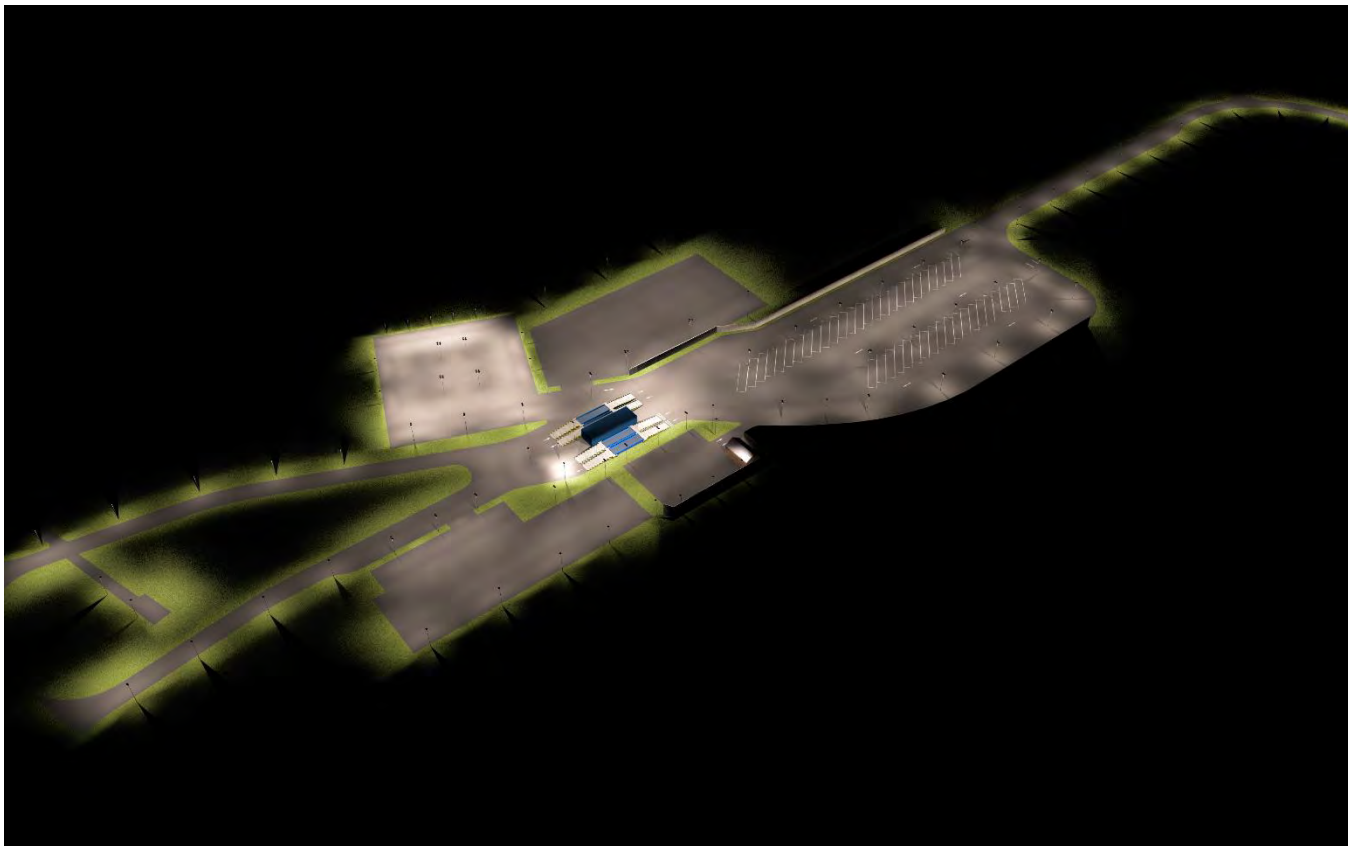
STRENGER



Proposed Lorry Park and Access Road, Kronospan, Chirk

Lighting Assessment

Prepared for: AXIS P.E.D. Ltd

Date: July 2023

TECHNICAL CONCEPTS

ILP Environmental Zone

ILP Guidance Note 01/21: The Reduction of Obtrusive Light sets out a series of environmental zones for classifying lighting assessment study areas based on their surroundings type e.g. rural, suburban etc., and the lighting environment e.g. low district brightness, medium district brightness etc. Based on the surroundings type and lighting environment, an environmental zone can be selected, from Zone E0 to Zone E4. The obtrusive light limits associated with the relevant environmental zone(s) are then adopted for assessment purposes.

Lighting curfew

A lighting curfew is an agreed time, beyond which, a lighting installation is subject to more stringent environmental control, generally as agreed with the local planning authority (LPA). Such controls may take the form of switching the lighting installation off in its entirety, switching the lighting installation off in part, dimming the lighting installation, or the implementation of smart lighting controls. Irrespective of the adopted control measures, suitable control of obtrusive light for the pre-curfew scenario and the post-curfew scenario can generally be demonstrated by adhering to ILP Guidance Note 01/21: The Reduction of Obtrusive Light. This national guidance document defines obtrusive light level limits separately for the pre-curfew scenario and the post-curfew scenario. Lighting curfews are generally best suited to facilities where a specific activity requiring artificial lighting ceases at a specific time e.g. a floodlit sports pitch, or a supermarket. However, in many cases, particularly 24-hour operations there is no clear change in activities requiring artificial lighting. In such cases, LPAs seldom impose a lighting curfew per se. However, for the sake of robustness in assessing obtrusive light, it is usual to adopt the ILP post-curfew obtrusive light criteria beyond a certain time. Where this time is not imposed by the LPA, 23:00 hours is generally adopted.

Light Spill

Light spill defines the amount of light spilling beyond an intentionally lit area. It is assessed in terms of the amount of light falling on a surface i.e. illuminance (E) and is measured in lux. Generally, light spill is measured in the horizontal plane to give the horizontal illuminance (E_h – lux). However, measurements in the vertical plane are also useful with regard to light-sensitive residential and ecological receptors.

'Light intrusion'

This occurs as a result of light spill falling on to a receptor, generally onto a residential property window (hence the term 'light intrusion') but equally could be any light-sensitive human receptor. It is assessed in terms of the amount of light falling on a surface i.e. illuminance (E) and is measured in lux. Where the receptor is a residential window, the level of illuminance is measured in the vertical plane parallel with the window, to give the vertical illuminance (E_v – lux).

'Glare' (residential context)

This is the degree of discomfort, adaptation or disability associated with a light source when viewed against a darker background. In the context of residential lighting assessment, the luminance of the background against which the intensity will be assessed is defined by means of the relevant ILP Environmental Zone. It is assessed in terms of the intensity of the light i.e. viewed light source intensity (I) and is measured in candelas (cd).

'Sky-glow'

This is the diffuse luminance of the night sky. Although there is a naturally occurring glow to the night sky, artificial lighting can potentially dominate the level of 'sky-glow'. This occurs due to direct upward lighting and reflected lighting off ground surfaces, buildings etc. reflecting off gaseous molecules in the atmosphere resulting in luminosity of the night sky. The level of 'sky-glow' will vary depending on prevailing atmospheric conditions, particularly metrological conditions i.e. cloud cover and precipitation. There are various potential means of quantifying 'skyglow'; however, in the case of new exterior lighting installations, 'sky-glow' is addressed by means of limiting the upward light ratio (ULR) of the installation i.e. the ratio between useful light downwards and wasted light upwards towards the sky.

EXECUTIVE SUMMARY

Outline Scope

Strenger Ltd was appointed by AXIS P.E.D. Ltd to undertake a lighting assessment for an exterior lighting installation associated with a proposed lorry park and access road associated with the Kronospan plant, Chirk (hereon in, the 'Proposed Development'). The assessment is required in order to quantify the impact of artificial light associated with the Proposed Development on its surroundings.

