None.	Between 17:26 and 17:27 from late February to early March. Between 17:47 and 18:51 from mid- April to the end of August. Between 16:57 and 17:05 from early October to late October.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
96	None.	Between 17:26 and 17:28 from late February to early March. Between 17:49 and 18:51 from early April to the beginning of September. Between 16:57 and 17:05 from early October to late October.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.



Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
97	None.	Between 18:09 and 18:10 from mid- March to mid- April. Between 17:51 and 18:07 from the beginning of September to late September.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
98	None.	Between 18:08 and 18:10 from late March to early April. Between 17:55 and 18:04 from early September to late September.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
99	None.	Between 17:41 and 18:26 from mid- March to late September.	Reflections from the proposed development are possible. Some screening in the form of vegetation has been identified. Furthermore, the developer has proposed screening which will block views of the reflective area.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
100	None.	Between 17:41 and 18:27 from mid- March to late September.	Reflections from the proposed development are possible. Some screening in the form of vegetation has been identified. Furthermore, the developer has proposed screening which will block views of the reflective area.  No impact expected. Discussed in Section 9.5.
101	None.	Between 17:42 and 18:27 from mid- March to late September.	Reflections from the proposed development are possible. Some screening in the form of vegetation has been identified. Furthermore, the developer has proposed screening which will block views of the reflective area.  No impact expected. Discussed in Section 9.5.
102	None.	Between 17:43 and 18:27 from mid- March to late September.	Reflections from the proposed development are possible. Some screening in the form of vegetation has been identified. Furthermore, the developer has proposed screening which will block views of the reflective area.  No impact expected. Discussed in Section 9.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward the dwelling receptors? (GMT)		
	am	pm	
103	None.	Between 18:09 and 18:14 from late March to mid- May. Between 17:55 and 18:24 from the beginning of August to late September.	Reflections from the proposed development are possible. However, existing screening in the form of vegetation has been identified.  No impact expected. Discussed in Section 9.5.
104 - 107	None.	None.	None.

Table 6 – Geometric analysis results for dwelling receptors

## 8.6 Geometric Calculation Results Overview – Roads

### 8.6.1 M1

The results of the geometric calculations for drivers travelling in both direction of the M1 are presented in Table 7 below.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on M1? (GMT)		
	am	pm	
0	Between 05:37 and 06:40 from early March to early October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
1	Between 05:37 and 06:57 from the beginning of March to mid- October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
2	Between 05:38 and 06:57 from the beginning of March to mid- October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
3	Between 05:35 and 07:01 from early March to early October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on M1? (GMT)		
	am	pm	
4	Between 04:53 and 07:07 from mid- March to early October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
5	Between 07:07 and 07:12 during early March. At circa 07:00 during late March. At circa 06:48 during early April. Between 04:54 and 07:07 from late April to mid- August. At circa 06:46 during the beginning of September. At circa 06:46 during late September. Between 06:46 and 06:47 during early October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
6	Between 04:55 and 05:45 from mid- May to the beginning of August.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
7	Between 05:00 and 05:18 from mid- April to the beginning of September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on M1? (GMT)		
	am	pm	
8	Between 04:57 and 06:05 from late March to late May. Between 04:58 and 05:03 during early June. Between 05:02 and 05:56 from the beginning of July to late September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
9	Between 05:38 and 06:04 from late March to early June. Between 05:42 and 05:43 during late June. Between 05:43 and 05:53 from early July to mid- September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
10	Between 05:39 and 05:53 from mid- April to the end of August.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.1.
11 - 17	None.	None.	None.

Table 7 – Geometric analysis results for M1 receptors

8.6.2 A41

The results of the geometric calculations for drivers travelling in both direction of the A41 are presented in Table 8 below.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on A41? (GMT)		
	am	pm	
18	At circa 07:17 during mid- February. Between 07:00 and 07:08 from early March to late March. At circa 06:50 during early April. Between 04:54 and 07:08 from late April to late August. At circa 06:46 during early September. At circa 06:46 during late September. At circa 06:46 during early October. At circa 06:47 during mid- October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.2.
19	Between 04:54 and 05:47 from early May to early August.	None.	Reflections from the proposed development are possible. However, visibility of the reflective surface will not be possible.  No impact expected. Discussed in Section 9.6.2.
20	At circa 05:19 during early April. At circa 05:09 during late April. Between 04:57 and 05:13 from late May to late July. Between 05:16 and 05:17 from mid- August to early September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.2.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on A41? (GMT)		
	am	pm	
21	Between 04:58 and 05:16 from mid- April to late May. At circa 05:05 during mid- June. At circa 05:09 during the end of June. Between 05:07 and 05:17 from late July to late August.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.2.
22	Between 05:11 and 06:08 from late March to the end of May. Between 05:20 and 06:01 from mid- July to mid- September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.2.
23	Between 06:07 and 06:09 during late March. Between 05:41 and 05:58 from early April to the end of May. At circa 05:43 during early June. At circa 05:48 during the beginning of July. Between 05:50 and 05:56 from mid- July to early September. Between 05:53 and 05:54 during late September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.2.
24	At circa 05:43 during late April. At circa 05:48 during late August.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.2.



Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on A41? (GMT)		
	am	pm	
25 – 27	None.	None.	None.

Table 8 – Geometric analysis results for the A41 receptors

### 8.6.3 Hilfield Lane

The results of the geometric calculations for drivers travelling in both direction of Hilfield Lane are presented in Table 9 below.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Hilfield Lane? (GMT)		
	am	pm	
28	Between 05:38 and 06:57 from the end of February to mid-October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Hilfield Lane? (GMT)		
	am	pm	
29	Between 05:38 and 06:57 from the beginning of March to mid- October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.
30	Between 05:34 and 06:56 from the beginning of March to mid- October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.
31	Between 05:34 and 07:06 from early March to early October.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Hilfield Lane? (GMT)		
	am	pm	
32	Between 04:54 and 07:04 from late April to late August.	Between 19:04 and 19:05 from late April to early May. Between 19:10 and 19:12 during mid- August.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.
33	Between 04:55 and 05:44 from mid-May to the end of July.	Between 19:04 and 19:06 from late April to early May. Between 19:09 and 19:12 during late May. At circa 19:16 during mid- June. At circa 19:19 during the end of June. Between 19:18 and 19:20 from mid- July to late July. At circa 19:14 during early August. At circa 19:08 during late August.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Hilfield Lane? (GMT)		
	am	pm	
34	None.	Between 17:30 and 19:16 from the end of February to mid- June. Between 17:34 and 19:21 from the beginning of July to late August. Between 17:05 and 17:28 from early September to mid- October.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.
35	None.	Between 17:28 and 17:36 from mid- March to late March. Between 17:29 and 19:19 from early April to late June. Between 17:30 and 19:20 from early July to early September. Between 17:07 and 17:23 from mid- September to the beginning of October.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Hilfield Lane? (GMT)		
	am	pm	
36	None.	At circa 18:04 during mid- March. Between 17:33 and 18:16 from the end of March to the beginning of June. Between 17:43 and 17:46 from mid- June to the end of June. Between 17:42 and 18:25 from mid- July to mid- September. At circa 17:49 during late September	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.
37	None.	Between 18:10 and 18:23 from late March to mid- June. Between 18:00 and 18:27 from late June to mid- September.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.
38	None.	At circa 18:11 during mid- May. At circa 18:21 during the end of July.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Hilfield Lane? (GMT)		
	am	pm	
39	None.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation or roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.3.

