

Water Eaton

PR6a : Land East of Oxford Road

Environmental Statement Appendix 12.3:
Illumination Impact Assessment

Bellway


**STRATEGIC
LAND**



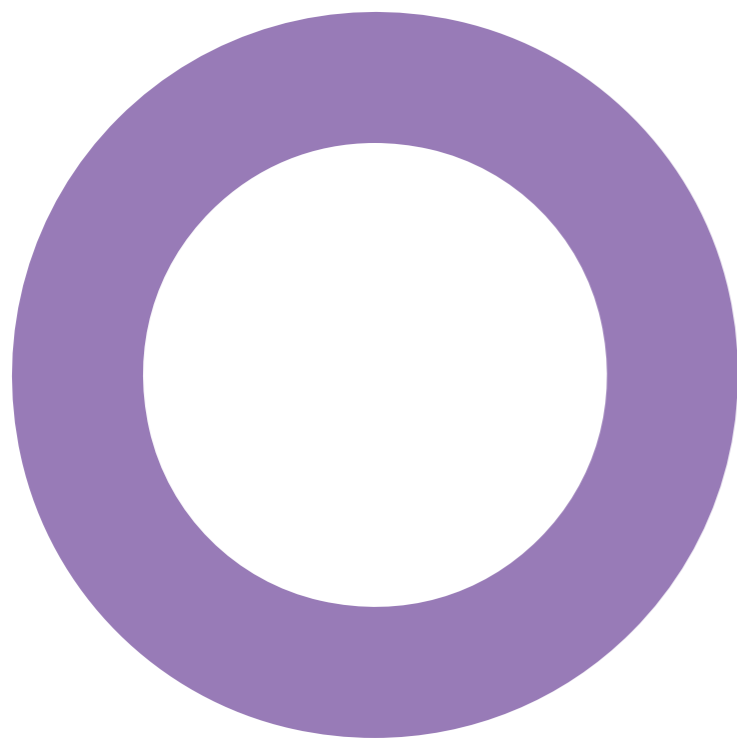
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Water Eaton (PR6A), Oxford. Savills.

16-16913

LIGHTING IMPACT ASSESSMENT - ILLUMINATION IMPACT PROFILE
PR6A - LAND EAST OF OXFORD.
AUGUST 2022

DOC-16-16913-5A-20220804-SMK-PR6A-IIP-01



Audit sheet.

Rev	Date	Description	Prepared	Verified	Authorised
01	04/08/2022	First draft for review.	EFR	SMK	DDM

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1.0 Introduction.

This report has been prepared by Hoare Lea to present quantitative information regarding pre and post development illuminance and luminance effects for residential locations. The information and data derived from this report may be used in ecology reports, where any discussion on impact be clarified.

IIP – Illumination Impact Profile

The following provides an Illumination Impact Profile, in tandem with the Planning Application, which gives assessment of the exterior lighting design proposal's impact on the surrounding Environmental Zone. With the passing into law of the 'Clean Neighbourhood and Environmental Act' 2005 this issue is a major deliverable for exterior lighting projects.

The intention of the Illumination Impact Profile package is to convey how the proposed development will affect the illumination profile of the area and how that will comply with relevant legislation requirements and best practice design guidance.

In accordance with CIE guidance 2003 & 2017 and the ILP Guidance Notes for the Reduction of Obtrusive Light (2021) and in relation to the assessment, the following definitions are used in describing obtrusive lighting effects:

- Direct sky glow: the direct upward spill of light into the sky, which can cause a glowing effect and is often seen above cities when viewed from a dark area.
- Upward reflected light: the reflected upward spill of light into the sky, from surfaces below the light sources. A contributor to sky glow.
- Glare: (viewed source intensity) the uncomfortable brightness of the light source against a dark background which results in dazzling the observer, which may cause nuisance to residents and a hazard to road users.
- Light spill: the spilling of light beyond the boundary of the area being lit.
- Light intrusion: nuisance light, levels of light above defined values into residential properties.

Supporting documentation

This report should be read in conjunction with:

DOC-16-16913-5A-20210625-SMK-PR6A-BLS-01 provides an assessment of the current base line lighting for the area surrounding the development.

DOC-16-16913-5A-20210625-JB-PR6A-PP-01 provides details regarding fitting types and recommended lighting levels of illumination.



Figure 1.0 Aerial view of site with Redline boundary.

1.0 Introduction.

Assessment Criteria for the Completed Development

The planning application seeks permission for a residential, educational, green space development & supporting infrastructure.

For the purposes of demonstrating a robust assessment, the following standard industry precautionary measures are applied to the assessment calculation:

- It has been assumed that all relevant external lighting is operational simultaneously for the relevant pre or post curfew operational condition (i.e. a maximum adverse scenario).
- Small feature lighting, such as bench or uplights have been excluded from the assessment. The low output and orientation limit their impact.
- A unity Maintenance Factor (1.0) is applied to represent the maximum adverse condition from initial installation. This equates to "day one" lumen output of the luminaires, with no depreciation for luminaire cleaning.
- As per standard industry practice existing and proposed planting / trees have not been included within the assessment calculations. Physical mitigation such as solid fencing has been included in the calculation model.
- Ground surface reflectance has been taken as 22% based on data from CIBSE LG11: Surface Reflectance and Colour. This is an Area Weighted Reflectance based on typical sports surfaces & natural landscaping.
- The lighting design and subsequent plots should be based on lower than unity Maintenance Factor to reflect likely cleaning intervals and lumen depreciation. This will deliver the design-lighting levels in use and result in higher than design-lighting levels when new.
- The lighting calculations were based upon the supplied image 477898 - PR6a - Illustrative Masterplan-01 (**Figure 1.4**) and the parameter plan DOC-16-16913-5A-20210625-JB-PR6A-PP-01.



Figure 1.1 Rendered site plan, aerial view.

