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High-level Investigative Report

April 2025

PAGERPOWER
Urban & Renewables

High-Level Investigative Report

Stantec UK Ltd

Helios Renewable Energy Project

April~~February~~ 2025

PLANNING SOLUTIONS FOR:

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has conducted analysis to identify the most significant risks associated with the development of the proposed solar development: the Helios Renewable Energy Project. This report investigates concerns with regards to: Glider Launch Failure (GLF), wind shear and turbulence, updraft, electromagnetic field (EMF) and interference (EMI) in the interest of Burn Airfield and Burn Gliding Club.

Assessment Conclusions

No significant impacts are predicted upon aviation activity associated with Burn Airfield and Burn Gliding Club.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 60 countries within Europe, Africa, America, Asia and Australasia.

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

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

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

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

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

1 BACKGROUND

1.1 Introduction

Pager Power has conducted analysis to identify the most significant risks associated with the development of the proposed solar development: the Helios Renewable Energy Project. This report investigates concerns with regards to Glider Launch Failure (GLF), wind shear and turbulence, updraft, electromagnetic field (EMF) and interference (EMI) in the interest of Burn Airfield and Burn Gliding Club.

In detail, the report includes:

- Proposed development details;
- Burn Airfield and Burn Gliding Club details;
- High-level commentary regarding glider launch failure (GLF);
- High-level commentary regarding wind shear, updraft and turbulence;
- High-level commentary regarding EMF and EMI;
- Conclusions and recommendations.

1.2 Guidance and Methodology

There is no known guidance in the United Kingdom or internationally pertaining to the GLF and EMI effects of solar developments upon aviation operations.

There is no known guidance in the United Kingdom or internationally pertaining to the turbulence effects of solar developments on aviation operations. The United Kingdom's (UK) Civil Aviation Authority (CAA) Policy and Guidelines on Wind Turbines[1] and Pager Power's industry experience has been used for reference (and its technical merit) within this assessment.

The Combined Aerodrome Safeguarding Team (CAST), supported by the CAA have published a Guidance Note[2] that outlines safeguarding considerations for solar developments but does not provide specific details.

Furthermore, Pager Power's industry experience has shown that turbulence effects can extend downstream of a development between 10-20 times the height of the building/development. This is further reinforced by the recommended 16 rotor diameter distance (for wind turbines) defined by the CAA for wind turbines. This distance represents a highly conservative case as wind turbines are significantly larger than solar panels and buildings in addition to also having moving components.

[1] CAP 764 Sixth Edition dated February 2016 - Paragraphs 2.51 through 2.61 cover Turbulence and Wake Effects.

[2] CAST Aerodrome Safeguarding Guidance Note, 'Renewable energy developments: solar photovoltaic developments', July 2023

1.3 CAA CAP 764

The guidance discussed is contained within the CAA Civil Aviation Publication (CAP) 764 guidance, Sixth Edition, published in February 2016. Key information has been underlined for reference.

'2.51 Turbulence is caused by the wake of the turbine which extends down-wind behind the blades and the tower, from a near to a far field. The dissipation of the wake and the reduction of its intensity depend on the convection, the turbulence diffusion, the topography (obstacles, terrain etc.) and the atmospheric conditions.

2.52 There is evidence of considerable research activity on modelling and studying the wake characteristics within wind developments, using computational fluid dynamics techniques, wind tunnel tests and on site LIDAR measurements. A literature survey was recently conducted by the University of Liverpool and CAA[3] to establish the scale and the advances of current research on this front.

2.53 It is recognised that aircraft wake vortices can be hazardous to other aircraft, and that wind turbines produce wakes of similar, but not identical, characteristics to aircraft. Although there are independent bodies of knowledge for both of the above, currently, there is no known method of linking the two. <u>Published research shows measurements at 16 rotor diameters downstream of the wind turbine indicating that turbulence effects are still noticeable[4].</u> Measurement work has been focused on the near wake due to technical challenges of the experimental set up, while modelling studies are capable of examining the wake turbulence further downstream[5,6]. Although models can be used to study the effects of the far wake, verification and validation processes of these models are still ongoing[7].

2.54 There are currently no Mandatory Occurrence Reports (MOR)[8] or aircraft accident reports related to wind turbines in the UK. However, the CAA has received anecdotal reports of aircraft encounters with wind turbine wakes representing a wide variety of views as to the significance of the turbulence. Although research on wind turbine wakes has been carried out, the effects of these wakes on aircraft are not yet known. Furthermore, the CAA is not aware of any formal flight trials to investigate wake effects behind operating wind turbines. In the UK wind turbines are being proposed and built close to aerodromes (both licensed and unlicensed), including some developments on

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[3] http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

[4] Wind Turbine Wake Analysis, L.J. Vermeer, J.N. Sorenson, A Crespo, Progress in Aerospace Sciences, 39 (2003) 467-510.

[5] Calculating the flow field in the wake of wind turbines, J.F. Ainslie, Journal of Wind Engineering and Industrial Aerodynamics, 27 (1988) 213-224.

[6] Turbulence characteristics in wind-turbine wakes, A Crespo and J Hernandez, Journal of Wind Engineering and Industrial Aerodynamics 61 (1996) 71-85.

[7] Investigation and Validation or Wind turbine Wake Models, A Duckworth and R.J. Barthelmie, Wind Engineering, 32 (2008) 459-475. Also http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/ Investigation and Validation or Wind turbine Wake Models, A Duckworth and R.J. Barthelmie, Wind Engineering, 32 (2008) 459-475. Also http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

[8] CAP 382 - The Mandatory Occurrence Reporting Scheme - comment verified against CAA database up to 30 June 2015.

aerodrome sites, indicating an urgent need to assess the potential impact of turbulence on aircraft and in particular, to light aircraft and helicopters.

2.55 The CAA has so far investigated the effects of small wind turbine wakes on GA aircraft[9]*. The results of this study show that wind turbines of rotor diameter (RD) of less than 30m should be treated like an obstacle and GA aircraft should maintain a 500ft clearance. Regarding wind turbines of larger RD than 30m; these are subject to further investigations. Until the results of these investigations are available, discussions between aerodrome managers and wind farm developers are encouraged, taking note of existing CAA safeguarding guidance. As the results of this research become available the CAA Wind Energy web pages will be updated.*

2.56 Pilots of any air vehicle who firmly believe that they have encountered significant turbulence, which they believe to have been caused by a wind turbine, should consider the need to report this through the existing MOR scheme.