Table 9 – Geometric analysis results for Hilfield Lane receptors

#### 8.6.4 Aldenham Road

The results of the geometric calculations for drivers travelling in both direction of Aldenham Road are presented in Table 10 below.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Aldenham Road? (GMT)		
	am	pm	
40	Between 05:38 and 06:07 from late March to late May. Between 05:48 and 05:58 from late July to late September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerow or buildings has been identified.  No impact expected. Discussed in Section 9.6.4.
41	Between 05:37 and 06:07 from late March to late September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerow or buildings has been identified.  No impact expected. Discussed in Section 9.6.4.
42	Between 05:36 and 06:07 from late March to early June. Between 05:42 and 06:11 from early July to late September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerow or buildings has been identified.  No impact expected. Discussed in Section 9.6.4.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Aldenham Road? (GMT)		
	am	pm	
43	Between 05:39 and 06:19 from mid- March to late September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerow or buildings has been identified.  No impact expected. Discussed in Section 9.6.4.
44	Between 05:41 and 06:22 from mid- March to late September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerow or buildings has been identified.  No impact expected. Discussed in Section 9.6.4.
45	Between 05:41 and 06:23 from mid- March to the end of September.	None.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerow or buildings has been identified.  No impact expected. Discussed in Section 9.6.4.



Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Aldenham Road? (GMT)		
	am	pm	
46	Between 05:42 and 06:23 from mid- March to the end of September.	None.	Reflections from the proposed development are possible. However, screening in the form of roadside hedgerow has been identified.  No to low impact expected. Discussed in Section 9.6.4.
47	Between 05:40 and 06:24 from the end of March to mid- September.	None.	Reflections from the proposed development are possible. However, screening in the form of roadside hedgerow has been identified.  No to low impact expected. Discussed in Section 9.6.4.
48	At circa 04:57 during late April. Between 04:59 and 05:52 from early May to early August. At circa 05:02 during late August.	Between 18:09 and 18:11 during late March. Between 17:56 and 17:59 during mid- September.	Reflections from the proposed development are possible. However, screening in the form of roadside hedgerow has been identified.  No to low impact expected. Discussed in Section 9.6.4.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Aldenham Road? (GMT)		
	am	pm	
49	None.	Between 18:09 and 18:11 from late March to mid- April. Between 17:55 and 18:10 from the end of August to late September.	Reflections from the proposed development are possible. However, screening in the form of roadside hedgerow has been identified.  No impact expected. Discussed in Section 9.6.4.
50	None.	Between 18:05 and 18:37 from mid- March to the end of April. Between 17:51 and 18:31 from mid- August to late September.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerow or buildings has been identified.  No impact expected. Discussed in Section 9.6.4.

Table 10 – Geometric analysis results for Aldenham Road receptors

### 8.6.5 Butterfly Lane

The results of the geometric calculations for drivers travelling in both direction of Butterfly Lane are presented in Table 11 below.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Butterfly Lane? (GMT)		
	am	pm	
51	None.	Between 18:08 and 18:37 from mid- March to late April. Between 17:51 and 18:31 from mid- August to late September.	Reflections from the proposed development are possible. However, terrain will block all views of the reflective area.  No impact expected. Discussed in Section 9.6.5.
52	None.	Between 18:09 and 18:10 from late March to early April. Between 17:55 and 18:07 from the beginning of September to late September.	Reflections from the proposed development are possible. However, terrain will block all views of the reflective area.  No impact expected. Discussed in Section 9.6.5.
53	None.	Between 18:09 and 18:10 during late March. At circa 16:41 during the end of April. Between 16:36 and 17:45 from mid- May to mid- June. Between 16:43 and 17:52 from the end of June to the beginning of August. At circa 16:48 during mid-August. Between 17:55 and 18:00 during mid-September.	Reflections from the proposed development are possible. The developer has proposed screening in the form of vegetation which will be sufficient to block all view of the proposed development.  No impact expected. Discussed in Section 9.6.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Butterfly Lane? (GMT)		
	am	pm	
54	None.	Between 16:36 and 18:10 from mid- March to late September.	Reflections from the proposed development are possible. The developer has proposed screening in the form of vegetation which will be sufficient to block all view of the proposed development.  No impact expected. Discussed in Section 9.6.5.
55	None.	Between 16:43 and 18:16 from mid- March to mid- June. Between 16:41 and 18:22 from the end of June to the beginning of October.	Reflections from the proposed development are possible. The developer has proposed screening in the form of vegetation which will be sufficient to block all view of the proposed development.  No impact expected. Discussed in Section 9.6.5.
56	None.	Between 16:41 and 18:26 from late February to mid- October.	Reflections from the proposed development are possible. The developer has proposed screening in the form of vegetation which will be sufficient to block all view of the proposed development.  No impact expected. Discussed in Section 9.6.5.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on Butterfly Lane? (GMT)		
	am	pm	
57	None.	Between 16:40 and 18:26 from mid- February to late October.	Reflections from the proposed development are possible. The developer has proposed screening in the form of vegetation which will be sufficient to block all view of the proposed development.  No impact expected. Discussed in Section 9.6.5.
58	None.	Between 16:41 and 18:26 from mid- February to late October.	Reflections from the proposed development are possible. The developer has proposed screening in the form of vegetation which will be sufficient to block all view of the proposed development.  No impact expected. Discussed in Section 9.6.5..

Table 11 – Geometric analysis results for Butterfly Lane receptors

### 8.6.6 A5183

The results of the geometric calculations for drivers travelling in both direction of the A5183 are presented in Table 12 below.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on the A5183? (GMT)		
	am	pm	
59 – 61	None.	None.	None.
62	None.	Between 18:11 and 18:12 from late March to late April. Between 17:58 and 18:17 from late August to late September.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation and roadside hedgerows has been identified.  No impact expected. Discussed in Section 9.6.6.
63	None.	Between 18:06 and 18:23 from late March to mid- June. Between 17:54 and 18:27 from the end of June to late September.	Reflections from the proposed development are possible. Some existing screening in the form of roadside hedgerows has been identified.  Low impact expected. Discussed in Section 9.6.6.
64	None.	Between 17:48 and 18:27 from late March to late September.	Reflections from the proposed development are possible. Some existing screening in the form of existing vegetation has been identified.  Low impact expected. Discussed in Section 9.6.6.

Receptor	Pager Power Results		Reflection Expected
	Reflection possible toward drivers travelling on the A5183? (GMT)		
	am	pm	
65	None.	Between 17:42 and 18:26 from mid- March to late September.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation, roadside hedgerows and buildings has been identified.  No impact expected. Discussed in Section 9.6.6.
66	None.	Between 17:09 and 17:12 from mid- February to late February. Between 17:42 and 18:26 from mid- March to late September. Between 16:41 and 16:42 during late October.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.6.
67	None.	Between 16:41 and 18:26 from late February to mid- October.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.6.
68	None.	Between 16:43 and 18:25 from mid- March to late September.	Reflections from the proposed development are possible. However, screening in the form of existing vegetation has been identified.  No impact expected. Discussed in Section 9.6.6.

Table 12 – Geometric analysis results for the A5183 receptors

## 9 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

### 9.1 Overview

The results of the glint and glare calculations are presented in the following sub-sections.

### 9.2 Aviation Receptors – ATC Tower

The analysis has shown that solar reflections from the proposed solar development towards the ATC Tower are geometrically possible. Reflections will generate from the sites located west of the ATC Tower (Site 2 to 10 see Figure 21<sup>31</sup> below).



Figure 21 – Reflective areas for ATC Tower

A review of available imagery (Figure 22<sup>32</sup> on the following page) and on-site survey (Figure 23<sup>33</sup> on the following page) have shown that visibility of the reflective area is not possible due to intervening terrain.

Therefore, no impact is expected and no mitigation is required.

<sup>31</sup> Source: Copyright © 2020 Google.

<sup>32</sup> Source: Copyright © 2020 Google.

<sup>33</sup> The site survey has been undertaken by the developer. Elstree Solar Development, Nick Leaney, date: 01/10/2020.