1.0 Introduction.

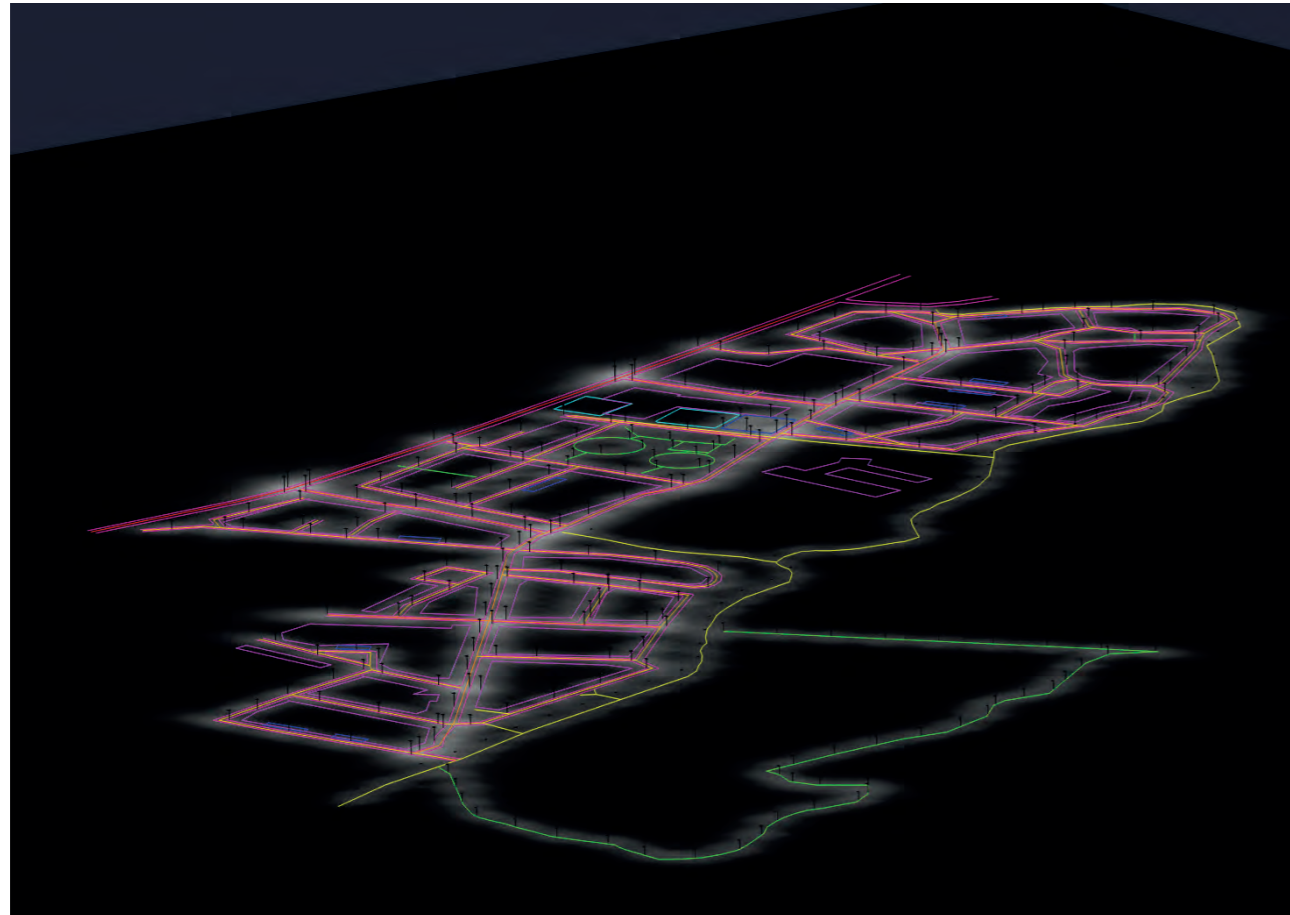


Figure 1.2. Rendered site plan, south east view.

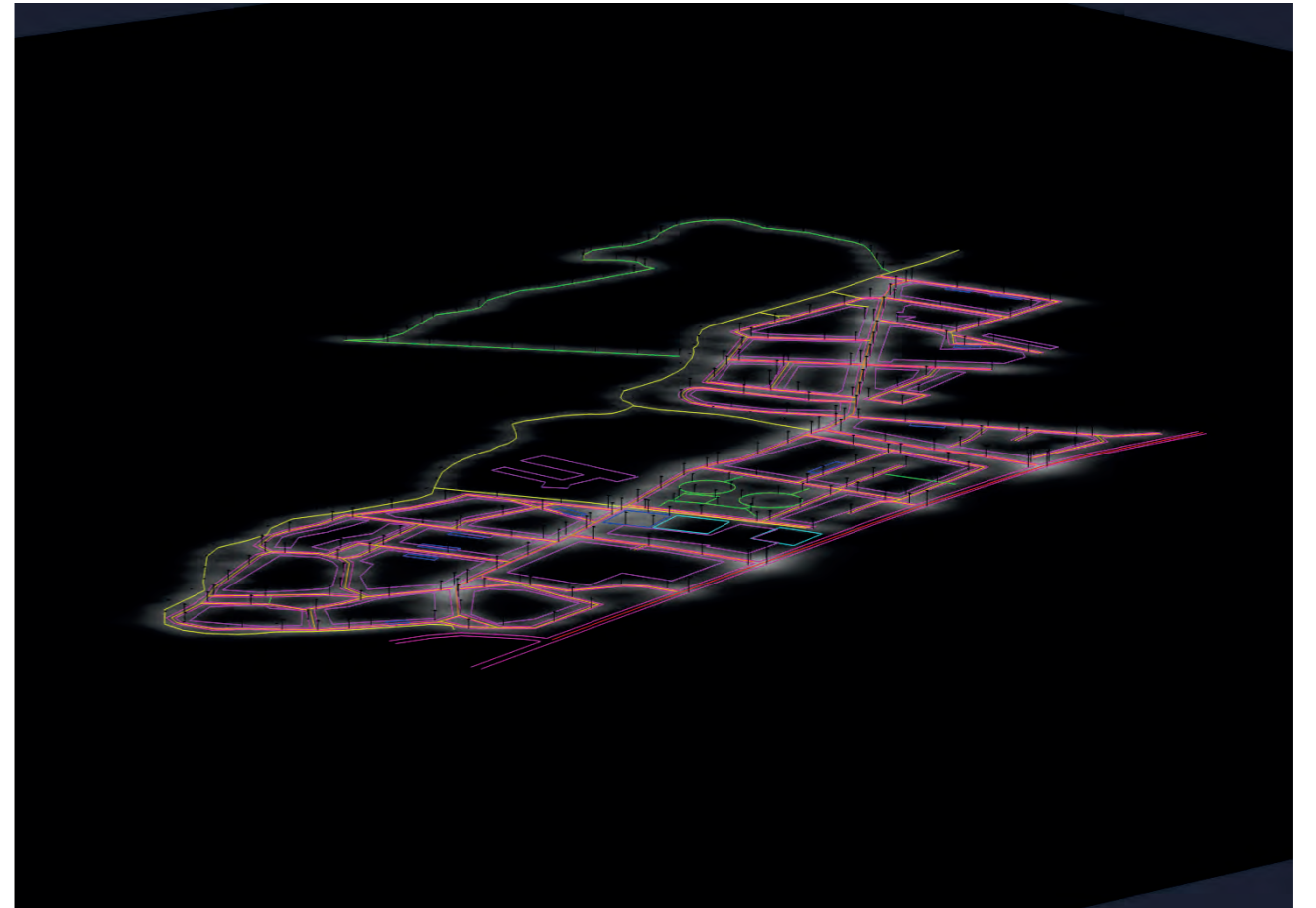


Figure 1.3. Rendered site plan, north west view.