This environmental lighting assessment excludes consideration of emergency lighting.

This report shall be read in conjunction with the following accompanying drawings produced by Strenger Ltd:

- SK-01 Residential Receptor Location Plan
- SK-02 Assessed Scheme of Lighting
- SK-03 Light Spill
- SK-04 Light Monitoring Location Plan
- SK-05 Heritage and AONB Residential Receptor Location Plan

Assessment

In order to assess the impacts associated with the lighting installation, the following has been undertaken:

- review of pertinent legislation, policy and guidance;
- review of the site and surrounding area using aerial photography and OS mapping;
- undertaking a baseline light survey;
- production of a scheme of lighting (Assessed Scheme of Lighting) suitable for environmental assessment;
- detailed 3D computational modelling of the Assessed Scheme of Lighting;
- calculation of 'light intrusion' (vertical illuminance) at residential receptors;
- calculation of 'glare' (viewed source intensity) at residential receptors;
- calculation of 'sky-glow' (upward light ratio) affecting residential and dark-sky receptors;
- comparison of the obtrusive light levels with national guideline values;
- calculation of light spill at ecological receptors;
- comparison of ecological light spill levels with the adopted criteria;
- calculation of heritage artefact 'glow' (luminance) by means of predicted illuminance;
- calculation of light spill (vertical illuminance) at heritage receptors;
- calculation of 'glare' (viewed source intensity) at heritage receptors;
- comparison of heritage artefact 'glow', light spill and 'glare' with the adopted criteria;
- production of ray-traced lighting model imagery;
- production of light spill contours; and
- production of CAD drawings.

Conclusions

Residential Receptors

Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the residential receptor criteria as set out in the Institution of Lighting Professionals (ILP) (2021) Guidance Note for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the post-curfew obtrusive light criteria as set out for ILP Environmental Zone E1 and E2. The criteria are as follows:

- 'Light intrusion' limits of E1: < 0.1 lux, E2: 1 lux (E_v - vertical illuminance)
- 'Glare' limits of E1: 0, E2: 5.1d to 500 cd (I - source intensity)
- 'Sky-glow' limits of E1: 0 % , E2: 2.5 % (upward light ratio)

Dark Sky Receptors

Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the 'sky-glow' criterion as set out in the Institution of Lighting Professionals (ILP) (2021) Guidance Note for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the 'sky-glow' criterion as set out for ILP Environmental Zone E0. The criterion is as follows:

- 'Sky-glow' limit of 0 % (upward light ratio)

Ecological Receptors

The levels of light spill from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at ecological receptors. The resultant levels of light spill are set out in the form of isolux contours within Strenger drawing ref: SK-03 Light Spill.

Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant the adopted light spill criteria for particularly light-sensitive bats undertaking commuting and foraging activities. The adopted criteria are as follows:

- Average light spill limit of 0.5 lux (E - illuminance)
- Maximum light spill limit of 1 lux (E - illuminance)

Heritage Receptors

Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the adopted heritage receptor criteria. Specifically, the assessed lighting associated with the Proposed Development is compliant with the following:

- Light spill limits of E1: < 0.1 lux, E2: 1 lux (E_v - vertical illuminance)
- 'Glare' limits of E1: 0, E2: 5.1d to 500 cd (I - source intensity)
- 'Glow' limit of 0 cd/m^2

Mitigation

The following mitigation measures are integral to good lighting design, and have therefore been included in the Assessed Scheme of Lighting as a matter of course:

- the use of luminaires with zero direct contribution to upward light;
- careful aiming and positioning of luminaires;
- careful selection of luminaires;
- the use of optimal light distributions for their specific location and orientation;
- optimisation of mounting heights;
- the use of presence detection controls, a 365-day timer clock and photocell control; and
- the adoption of the lowest intensity LED modules practicable.

1.2 The following specific mitigation measures (as adopted within other UK IDSR dark sky guidance) have been adopted in view of protecting the potential future IDSR, and have therefore been included in the Assessed Scheme of Lighting:

- limiting light source colour temperatures to no more than 3000K;
- having zero degrees uplift to luminaires;
- minimising the task illuminance level to within a tight tolerance of the illuminance criteria; and
- the use of zoned presence detection controls for the Assessed Scheme of Lighting to less frequently used areas, such that the lighting remains normally off or dimmed down unless a presence is detected.

1. LEGISLATION, POLICY, GUIDANCE & STANDARDS

Legislation

Clean Neighbourhoods and Environment Act (CNEA), 2005

1.1 Light pollution was introduced within the Clean Neighbourhoods and Environment Act 2005 *('CNEA* 2005')as a form of statutory nuisance under the Environmental Protection Act 1990 (the 'EPA 1990') which was amended in 2006 to include the following nuisance definition:

"(fb) artificial light emitted from premises so as to be prejudicial to health or nuisance;"

1.2 Guidance produced by DEFRA, Statutory Nuisance from Insects & Artificial Light (2006) on s101 to s103 of the CNEA 2005 has also been referred to which places a duty on local authorities to ensure that their areas are checked periodically for existing and potential sources of statutory nuisances - including nuisances arising from artificial lighting. Local authorities must take reasonable steps to investigate complaints of such nuisances from artificial light. Once satisfied that a statutory nuisance exists or may occur or recur, local authorities must issue an abatement notice (in accordance with s80(2) of the EPA 1990), requiring that the nuisance cease or be abated within a set timescale.

1.3 Although light was described as having the potential to cause statutory nuisance in the CNEA 2005, no prescriptive limits or rules were set for impact assessment purposes. The Institute of Lighting Professionals Guidance Note 01/21 has therefore been referred to for the purposes of this assessment.

National Planning Policy

National Planning Policy Framework (NPPF), 2021

1.4 The National Planning Policy Framework (NPPF) states that the purpose of the planning system is to contribute to the achievement of sustainable development and constitute the Government's view on what sustainable development in England means in practice for the planning system. A principal concept contained within the NPPF is the presumption in favour of sustainable development and with regard to artificial lighting, the NPPF states:

'Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

… (c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.'

International Guidance

Comission Internationale De L'Eclairage 150: Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 2017 (CIE-150)

1.5 The purpose of CIE-150: Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 2017 is to help formulate guidelines for assessing the environmental impacts of outdoor lighting and to give recommended limits for relevant lighting parameters to contain the obtrusive effects of outdoor lighting within tolerable levels. As the obtrusive effects of outdoor lighting are best controlled initially by appropriate design, the guidance given is primarily applicable to new installations; however, some advice is also provided on remedial measures which may be taken for existing installations. This Guide refers to the potentially adverse effects of outdoor lighting on both natural and man-made environments for people in most aspects of daily life, from residents, sightseers, transport users to environmentalists and astronomers.

Comission Internationale De L'Eclairage 126: Guidelines for Minimising Sky Glow, 1997 (CIE-126)

1.6 CIE-126: Guidelines for Minimising Sky Glow, 1997 gives general guidance for lighting designers and policy makers on the reduction of sky glow. The report gives recommendations about maximum permissible values for exterior lighting installations. These values are regarded as limiting values. Lighting designers should strive to meet the lowest criteria for the design. Practical implementation of the general guidance is left to national regulations.

National Guidance

Institute of Lighting Professionals (ILP) Guidance Note 01/21: The Reduction of Obtrusive Light, 2021

1.7 The ILP has proposed obtrusive lighting guidance and criteria for local authorities with a recommendation that these are incorporated at the local plan level. ILP Guidance Note 01/21 defines various forms of light pollution and describes a series of environmental zones. ILP Guidance Note 01/21 provides suitable criteria against which the effects of artificial lighting can be assessed.

