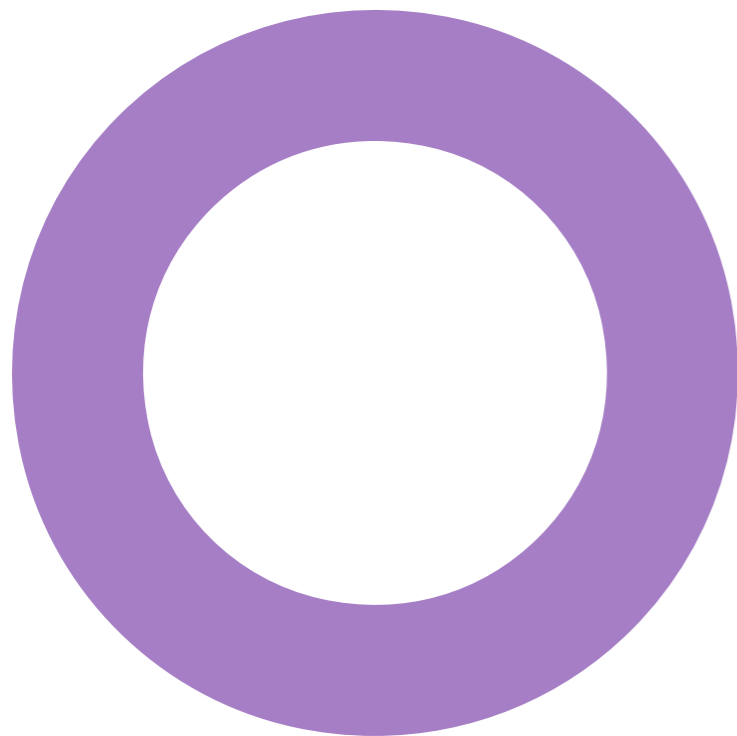


Proposed Great Wolf Lodge. Great Lakes UK Limited.

16-16472

ILLUMINATION IMPACT PROFILE
NOVEMBER 2019

DOC-16-16472-20191024-SMK-GREAT WOLF IIP-04



Audit sheet.

Rev	Date	Description	Prepared	Verified
01	17/10/2019	First issue	SMK	DLB
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1.0 Introduction.

This has been prepared by Hoare Lea to present quantitative information regarding pre and post development luminance (Candelas) & illuminance effects (Lux) for residential locations.

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 has now become 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 practise design guidance.

In accordance with current CIE guidance and the ILP Guidance Notes for the Reduction of Obtrusive Light (2011) 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.
- Light spill: the unwanted spillage of light onto adjacent areas and may affect sensitive receptors, particularly residential properties and ecological sites.
- Glare: 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 trespass (vertical and horizontal): the spilling of light beyond the boundary of a property, which may cause nuisance to others.

Completed Development Lighting Parameters

The External Lighting Baseline Survey provides an assessment of the current base line lighting for the area surrounding the development. This informs the modelling of the site and likely impact on the surrounding environment.

The lighting design masterplan sets out the type and typical luminaire spacings.



Figure 1.1. Overview of site (taken from BMD Drawing BMD.19.010.DR.P001, 03/10/19).

Note. All visualisations within the document are for illustrative purposes only.

1.0 Introduction.

Assessment Criteria for the Completed Development

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).
- A unity Maintenance Factor 1.0 is applied to represent the maximum adverse condition from initial installation.
- As per standard industry practise existing and proposed landscape bunding and planting / trees have not been included within the assessment calculations.
- Reflected sky glow component should be taken into account where landscape surfaces are relatively light in colour and typically >30%. In the case of this assessment, it is assumed that the typical landscape reflectance value is <30% and will not provide significant contribution, by reflection.



Figure 1.2. Aerial view of site.

2.0 Lighting design proposals.

Lighting requirements

It is important that the lighting applications provide both an aesthetic quality and also the appropriate levels of illumination required for the space they inhabit.

The adjacent table, extracted from BS EN 12464-2:2014 gives a guide to the target levels of illumination within the parking area.

It is important to remember however that these are a guide only, appropriate interpretation of the space and how these requirements align with its intended use should be taken into account.

The lighting requirements within the scope area fall into the following categories:

Service/Loading Yard	5.1.4 Pedestrian passages, vehicle turning, loading and unloading points
Service Road	5.1.2 Traffic areas of slowly moving vehicles
Car Par	5.9.2 Medium Traffic.
Pedestrian Routes	No class, illumination for ease of navigation only

Depending on the light source used for the final specification, the S/P ratio should be taken into account and the lighting level requirements adjusted accordingly in accordance with BS5489. The S/P ratio is a formula which takes into account the ability of the human eye to respond more effectively some white light sources in comparison to older types of lighting which emit a "yellow" type of light.