1.0 Introduction.

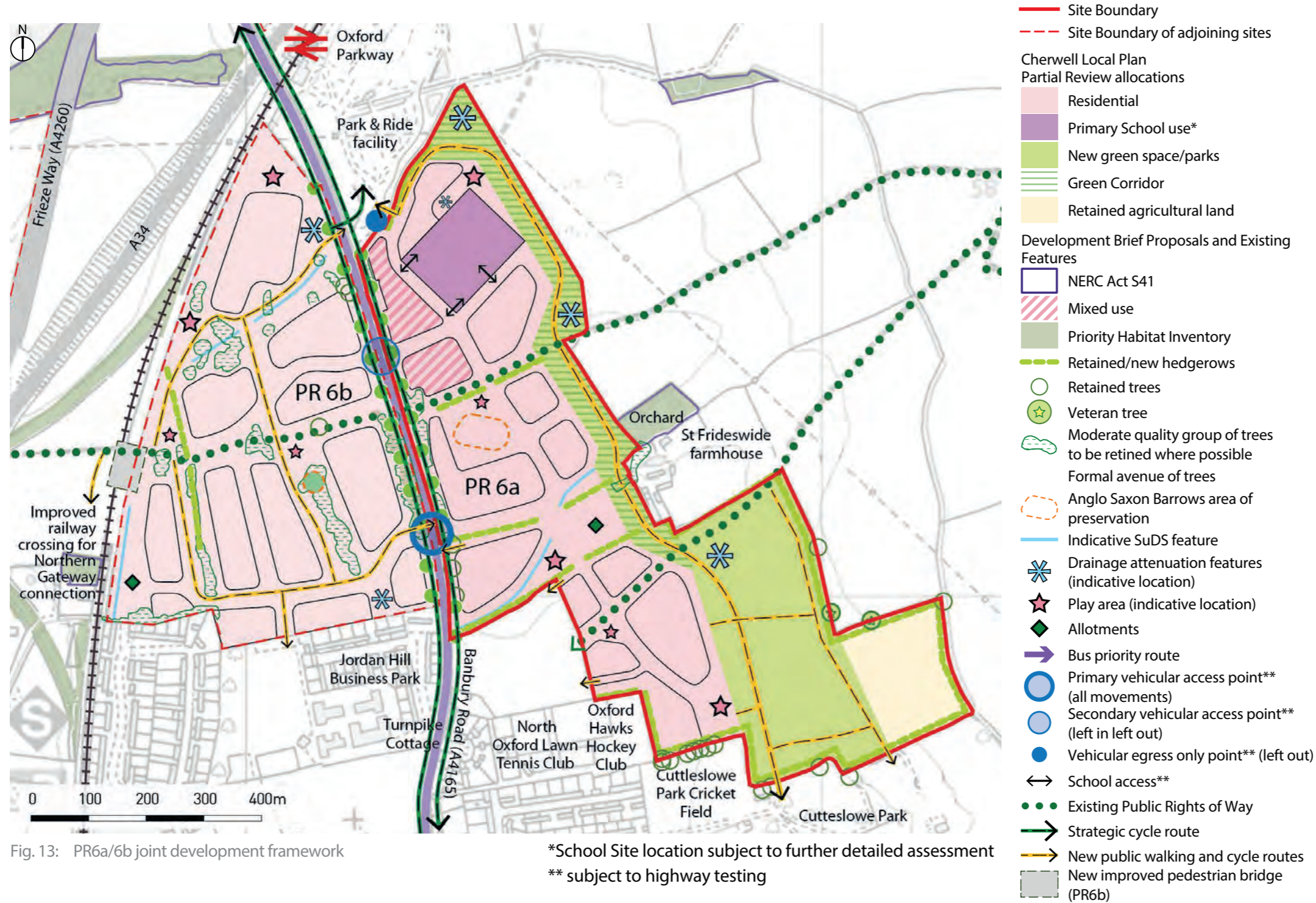


Fig. 13: PR6a/6b joint development framework

*School Site location subject to further detailed assessment
** subject to highway testing

Development Brief PR6a / January 2022

Alan Baxter

Figure 1.4 Supplied - Development Brief showing proposed zoning of site.

1.0 Introduction.



Figure 1.5 Supplied - illustrative masterplan - used as base reference for calculations and parameter plan.

2.0 Guidelines & legislation.

External realm lighting

A number of documents lay down the best practice and guidance on providing sufficient and appropriate lighting for vehicular thoroughfares, pedestrians passage and visual interest.

These are:

- BS 5489-1:2020
- BS EN 13201-2:2015
- CIE 136:2000
- ILP Lighting for cycling infrastructure (PLG 23)

And if appropriate:

- CIBSE Lighting Guide 6: The Outdoor Environment 1992
- CIBSE Lighting the Environment: A guide to good urban design
- Secure by Design - Lighting Against Crime

It should be noted that where the scope line of the site ends, HL assume that the ambient lighting is sufficient and meets the required lighting criteria beyond the boundary line. It is not the responsibility of HL to provide the lighting for these areas.

Light pollution

A number of documents lay down the best practise and guidance on reducing the visual and environmental impact of external lighting in relation to light pollution.

These are:

- CIE Technical Report - CIE 150: 2017
- ILP Guidance Notes for the Reduction of Obtrusive Light 2021 (GN01/21)
- Institution of Lighting Professionals (ILP) Guidance Note 08/18 "Bats and artificial lighting in the UK" ILP

The implementation of these standards is vital because of "The Clean Neighbourhoods and Environment Act, 2005" which makes light a statutory nuisance.

It should be noted that, based on the current ecological conditions of the site and the proposed changes to the site, any lighting proposed to the site shall be considerate of any wildlife or potential new wildlife by ensuring that where possible light is directed into the site and any luminaires that are in close proximity to wildlife have good optical control and/or back spill shielding to minimize the impact on these areas.



3.0 Results.



Figure 3.0 Image taken from Microsoft mapping - Showing survey locations.

3.0 Results.

Overview

Referring to Figure 3.0, illuminance levels (lux) were measured at night to establish baseline conditions at (1 to 45) locations on the horizontal and vertical planes. The baseline measurements (lux) were then added to the illuminance levels (lux) calculated, to provide a resultant illuminance on both the horizontal and vertical for all (1-45) locations.

The proposed lighting strategy was model in specialist lighting software to generate the calculations.

The data represented in **Table 3.4** provides the calculated results of significant effects on the horizontal plane. Location points calculated to have a moderate adverse effect were 18, 23 & 29.

The data represented in **Table 3.5** provides the calculated results of significant affects on the vertical plane. Location points calculated to have a moderate adverse effect were 18, 23 & 29.

Some survey positions have been noted to be in or in close proximity to the proposed 'green corridor' at the eastern boundary of the site identified in **Figure 3.2**. These survey positions can be seen in the adjacent **Figure.3.1**. These location show a negligible effect.

The data represented in **Table 3.6** provides the calculated results of possible residential locations where vertical illuminance to windows (as opposed to horizontal illuminance) and luminaire source intensity is assessed. Due to the nature of gaining access to private property only calculated values from the proposed site are shown. All results are compliant with ILP Guidance Note 01/21.

Natural Receptor – Direct Sky Glow (SG1)

Direct sky glow is assessed as a site wide impact and is based on a scenario where the most onerous of lighting impact is applied relative to the potential uses within each area.

Calculated in accordance with CIE 150 (2003) Section 5.5.2 & ILP guidelines.

See page 14 for details.

Natural Receptor – Direct & Indirect Sky Glow (SG2)

Calculated in accordance with CIE 150 (2017). This is referred to as the Upward Flux Ratio (UFR).

See page 14 for details.



Figure 3.1. Survey locations in or in close proximity to the 'green corridor' (hatched in green).



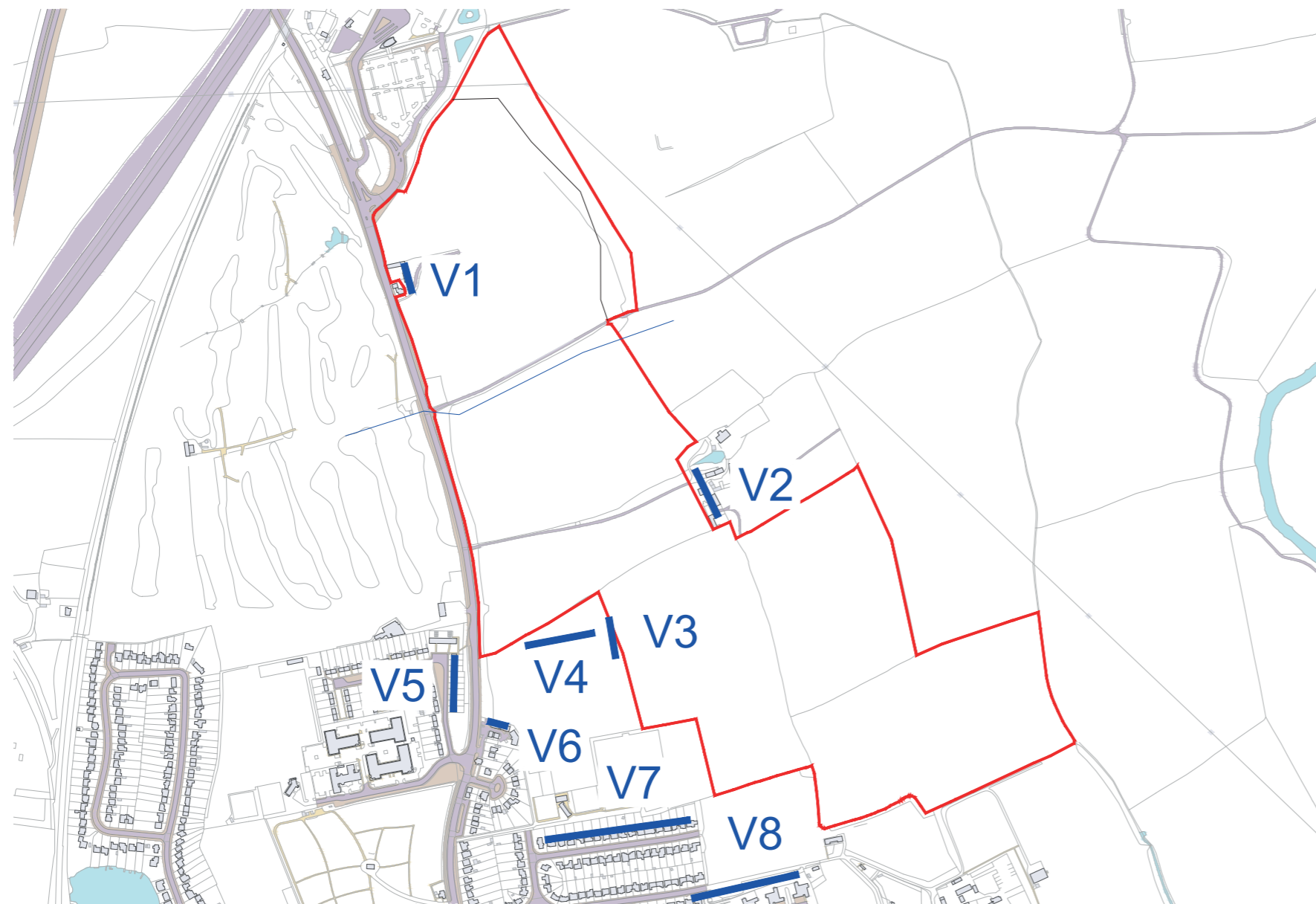
Figure 3.2. Supplied - Development Brief showing proposed zoning of site. Green corridor shown as horizontal green hatching.