Figure 22 – View from the ATC Tower towards the proposed development



Figure 23 – Site survey picture taken from the western panel array fields by Hilfield Farm looking back up towards the aerodrome

### 9.3 Aviation Receptors – Approach 08

The Pager Power model indicates that solar reflections are possible towards the entire runway 08 approach path. Forge has predicted that at a distance of 1.1 miles from the threshold, the intensity of reflections is expected to have a potential for temporary after-image meanwhile for the rest of the approach path the intensity of reflections is expected to have a low potential for temporary after-image.

Solar reflections with potential for temporary after-image will occur at circa 6:50 GMT at the beginning of March and at circa 6:20 GMT at the beginning of October. In total solar reflections with potential for temporary after-image are predicted to for a maximum of 3 minutes per year.

Although predicted glare with potential for temporary after-image towards pilots approaching the runway is not acceptable based on the FAA guidance, Pager Power recommends a pragmatic approach within its guidance document. Therefore, the following should be considered:

- Visibility of the solar panel areas;
- The glare duration;
- Glare location relative to key operational areas;
- Existing reflecting surfaces.

Considering the above, the points below are applicable:

- Visibility of the reflecting solar panel area producing glare with potential for after-image is expected at 1.1 miles from threshold, However existing vegetation is likely to partially screened the view (Figure 24<sup>34</sup> below);

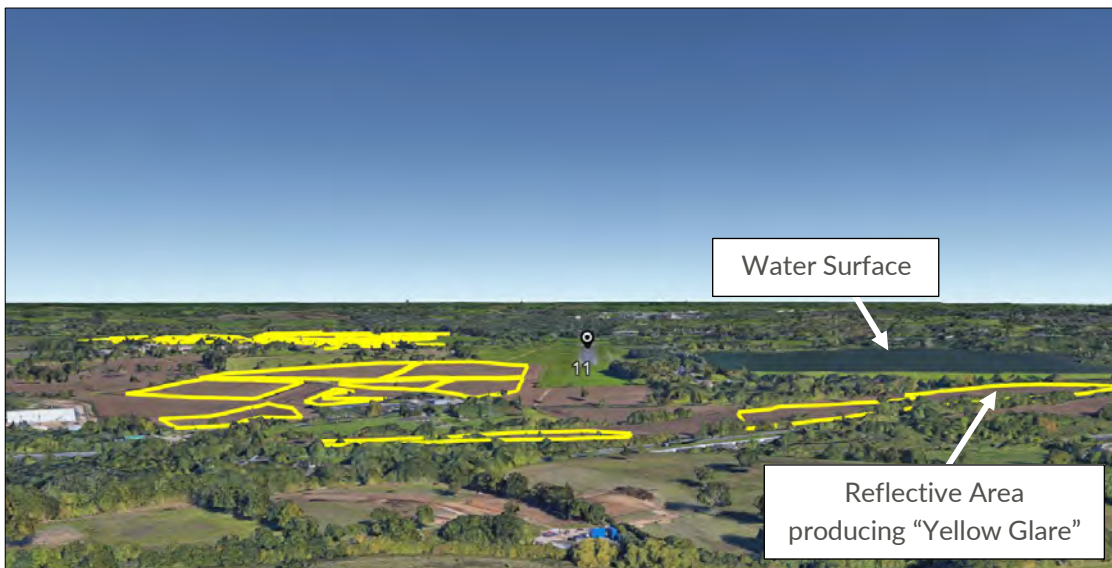


Figure 24 - View of the reflective area at 1.1 miles from the runway 08 threshold

- Solar reflections with potential for temporary after-image are predicted to occur for only 3 minutes per year. This is equivalent to 0.001% of daylight time per year – this is based on the assumption of 12 hours of daylight per day.
- Sun light and reflections will always generate from approximately the same point in space (see Figure 25<sup>35</sup> on the following page).

<sup>34</sup> Source: Copyright © 2020 Google.

<sup>35</sup> Source: Copyright © 2020 Google.

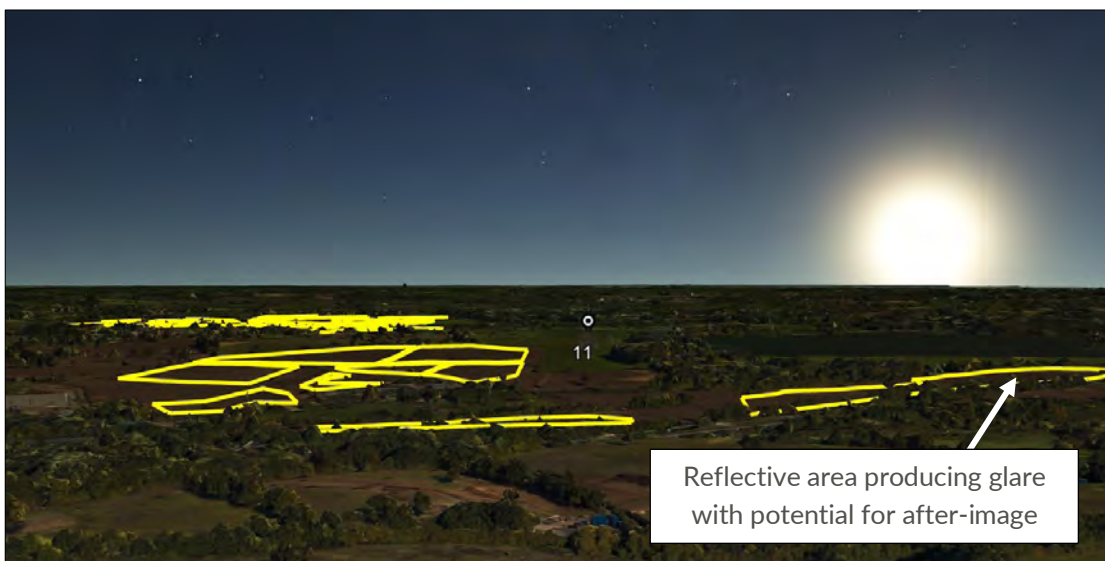


Figure 25 – Location of the sun in the sky at the time of reflection (1<sup>st</sup> October at 6:20am)

- Existing reflective surfaces located near the proposed development (water surface) have been identified (see Figure 24 on the previous page).
- Furthermore, the following will have to occur concurrently:
  - Clear sky when glare with potential for after-image is predicted; and
  - An aircraft approaching at this specific time.

While glare with potential for temporary after image has been predicted, impacts upon pilots approaching the runway 08 are judged to be not significant. This because the amount of glare where potential for after-image is possible per year is minimal (only 0.001% of daylight time per year) and glare produced by the panels and sunlight will generate from approximately the same point in space. The airport's position regarding this potential glare should be confirmed. Mitigation strategies are not recommended.

#### 9.4 Aviation Receptors – Approach 26

The Pager Power model indicates that solar reflections are possible towards the entire runway 26 approach path. Forge predicts solar reflection to have potential for after-image between the runway threshold and 0.2 miles, at 0.8 miles from the threshold and between 1.0 mile and 1.2 miles from the threshold meanwhile for the rest of the approach path the intensity of reflections is expected to have low potential for temporary after-image.

A review of the available imagery shows that the views of Site 6 are significantly obstructed from view of a pilot by terrain and vegetation for aircrafts travelling between 0.2 miles and the threshold (see Figure 26<sup>36</sup> on the following page). Therefore, any glare with potential for after-image will be sufficiently screened and pilots approaching runway 26 will not be affected.

<sup>36</sup> Source: Copyright © 2020 Google.