Institute of Lighting Professionals (ILP) PLG 04 - Guidance on Undertaking Environmental Lighting Impact Assessments, 2013 (update pending)

1.8 The aim of the Guidance on Undertaking Environmental Lighting Impact Assessments (ILP PLG04:2013) is to outline good practice in lighting design and provide practical guidance on production and assessment of lighting impacts within new developments. The document was produced following the publication of the NPPF in April 2012 and the importance of lighting design being part of a planning application, this document aims to:

- provide an explanation of, and guidance on, the process for producing a lighting assessment;
- prompt the lighting designer on important aspects of specific projects which should be used to remove or minimise potential environmental problems; and
- look at the overall processes and evaluation procedures regarding lighting which are considered to be relevant.

Buglife - The Invertebrate Conservation Trust - A review of the Impact of Artificial Light on Invertebrates, 2011

1.9 A review of the Impact of Artificial Light on Invertebrates is a published literature review on how humans are changing the light environment and the impact that this has on insects and other invertebrates. It makes various recommendations and identifies several further research areas.

Institute of Lighting Professionals Guidance Note 08/18 Bats artificial lighting in the UK: Bats and the Built Environment series, 2018

1.10 This working document produced by the ILP in conjunction with the Bat Conservation Trust (BCT), is aimed at lighting professionals, lighting designers, planning officers, developers, bat workers/ecologists and anyone specifying lighting. It is intended to raise awareness of the impacts of artificial lighting on bats, and mitigation is suggested for various scenarios. However, it is not meant to replace site-specific ecological and lighting assessments.

The Royal Commission on Environmental Pollution (RCEP) – Artificial Light in the Environment, 2009

1.11 This RCEP document discusses the social benefits and drawbacks of outdoor lighting, the impacts of light pollution on organisms and ecosystems, discusses road lighting technology, and makes various concluding recommendations.

National Guidance

HSG38

1.12 The Health and Safety Executive published HSG38: Lighting at Work aimed at those who are responsible for health and safety at work. The guidance explains how lighting contributes to the health and safety of people at work. It deals with assessing and managing the health and safety risks attributable to lighting in the workplace, good practice and the minimum recommended illumination levels that meet health and safety requirements. As the lighting level criteria as set out in HSG38 is relatively limited in comparison to that as set out in BS EN 12464-2, no further consideration is given to HSG38 within this lighting study.

The SLL Lighting Handbook

1.13 The Society of Light and Lighting (SLL) published the SLL Lighting Handbook in addition to the SLL Code for lighting and the SLL Lighting Guides. The Handbook includes criteria from the Code and the various Lighting Guides. The Handbook includes an exterior workplace chapter, which is the most relevant to this assessment.

British & European Standards

BS EN 12464-2:2014 Light and lighting – Lighting of work places Part 2: Outdoor work places

1.14 This standard specifies requirements for lighting of tasks in most outdoor work places and their associated areas in terms of quantity and quality of illumination. In addition, recommendations are given for good lighting practice.

2. CRITERIA

Residential

2.1 In the absence of statutory guidance, ILP Guidance Note 01/21 has been used as criteria against which to assess the effects of artificial lighting associated with the Proposed Development on residential receptors; this is considered best practice.

ILP Environmental Zone Classification

2.2 The ILP has developed an Environmental Zone classification system for the categorisation of areas with regard to suitable obtrusive lighting limits. The Environmental Zone classifications are reproduced in (Table 2.1).

Table 2.1: ILP Environmental Zone Classification

Zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark (SQM 20.5+)	Astronomical Observable dark skies, UNESCO starlight reserves, IDA dark sky places
E1	Natural	Dark (SQM 20 to 20.5)	Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty, IDA buffer zones etc.
E2	Rural	Low district brightness (SQM 15 to 20)	Sparsely inhabited rural areas, village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Well inhabited rural and urban settlements, small town centres of suburban locations
E4	Urban	High district brightness	Town/city centres with high levels of night-time activity

ILP Environmental Zone Criteria

2.3 For each Environmental Zone, obtrusive light limits for exterior lighting installations have been determined. These are summarised in (Table. 2.2 to Table 2.4) below and are intended to support decision makers in establishing whether artificial lighting is detrimental to local amenity or a potential statutory nuisance.

Table 2.2: ILP 'Light Intrusion' (vertical illuminance) Limits E_v - lux

Application Conditions	Environmental Zone				
	E0	E1	E2	E3	E4
Pre-curfew	n/a	2	5	10	25
Post-curfew	n/a	< 0.1 *	1	2	5

* If the installation is for public (road) lighting then this may be up to 1 lux.

Table 2.3: ILP 'Glare' (source intensity) Limits I - cd						
Application Conditions	**Luminaire group (projected area A_p in m²)**					
	0 < Ap ≤ 0.002	**0.002 < Ap ≤ 0.01**	**0.01 < Ap ≤ 0.03**	**0.03 < Ap ≤ 0.13**	**0.13 < Ap ≤ 0.50**	**Ap > 0.50**
E0 Pre-curfew E0 Post-curfew	0 0	0 0	0 0	0 0	0 0	0 0
E1 Pre-curfew E1 Post-curfew	0.29 d 0	0.63 d 0	1.3 d 0	2.5 d 0	5.1 d 0	2,500 0
E2 Pre-curfew E2 Post-curfew	0.57 d 0.29 d	1.3 d 0.63 d	2.5 d 1.3 d	5.0 d 2.5 d	10 d 5.1 d	7,500 500
E3 Pre-curfew E3 Post-curfew	0.86 d 0.29 d	1.9 d 0.63 d	3.8 d 1.3 d	7.5 d 2.5 d	15 d 5.1 d	10,000 1,000
E4 Pre-curfew E4 Post-curfew	1.4 d 0.29 d	3.1 d 0.63 d	6.3 d 1.3 d	13 d 2.5 d	26 d 5.1 d	25,000 2,500

1) d is the distance between the observer and the 'glare' source in metres

2) Upper limits for each zone shall be taken as those with column $A_p > 0.5$

Table 2.4: ILP 'Sky-glow' (upward light ratio) Limits ULR - %				
Environmental Zone				
E0	**E1**	**E2**	**E3**	**E4**
0	0	2.5	5	15

Determination of ILP Environmental Zones

2.4 Despite high levels of 'sky-glow' the Proposed Development site falls within relatively dark surroundings. For non-AONB residential receptors, ILP Environmental Zone E2 has been adopted for the purposes of this lighting assessment in order to represent a reasonable worst-case scenario. For AONB residential receptors, ILP Environmental Zone E1 has been adopted.

ILP Environmental Zone E2 Criteria

2.5 Based on ILP Environmental Zone E2, the obtrusive light limits for the Proposed Development are as follows:

- Pre-curfew 'light intrusion' limit of 5 lux (E_v - vertical illuminance)
- Post-curfew 'light intrusion' limit of 1 lux (E_v - vertical illuminance)
- Pre-curfew 'glare' limit # of 10d to 7,500 cd (I - source intensity)
- Post-curfew 'glare' limit # of 5.1d to 500 cd (I - source intensity)
- 'Sky-glow' limit of 2.5 % (upward light ratio)

 # 'Glare' limit calculated based on observer to worst-case offending 'glare' source distance and projected area of $0.13 < Ap \leq 0.50$

ILP Environmental Zone E1 Criteria

2.6 Based on ILP Environmental Zone E1, the obtrusive light limits for the Proposed Development are as follows:

- Pre-curfew 'light intrusion' limit of 2 lux (E_v - vertical illuminance)
- Post-curfew 'light intrusion' limit of < 0.1 lux (E_v - vertical illuminance)
- Pre-curfew 'glare' limit of 5.1d to 2,500 cd (I - source intensity)
- Post-curfew 'glare' limit of 0 cd (I - source intensity)
- 'Sky-glow' limit of 0 % (upward light ratio)

Adopted ILP Criteria

2.7 Such as to demonstrate that it would be possible to operate lighting during any hours of darkness, only the post-curfew ILP criteria have been adopted for the purposes of this assessment. As such, the adopted criteria are as follows:

- 'Light intrusion' limits of E1: < 0.1 lux, E2: 1 lux (E_v - vertical illuminance)
- 'Glare' limits of E1: 0, E2: 5.1d to 500 cd (I - source intensity)
- 'Sky-glow' limits of E1: 0 % , E2: 2.5 % (upward light ratio)

Dark Skies

2.8 In the absence of statutory guidance, ILP Guidance Note 01/21 has been used as criteria against which to assess the effects of artificial lighting associated with the Proposed Development on dark skies receptors; this is considered best practice.