3.0 Results - existing residential locations.

Residential vertical calculation surfaces V1 to V8.

Some areas on site are not practical to survey to obtain a baseline level to measure any potential impact from a development. In these situations virtual calculation surfaces are placed at the locations of existing and proposed residential properties.

The measuring surface will extend along the length of a known property and calculate values from ground level to 10m high. This methodology ensures any windows along the property can be assessed for potential impact from obtrusive light and glare (luminous source intensity).



Residential surfaces and orientation.	
V1	Existing residential - facing east.
V2	Existing residential - facing west.
V3	Future residential - facing east.
V4	Future residential - facing north.
V5	Existing residential - facing east.
V6	Existing residential - facing north.
V7	Existing residential - facing north.
V8	Existing residential - facing north.

Figure 3.3. Vertical residential calculation surfaces overlaid supplied plan of existing site.

3.0 Results.

Tables 3.1 to 3.3 (inclusive) define the parameters for evaluating change to the site and surrounding areas. They define percentage rates of change from baseline and the sensitivity of receptors. These definitions are used in tables 3.4 & 3.5.

These tables are based upon the DMRB (Design Manual for Roads and Bridges). Document reference LA 104 - Environmental assessment and monitoring. Human receptors are assessed as low sensitivity and the magnitude of effect is defined by the change in value from the base line survey. The significance of effect is the product of these two afore mentioned criteria.

ILP guidelines provide limiting criteria for luminous source intensity (glare) and light intrusion to residential locations. Many of the positions assessed do not have a residence at that location, the purpose of assessment is to define the potential percentage increase in lighting levels in and around the development. This process forms the basis of assigning a lighting zone (as per ILP guidelines) to the area. These tables (3.4 & 3.5) only assess residential (human) receptors. However the data derived at these locations may be of use in ecology reports, where any discussion on significance will be clarified.

Defining Sensitivity of Receptor.	
Sensitivity	Definition
High	The receptor has little ability to absorb change in artificial light conditions without fundamentally altering its present character, or is of international or national importance.
Moderate	The receptor has moderate capacity to absorb change in artificial light conditions without significantly altering its present character, or is of high importance.
Low	The receptor is tolerant of change in artificial light conditions without detriment to its character, or is of low or local importance.

Table 3.1

Defining Magnitude of Effect.			
Magnitude of Effect	Horizontal and Vertical Light Trespass (Lux)	Direct Sky Glow ULR%	Glare Luminaire Source intensity
	Percentage Change Between Baseline Value and Baseline Value + Development	Percentage increase over guidance limits for the Environmental Zone (Baseline value not available).	Percentage increase over guidance limits for the Environmental Zone. (Baseline value not available).
High	75 to 100%	75 to 100%	75 to 100%
Medium	45 to 75%	45 to 75%	45 to 75%
Low	10 to 45%	10 to 45%	10 to 45%
Negligible	0 to 10%	0 to 10 %	0 to 10 %

Table 3.2

3.0 Results.

Assessing Significance of Effects			
Magnitude of Effect	Sensitivity		
	High	Moderate	Low
High	Major Adverse / Beneficial	Moderate Adverse / Beneficial	Moderate Adverse / Beneficial
Medium	Moderate Adverse / Beneficial	Moderate Adverse / Beneficial	Minor Adverse / Beneficial
Low	Moderate Adverse / Beneficial	Minor Adverse / Beneficial	Negligible
Negligible	Negligible	Negligible	Negligible

Table 3.3

3.0 Results.

Natural Receptor – Direct Sky Glow (SG1)

Sky glow is often seen above areas with high levels of illumination, it's typically the yellow/orange glow to the sky which can make viewing stars etc. more difficult. It can also have an ecological impact as it can disturb the natural cycles of wildlife. It is easiest to spot when viewing a city from a nearby darker area. Sky glow is produced by the light from poorly aimed or poorly designed luminaires being directed up into the sky rather than towards the ground where it can have a useful function. When developed, this area would likely be classified as E2 a figure of 2.5% of the total light used is allowable as direct upward light. The following shows the formula for calculating direct sky glow and demonstrating compliance.

Direct sky glow is assessed as a site wide impact and is based on a scenario where the most onerous of lighting impact is applied relative to the potential uses within each area.

In accordance with CIE 150 (2003) Section 5.5.2 & ILP guidelines the Upward Direct Light Ratio is calculated as follows:

$ULR = Eup / (Edown + Eup)$

- Eup – Resultant average illuminance taken from a grid 1.0m above the highest luminaire
- Edown – Resultant average illuminance taken from a grid 1.0m below the lowest luminaire

For the purposes of direct sky glow assessment the majority of the site an surrounding area is currently considered to be representative environmental zone classification of an E2 Rural, Low district brightness (SQM ~ 15 to 20). Sparsely inhabited rural areas, village or relatively dark outer suburban locations.

In maintaining a no change / improved environment the ILP Guidance Notes for the Reduction of Obtrusive Light (2021) provides a limiting sky glow percentage of 2.5%.

ULR = 0%.

Natural Receptor – Direct & Indirect Sky Glow (SG2)

In accordance with CIE 150 (2017) Section 6.4.3 the total upward light both direct & reflected can be calculated. This is referred to as the Upward Flux Ratio (UFR).

The whole site was calculated with an average lux level, based upon the variety of uses on site and weighted accordingly.

- Whole site. Average surface reflectance 22%, surrounding area surface reflectance 22%, average maintained illuminance required 5 lux. Maximum allowable UFR value allowable = 5. This is based on a road area in an E2 Zone.

The lighting layout calculates a value of 0.40 which is within guidelines for the area.