Figure 26 - View of the reflective area at 0.2 miles from the runway 26 threshold

Therefore, glare with potential for afterimage is expected to be experienced at 0.8 miles from the threshold and between 1.0 mile and 1.2 miles from the threshold. Solar reflections with potential for temporary after-image will occur at circa 17:30 from the end of April to the end of May and from mid-July to mid-August and at circa 18:00 from the end of May until mid-July. In total solar reflections with potential for temporary after-image are predicted to for a maximum of 172 minutes per year.

As stated in the previous page Pager Power recommends a pragmatic approach within its guidance document. Considering the above, the points below are applicable:

- Visibility of the reflecting solar panels area producing glare with potential for after-image is expected at 0.8 miles from threshold and between 1.0 mile and 1.2 miles from threshold (Figure 27 and Figure 28<sup>37</sup> on the following page). However, the reflective area generating glare with potential for after-image will not be directly in front of the pilot approaching the runway and far from the threshold;

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<sup>37</sup> Source: Copyright © 2020 Google.



Figure 27 – View of the reflective area at 0.8 miles from the runway 26 threshold

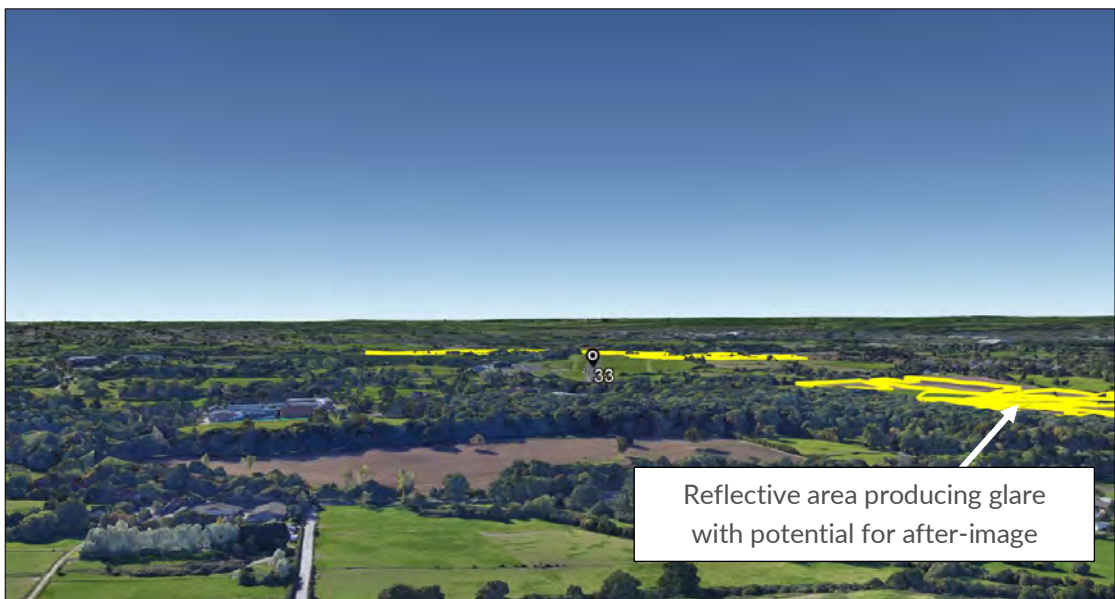


Figure 28 – View of the reflective area at 1.2 miles from the runway 26 threshold

- Solar reflections with potential for temporary after-image is predicted to occur for only 172 minutes per year. This is equivalent to 0.065% of daylight time per year – this is based on the assumption of 12 hours of daylight per day.
- The Sun, which is a much brighter source of light, is expected to be directly in front of a pilot on the 2-mile approach path at the time a reflection with potential for temporary after-image is possible (see Figure 29<sup>38</sup> on the following page).

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<sup>38</sup> Source: Copyright © 2020 Google.



Figure 29 – Location of the sun in the sky at the time of reflection (1<sup>st</sup> April at 17:30)

- Furthermore, the following will have to occur concurrently:
  - Clear sky when glare with potential for after-image is predicted; and
  - An aircraft approaching at this specific time.

While glare with potential with potential for temporary after-image has been predicted, impacts upon pilots approaching runway 26 are judged to be not significant. This because the amount of glare where potential for after-image is possible per year is minimal (only 0.065% of daylight time per year) and the glare will not generate near the threshold. The airport's position regarding this potential glare should be confirmed. Mitigation strategies are not recommended.

## 9.5 Dwellings

The results of the analysis have shown that the reflections from the proposed development are geometrically possible towards 85 of the 108 identified dwelling receptors. Impact significance is determined on the level of visibility, the duration of effects and the relative position of the sun.

For 10 dwellings where reflections are expected to last for more than 3 months per year but for less than 1 hour per day, some or no screening will result in low or moderate impact:

- Dwelling 23 and 24: a review of the available imagery showed some intervening screening in the form of existing vegetation (Figure 30<sup>39</sup> on the following page) which will significantly reduce the duration of effects. Furthermore, the developer has proposed screening in the form of vegetation. No impact expected, and no further mitigation required.
- Dwelling 88: a review of available imagery shows that, under the current baseline scenario, an observer located in the dwelling will have a clear view of the closest two areas however existing vegetation will fully or partially block the view of the rest of the reflective area (yellow area in Figure 31 on the following page). This means that reflection will last less than 3 months per year. Furthermore, the developer has proposed screening in the form of vegetation next to the dwelling which will block all view of the closest two development. No impact expected, and no further mitigation required.
- Dwelling 89: a review of available imagery shows that views of the reflective area will be either significantly or fully blocked by existing vegetation and buildings (green area in Figure 31 on the following page). Low impact expected and no mitigation required.
- Dwelling 90: a review of available imagery shows that an observer located in the dwelling will have a partially obstructed view of the reflective area (red area in Figure 31 on the following page). This means that reflections will last less than 3 months per year. Furthermore, sunlight and reflections will generate approximately in the same point in space with sun being a much brighter source of light. Low impact expected and no mitigation required.
- Dwelling 91: a review of available imagery shows that views of the reflective area will be either significantly or fully blocked by existing vegetation and buildings (red area in Figure 31 on the following page). This means that reflections will last less than 3 months per year. Low impact expected and no mitigation required.
- Dwellings 99 to 102: a review of available imagery shows that an observer located in each dwelling will have a partial view of the reflective area under current baseline scenario (yellow area in Figure 32 on page 128). An example of where mitigation should be installed is shown in Figure 33 on page 128. However, the developer has subsequently proposed screening at these locations (Figure 34<sup>40</sup> on page 129) which will be sufficient to remove all views of the reflective areas.

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<sup>39</sup> Source: Copyright © 2020 Google.

<sup>40</sup> HILFIELD SOLAR FARM AND BATTERY STORAGE, LDA Design, 19/11/2020, DRAWING No.: 7533\_012, cropped.