Determination of ILP Environmental Zone

2.9 The Clwydian Range & Dee Valley is a designated AONB and therefore the Environmental Zone E1 'sky-glow' criterion applies. However, as the Clwydian Range & Dee Valley AONB is a potential future IDSR, the Environmental Zone E0 'sky-glow' criterion has been adopted for the purpose of this assessment.

Ecological

2.10 Although significant research into lighting and ecological effects is currently underway, there are currently no definitive guidelines in wide acceptance setting out absolute light pollution limits affecting light-sensitive ecological receptors. However, limited research into lighting and ecological effects has been undertaken and potentially suitable light spill level limits are in existence.

2.11 For the sake of this report, in order to present a reasonable worst-case assessment, 0.5 lux has been utilised as the average level of illuminance to be met at light-sensitive ecological receptors. A 0.5 lux criterion is commonly adopted for particularly light-sensitive bat species undertaking commuting and foraging activities. As the ecological corridors require suitably continuous levels of darkness, it has also been considered appropriate to adopt a maximum level of illuminance to be met at light-sensitive ecological receptors. Therefore, a 1 lux criterion has been adopted accordingly.

Heritage

2.12 In the absence of statutory guidance, ILP Guidance Note 01/21 has been used as criteria against which to assess light spill and 'glare' effects of artificial lighting associated with the Proposed Development on heritage receptors; this is considered best practice. Such as to demonstrate that it would be possible to operate lighting during any hours of darkness, only the post-curfew ILP criteria have been adopted for the purposes of this assessment. As such, the adopted criteria are as follows:

- Light spill limits of E1: < 0.1 lux, E2: 1 lux (E_v - vertical illuminance)
- 'Glare' limits of E1: 0, E2: 5.1d to 500 cd (I - source intensity)

2.13 However, as the view of the heritage artefact is also of importance, it has also been considered necessary to adopt an artefact 'glow' limit. In order to represent a worst-case scenario, a luminance limit of 0 cd/m^2 has been adopted. As the reflectance values of the artefact are unknown, a 0.00 lux illuminance has been targeted in view of demonstrating compliance with the 0 cd/m^2 criterion.

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3. RECEPTORS

Non-AONB Residential

3.1 Within the context of this assessment, non-AONB residential receptors are taken as those with the potential to be affected by obtrusive light associated with the Proposed Development. Key existing non-AONB residential receptors which have the potential to be impacted by obtrusive light from the Proposed Development have been identified and adopted as receptor locations within this assessment. Non-AONB residential receptors are positioned at local ground level +2.0 m (i.e. ground floor level windows). At such a height, the angle subtended with the light sources will be less than that if assessed at first floor level windows. The assessed receptor height therefore represents a reasonable worst-case scenario, as the level of 'glare' (viewed source intensity) will be at its maximum. The assessed non-AONB residential receptors are set out in Strenger drawing ref: SK-01 Residential Receptor Location Plan.

AONB Residential

3.2 Within the context of this assessment, AONB residential receptors are taken as those with the potential to be affected by obtrusive light associated with the Proposed Development. Key existing AONB residential receptors which have the potential to be impacted by obtrusive light from the Proposed Development have been identified and adopted as receptor locations within this assessment. AONB residential receptors are positioned at local ground level +2.0 m (i.e. ground floor level windows). At such a height, the angle subtended with the light sources will be less than that if assessed at first floor level windows. The assessed receptor height therefore represents a reasonable worst-case scenario, as the level of 'glare' (viewed source intensity) will be at its maximum. Significant differences in ground height between the Proposed Development site and AONB residential receptors have been accounted for by adopting appropriate relative heights for the receptor calculation points. The assessed AONB residential receptors are set out in Strenger drawing ref: SK-05 Heritage and AONB Residential Receptor Location Plan.

Dark Skies

3.3 Within the context of this assessment, dark sky receptors are taken as those with the potential to be affected by upward light associated with the Proposed Development. Key existing dark sky receptors which have the potential to be impacted by obtrusive light from the Proposed Development have been identified and adopted as receptor locations within this assessment. Specifically, the Clwydian Range and Dee Valley AONB, which is a potential future International Dark Sky Reserve (IDSR). The significant distance between the Proposed Development site and identified dark skies receptors is worthy of mention; in reality, the potential for these receptors to be affected by 'sky-glow' associated with the Proposed Development is very low.

Ecological

3.4 Within the context of this assessment, ecological receptors are taken as those which have been identified as being potentially light-sensitive and having the potential to be affected by light spill from lighting associated with the Proposed Development. It is understood that the green corridor to the Afon Bradley is a potentially light-sensitive ecological receptor. As such, isolux contours of light spill associated with the Proposed Development have been produced.

Heritage

3.5 Within the context of this assessment, heritage receptors are taken as those with the potential to be affected by light pollution associated with the Proposed Development. Key existing heritage receptors which have the potential to be impacted by light pollution from the Proposed Development have been identified and adopted as light-sensitive artefacts within this assessment. Heritage receptors are positioned at local ground level +1.7 m; significant differences in ground height between the Proposed Development site and heritage receptors have been accounted for by adopting appropriate relative heights for the receptor calculation points. The assessed heritage receptors are set out in Strenger drawing ref: SK-05 Heritage and AONB Residential Receptor Location Plan. The adopted heritage receptors HER-01 and HER-02 could equally be considered as being residential receptors.

4. BASELINE

Light Survey

Overview

4.1 A survey of the study area was undertaken on Thursday 19th May 2022. The survey covered the Proposed Development site itself, along with other off-site locations.

Purpose

4.2 The purpose of the survey was to:

- gain an understanding of the existing sources of artificial lighting on and surrounding the site;
- gain an understanding of the current levels of obtrusive light;
- provide an understanding of the Proposed Development site and surroundings; and
- enable the Environmental Zone to be established based on sound quantitative and qualitative evidence.

Methodology

4.3 The survey involved the measurement of baseline light levels. The survey was conducted using a precision illuminance meter which was suitably calibrated in a UKAS accredited laboratory within one year. Measurements were recorded at 0.001 lux resolution. The survey also included undertaking long-exposure wide angle 'night-time' photography. The site photography is displayed in (Plate 4.1 to Plate 4.9)

Baseline Light Survey Results

4.4 The results of the light survey are displayed in (Table 4.1) overleaf. The light monitoring locations are set out in Strenger drawing ref: SK-04 Light Monitoring Location Plan.