3.0 Results - horizontal impact summary.

Sensitive receptor (human) - horizontal								
Survey location	Location name	Sensitivity	Environmental zone	Peak illuminance measurement (Lux) horizontal (H1) @ ground	Peak illuminance calculated (Lux) horizontal (H1) @ ground	Peak illuminance resultant (Lux) horizontal (H1) @ ground	Note	Significance of effect
1	Water Eaton Lane - Bridge over A34	Low	E1	0.15	0.00	0.15		Negligible
2	Water Eaton Lane	Low	E1	0.15	0.00	0.15		Negligible
3	Bridge over railway	Low	E1	0.15	0.00	0.15		Negligible
4	Lane adjacent to residential property	Low	E1	0.15	0.00	0.15		Negligible
5	Rail Depot	Low	E4	20.00	0.00	20.00		Negligible
6	A34 Layby	Low	E2	2.50	0.00	2.50		Negligible
7	Park & Ride	Low	E4	15.52	0.00	15.52		Negligible
8	Near Water Eaton Manor	Low	E1	0.15	0.00	0.15		Negligible
9	Park & Ride - access road, adjacent to fence	Low	E3	12.20	0.00	12.20	*2	Negligible
10	Park & Ride	Low	E2	3.04	0.00	3.04		Negligible
11	Park & Ride	Low	E3	8.12	0.00	8.12		Negligible
12	Park & Ride - directly under lighting column	Low	E4	50.24	0.00	50.24		Negligible
13	Park & Ride - access road	Low	E3	4.15	0.00	4.15		Negligible
14	Water Eaton - footpath	Low	E1	0.15	0.00	0.15		Negligible
15	Water Eaton - footpath	Low	E1	0.15	0.00	0.15		Negligible
16	Site boundary - footpath	Low	E1	0.15	0.00	0.15	*2	Negligible
17	Site boundary	Low	E1	0.15	0.00	0.15		Negligible
18	Footpath	Low	E1	0.15	0.48	0.63	*1	Moderate Adverse
19	Footpath - golf course	Low	E1	0.15	0.00	0.15		Negligible
20	Site boundary	Low	E1	0.15	0.00	0.15	*2	Negligible
21	St Frideswide - Farmhouse	Low	E1	0.15	0.00	0.15	*2	Negligible
Note 1* - survey position within site boundary.								
Note 2* - survey position in or in close proximity to 'green corridor', see page 10 for details.								
Table 3.4								

Legend to colour coding
Measured illumination (Taken from original baseline)
Calculated additional illumination (From modelled results)
Resultant illumination (Total value post development)

3.0 Results - horizontal impact summary.

Sensitive receptor (human) - horizontal								
Survey location	Location name	Sensitivity	Environmental zone	Peak illuminance measurement (Lux) horizontal (H1) @ ground	Peak illuminance calculated (Lux) horizontal (H1) @ ground	Peak illuminance resultant (Lux) horizontal (H1) @ ground	Note	Significance of effect
22	St Frideswide - Farmhouse	Low	E1	0.15	0.00	0.15	*2	Negligible
23	St Frideswide - access road	Low	E3	0.15	3.82	3.97	*1	Moderate Adverse
24	Golf course - car park	Low	E1	0.15	0.00	0.15		Negligible
25	Site boundary	Low	E1	0.15	0.00	0.15		Negligible
26	Site boundary	Low	E1	0.15	0.00	0.15		Negligible
27	Jordan Hill	Low	E2	1.14	0.00	1.14		Negligible
28	Hockey club - northern edge	Low	E1	0.15	0.00	0.15		Negligible
29	Field adjacent to sports lighting	Low	E3	0.13	8.42	8.55	*1	Moderate Adverse
30	Field adjacent to sports lighting	Low	E1	0.94	0.00	0.94		Negligible
31	Field adjacent to sports lighting	Low	E3	4.03	0.00	4.03		Negligible
32	Field adjacent to sports lighting	Low	E4	30.00	0.33	30.33		Negligible
33	Southern field	Low	E1	0.15	0.00	0.15		Negligible
34	Site boundary	Low	E1	0.15	0.00	0.15		Negligible
35	Banbury Road	Low	E3	7.68	0.00	7.68		Negligible
36	Jordan Business Park	Low	E3	4.49	0.00	4.49		Negligible
37	Tennis & Hockey Club - car park	Low	E1	0.40	0.00	0.40		Negligible
38	Cricket pitch	Low	E1	0.15	0.00	0.15		Negligible
39	Heywood Road	Low	E2	2.65	0.00	2.65		Negligible
40	Harbord Road	Low	E1	0.04	0.00	0.04		Negligible
41	Local authority - works depot	Low	E1	0.66	0.00	0.66		Negligible
42	Cuttleslowe Park	Low	E1	0.48	0.00	0.48		Negligible
43	Sparsey Place	Low	E3	4.07	0.00	4.07		Negligible
44	Harefields	Low	E2	1.40	0.00	1.40		Negligible
45	Oxford Beach	Low	E1	0.08	0.00	0.08		Negligible
Note 1* - survey position within site boundary.								
Note 2* - survey position in or in close proximity to 'green corridor', see page 10 for details.								
Table 3.4								

Legend to colour coding
Measured illumination (Taken from original baseline)
Calculated additional illumination (From modelled results)
Resultant illumination (Total value post development)

3.0 Results - vertical impact summary.

Sensitive receptor (human) - vertical									
Survey location	Location name	Sensitivity	Environmental zone	Peak illuminance measurement (Lux) vertical (V1) @ 1.5m AFFL (See baseline survey for direction)	Peak illuminance calculated (Lux) vertical (V1) @ 1.5m AFFL	Direction of Peak illuminance calculated (Lux) vertical (V1) @ 1.5m AFFL	Peak illuminance resultant (Lux) vertical (V1) @ 1.5m AFFL	Note	Significance of effect
1	Water Eaton Lane - Bridge over A34	Low	E1	0.15	0.00	N/A	0.15		Negligible
2	Water Eaton Lane	Low	E1	0.15	0.00	N/A	0.15		Negligible
3	Bridge over railway	Low	E1	0.15	0.00	N/A	0.15		Negligible
4	Lane adjacent to residential property	Low	E1	0.15	0.00	N/A	0.15		Negligible
5	Rail Depot	Low	E1	10.00	0.00	N/A	10.00		Negligible
6	A34 Layby	Low	E1	7.50	0.00	N/A	7.50		Negligible
7	Park & Ride	Low	E1	18.54	0.00	N/A	18.54		Negligible
8	Near Water Eaton Manor	Low	E1	0.15	0.00	N/A	0.15		Negligible
9	Park & Ride - access road, adjacent to fence	Low	E1	14.67	0.00	N/A	14.67	*2	Negligible
10	Park & Ride	Low	E1	11.81	0.00	N/A	11.81		Negligible
11	Park & Ride	Low	E1	26.08	0.00	N/A	26.08		Negligible
12	Park & Ride - directly under lighting column	Low	E1	39.40	0.00	N/A	39.40		Negligible
13	Park & Ride - access road	Low	E1	7.80	0.02	East	7.82		Negligible
14	Water Eaton - footpath	Low	E1	0.15	0.00	N/A	0.15		Negligible
15	Water Eaton - footpath	Low	E1	0.15	0.00	N/A	0.15		Negligible
16	Site boundary - footpath	Low	E1	0.15	0.00	N/A	0.15	*2	Negligible
17	Site boundary	Low	E1	0.15	0.00	N/A	0.15		Negligible
18	Footpath	Low	E1	0.15	0.66	East	0.81	*1	Moderate Adverse
19	Footpath - golf course	Low	E1	0.15	0.00	N/A	0.15		Negligible
20	Site boundary	Low	E1	0.15	0.01	West	0.16	*2	Negligible
21	St Frideswide - Farmhouse	Low	E1	0.15	0.00	N/A	0.15	*2	Negligible

Note 1* - survey position within site boundary.

Note 2* - survey position in or in close proximity to 'green corridor', see page 10 for details.