2.57 Until the result of further research is known, analysis of turbulence can only be undertaken on a case-by-case basis, taking into account the proximity of the development and the type of aviation activity conducted. Whilst being a consideration for all aircraft (particularly in critical stages of flight), turbulence is of particular concern to those involved in very light sport aviation such as gliding, parachuting, hang-gliding, paragliding or microlight operations as in certain circumstances turbulence could potentially cause loss of control that is impossible to recover from.'

[9] http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

2 PROPOSED DEVELOPMENT DETAILS

2.1 Overview

The site boundary[10] is shown by the redline in Figure 1 below.

Figure 1 *Site boundary*

The proposed panels will be three metres above ground level at maximum height and implement a single-axis tracking system that tracks the movement of the Sun between angles ±60° from the horizontal.

[10] Source: Stantec, February 2024, 'DX-01-P01 Rev11 Site Location Plan'

3 BURN AIRFIELD AND BURN GLIDING CLUB DETAILS

3.1 Overview

The following sections present key information[11] regarding Burn Airfield; an unlicensed aerodrome operated by Burn Gliding Club. Further information can be found via their website[12].

The proposed development relative to Burn Airfield is shown in Figure 2 below.

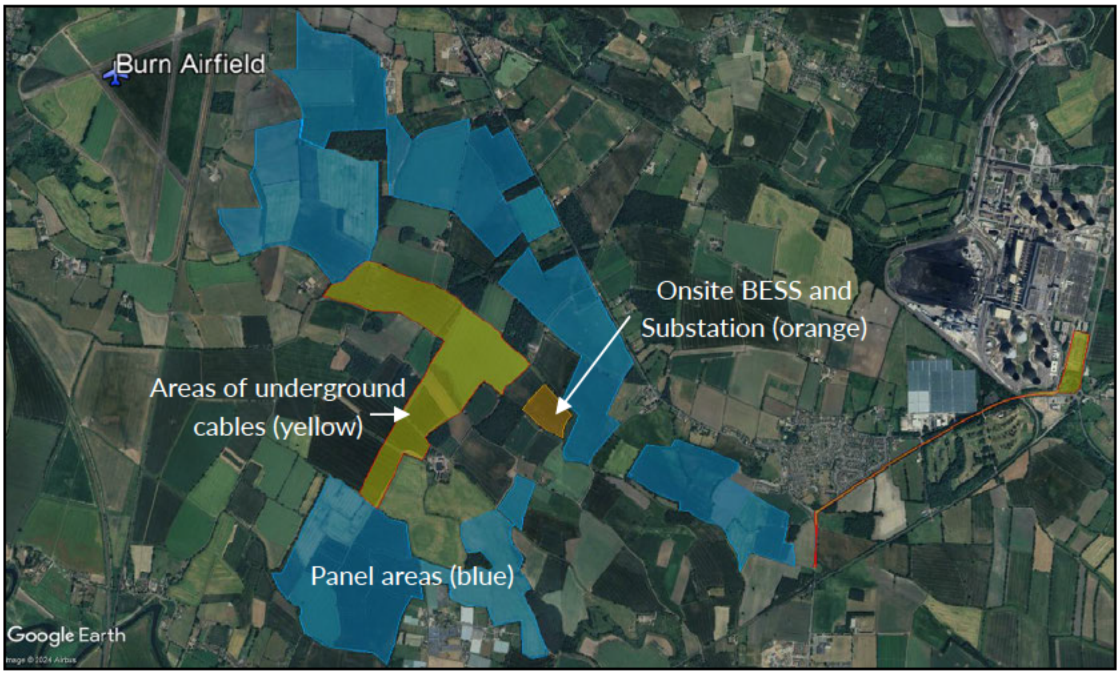

Figure 2 *Burn Airfield relative to proposed development*

3.2 Runway Details

Burn Airfield is elevated at 20 feet above mean sea level (amsl) and has three operational runways, the details of which are presented in Table 1 below.

Runway	Dimensions (used by aircraft)	Dimensions (used by support vehicles)
01/19	1,100m × 19m	1,520m × 45m
07/25	1300m × 25m	1370m × 45m
15/33	950m × 33m	1270m × 45m

Table 1 *Runway dimensions*

[11] Source: Burn Gliding Club Chief Flight Instructor
[12] Source: https://burnglidingclub.co.uk/

3.3 Navigation Aids and Radio Communications

Burn Airfield does not use navigation aids. The details of the radio communications and frequencies are presented in Table 2 below.

Radio Communication	Frequency
Airband Radio	129.98 MHz
FLARM (Flight Alarm System)	868.20 – 868.40 MHz
Sky Launch Assist	869.75 MHz
ADS-B (Automatic Dependent Surveillance – Broadcast)	1090.00 MHz
Ground Ultra-High Frequency (UHF) Radios	400.00 – 470.00 MHz

Table 2 *Radio communication and frequencies*

4 HIGH-LEVEL GLIDER LAUNCH FAILURE ASSESSMENT

4.1 Overview

Glider Launch Failure (GLF) can be considered as a failure of the launch from the point after the wheels leave the ground until the aircraft reaches a height[13] of 300ft above the ground.

To maintain air speed, it is recommended that turns greater than 45 degrees are avoided. The GLF areas therefore start from the runway threshold and extend 45 degrees on each side.

4.2 Assessment

The areas for GLF are located beyond the runway thresholds in the direction of the extended runway centreline. The following GLF areas are defined by Burn Gliding Club:

> *'Where there is insufficient height to turn then the glider must land in any suitable area ahead. We currently have suitable fields along the launch paths from all of our runways extending 2km from the launch points (Runway intersections) Depending on the local weather conditions the glider may be able to turn back towards the airfield above 400ft AGL.'*
>
> *'Suitable fields need to be some 200m long, 50m wide, flat without any obstructions such as overhead cables, livestock.'*
>
> *'A gentle upslope can be accepted but a landing across a slope is not encouraged while landing down a slope is not achievable.'*

The proposed development is directly adjacent of Burn Airfield. Therefore, the proposed development has the potential to effect GLF areas associated with runways 07, 15 and 19.

Figures 3 to 5 on the following pages show the areas of land relative to the proposed development within 2.00km from the launch points (runway intersections), considering 45 degrees either side of the runway centreline. The runway centreline and 45-degree areas either side of the runway have been illustrated for runway 07 (Figure 3).