Figure 30 – Location of dwellings 23 and 24 relative to the reflective area and level of screening



Figure 31 – Location of dwellings 88 to 91 relative to the reflective area and level of screening





Figure 32 – Location of dwellings 99 to 102 relative to the reflective area and level of screening



Figure 33 – Screening (green line) to reduce the impact upon dwellings 99 to 102



Figure 34 – Proposed mitigation screening for dwelling 99 to 102



Figure 35 – Existing screening for dwellings 0 to 8 and 27 and 28



Figure 36 - Existing screening for dwellings 9 to 22 and 29 to 40

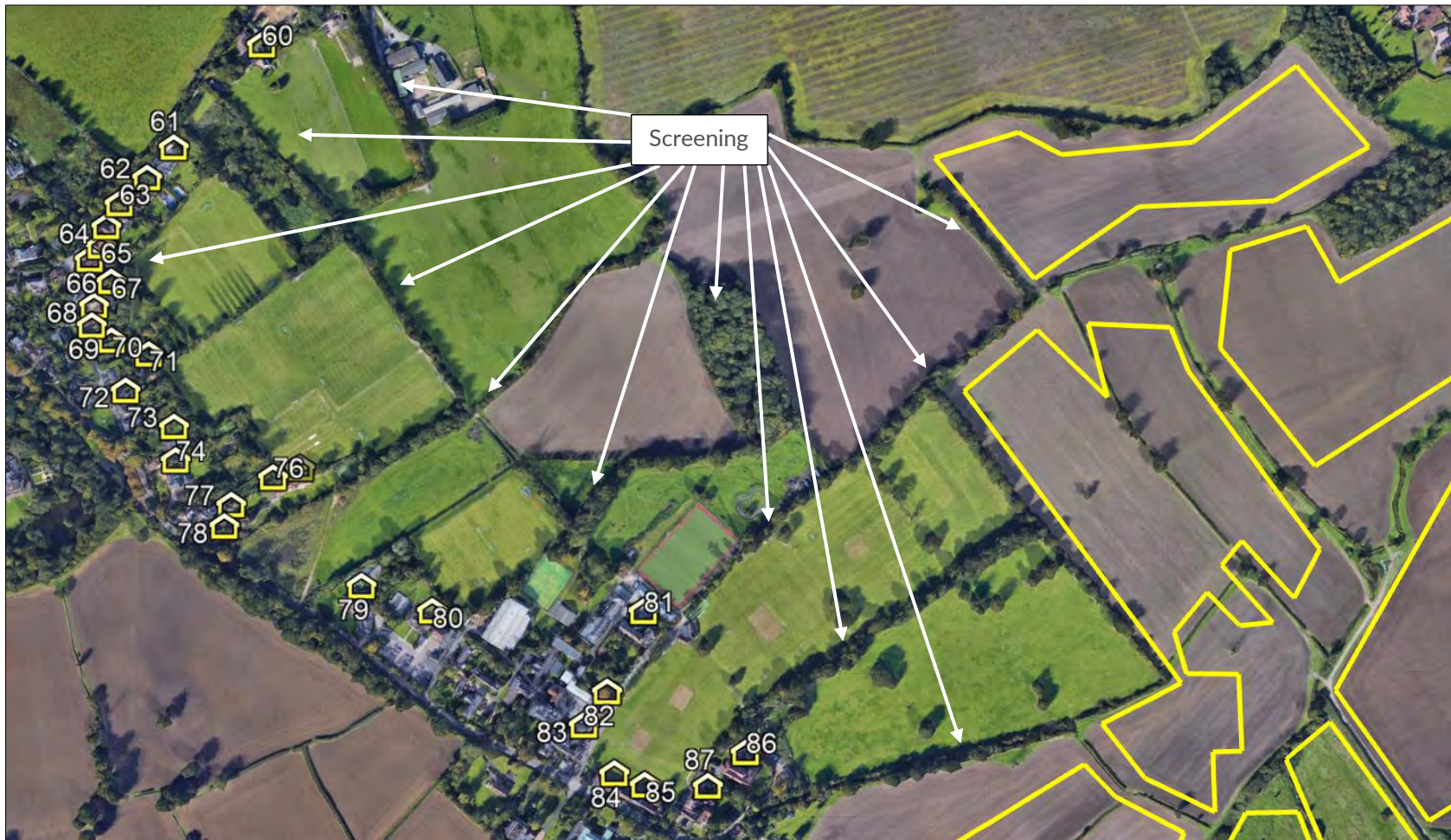


Figure 37 - Existing screening for dwellings 60 to 87



Figure 38 – Existing screening for dwellings 92 to 98

## 9.6 Roads

### 9.6.1 M1

The results of the analysis have shown that the reflections from the proposed development are geometrically possible towards 12 out of the 18 identified road receptors along the M1. Impact significance is determined on the level of visibility, the classification of the road and its relative traffic volumes, the location of the reflection relative to the road, and the relative position of the sun.

The potentially affected road locations are shown in the Figure 39<sup>41</sup> below. It can be seen from the same image that screening in the form of existing vegetation or buildings will block any view of the reflective surface for all identified locations.



Figure 39 – Potentially affected locations on M1

<sup>41</sup> Source: Copyright © 2020 Google.

Roadside screening has also been identified, which will further reduce the visibility of the proposed development (see Figure 40 and Figure 41<sup>42</sup> below).

No impact is expected and therefore, no further mitigation is required.

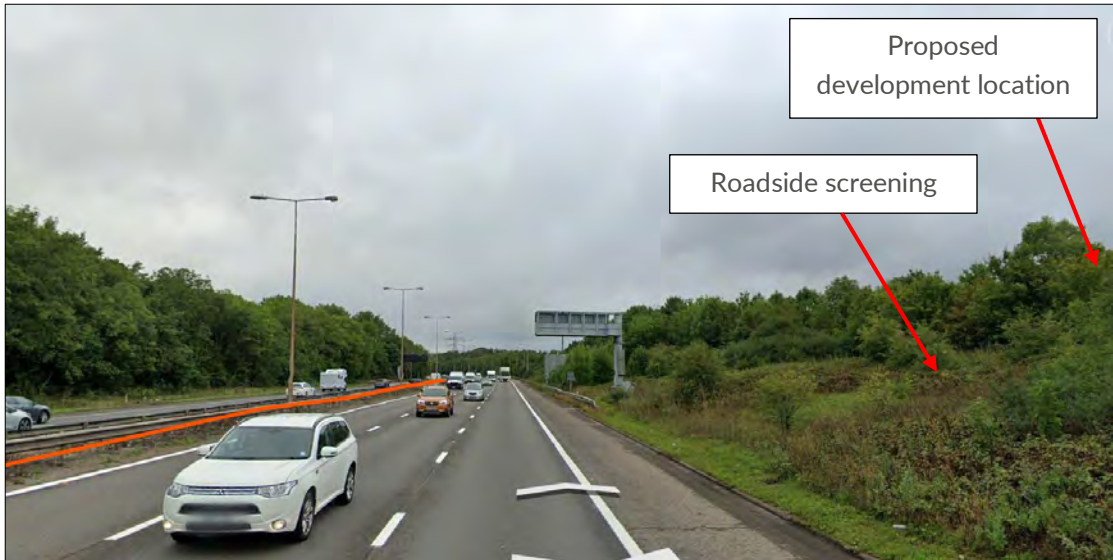


Figure 40 – Roadside screening for M1 at receptor 5 facing receptor 4

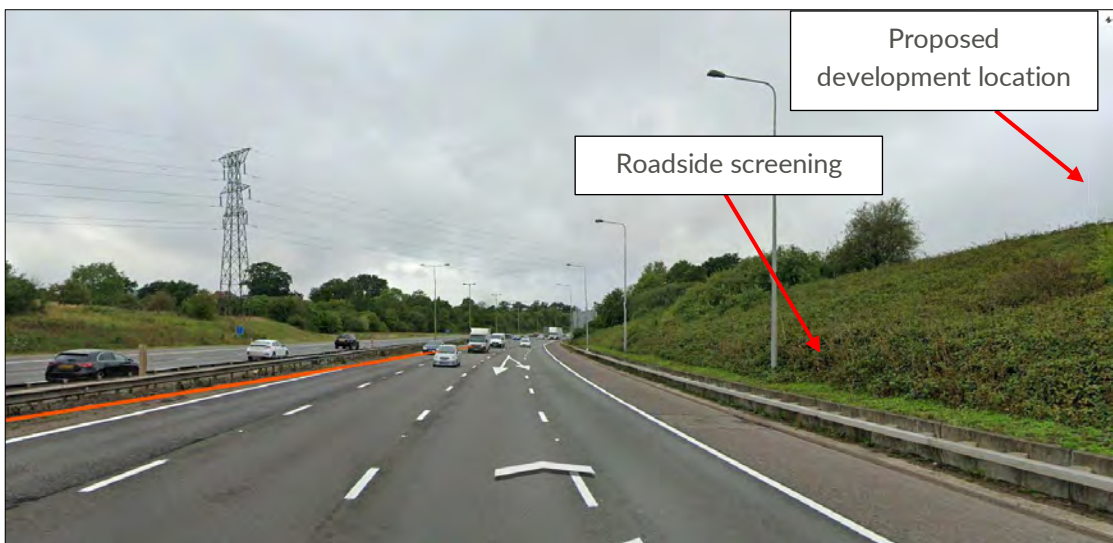


Figure 41 – Roadside screening for M1 at receptor 10 facing receptor 9

<sup>42</sup> Source: Copyright © 2020 Google.