Table 5.1 General requirements for areas and for cleaning at outdoor work places

Ref. no.	Types of area, task or activity	Em lx	Uo -	R/GL -	Ra -
5.1.1	Walkway exclusively for pedestrians	5	0.25	50	20
5.1.2	Traffic areas for slowly moving vehicles (max. 10km/h), e.g. bicycles, trucks and excavators	10	0.4	50	20
5.1.3	Regular vehicle traffic (max 40 km/h)	20	0.4	45	20
5.1.4	Pedestrian passages, vehicle turning, loading and unloading points	50	0.4	50	20
5.1.5	Cleaning and servicing	50	0.25	50	20

Table extracted from 'BS EN 12464-2:2014'

Table 5.9 Parking Areas

Ref. no.	Types of area, task or activity	Em lx	Uo -	R/GL -	Ra -
5.9.1	Light traffic e.g. parking areas of shops, terraced and apartment houses: cycle parks	5	0.25	55	20
5.9.2	Medium traffic e.g. parking areas of department stores, office buildings, plants, sports and multi-purpose building complexes	10	0.25	50	20
5.9.3	Heavy traffic e.g. parking areas of major shopping centres, major sports and multi-purpose building complexes	20	0.25	50	20

Table extracted from 'BS EN 12464-2:2014'

Lighting Criteria.

Lighting levels

The below table and adjacent plan sets out the lighting class and lighting level requirements to all areas.

While the vehicle route follows the British Standards figures as set out on the previous pages, it is proposed that the pedestrian routes will not be illuminated to a specific lux level.

Instead, low level discrete lighting will be provided from a number of different techniques that will allow for the safe navigation of the site. This approach has been developed in particular for the amenity areas to the north west of the building in an effort to minimise light pollution with unnecessary lighting. This approach not only minimises unnecessary light but will also lead to a visually interesting environment.

Area	Average Lux	Minimum Lux	Uniformity (Minimum)
Car Parks / Service Road	10	2.5	0.25
Vehicle Routes (Main Entrance)	20	8	0.4
Pedestrian Routes	Navigational assistance only		
Service Yard	50	20	0.4



3.0 Assessment Criteria.

Current Guidance on Light Pollution Assessment.

The proposed installation of light around the Site will cause a certain amount of 'light pollution' this is the overarching term which is made up of three elements. These are:

- Light encroachment/trespass.
- Glare.
- Sky Glow.

Therefore the potential 'statutory nuisance' of any light entering the windows of a neighbouring domestic dwelling is covered by The Clean Neighbourhoods and Environment Act 2005, which covers 'artificial light emitted from premises.

In the DEFRA document 'Guidance on Sections 101 to 103 of the Clean Neighbourhoods and Environment Act 2005' (hereafter referred to as the DEFRA document) it clearly states (page 6) that the Act covers 'artificial light emitted from premises so as to be prejudicial to health or a nuisance' The question that arises, therefore, is whether the proposed lighting either runs the risk of being a 'prejudice to health' or could be considered a 'nuisance'.

The DEFRA document gives some guidance on what factors might be considered when deciding whether an exterior lighting scheme at night constitutes a 'nuisance'. Their guidance, on page 9, is entitled 'Guidance on using the new powers' and the relevant text on this issue can be found in section 18 which starts with the word 'Nuisance'. Half way through this section the factors to be considered 'statutory nuisance' are as follows:

'As for all statutory nuisances, when assessing a case of potential statutory nuisance, the Environmental Health Practitioner should take account of a range of factors including':

- Duration
- Frequency
- Impact – i.e. material interference with use of property or personal well-being; actually, or likely to be adverse to health
- Local environment
- Motive – i.e. unreasonable behaviour or normal user
- Sensitivity of the plaintiff – statutory nuisance relies on the concept of the average person, and is not designed to take account of unusual sensibilities'

The last 3 issues are further expanded on in section 19 of the same guidance where it states –

'For statutory artificial light nuisance, technical parameters on obtrusive lighting, formulated by the International Commission on Illumination (CIE) and Institution of Lighting Engineers from research into individual sensitivity to light, may help inform consideration of the level of sensitivity that might be considered that of the 'average person'.