Table 3.5

Legend to colour coding
Measured illumination (Taken from original baseline)
Calculated additional illumination (From modelled results)
Resultant illumination (Total value post development)

3.0 Results - vertical impact summary.

Sensitive receptor (human) - vertical									
Survey location	Location name	Sensitivity	Environmental zone	Peak illuminance measurement (Lux) vertical (V1) @ 1.5m AFFL (See baseline survey for direction)	Peak illuminance calculated (Lux) vertical (V1) @ 1.5m AFFL	Direction of Peak illuminance calculated (Lux) vertical (V1) @ 1.5m AFFL	Peak illuminance resultant (Lux) vertical (V1) @ 1.5m AFFL	Note	Significance of effect
22	St Frideswide - Farmhouse	Low	E1	0.15	0.00	N/A	0.15	*2	Negligible
23	St Frideswide - access road	Low	E1	0.15	6.10	North	6.25	*1	Moderate Adverse
24	Golf course - car park	Low	E1	0.15	0.07	East	0.22		Minor Adverse
25	Site boundary	Low	E1	0.15	0.00	N/A	0.15		Negligible
26	Site boundary	Low	E1	0.15	0.00	N/A	0.15		Negligible
27	Jordan Hill	Low	E1	2.30	0.00	N/A	2.30		Negligible
28	Hockey club - northern edge	Low	E1	0.15	0.04	North	0.19		Negligible
29	Field adjacent to sports lighting	Low	E1	0.76	8.65	West	9.41	*1	Moderate Adverse
30	Field adjacent to sports lighting	Low	E1	3.27	0.06	North	3.33		Negligible
31	Field adjacent to sports lighting	Low	E1	11.39	0.09	West	11.48		Negligible
32	Field adjacent to sports lighting	Low	E1	37.10	0.45	East	37.55		Negligible
33	Southern field	Low	E1	0.15	0.00	N/A	0.15		Negligible
34	Site boundary	Low	E1	0.15	0.00	N/A	0.15		Negligible
35	Banbury Road	Low	E1	5.93	0.00	N/A	5.93		Negligible
36	Jordan Business Park	Low	E1	5.58	0.00	N/A	5.58		Negligible
37	Tennis & Hockey Club - car park	Low	E1	0.15	0.00	N/A	0.15		Negligible
38	Cricket pitch	Low	E1	0.15	0.00	N/A	0.15		Negligible
39	Heywood Road	Low	E1	4.76	0.00	N/A	4.76		Negligible
40	Harbord Road	Low	E1	5.06	0.00	N/A	5.06		Negligible
41	Local authority - works depot	Low	E1	3.26	0.00	N/A	3.26		Negligible
42	Cuttleslowe Park	Low	E1	1.56	0.00	N/A	1.56		Negligible
43	Sparsey Place	Low	E1	7.13	0.00	N/A	7.13		Negligible
44	Harefields	Low	E1	2.52	0.00	N/A	2.52		Negligible
45	Oxford Beach	Low	E1	0.25	0.00	N/A	0.25		Negligible

Legend to colour coding

Measured illumination (Taken from original baseline)

Calculated additional illumination (From modelled results)

Resultant illumination (Total value post development)

Note 1* - survey position within site boundary.

Note 2* - survey position in or in close proximity to 'green corridor', see page 10 for details.

Table 3.5

3.0 Results - existing residential locations.

Sensitive receptor (human) - vertical (ILP Guidance notes 2021)				Light trespass			Glare (Luminous source intensity)
Survey location	Location name	Sensitivity	Environmental zone	Vertical illuminance Max. into windows (ILP guidance notes 2011 & 2021) (Lux). Pre curfew	Calculated Max. vertical illuminance (Lux) (maximum value to elevation) *1	Compliant with ILP guidelines for noted zone. (Residential) *1	Compliant with ILP guidelines for noted zone. (Residential)*1 *2
V1	Existing residential - facing east.	Low	E2	5 Lux	1.50 Lux	Pass	Pass
V2	Existing residential - facing west.	Low	E2	5 Lux	0.10 Lux	Pass	Pass
V3	Future residential - facing east.	Low	E2	5 Lux	0.40 Lux	Pass	Pass
V4	Future residential - facing north.	Low	E2	5 Lux	0.10 Lux	Pass	Pass
V5	Existing residential - facing east.	Low	E2	5 Lux	0.00 Lux	Pass	Pass
V6	Existing residential - facing north.	Low	E2	5 Lux	0.00 Lux	Pass	Pass
V7	Existing residential - facing north.	Low	E2	5 Lux	0.00 Lux	Pass	Pass
V8	Existing residential - facing north.	Low	E2	5 Lux	0.00 Lux	Pass	Pass
<p>*1) These calculated values and pass/fail notations are based on a virtual surface 10m high, length as shown in Figure 6.</p>							
<p>*2) Glare, Maximum allowable value calculated is from CIE 150:2017 referenced in ILP Guidance Note 01/21 - Table 4. The allowable value varies by Projected Area (sq.m.) and Distance Factor. This parameter plan design demonstrates compliance with these guidelines. Note: Glare, Maximum allowable value calculated from CIE 150:2017 referenced in ILP Guidance Note 01/21 - Table 4. (varies by Projected Area sq.m. and Distance Factor).</p>							
<p>*3) The detailed design stage, will require careful consideration of the luminous source intensity of luminaires visible from residential locations. The detailed design will use adoptable luminaires as approved by the highways department of the local planning authority. Lighting for roads is not covered by the legislation regarding light pollution, however it is good practice to achieve compliance with Institution of Lighting Professionals (ILP) guidelines. In our professional judgement a developed detailed design can meet the guidelines required by the ILP for this criteria. However additional secondary mitigation such as louvres, shields and baffles can be additionally and retrospectively used should any issues arise.</p>							
<p>Table 3.6.</p>							