[13] This figure is based on a literature review of *The Glider Pilot's Manual* by Ken Stewart

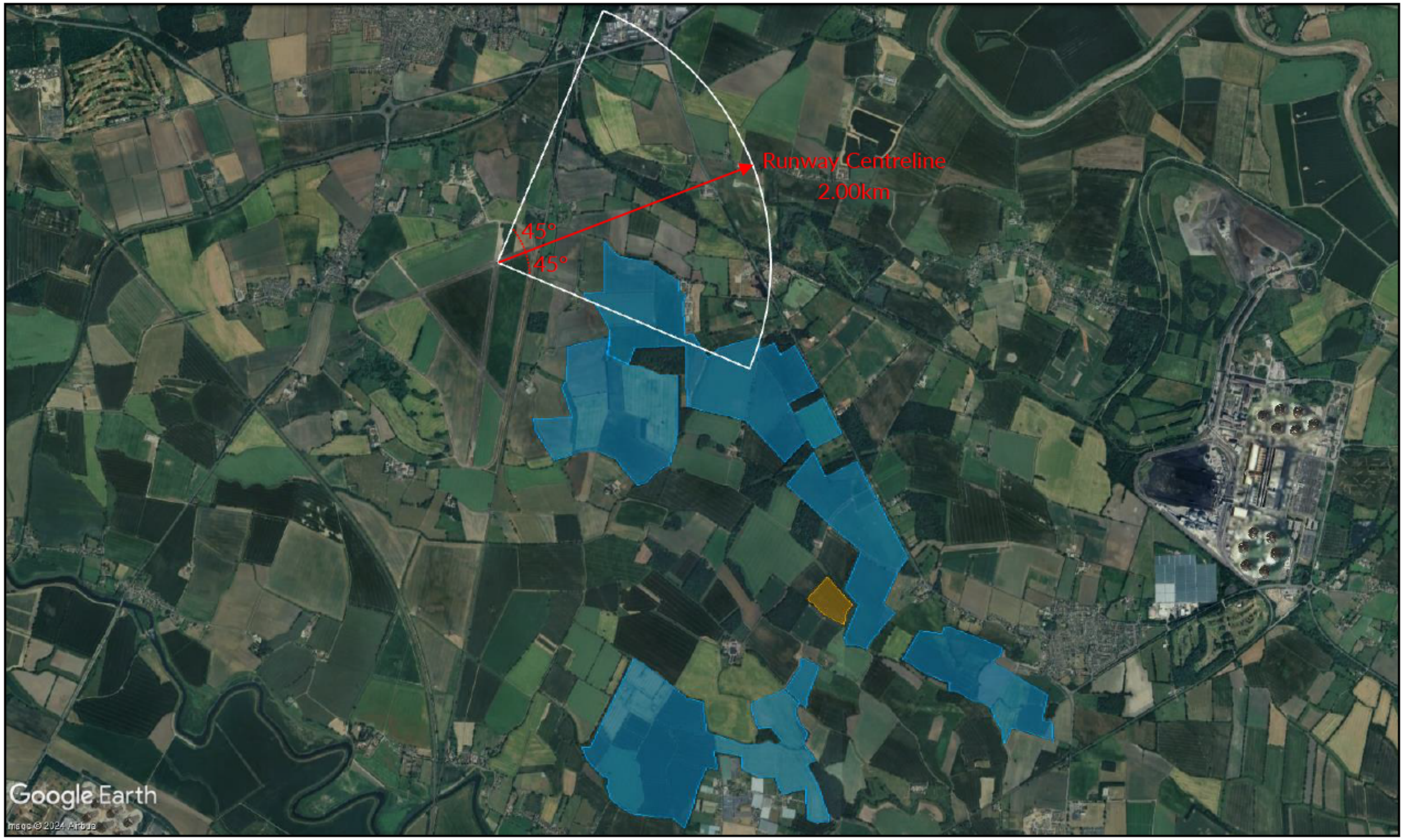

Figure 3 *GLF areas from runway 07 relative to proposed development*

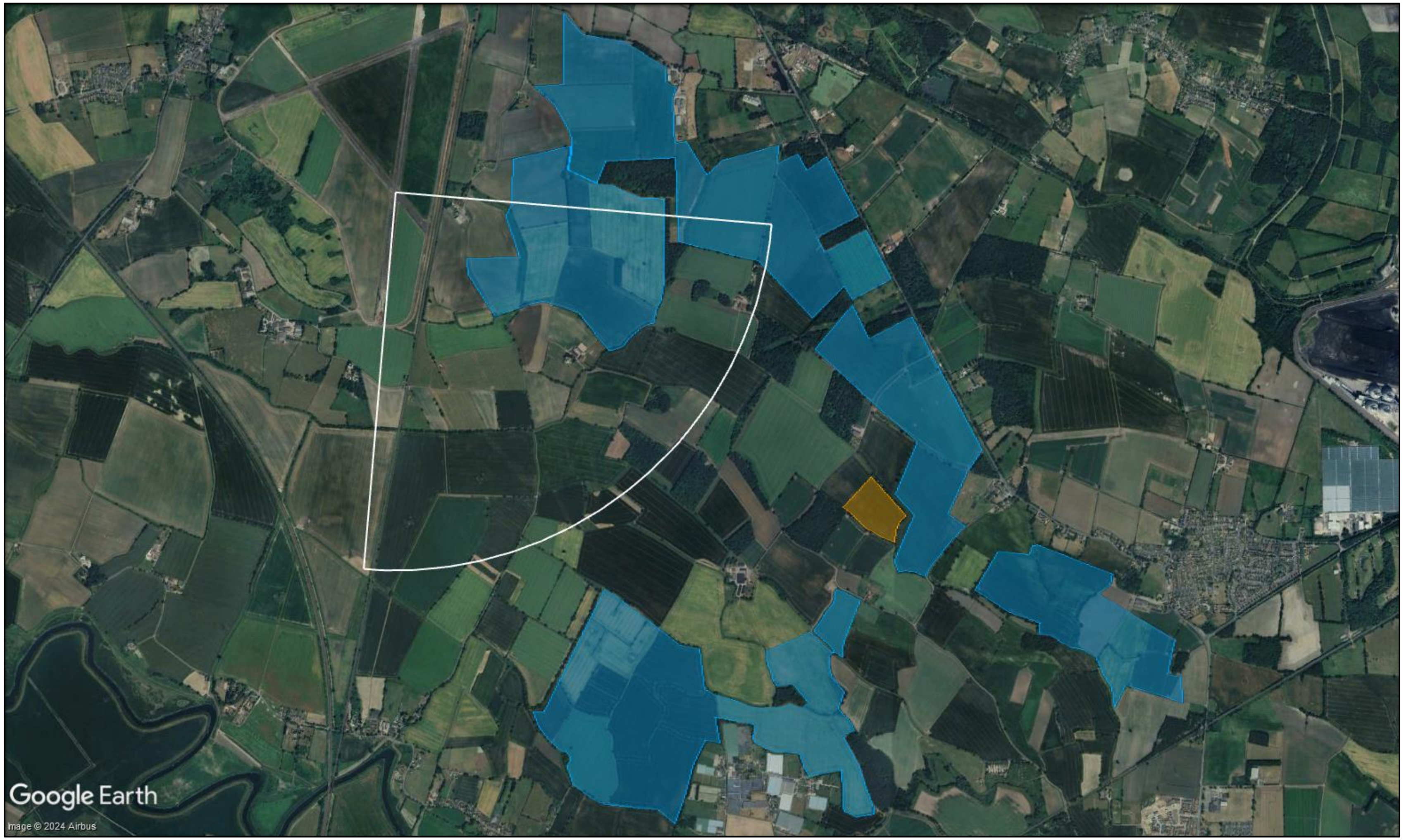

Figure 4 *GLF areas from runway 15 relative to proposed development*

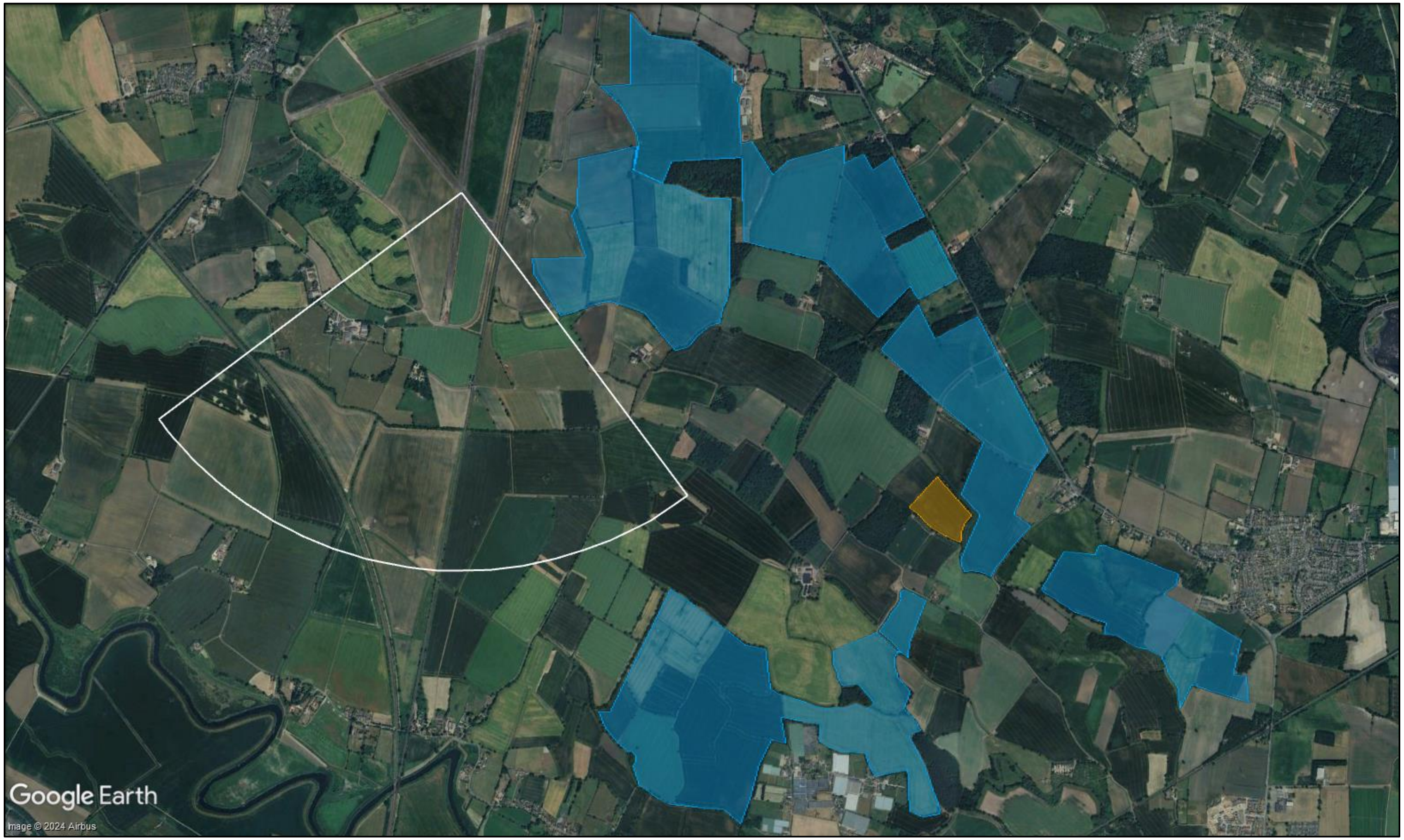

Figure 5 *GLF areas from runway 19 relative to proposed development*

The proposed development is shown not to reduce the area defined for GLF from runway 19. Therefore, no further analysis is presented for this runway.

Burn Gliding Club have defined suitable areas available following GLF from runways 07 and 15 (without consideration to the proposed development). Figures 6 and 7 on the following pages show areas that are not suitable for an emergency landing (in areas of red) relative to the panel areas (blue) and the BESS (orange) for the proposed development.