Current International Commission on Illumination (CIE) and Institution of Lighting Engineers guidance sets out the other factors which need to be considered with regard to the potential negative impact of light at night. These are the sensitivity of the 'local environment', the amount of light generated (measured in lux and cd) and the sensitivity of a receptor in the local area of the lighting.

As indicated in the DEFRA document the guidance on these issues are in the two documents it references and, in the case of this site, **Table 2** from page 5 of the Institute of Lighting Professionals (ILP) 'Guidance Notes for the Reduction of Obtrusive Light (2011)', reproduced further on in this document.

It is important to note that both of these guidance documents show that it is not that there should be no light at night but that any light generated should be limited dependant on the Environmental Zone, and different levels of light are considered acceptable pre and post curfew, which is usually considered as being 11.00pm.

If it is accepted that the proposed lighting installation may cause some light pollution then, in the case of the residential receptors dwelling, window size, room use and a receptors ability to adapt to a change also play an important part.

Table 1.1 reproduced below (taken from current EIA guidance) qualifies receptor sensitivity and, in our professional judgement, the majority of human receptors are regarded as 'low', i.e. they can adapt to certain changes relating to light by choosing to obscure artificial light. This adaptation is also referenced in the DEFRA document where it states:

'It is sometimes suggested that a complaint of artificial light nuisance could easily be mitigated by the use of curtains or blinds, even blackout curtains or blinds, by the complainant. It is for the Environmental Health Practitioner to exercise discretion over what is reasonable and what is not. It might be reasonable to expect a complainant to use curtains or blinds of everyday standard if they are bothered by unwanted light in their home. It might not be reasonable to require a complainant to purchase and install blackout hangings which might be expensive, and/or impair that person's enjoyment of his property. Few would wish to have their curtains drawn on a hot summers night. It is not reasonable to leave the solution and cost of abatement to the complainant rather than the perpetrator'.

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

It should be remembered that the site is an environment for those visiting and employed there, and they too need light in order to safely navigate and carry out their working practises. The lighting level guidance for such sites is given in 'BS EN 12464-2:2014, Light and lighting – Lighting of work places Part 2: Outdoor work places', where **Table 5.1 & 5.9**, reproduced previously shows the required levels of illumination.

3.0 Assessment Criteria.

Tables 1.1 to 1.3 (inclusive) define the parameters for evaluating change to the site and surrounding areas. They define percentage rates of change from baseline and sensitivity of receptors. These definitions are used in **Tables 1.4 & 1.5**.

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 1.1

Defining Magnitude of Effect - Operation			
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 1.2

3.0 Assessment Criteria.

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 1.3

4.0 Results.

Overview

1 to 30 – horizontal - measured & calculated.

This data is represented in **Table 1.4** and is relevant to identified residential locations where horizontal illuminance is the recognised key indicator.

1 to 30 – vertical - measured & calculated.

This data is represented in **Table 1.5** and is relevant to identified residential locations where vertical illuminance is the recognised key indicator.

Site – Direct Sky Glow (SG1)

Direct sky glow is assessed as a site wide impact and is based on a scenario where the most onerous lighting impact is applied relative to the potential uses within each area. In accordance with CIE 150 Section 5.5.2 the upward direct light ratio is calculated and referenced against ILP sky glow guidance.

Figure 2.1 illustrates the horizontal illuminance levels (Edown) at 1.0m below the lowest luminaire within the application Site.

Figure 2.2 illustrates the horizontal illuminance levels (Eup) at 1.0m above the highest luminaire.