3.0 Results - isoline of 0.5 lux horizontal (ground level).

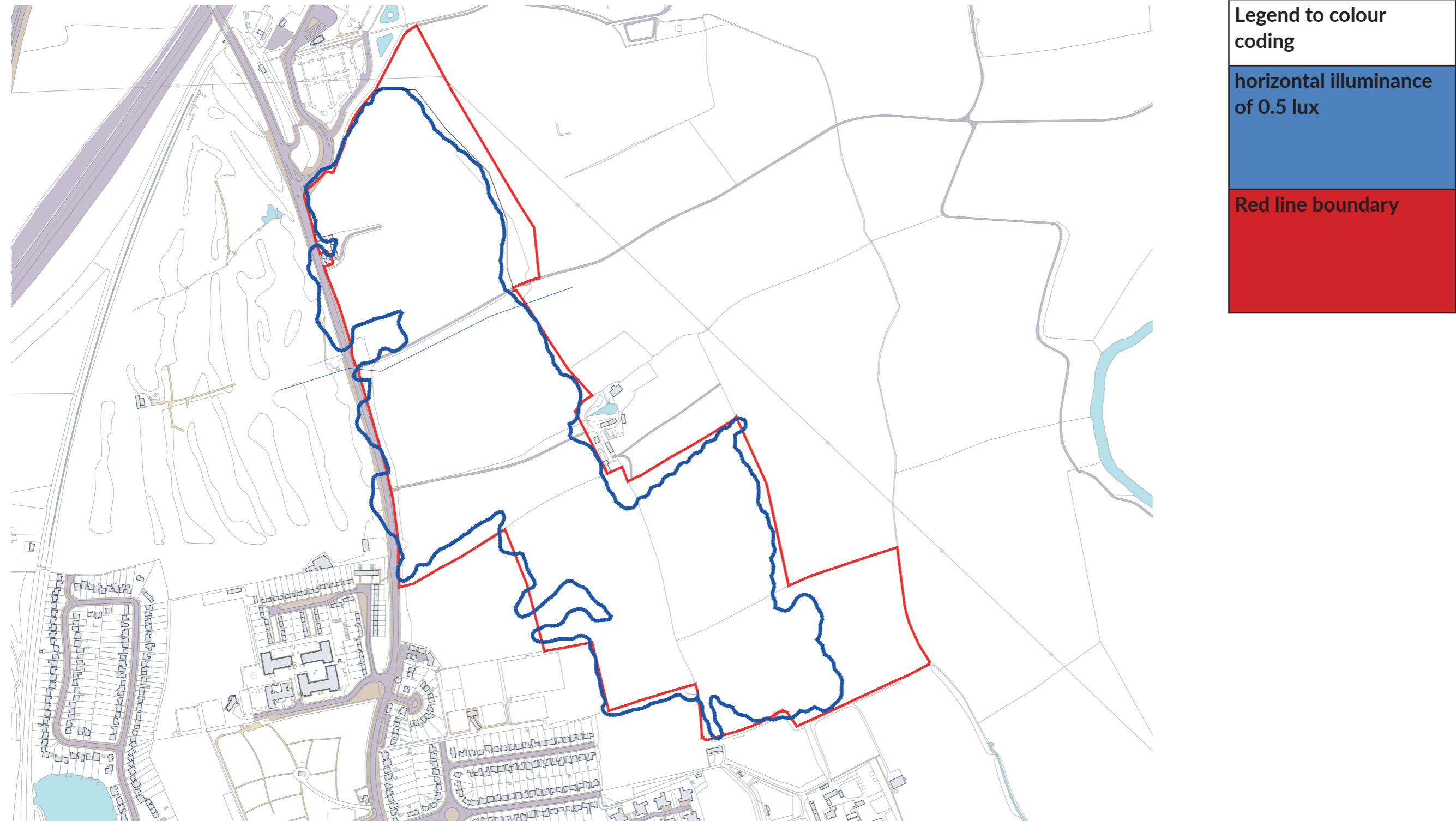


Figure 3.5 Horizontal Illuminance of 0.5 lux at ground level overlaid supplied plan of existing site.

4.0 Baseline site and environmental zone classification.

To assess the site we refer to the ILP guidance notes for the reduction of obtrusive light (2021) and CIE150.

In Figure 4.0 (adjacent map) areas would be classified as:



- **E1 Natural, Dark, (SQM 20 to 20.5+). Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty, IDA buffer zones etc.**

The areas with no colour coding would be classified as E1. Given the proximity to areas with higher levels of illumination it is likely that areas may often have a direct view of light fittings or sky glow is likely to be visible. There may however be pockets of land where sky glow is limited, and the horizon is clear of light sources.



- **E2 Rural, Low district brightness (SQM ~ 15 to 20). Sparsely inhabited rural areas, village or relatively dark outer suburban locations.**

Areas around the application site are lit to a level which fits the above categorization. Only the west would be regarded as mostly unlit. The type of light fittings, spacings between luminaires coupled with the type of road and traffic density would in our professional judgement lead to this conclusion. There are small pockets of landscaped green space where horizontal light levels would be in line with an E1 category, however vertical levels of illumination, sky glow and the presence of light on all horizons would place those areas in a higher classification.



- **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**

Two areas immediately adjacent to the application site, involve high levels of night-time activity. The Park & Ride in the north and the sports facility in the south. The Park & Ride was still illuminated past midnight, whilst the sports facility had a 9.30/10pm switch off during the site survey.

The light levels recorded will place these in an E3/E4 category. The type of luminaires, visibility from adjacent areas, height & positioning support this conclusion.

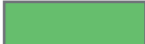


Figure 4.0. Map showing environmental lighting zones - Approximate red line of site shown.

5.0 Projected site and environmental zone classification.

To assess the site we refer to the ILP guidance notes for the reduction of obtrusive light (2021) and CIE150.

In Figure 5.0 (adjacent map) areas would be classified as:

 - E1  - E1*

E1 Natural, Dark, (SQM 20 to 20.5+). Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty, IDA buffer zones etc.

Areas in within the boundary at the south east of site have been retained as E1 due to only low lighting required for the pedestrian route through the an otherwise unlit area. A strip of space along the north eastern site boundary along the green corridor has been conserved as E1 due to minimal spill light from

PR6B to the east of site annotated with E1* and cyan hatching has been earmarked for future residential development. It will likely be lit to the standard typical of an E2 zone, similar to current and future nearby E2 zones.



E2 Rural, Low district brightness (SQM ~ 15 to 20). Sparsely inhabited rural areas, village or relatively dark outer suburban locations.

The vast majority of space within the site boundary has been reclassified as 'E2 Rural, Low district brightness' in accordance with its change of use from unlit to lighting for residential areas. This decision is based upon calculations undertaken with reference to guidance informing type of light fittings, spacings between luminaires coupled with vertical illumination and visibility of lit areas.



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

Two areas immediately adjacent to the application site, involve high levels of night-time activity. The Park & Ride in the north and the sports facility in the south. The Park & Ride was still illuminated past midnight, whilst the sports facility had a 9.30/10pm switch off during the site survey. The light levels recorded will place these in an E3/E4 category. The type of luminaires, visibility from adjacent areas, height & positioning support this conclusion.

There have been no changes to E3 environmental zones identified, although new E2 environmental zone residential areas now border E3 zones as a result of the proposed development.

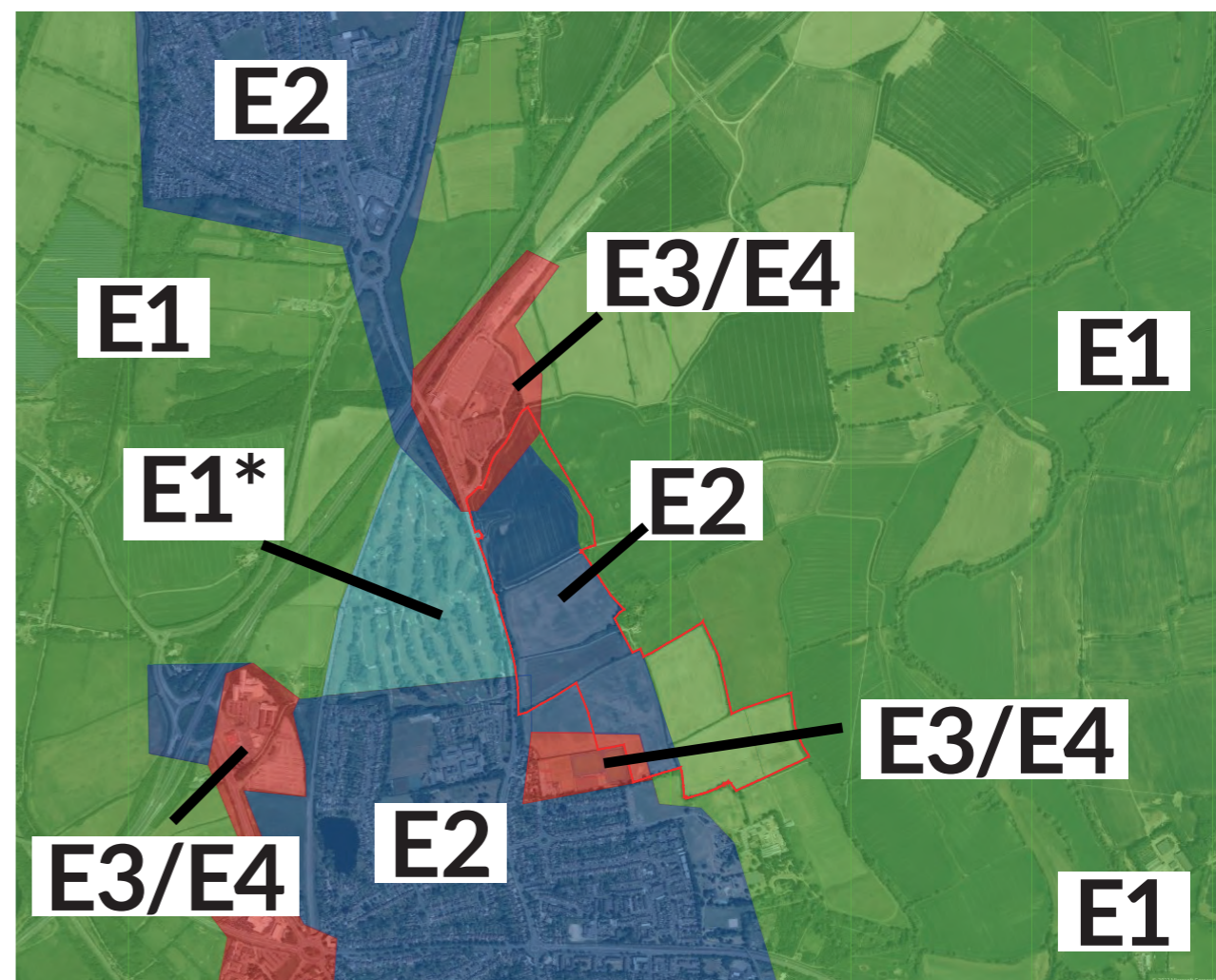


Figure 5.0 Map showing environmental lighting zones - Approximate red line of site shown.