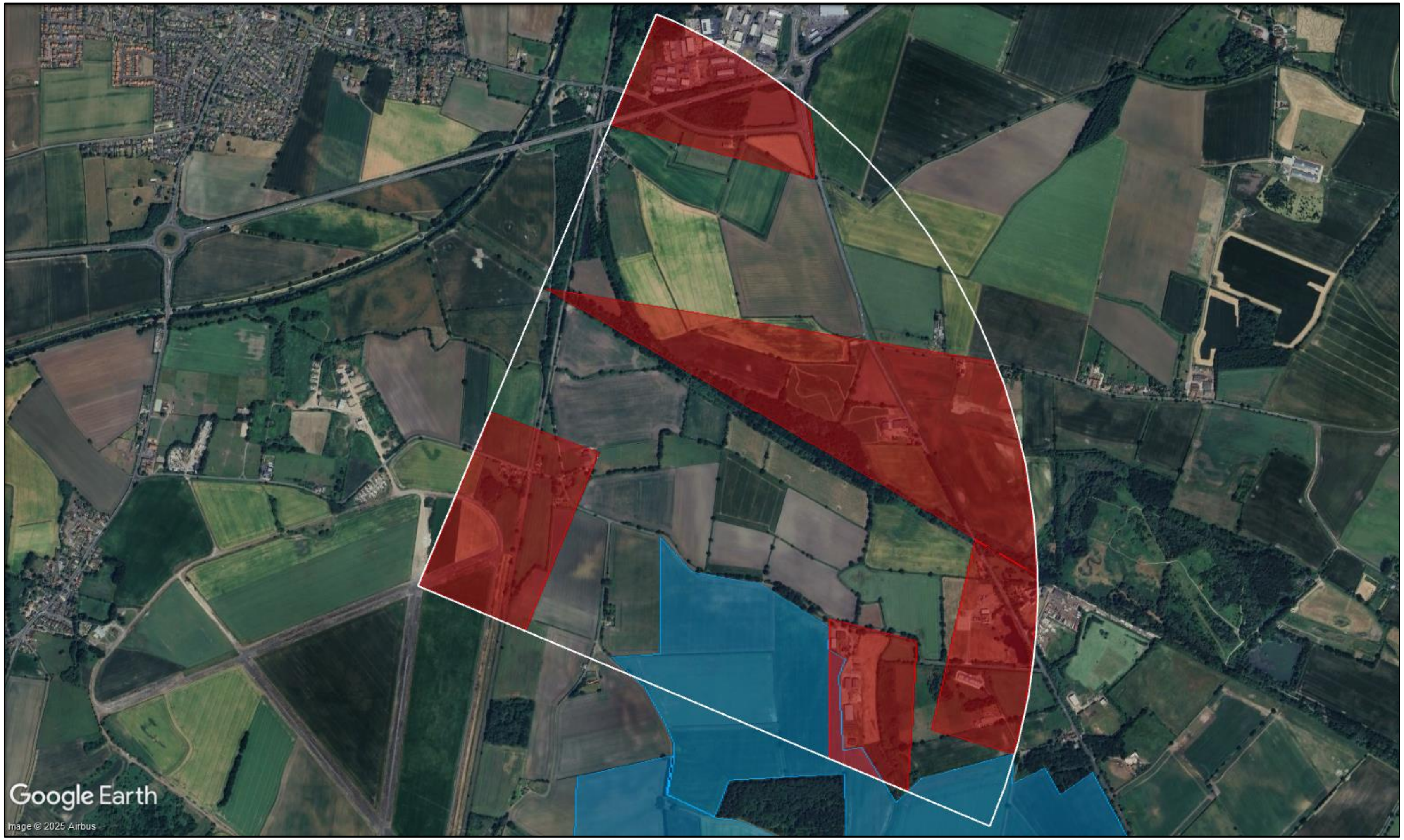

Figure 6 *GLF areas from runway 07 relative to proposed development and suitable areas*

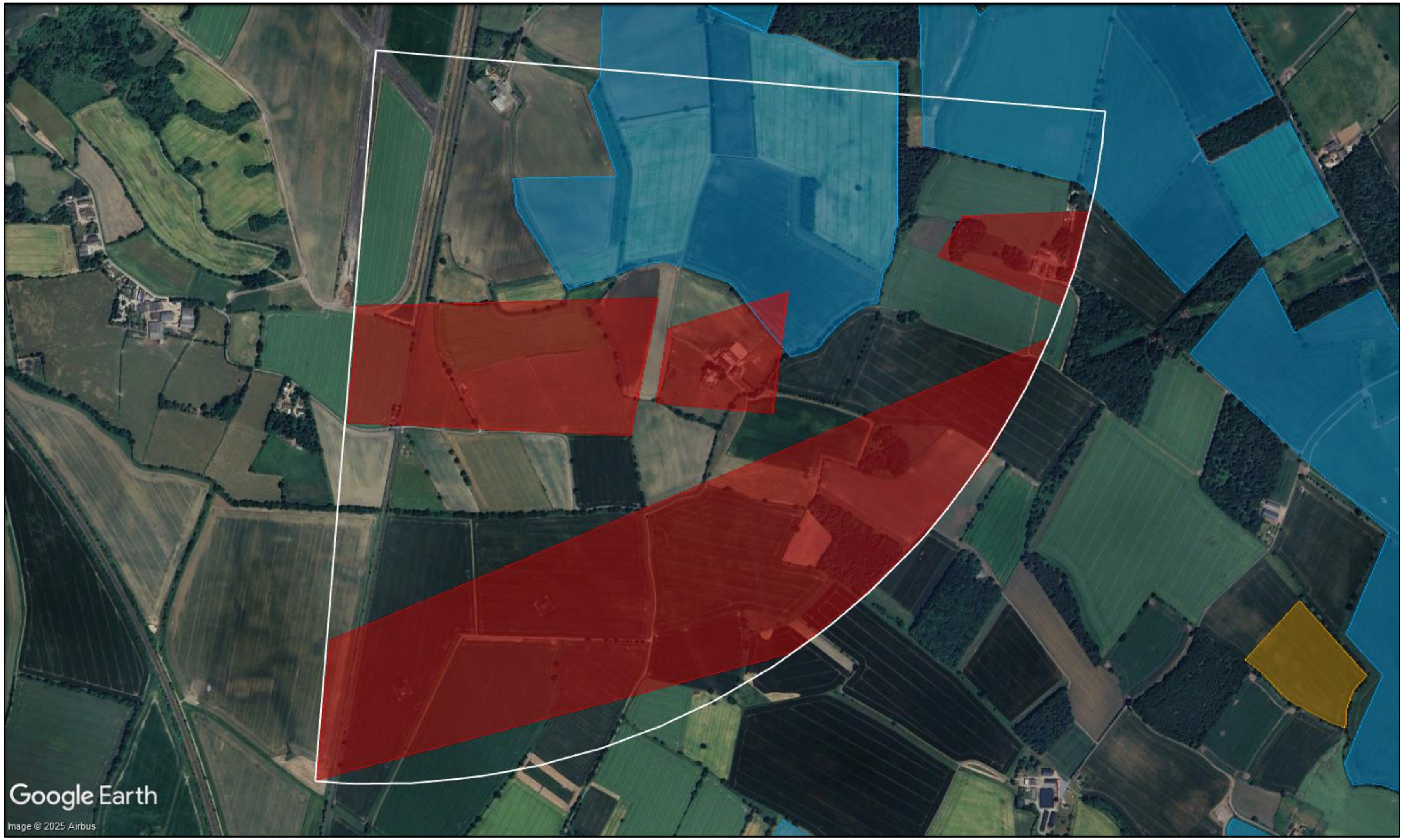

Figure 7 *GLF areas from runway 15 relative to proposed development and suitable areas*

Table 3 below summarises the percentage of area available within the defined areas with consideration to the proposed development and suitable areas defined by Burn Gliding Club.