### 9.6.2 A41

The results of the analysis have shown that the reflections from the proposed development are geometrically possible towards seven out of the nine identified road receptors along the A41.

The potentially affected road locations are shown in the Figure 42<sup>43</sup> below. It can be seen from the same image that screening in the form of vegetation will block any view of the reflective surface for some of the receptor locations (18 and 20 to 24), an example of the roadside screening is shown in Figure 43 on the following page. For drivers travelling across receptor location 19 views of the reflective area of Site 15 to 18 will not be possible.

No impact is expected and therefore, no further mitigation is required.



Figure 42 – Potentially affected locations on the A41

<sup>43</sup> Source: Copyright © 2020 Google.

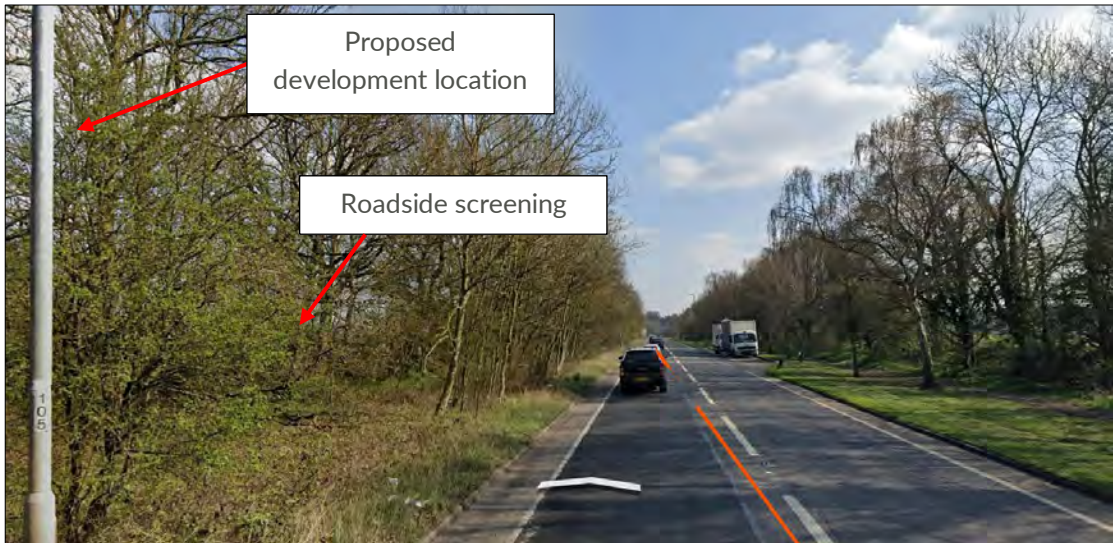


Figure 43 – Roadside screening for the A41 at receptor 21 proceeding south-east

### 9.6.3 Hilfield Lane

The results of the analysis have shown that the reflections from the proposed development are geometrically possible towards all the 12 identified road receptors along Hilfield Lane.

The potentially affected road locations are shown in the Figure 44<sup>44</sup> on the following page. It can be seen from the same image and from Figure 45 and Figure 46 on pages 139 and 139 respectively that screening in the form of vegetation will block any view of the reflective surface for all assessed locations.

No impact is expected and therefore, no further mitigation is required.

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<sup>44</sup> Source: Copyright © 2020 Google.