Table 4.1: Baseline Light Survey Results				
Monitoring Location	Illuminance E (lux)			
	Parallel with feature facing outwards	Facing out from site	Facing in towards site	Horizontal
LGT-01	0.037	-	-	-
LGT-02	0.004	-	-	-
LGT-03	-	1.507	0.080	0.591
LGT-04	-	-	0.152	0.056
LGT-05	2.18	-	-	-
LGT-06	-	0.374	0.081	0.127
LGT-07	-	-	0.165	0.024
LGT-08	1.12	-	-	-
LGT-09	-	0.867	0.114	0.264
LGT-10	-	-	0.121	0.044
LGT-11	2.5	-	-	-
LGT-12	-	0.826	0.108	0.356
LGT-13	-	-	0.104	0.022
LGT-14	1.13	-	-	-
LGT-15	-	1.597	0.100	0.556
LGT-16	-	-	0.072	0.019
LGT-17	4.1	-	-	-
LGT-18	3.54	-	-	-
LGT-19	-	-	0.040	0.022
LGT-20	4.07	-	-	-
LGT-21	12.34	-	-	-
LGT-22	1.78			
LGT-23	-	2.061	0.075	0.76
LGT-24	7.97	-	-	-
LGT-25	1.83	-	-	-
LGT-26	17.91	-	-	-
LGT-27	1.99	-	-	-
LGT-28	8.14	-	-	-
LGT-29	1.43	-	-	-
LGT-30	0.64	-	-	-
LGT-31	0.39	-	-	-
LGT-32	2.17	-	-	-
LGT-33	1.2	-	-	-
LGT-34	4.77	-	-	-
LGT-35	0.108	-	-	-
LGT-36	0.062	-	-	-
LGT-37	0.039	-	-	-

Table 4.1: Baseline Light Survey Results				
Monitoring Location	**Illuminance E (lux)**			
	Parallel with feature facing outwards	**Facing out from site**	**Facing in towards site**	**Horizontal**
LGT-38	0.036	-	-	-
LGT-39	0.042	-	-	-
LGT-40	0.040	-	-	-
LGT-41	0.093	-	-	-
LGT-42	0.045	-	-	-
LGT-43	0.11	-	-	-
LGT-44	0.089	-	-	-
LGT-45	0.144	-	-	-
LGT-46	0.112	-	-	-

Plate 4.1: Road lighting to Holyhead Road with existing Kronospan facility in background

Plate 4.2: Hedgerow bounding Holyhead Road showing light spill

Plate 4.3: Holyhead Road viewed from Proposed Development site

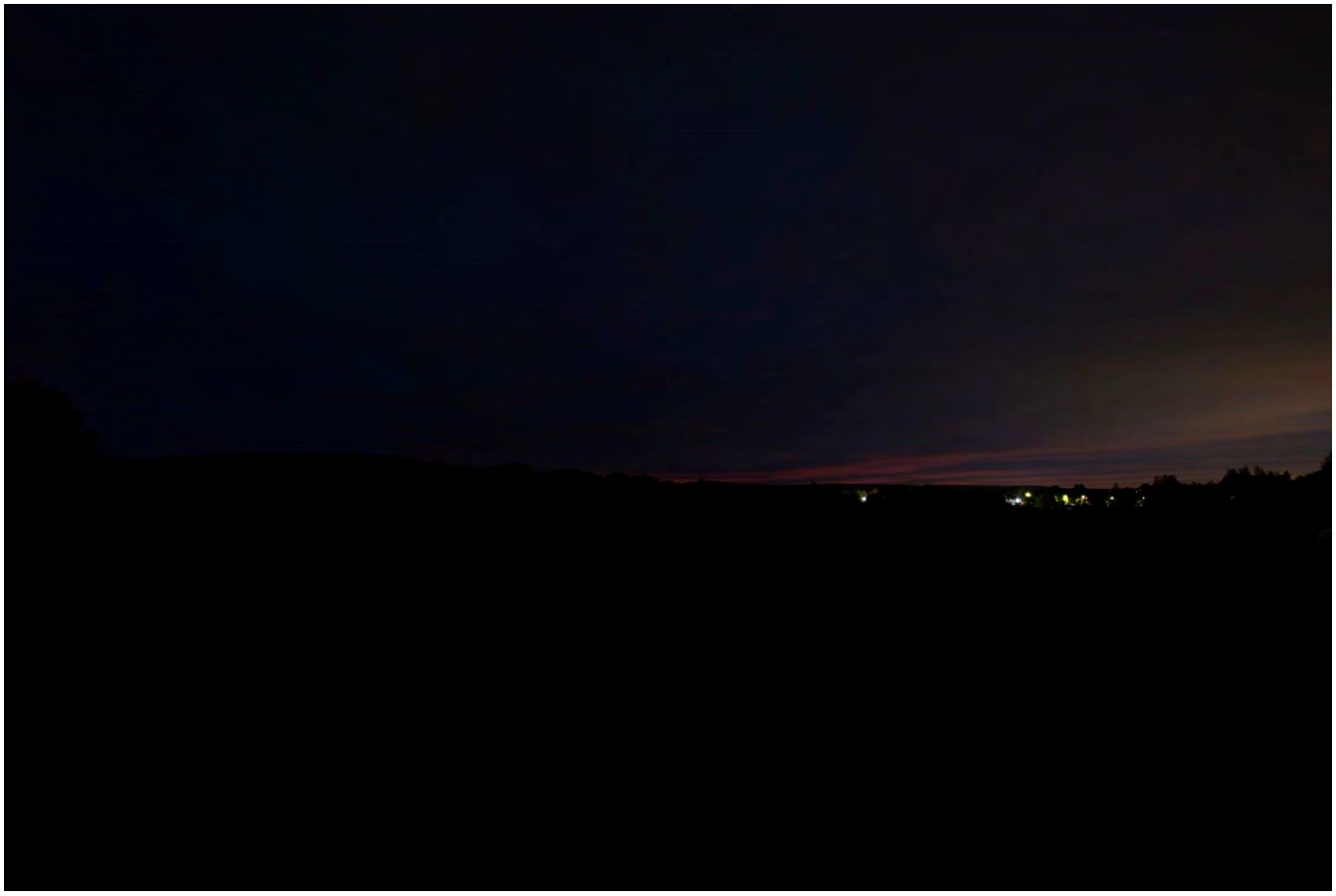


Plate 4.4: Holyhead Road lighting viewed from Proposed Development site western boundary

Plate 4.5: Holyhead Road lighting

Plate 4.6: Street lighting to Wern

Plate 4.7: Holyhead Road lighting

Plate 4.8: Holyhead Road lighting and street lighting to Crogen junction mouth

Plate 4.9: Street lighting to Crogen junction mouth

5. EXTERIOR LIGHTING

Overview

5.1 Artificial lighting will be required to allow work to take place, as part of safe passage, security and health & safety requirements, all during periods of reduced daylight availability / darkness. The associated potential obtrusive light effects towards surrounding light-sensitive receptors would be minimised through the controlled application of lighting in accordance with current best practice. In order for the Proposed Development to operate safely, it will be necessary to illuminate the site to reasonable workplace lighting standards, balanced with obtrusive light level limits.

Assessed Scheme of Lighting

5.2 An indicative outline scheme of lighting (Assessed Scheme of Lighting) has been produced for the Proposed Development. The Assessed Scheme of Lighting adopts LED luminaires; such technology offers significant energy savings and provide a high degree of optical control, thus minimising obtrusive light. With regard to this assessment, the luminaires - whilst specific, can be considered to be relatively generic; provided that sensible selection of another manufacturer's luminaires is made by a competent Lighting Engineer. The final selection of luminaires and their positioning shall be determined by the Responsible Lighting Engineer in order to meet the Proposed Development site final risk assessed lighting requirements; but bearing in mind any obtrusive lighting impact that the selection may have.

5.3 The details of the luminaires used in the Assessed Scheme of Lighting are set out in (Table 5.1) below. The Assessed Scheme of Lighting is set out in Strenger drawing ref: SK-02 Assessed Scheme of Lighting. The levels of light spill associated with the Assessed Scheme of Lighting are set out in Strenger drawing ref: SK-03 Light Spill.