Runway	Percentage of Land Unavailable (%)		Total Percentage of Available Land[14] (%)
	Due to Panels	Due to Unsuitability	
07	9%	38%	53%
15	17%	41%	42%

Table 3 *Available areas for emergency landing*

4.3 Discussion

The proposed development will reduce the available areas for an emergency landing following GLF from runways 07 and 15, but accounts for less than half of the reduction when compared to the existing baseline of available areas that are deemed suitable. The proposed development is calculated not to impact available areas following GLF from runway 19. Additionally, the options for landing straight ahead relative to the runway centreline, which is considered best practice, remains as per the baseline conditions (i.e. not impacted by the proposed development) for pilots following GLF for runways 07, 15 and 19.

The available areas for an emergency landing following GLF are not secured by landowner agreements. Therefore, the loss of land can be considered (in the worst case) comparable to a development other than a solar farm, such as livestock or industrial buildings which will pose a greater constraint than a solar panel.

4.4 Conclusion

No significant impact upon GLF is predicted due to:

- The proposed development accounting for the minority of land loss compared to existing baseline conditions;
- Landing straight ahead remains as per baseline conditions;
- The available land for an emergency landing is not secured by landowner agreement.

[14] As a total when considering the proposed development and suitable areas defined by Burn Gliding Club cumulatively.

5 HIGH-LEVEL WIND SHEAR, TURBULENCE AND UPDRAFT ASSESSMENT

5.1 Overview

Windshear and turbulence refer to the irregular movement of air caused by the changes in wind speed and direction over a short distance, due to obstacles encountered. The irregular movement of air can disrupt the stability of a glide.

During operation, especially within direct sunlight, the surface of solar panels can reach higher temperatures than its surroundings. Solar panels are designed to absorb as much energy from the sun (i.e. sunlight) as possible; however, some energy is wasted in the form of heat. This causes the surface of the panels to warm up. The heated surface then transfers this heat to the air immediately above it, causing it to increase in temperature. Warm air is less dense than the surrounding cooler air, so it rises. The upwards rising movement of warm air is what is referred to as thermal updraft/thermals.

5.2 Assessment

5.2.1 Wind Shear and Turbulence

A guideline of 10-20 times the maximum height of the proposed development, derived from Pager Power's industry experience, has been used in this high-level assessment, to remain conservative and give an overview of the potential effects.

The proposed development will implement solar panels with a maximum height of 3.0m above ground level. This height of the been multiplied by 20 to consider a 60m-buffer for the worst-case assessment, as tracking panels are parallel to the ground for the majority of the time.

The 60m-buffer centred on each runway is presented in Figure 10 on the following page.

Figure 8 *Turbulence buffer relative to the proposed development*

The proposed development is over <u>260m from the threshold at runway 33</u>~~600m away from runway 01/19~~ at its closest point, which is greater than the 60m turbulence buffer distance. Turbulence effects outside of the buffer distance would be expected to be significantly reduced and would be within the typical limits in which a pilot is trained to fly in.

Wake turbulence occurs when vortices of air form at the wingtip of an aircraft as it flies. The vortices are caused by differences in pressure above and below the wing, which causes lift.

Solar panels, including panels implementing a single-axis tracker, are stationary for the majority time as they do not move constantly, and have smooth surfaces that generate very little aerodynamic disruption. Unlike large and constantly moving objects, such as wind turbines, they do not create significant vortices or wake turbulence.

There are existing and larger obstructions such as the aerodrome clubhouse, hangar and residential areas closer to the aerodrome, and therefore a more significant source of wake turbulence due to their height. The solar panels will have a maximum height of 3m above ground level (agl), compared to the existing obstructions which have a height of up to two storeys (approximately 6m agl). Figure 8 below shows the existing obstructions relative to the proposed development.

Figure 9 *Existing obstructions relative to proposed development*

Analysis of wind data[15] (direction and mean speed) from the nearest weather station (Bramham[16]), taken from an average at a resolution of 1 hour, has been undertaken to further understand the potential impact of the proposed development from turbulence.

Figure 9 on the following page shows the duration in average hours in a year detailing wind direction[17] and mean speed, with the bearing of the wind in degrees shown on the circumference and the radial lines depicting average hours of wind direction and mean speed taken from data spanning 2013 to 2022. Turbulence towards runway 01 (bearing 280 degrees) northwest of the development is possible but historically would rarely occur at wind speeds greater than 15 knots[18].

Considering the prevailing wind direction, turbulence caused by the proposed development will most likely occur from a north-westerly through to a south-easterly direction. Turbulence is therefore most likely possible towards the west of the development towards the approach path for runway 01. Pilots on approach are expected to be of a height greater than 15m agl[19] on approach to any runway; given that the maximum height of the proposed development is 3m agl, turbulence caused by the development will be below the flight path of approaching aircraft and no significant impact is predicted. Turbulence in the southeast direction towards the runway is

[15] Met Office MIDAS Open: UK Land Surface Stations Data (1853-current). Centre for Environmental Data Analysis
[16] Located approximately 20km northwest of the proposed development
[17] The azimuth given is the true wind direction i.e., the direction from which the wind originate.
[18] Based on available data for local weather patterns and wind speeds, dependant on external factors such as terrain and atmospheric conditions
[19] Aircraft are expected to cross the threshold at a height of 50ft agl, determined through consultation with the Combined Airfield Safeguarding Team (CAST) concerning general aviation aerodromes such as Burn Airfield.

likely but for a low duration throughout the year (approximately 0.68% of hours in a year) and at low speeds (approximately 6-15 knots), therefore a negligible impact is predicted.