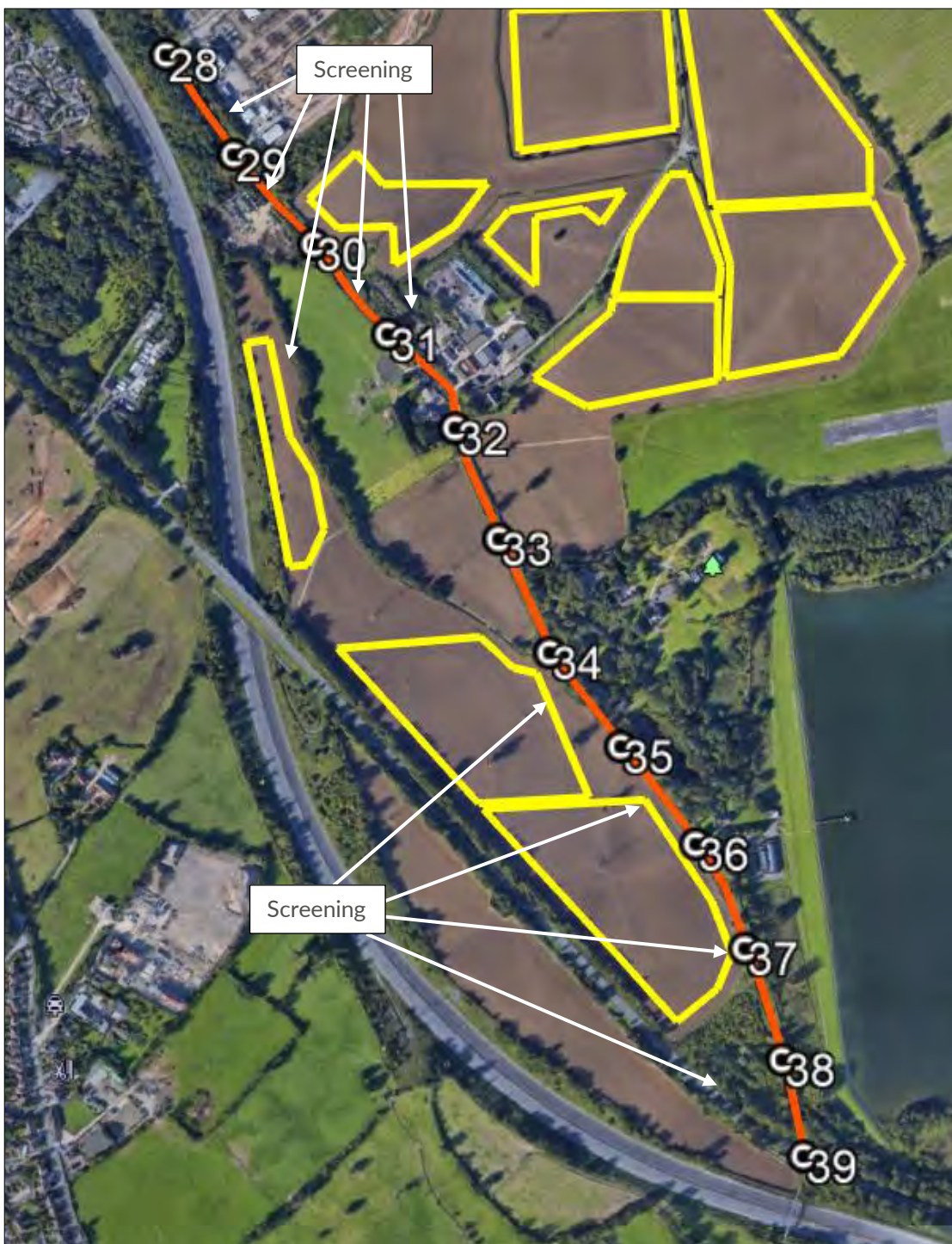


Figure 44 - Potentially affected locations on Hilfield Lane

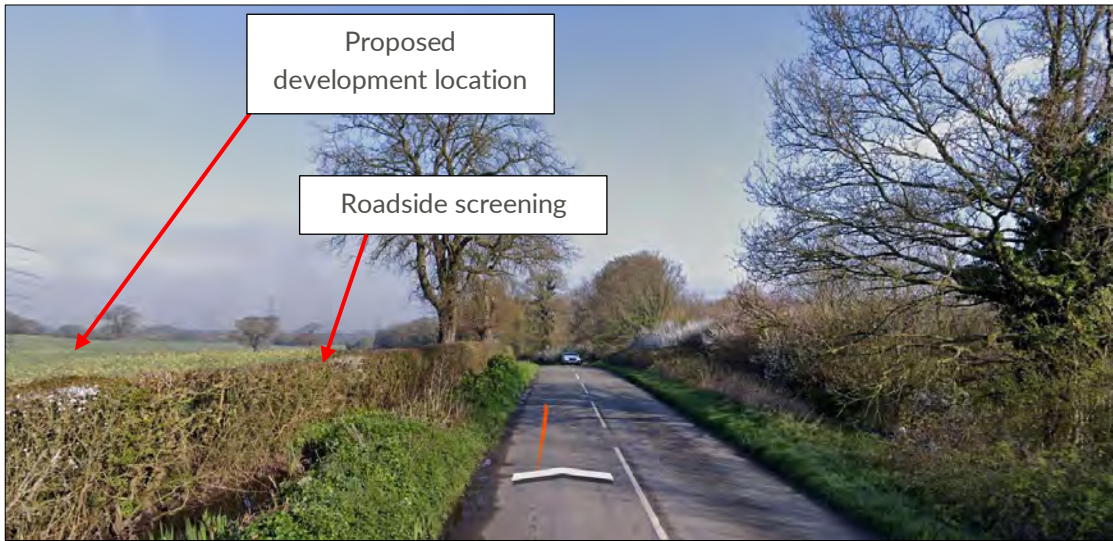


Figure 45 – Roadside screening for Hilfield Lane at receptor 37 proceeding north



Figure 46 – Roadside screening for Hilfield Lane at receptor 35 proceeding north

#### 9.6.4 Aldenham Road

The results of the analysis have shown that the reflections from the proposed development are geometrically possible towards all the 11 identified road receptors along Aldenham Road.

The potentially affected road locations are shown in the Figure 47<sup>45</sup> below. For locations 40 to 45 and 49 and 50 visibility of the reflective area will be blocked by either existing vegetation or terrain. For these locations, no impact is expected, and no mitigation will be required.

For road location 46, 47 and 48 visibility of the reflective area will be significantly reduced by roadside vegetation (see Figure 48, Figure 49 and Figure 50 on the following pages). Further considerations should be made:

- Despite reflections generating within the drivers' field of view, they will not generate in front of the drivers;
- Traffic volumes on Aldenham Road are not expected to be high;
- Sunlight and reflection will generate approximately in the same point in space with sun being a much brighter source of light;

Therefore, no to low impact is expected and no mitigation is required.



Figure 47 – Potentially affected locations on Aldenham Road

<sup>45</sup>Source: Aerial image copyright © 2020 Google.

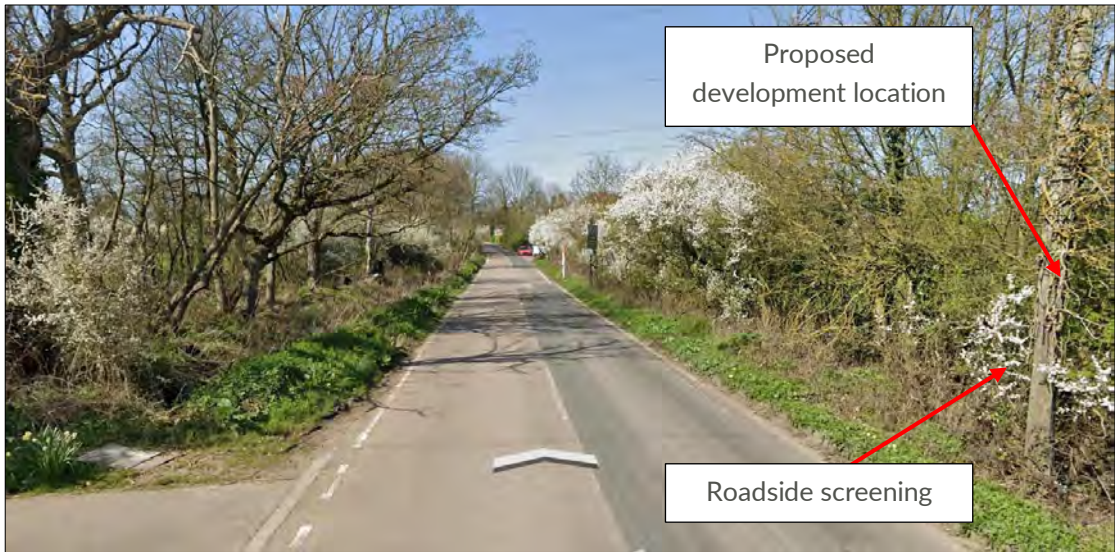


Figure 48 – Roadside screening for Aldenham Road at receptor 36 proceeding north



Figure 49 – Roadside screening for Aldenham Road at receptor 37 proceeding north



Figure 50 – Roadside screening for Aldenham Road at receptor 38 proceeding north

#### 9.6.5 Butterfly Lane

The results of the analysis have shown that the reflections from the proposed development are geometrically possible towards all the 8 identified road receptors along the Butterfly Lane.

For receptor 51 and 52 reflection will be screened by terrain and no impact is expected meanwhile buildings will block reflection for reflector points 55 and 56. The potentially remaining affected road locations are shown in the Figure 51<sup>46</sup> on the following page. It can be seen from Figure 52 on the following page that, under the current baseline scenario, some screening in the form of vegetation exist. However, this level of screening is not expected to remove views of the reflective area. The developer has therefore proposed screening in the form of vegetation on the southern boundary which is expected to eliminate all view of the proposed development (see Figure 53 on page 144).

Therefore, no impact is expected, and no further mitigation is required.

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<sup>46</sup> Source: Aerial image copyright © 2020 Google.



Figure 51 – Potentially affected locations on Butterfly Lane



Figure 52 – Roadside screening for Butterfly Lane at receptor 57 proceeding towards 56



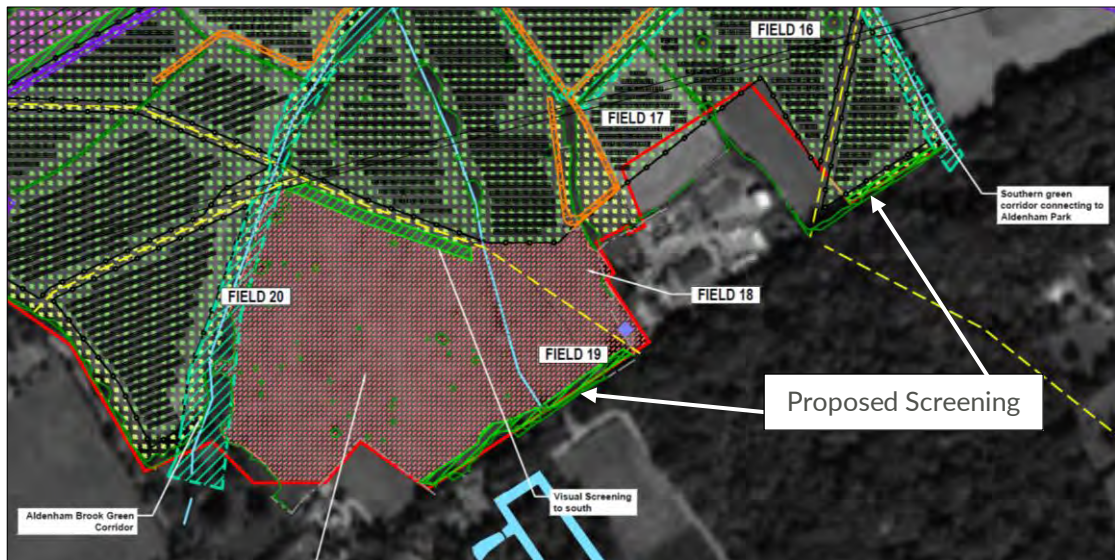


Figure 53 – Proposed Screening (green line) to eliminate any impact upon drivers travelling along Butterfly lane

#### 9.6.6 A5183

The results of the analysis have shown that the reflections from the proposed development are geometrically possible towards all the 12 identified road receptors along the A5183.