Table 5.1: Assessed Scheme of Lighting Details

Reference	No. off	Manufacturer	Luminaire	Light Source (dimming)	Distribution
LUM-A	2	DW Windsor	Sabre	3K 32 LED (1000 mA)	ZF
LUM-B	36	Philips	ClearFlood	830 130 LED (*max.*)	DX51
LUM-C	32	Philips	ClearFlood	830 220 LED (*max.*)	DX51
LUM-D	34	Philips	ClearFlood	830 70 LED (*max.*)	DM10
LUM-E	6	Philips	ClearFlood	830 70 LED (*max.*)	DX51
LUM-F	13	Philips	ClearFlood Large	830 310 LED (*max.*)	DX51
LUM-G	7	Philips	ClearFlood Large	830 400 LED (*max.*)	DX51
LUM-H	4	Philips	ClearFlood Large	830 650 LED (*max.*)	DX51

Figure 5.1: DW Windsor Sabre

Figure 5.2: Philips ClearFlood

6. MODELLING

6.1 Light modelling was undertaken using DIALux software, an independent lighting modelling software tool which is capable of calculating artificial lighting scenes in exterior scenarios. The software incorporates recognised calculation methodologies and is commonly used for lighting assessment throughout Europe. An indicative scheme of lighting for the Proposed Development has been produced for the purposes of this assessment and has been inputted into the lighting model.

6.2 In order to represent a reasonable worst-case scenario for environmental assessment, the maintenance factor within the lighting model was set to 1.0, such that the scheme was assessed based on the full design lumen output, rather than the maintained minimum design lumen output.

6.3 The lighting model used in the predictions for non-AONB residential receptors and for producing the ecological light spill contours adopts a flat ground plane i.e. does not take account of changes in ground height. As such, the lighting model does not take into account significant intervening landform which would provide screening of the light sources. Furthermore, the lighting model does not take account of vegetation and off-site buildings. As such screening has not been accounted for, this can be considered to be a reasonably conservative assessment of obtrusive light.

6.4 The lighting model used in the predictions for AONB residential receptors and heritage receptors does however take account of changes in ground height by means of adopting receptor heights relative to the average Proposed Development site level.

6.5 Such as to provide an illustrative overview of the lighting model, ray-traced imagery of the rendered lighting model is appended to this report in Appendix A. As stated above, the lighting model does not take into account intervening landform, vegetation and off-site buildings. Accordingly, such entities do not feature within the appended imagery.

7. MITIGATION

7.1 The following mitigation measures are integral to good lighting design, and have therefore been included in the Assessed Scheme of Lighting as a matter of course:

- the use of luminaires with zero direct contribution to upward light;
- careful aiming and positioning of luminaires;
- careful selection of luminaires;
- the use of optimal light distributions for their specific location and orientation;
- optimisation of mounting heights;
- the use of presence detection controls, a 365-day timer clock and photocell control; and
- the adoption of the lowest intensity LED modules practicable.

7.2 The following specific mitigation measures (as adopted within other UK IDSR dark sky guidance) have been adopted in view of protecting the potential future IDSR, and have therefore been included in the Assessed Scheme of Lighting:

- limiting light source colour temperatures to no more than 3000K;
- having zero degrees uplift to luminaires;
- minimising the task illuminance level to within a tight tolerance of the illuminance criteria; and
- the use of zoned presence detection controls for the Assessed Scheme of Lighting to less frequently used areas, such that the lighting remains normally off or dimmed down unless a presence is detected.

8. ASSESSMENT

Residential

'Light Intrusion' (vertical illuminance)

8.1 The levels of 'light intrusion' from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at residential receptors. The resultant levels of 'light intrusion' are set out in (Table 8.1) against the ILP post-curfew 'light intrusion' criteria for ILP Environmental Zone E1 and E2 as appropriate. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 8.1: 'Light Intrusion' Assessment

Receptor	'Light Intrusion' Criteria - E_v (lux)	Predicted 'Light Intrusion' - E_v (lux)	Outcome
RES-01 (E2)	1	0.01	**PASS**
RES-02 (E2)	1	0.01	**PASS**
RES-03 (E2)	1	0.00	**PASS**
RES-04 (E2)	1	0.00	**PASS**
RES-05 (E2)	1	0.00	**PASS**
RES-06 (E2)	1	0.00	**PASS**
RES-07 (E2)	1	0.01	**PASS**
RES-08 (E2)	1	0.04	**PASS**
RES-09 (E2)	1	0.04	**PASS**
RES-10 (E2)	1	0.07	**PASS**
RES-11 (E2)	1	0.07	**PASS**
RES-12 (E2)	1	0.06	**PASS**
RES-13 (E2)	1	0.03	**PASS**
RES-AONB-01 (E1)	< 0.1	0.00	**PASS**
RES-AONB-02 (E1)	< 0.1	0.00	**PASS**

8.2 As can be seen from (Table 8.1) above, the predicted levels of 'light intrusion' at residential receptors from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP post-curfew 'light intrusion' criteria for ILP Environmental Zone E1 and E2 as appropriate.

'Glare' (viewed source intensity)

8.3 The maximum levels of 'glare' from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at residential receptors. The resultant maximum levels of 'glare' are set out in (Table 8.2) against the ILP post-curfew 'glare' criteria for ILP Environmental Zone E1 and E2 as appropriate. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 8.2: 'Glare' Assessment

Receptor	'Glare' Criteria - I (cd)	Predicted Maximum 'Glare' - I (cd)	Outcome
RES-01 (E2)	500	9	**PASS**
RES-02 (E2)	500	4	**PASS**
RES-03 (E2)	500	4	**PASS**
RES-04 (E2)	500	8	**PASS**
RES-05 (E2)	500	10	**PASS**
RES-06 (E2)	500	11	**PASS**
RES-07 (E2)	500	14	**PASS**
RES-08 (E2)	500	19	**PASS**
RES-09 (E2)	500	31	**PASS**
RES-10 (E2)	500	41	**PASS**
RES-11 (E2)	500	23	**PASS**
RES-12 (E2)	500	19	**PASS**
RES-13 (E2)	500	13	**PASS**
RES-AONB-01 (E1)	0	0	**PASS**
RES-AONB-02 (E1)	0	0	**PASS**

8.4 As can be seen from (Table 8.2) above, the predicted maximum levels of 'glare' at residential receptors from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP post-curfew 'glare' criteria for ILP Environmental Zone E1 and E2 as appropriate.

'Sky-glow' (upward light ratio)

8.5 The level of 'sky-glow' from the Assessed Scheme of Lighting associated with the Proposed Development has been predicted. The resultant level of 'sky-glow' is set out in (Table 8.3) against the ILP 'sky-glow' criteria for ILP Environmental Zone E0, E1, and E2 as appropriate. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 8.3: 'Sky-glow' Assessment

Receptor	'Sky-glow' Criteria (ULR %)	Predicted 'Sky-glow' (ULR %)	Outcome
CRDV AONB Potential Future IDSR (E0)	0 %	0 %	**PASS**
CRDV AONB (E1)	0 %	0 %	**PASS**
Surrounding Residential / L&V General Observers (E2)	2.5 %	0 %	**PASS**

8.6 As can be seen from (Table 8.3) above, the predicted level of 'sky-glow' from the Assessed Scheme of Lighting associated with the Proposed Development is compliant with the ILP 'sky-glow' criteria for ILP Environmental Zone E0, E1 and E2 as appropriate.

Ecological

Light Spill (illuminance)

8.7 The levels of light spill from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at ecological receptors. The resultant levels of light spill are set out in the form of isolux contours within Strenger drawing ref: SK-03.

8.8 As can be seen from SK-03, the predicted levels of light spill at ecological receptors from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the adopted light spill criteria of 0.5 lux (average) and 1 lux (maximum).