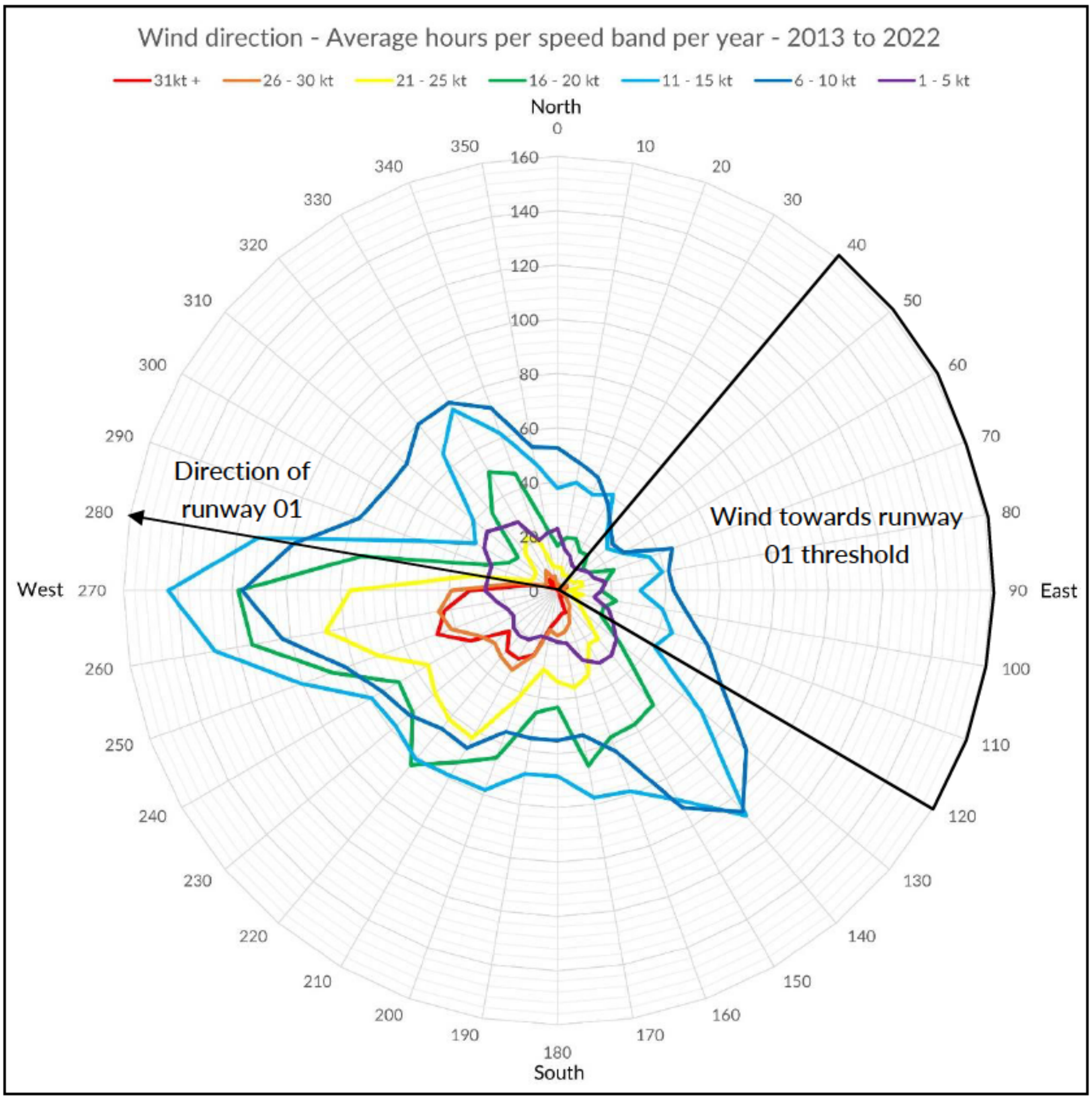

Figure 10 *Bramham historic wind data*

5.2.2 Updraft

Thermals are used by gliders to gain and maintain altitude during flight. In order to do so, gliders manoeuvre into the core of a rising thermal, referred to as centring.

Thermals from solar panels are generally weaker than natural sources relied upon, such as changes in terrain (i.e. hills), warm ground and buildings, and limited to the immediate vicinity of the solar panels (i.e. localised). Glider pilots rely on strong, sustained thermals created by larger land features such as open fields, hills, or other expansive heat sources to gain altitude and extend their flights. In comparison to solar panels which produce relatively uniform heat over a localised area, the resulting thermals lack the strength to significantly impact a glider's activity. Solar panels are designed to absorb light from the sun and typically operate most efficiently at a temperature of approximately 25°C. The panels are therefore designed to remain cool in direct sunlight, and it is not anticipated that panels would reach temperatures significantly greater than the surrounding ground.

Additionally, the configuration of solar panels will be in uniform arrays and have a consistent surface temperature during operation, the resulting updrafts are weaker due to the more uniform arrangement of panels compared to natural thermals, generated by uneven heating of the Earth's surface due to varied terrain or land cover. The resulting thermals from natural sources are much stronger and larger updrafts that are more noticeable and useful for activities like glider flight.

Gliding through a thermal without using it (i.e. centring) has minimal impact on a glider's flight performance. As the glider enters a thermal, the rising air can momentarily increase its wing tip attitude, causing the glider to tip the glider away from the thermal. These effects are momentarily experienced and not significant if not utilised by centring.

5.3 Conclusions

Following a review of the published guidance, industry experience and local weather data, it is judged that wind shear and turbulence, and updraft impacts of the proposed development upon aircraft using Burn Airfield will be of negligible impact. Detailed modelling is not recommended.

6 HIGH-LEVEL ELECTROMAGNETIC INTERFERENCE ASSESSMENT

6.1 Overview

All electrical equipment emits electric and magnetic radiation. Any power cable located within the potential development will therefore emit magnetic radiations which could negatively affect the infrastructure at Burn Airfield. Furthermore, power cables produce both electric and magnetic fields which can potentially affect human health.

Radiation from underground cables is generally less than radiation from overhead lines because emissions from adjacent conductors within a cable tend to cancel each other out. When assessing the impacts of overhead power lines, it is important to consider the impact of both electric and magnetic fields. The proposed development does not use overhead power lines.

Underground cables generally cause a negligible electric field above ground but can cause a significant magnetic field which is dependent on the current in the conductors.

6.2 Assessment

The voltages of the substation and underground cables for the proposed development are summarised in the Table 4 below.

Component	Voltage
Substation	132 kV
Underground cables	33 kV

Table 4 *Voltages of substation and underground cables*

Figure 13 on the following page shows the magnetic field strength for 132 kV underground cables relative to the distance from the cable centreline in metres. Table 5 provides the associated indicative numerical values at set distances.