The potentially affected road locations are shown in the Figure 54<sup>47</sup> on the following page. It can be seen from the Figure 54 and from Figure 55 on the following page that screening in the form of vegetation will block any view of the reflective surface for all assessed locations. Furthermore, reflections are expected not to generate in front of drivers travelling across the A5183.

No impact is expected and therefore, no further mitigation is required.

<sup>47</sup> Source: Aerial image copyright © 2020 Google.



Figure 54 – Potentially affected locations on the A5183

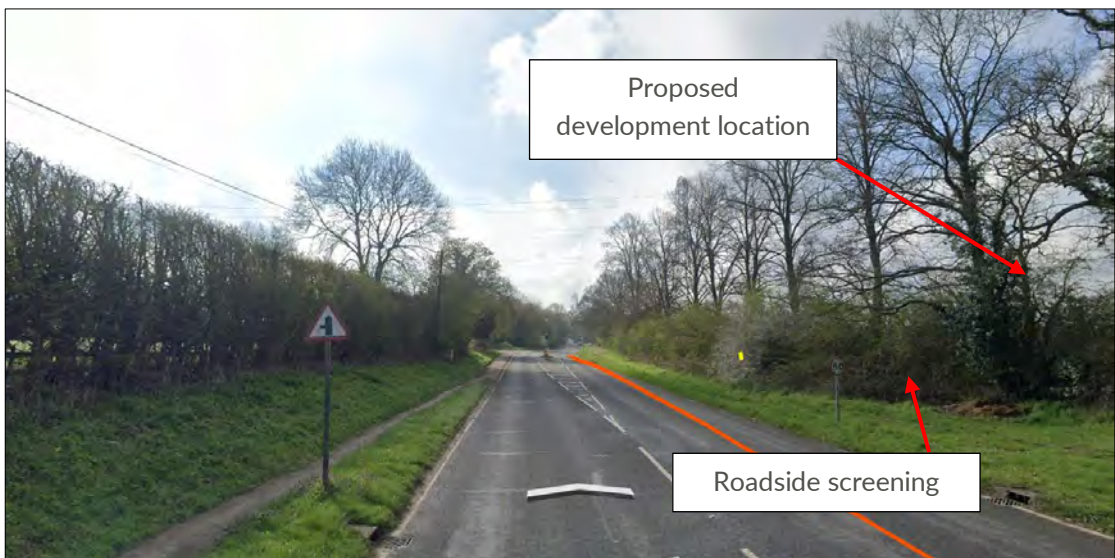


Figure 55 – Roadside screening for the A5183 at receptor 62 proceeding south

## 10 OVERALL CONCLUSIONS

### Assessment Results – Overall Conclusion

The glint and glare assessment has shown that:

- For all aviation receptors, the maximum impact is low and no mitigation is required. However, the airport's position regarding this potential glare should be confirmed. Mitigation strategies are not recommended.
- For only four dwelling receptors, the impact is moderate under the current baseline conditions and mitigation is required. For these dwelling receptors, no impact is expected once the mitigation strategy shown on the LEEP plan is implemented which will be sufficient to remove all views of the reflective areas.
- For only four road receptors the impact is moderate, and mitigation is recommended.

### 10.1 Assessment Results – Aviation

#### 10.1.1 ATC Tower

The analysis has shown that solar reflections from the proposed solar development towards the ATC Tower are geometrically possible. However, a review of available imagery and on-site survey have shown that visibility of the reflective area is not possible due to intervening terrain. Therefore, no impact is expected, and no mitigation is required.

#### 10.1.2 Aviation Receptors – Approach 08

The Pager Power model indicates that solar reflections are possible towards the entire runway 08 approach path. Forge predicts that at a distance of 1.1 miles from the threshold, the intensity of reflections is expected to have a potential for temporary after-image meanwhile for the rest of the approach path the intensity of reflections is expected to have a low potential for temporary after-image.

Solar reflections with potential for temporary after-image will occur at circa 6:50 GMT at the beginning of March and at circa 6:20 GMT at the beginning of October. In total solar reflections with potential for temporary after-image are predicted to for a maximum of 3 minutes per year.

While glare with potential for temporary after-image has been predicted, impacts upon pilots approaching runway 08 are judged to be not significant. This because the amount of glare where potential for after-image is possible per year is minimal (only 0.001% of daylight time per year) and the glare produced by the panels and sunlight will generate from approximately the same point in space.

#### 10.1.3 Aviation Receptors – Approach 26

The Pager Power model indicates that solar reflections are possible towards the entire runway 26 approach path. Forge predicts solar reflection with potential for after-image between threshold and 0.2 miles, at 0.8 miles from the threshold and between 1.0 mile and 1.2 miles from

the threshold. At all other locations, the intensity of reflections is expected to have low potential for temporary after-image.

A review of the available imagery shows that the reflective area located west of the airport is significantly obstructed from view of a pilot by terrain and vegetation for aircrafts travelling between 0.2 miles and the threshold. Therefore, at these locations, any glare with potential for after-image will be sufficiently screened and pilots approaching runway 26 will not be affected.

Solar reflections with potential for temporary after-image will occur at circa 17:30 from the end of April to the end of end of May and from mid-July to mid-August and at circa 18:00 from the end of May until mid-July. In total solar reflections with potential for temporary after-image are predicted to for a maximum of 172 minutes per year.

While glare with potential with potential for temporary after-image has been predicted, impacts upon pilots approaching runway 26 are judged to be not significant. This because the amount of glare where potential for after-image is possible per year is minimal (only 0.065% of daylight time per year) and the glare will not generate near the threshold.

### **10.2 Assessment Results - Dwellings**

Four dwelling receptors located immediately east of the proposed development will concurrently experience reflections for more than 3 months per year but for less than 1 hour per day and be only partially screened under baseline conditions. While the results of the analysis have shown that the solar reflections from the proposed development are geometrically possible towards four dwelling receptors under the baseline, the review of available imagery showed that existing screening in form of vegetation and the proposed screening as shown the LEEP will sufficiently remove all views of the reflective areas from dwelling receptors.

Therefore, no impact is expected, and no further mitigation is required.

### **10.3 Assessment Results - Roads**

While the results of the analysis have shown that the solar reflections from the proposed development are geometrically possible towards 57 out of the 69 identified road receptors, the review of available imagery showed that existing screening in form of vegetation will block all views of the reflective area for 53 of those road receptors.

The remaining four receptors are located on Butterfly Lane where some existing screening, which will partially screen the proposed development, has been identified. The developer has however proposed further screening which will fully block all views of the proposed development.

Therefore, no impact is expected and therefore further mitigation is not required.