Heritage

'Glow' (luminance)

8.9 The level of artefact 'glow' observable at landscape & visual general observers and residential receptors from the Assessed Scheme of Lighting associated with the Proposed Development has been predicted. The resultant level of 'glow' is set out in (Table 8.4) against the adopted criterion of 0 cd/m^2. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 8.4: Artefact 'Glow' Assessment

Receptor	'Glow' Criterion (cd/m^2)	Predicted 'Glow' (cd/m^2)	Outcome
L&V General Observer / Residential	0	0 (derived from 0.00 lux)	**PASS**

8.10 As can be seen from (Table 8.4) above, the predicted level of artefact 'glow' observable at landscape & visual general observer and residential receptors from the Assessed Scheme of Lighting associated with the Proposed Development is compliant with the adopted 'glow' criterion of 0 cd/m^2.

Light Spill (vertical illuminance)

8.11 The levels of light spill from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at heritage receptors. The resultant levels of light spill are set out in (Table 8.5) against the ILP post-curfew 'light intrusion' criteria for ILP Environmental Zone E1 and E2 as appropriate. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 8.5: Light Spill Assessment

Receptor	Light Spill Criteria - E_v (lux)	Predicted Light Spill - E_v (lux)	Outcome
HER-01 (E2)	1	0.00	**PASS**
HER-02 (E2)	1	0.00	**PASS**
HER-03 (E1)	< 0.1	0.00	**PASS**

8.12 As can be seen from (Table 8.5) above, the predicted levels of light spill at heritage receptors from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP post-curfew 'light intrusion' criteria for ILP Environmental Zone E1 and E2 as appropriate.

'Glare' (viewed source intensity)

8.13 The maximum levels of 'glare' from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at heritage receptors. The resultant maximum levels of 'glare' are set out in (Table 8.6) against the ILP post-curfew 'glare' criteria for ILP Environmental Zone E1 and E2 as appropriate. Each receptor has been assigned a PASS / FAIL outcome accordingly.

Table 8.6: 'Glare' Assessment			
Receptor	**'Glare' Criteria - I (cd)**	**Predicted Maximum 'Glare' - I (cd)**	**Outcome**
HER-01 (E2)	500	0	**PASS**
HER-02 (E2)	500	0	**PASS**
HER-03 (E1)	0	0	**PASS**

8.14 As can be seen from (Table 8.6) above, the predicted maximum levels of 'glare' at heritage receptors from the Assessed Scheme of Lighting associated with the Proposed Development are compliant with the ILP post-curfew 'glare' criteria for ILP Environmental Zone E1 and E2 as appropriate.

9. CONCLUSIONS

Residential Receptors

9.1 Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the residential receptor criteria as set out in the Institution of Lighting Professionals (ILP) (2021) Guidance Note for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the post-curfew obtrusive light criteria as set out for ILP Environmental Zone E1 and E2. The criteria are as follows:

- 'Light intrusion' limits of E1: < 0.1 lux, E2: 1 lux (E_v - vertical illuminance)
- 'Glare' limits of E1: 0, E2: 5.1d to 500 cd (I - source intensity)
- 'Sky-glow' limits of E1: 0 % , E2: 2.5 % (upward light ratio)

Dark Sky Receptors

9.2 Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the 'sky-glow' criterion as set out in the Institution of Lighting Professionals (ILP) (2021) Guidance Note for the Reduction of Obtrusive Light. Specifically, the assessed lighting associated with the Proposed Development is compliant with the 'sky-glow' criterion as set out for ILP Environmental Zone E0. The criterion is as follows:

- 'Sky-glow' limit of 0 % (upward light ratio)

Ecological Receptors

9.3 The levels of light spill from the Assessed Scheme of Lighting associated with the Proposed Development have been predicted at ecological receptors. The resultant levels of light spill are set out in the form of isolux contours within Strenger drawing ref: SK-03.

9.4 Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant the adopted light spill criteria for particularly light-sensitive bats undertaking commuting and foraging activities. The adopted criteria are as follows:

- Average light spill limit of 0.5 lux (E - illuminance)
- Maximum light spill limit of 1 lux (E - illuminance)

Heritage Receptors

9.5 Based on the Assessed Scheme of Lighting, it has been demonstrated that the Proposed Development will be compliant with the adopted heritage receptor criteria. Specifically, the assessed lighting associated with the Proposed Development is compliant with the following:

- Light spill limits of E1: < 0.1 lux, E2: 1 lux (E_v - vertical illuminance)
- 'Glare' limits of E1: 0, E2: 5.1d to 500 cd (I - source intensity)
- 'Glow' limit of 0 cd/m^2

Mitigation

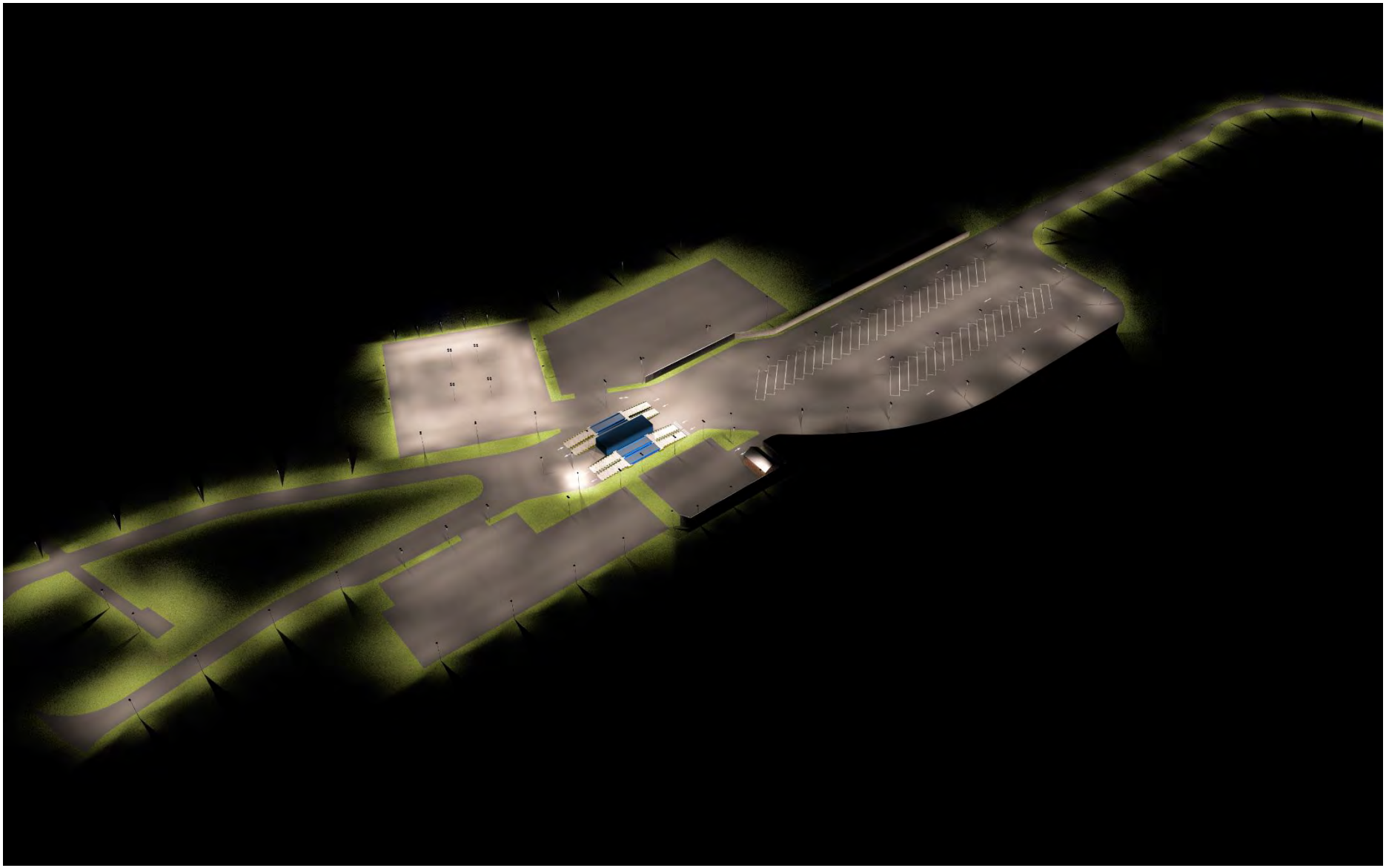
9.6 The following mitigation measures are integral to good lighting design, and have therefore been included in the Assessed Scheme of Lighting as a matter of course:

- the use of luminaires with zero direct contribution to upward light;
- careful aiming and positioning of luminaires;
- careful selection of luminaires;
- the use of optimal light distributions for their specific location and orientation;
- optimisation of mounting heights;
- the use of presence detection controls, a 365-day timer clock and photocell control; and
- the adoption of the lowest intensity LED modules practicable.

9.7 The following specific mitigation measures (as adopted within other UK IDSR dark sky guidance) have been adopted in view of protecting the potential future IDSR, and have therefore been included in the Assessed Scheme of Lighting:

- limiting light source colour temperatures to no more than 3000K;
- having zero degrees uplift to luminaires;
- minimising the task illuminance level to within a tight tolerance of the illuminance criteria; and
- the use of zoned presence detection controls for the Assessed Scheme of Lighting to less frequently used areas, such that the lighting remains normally off or dimmed down unless a presence is detected.

Appendix A - Lighting Model Ray-traced Imagery



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STRENGER LTD	KRONOSPAN NORTH ACCESS ROAD
	SK-01 REV_A
	Residential Receptor Location Plan
	Scale 1:2500@A3 / Date July 2023

Z:\Work\2021\0213010 Kronospan - AXIS\Revised\Drawings\1213010 Kronospan Lorry Park & Access Road.dwg

Layout/specification subject to safe arcing distances, maintenance method and emergency backup

Layout/specification subject to DSEAR RA

LUMINAIRE SCHEDULE

- DW Windsor Sabre 32 LED 3K ZF 1000mA
- PHILIPS BVP650 T25 LED130-4S/830 DX51
- PHILIPS BVP650 T25 LED220-4S/830 DX51
- PHILIPS BVP650 T25 LED70-4S/830 DM10
- PHILIPS BVP650 T25 LED70-4S/830 DX51
- PHILIPS BVP650 T25 LED310-4S/830 DX51
- PHILIPS BVP650 T25 LED400-4S/830 DX51
- PHILIPS BVP650 T25 LED650-4S/830 DX51

STRENGER LTD

KRONOSPAN NORTH ACCESS ROAD

SK-02 REV_A

Assessed Scheme of Lighting

Scale	Date
1:2500@A3	July 2023

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Isolines

- 0.1 lx
- 0.2 lx
- 0.5 lx
- 1.0 lx

STRENGER LTD

KRONOSPAN NORTH ACCESS ROAD

SK-03 REV_A

Light Spill

Scale	Date
1:2500@A3	July 2023

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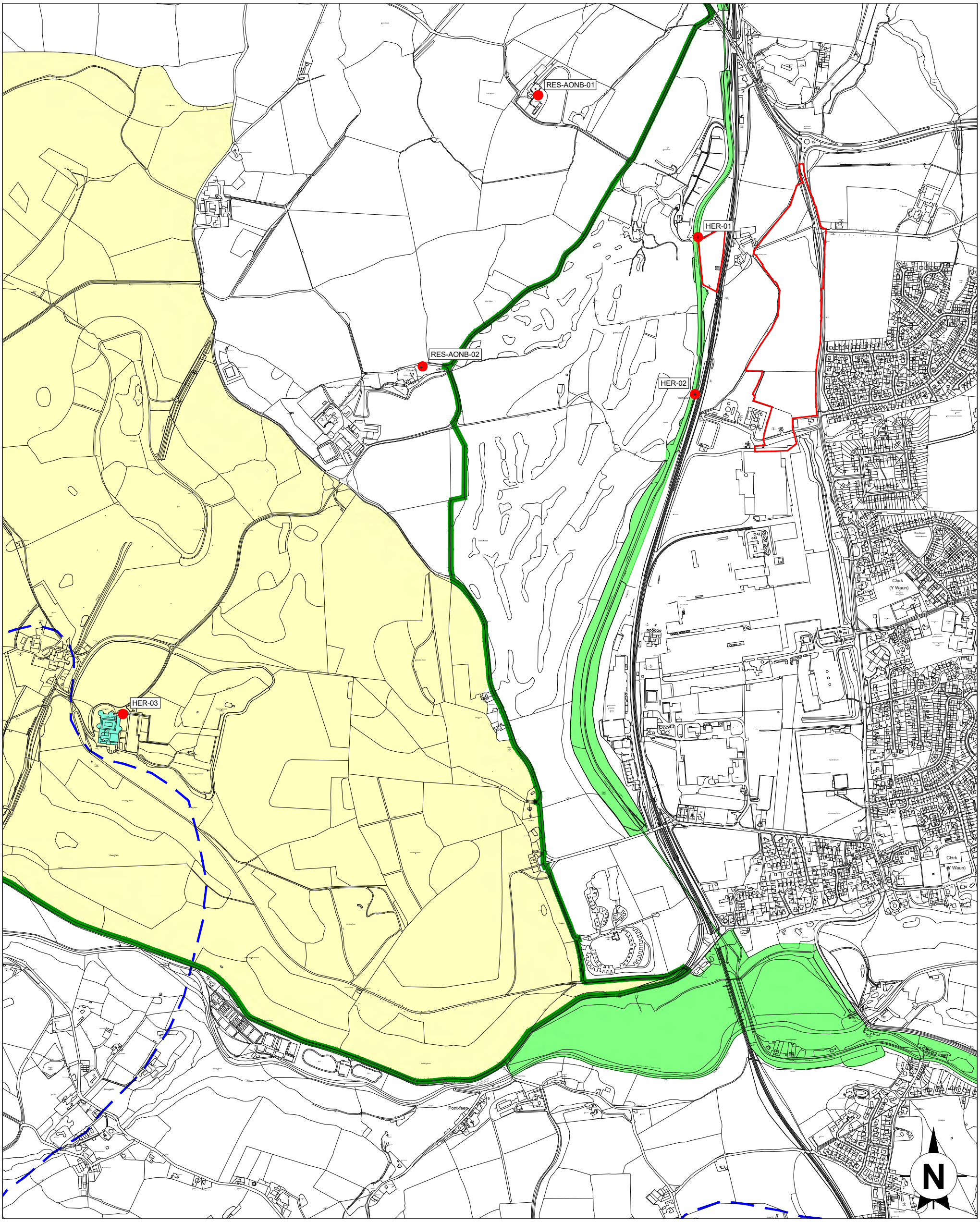
STRENGER LTD	KRONOSPAN NORTH ACCESS ROAD	
	SK-04 REV_A	
	Light Monitoring Location Plan	
	Scale 1:2500@A3	Date July 2023



Key:

- Location of Proposed Development
- Area of Outstanding Natural Beauty
- World Heritage Site
- World Heritage Site Buffer Zone
- Chirk Castle Registered Park and Garden
- Chirk Castle Grade I Listed Building

STRENGER LTD

KRONOSPAN NORTH ACCESS ROAD

SK-05 REV_B

Heritage and AONB Residential Receptor Location Plan

Scale
NTS

Date
July 2023