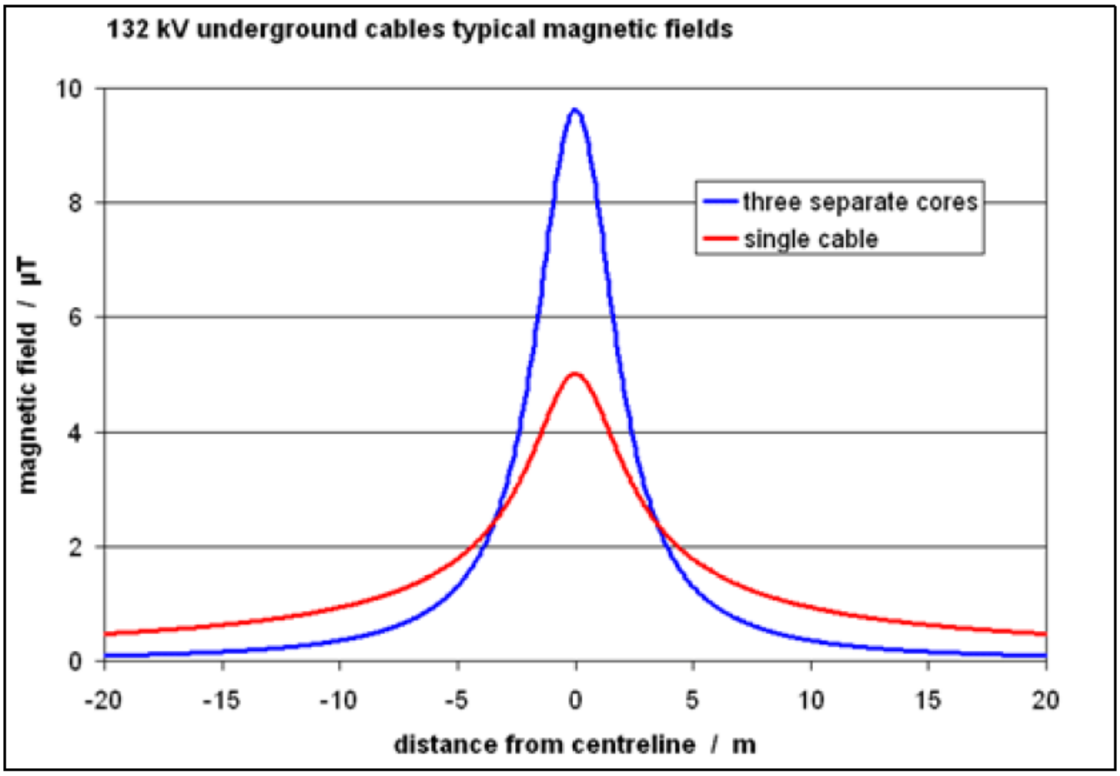

Figure 11 *Typical magnetic fields associated with 132 kV underground cable*

Distance from Centreline (m)	Magnetic Field (single 33 kV cable at 0.5m depth)
0	5.01 micro-Teslas
5	1.78 micro-Teslas
10	0.94 micro-Teslas
20	0.47 micro-Teslas

Table 5 *Typical magnetic field levels for an underground 33 kV cable (source: EMFS.info)*

The magnetic field strength for a 33 kV underground cable is seen to diminish exponentially to negligible levels within 20m. The onsite BESS and substation are more than 3.4km away from Burn Airfield.

Figure 14 on the following page shows the magnetic field strength for 33 kV underground cables relative to the distance from the cable centreline in metres. Table 6 provides the associated indicative numerical values at set distances.

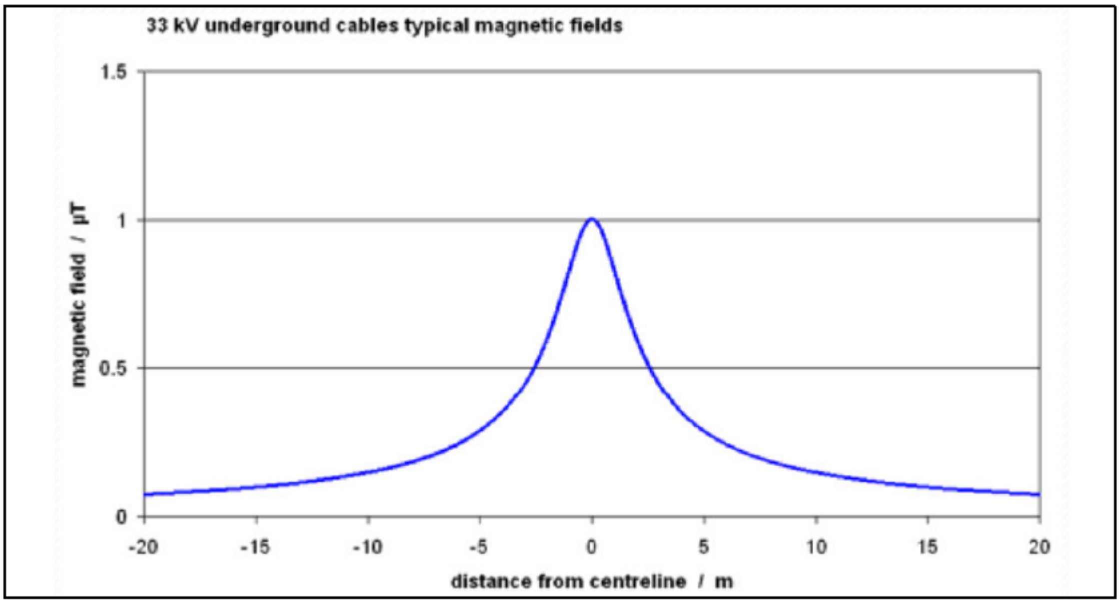

Figure 12 *Typical magnetic fields associated with 33 kV underground cable*

Distance from Centreline (m)	Magnetic Field (single 33 kV cable at 0.5m depth)
0	1.00 micro Teslas
5	0.29 micro Teslas
10	0.15 micro Teslas
20	0.07 micro Teslas

Table 6 *Typical magnetic field levels for an underground 33 kV cable (source: EMFS.info)*

The magnetic field strength for a 33 kV underground cable is seen to diminish exponentially to negligible levels within 20m. Areas of underground cables pertaining to the proposed development are more than 2.4km away from Burn Airfield.

6.3 Conclusions

Considering the distance between the proposed development and Burn Airfield, it is unlikely that the power cables and other electric equipment (transformers, inverters and batteries) pertaining to the proposed development will have technical or operational effects upon the facilities at Burn Airfield.

7 OVERALL CONCLUSIONS

7.1 Assessment Conclusions

No significant impacts are predicted upon aviation activity associated with Burn Airfield and Burn Gliding Club.

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