6.0 Summary, Mitigation and Conclusion.

This document is the Illumination Impact Profile report (IIP) to inform the lighting impact on the surrounding environment post development. This report should be read in conjunction with:

DOC-16-16913-5A-20210625-SMK-PR6A-BLS-01 provides an assessment of the current base line lighting for the area surrounding the development.

DOC-16-16913-5A-20210625-JB-PR6A-PP-01 provides details regarding fitting types and recommended lighting levels of illumination.

Summary

- Of the reference locations: three locations (18, 23, 29) were found to have a moderate adverse effect on the horizontal planes. These locations are illustrated in the adjacent Figure 6.0. The baseline conditions for two of these locations were recorded as natural light levels (0.15 lux) and the addition of artificial lighting from the proposed development has modified the lighting condition to a significant level (additional 6.10 lux in location 23). However, these locations are all within the site boundary and therefore will be experiencing usage change because of the proposed development.
- The survey locations 18, 23, 29 previously discussed as having horizontally adverse conditions were also found to have been moderately adversely effected on the vertical planes. The same considerations can be applied for these positions as they are within the site boundary.
- Survey positions 9,16,20,21,22 were identified to be in or in close proximity to the green corridor identified in Figure 3.1.
- All these positions were found to have negligible changes in lighting level from baseline condition because of the lighting scheme. Position 20 was calculated to experience only an additional 0.01 lux from baseline conditions. Positions 9,16,21,22 experienced no additional illuminance from the site. Figure 3.5 shows extent of horizontal illumination 0.5 lux at ground level.
- All the sensitive receptor vertical planes (V1 to V8) passed in both vertical illuminance (lux) and glare (candelas) with minimal change from baseline conditions. The calculations show full compliance with guidelines for vertical illumination. This demonstrates little light trespass into nearby existing and future residential properties.
- The Upward Light Ratio (ULR) and Upward Flux Ratio (UFR) both passes comfortably within the guidelines for an E2 Rural, Low district brightness Sparsely inhabited rural areas, village or relatively dark outer suburban locations.

In order to minimise potential obtrusive light from the proposed development, the following mitigation measures can be employed in the development of the lighting design for the Site:

Embedded mitigation

Careful attention has been given in developing the lighting design including:

- Careful selection and consideration of placement of luminaires;
- Careful selection and consideration of column heights to ensure lighting is focused on thoroughfares minimising light spill to existing and proposed ecology and vegetation;
- Careful selection of luminaire control gear, to ensure light outputs can be dimmed;
- Adopting lamps / LEDs with similar correlated colour temperatures to reduce visual disturbance;



Figure 6.0 Aerial image, with positions of moderate adverse impact marked, all positions are within the developed site.

6.0 Summary, Mitigation and Conclusion.

- Use of LED luminaires with specific optical control to minimise the potential for obtrusive light due to their light distribution and;
- Optimising luminaire angle, lumen package (light output) and position to minimise light spill and night time visibility.

Adaptive mitigation

Additional measures to mitigate obtrusive light impacts on sensitive receptors are proposed as follows:

- In consultation with latest research, the specific colour temperatures used around the thoroughfare crossing, could be chosen to minimise potential impact on specific bat species.
- Appropriate lighting controls should be employed so that, when not required and subject to Health and Safety requirements, non-essential lighting is dimmed / switched off in order to further reduce the light impact. Controls such as photocells, motion detectors and time-clock could be adopted.
- A curfew operation of lighting to minimise energy use and to limit the periods of potential intrusive light exposure can be used where appropriate.
- Buffers, planting, banks, fences and reduced building heights, to reduce spillage and not compromise the required light levels on sensitive receptors.
- Appropriate use of shields, louvres and baffles as required locally.

Conclusion

At the time of writing this report the contractor has not been appointed and detailed design work for the Proposed Development has not been carried out. Nevertheless, it is recognised that potential nuisance from lighting of the Proposed Development may be a concern for local communities and certain statutory consultees.

In our professional judgement a considered lighting design is capable of satisfying the criteria set out in *ILP GN01/21 The Reduction Of Obtrusive Light* and *Bat Conservation Trust/ILP –Bats and Artificial Lighting in the UK. Guidance Note: 08/18*.

7.0 Glossary of terms.

- AONB, Areas of Outstanding Natural Beauty.
- Candela, (cd) is the base unit of luminous intensity in the International System of Units (SI); that is, luminous power per unit solid angle emitted by a point light source in a particular direction.
- CIE, Commission Internationale de l'Eclairage (International Commission on Illumination).
- Direct Sky glow: the direct upward spill of light into the sky, which can cause a glowing effect and is often seen above cities when viewed from a dark area.
- Glare: (viewed source intensity) the uncomfortable brightness of the light source against a dark background which results in dazzling the observer, which may cause nuisance to residents and a hazard to road users.
- IDA, International Dark-Sky Association.
- Illuminance, is calculated as the density of lumen's per unit area and is expressed using lux (lumen's/square meter). Illuminance can be measured using a light meter.
- ILP, Institution of Lighting Professionals.
- Light trespass/intrusion (vertical and horizontal): the spilling of light beyond the boundary of a property, which may cause nuisance to others.
- Lumen's, a measure of the quantity of light, referred to as luminous flux or just flux, emitted by a light source. For example, a 60-watt incandescent bulb provides about 840 lumen's.
- Luminance is a photometric measure of the luminous intensity per unit area of light travelling in a given direction. It describes the amount of light that passes through, is emitted or reflected from a particular area, In basic terms it would often be referred to as the "brightness" of an object typically when viewed against a dark background. This can be measured using a light meter but is more often calculated.
- Lux, is the SI derived unit of illuminance and luminous emittance, measuring luminous flux per unit area. It is equal to one lumen per square metre.
- Maintenance factor, usually a percentage is allowed for in lighting calculations to allow for the effects of time on fittings and their surroundings. Light sources, drop in output, fittings and surroundings become dirtier, several factors combine to reduce the amount of light available. A typical maintenance factor would be 70% this would ensure an installation was still meeting required light levels in for example 3 years. For this report a factor of 100% (unity) has been used, that is a day one, worst case scenario.
- Receptors, ecological, human, heritage, natural. These define positions around a site which may be impacted. Different receptors have various degrees of tolerance to increased light levels. For example an additional 10 lux in an already highly lit area (E4) could be described as negligible, whereas 0.5 lux to an ecological receptor in an intrinsically dark area (E1) could be described as major/adverse.
- Spill light: the unwanted spillage of light onto adjacent areas and may affect sensitive receptors, particularly residential properties and ecological sites.
- ULR, Upward Light Ratio. Expressed as a percentage of upward light compared to downward light.
- UNESCO, United Nations Educational, Scientific and Cultural Organization.



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