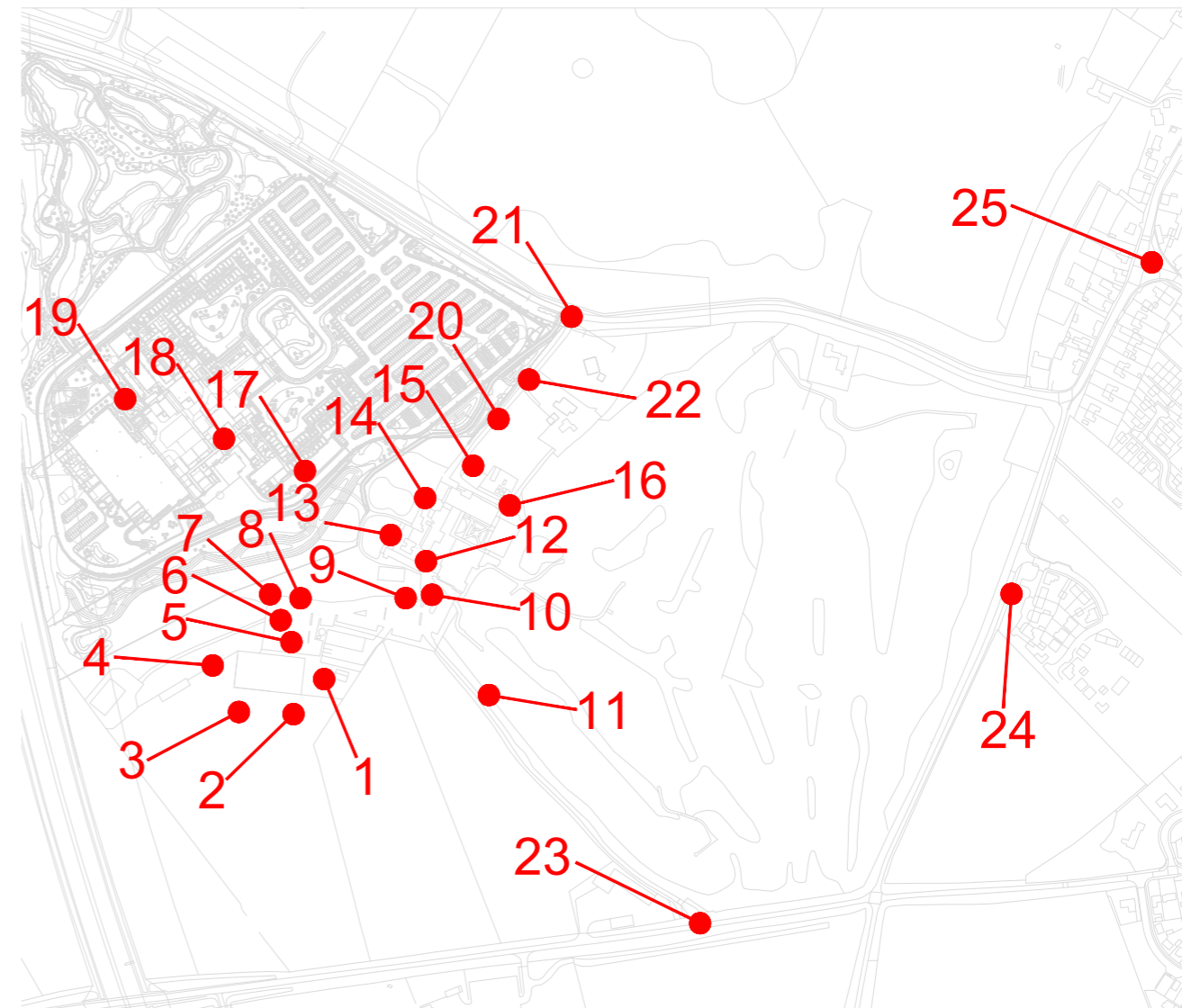


Figure 2.1 Image taken from CAD plans supplied - Showing survey points.

4.0 Results - Horizontal Spill Light (no mitigation allowed for in calculations).

Sensitive receptor - horizontal								
Survey location	Location name	Sensitivity	Environmental zone	Peak illuminance measurement (Lux) horizontal (H1) @ ground	Peak illuminance additional calculated (Lux) horizontal (H1) @ ground	Peak illuminance resultant (Lux) horizontal (H1) @ ground	Note	Significance of effect
1	Eastern side of tennis courts.	Low	E4	23.57	0.00	23.57		Zero
2	South eastern side of tennis courts.	Low	E4	27.70	0.00	27.70		Zero
3	South western side of tennis courts.	Low	E4	31.70	0.00	31.70		Zero
4	Western side of tennis courts.	Low	E3	8.37	0.00	8.37		Zero
5	Northern side of tennis courts.	Low	E4	40.70	0.00	40.70		Zero
6	Tennis car park (southern).	Low	E4	58.40	0.00	58.40		Zero
7	Tennis car park (middle).	Low	E4	20.94	0.00	20.94		Zero
8	Tennis car park (northern).	Low	E3	6.74	0.00	6.74		Zero
9	Main car park.	Low	E4	37.40	0.00	37.40		Zero
10	Main car park.	Low	E4	26.90	0.00	26.90		Zero
11	Inbetween feature lit trees.	Low	E1	0.07	0.00	0.07		Zero
12	Near Accessible bays and childrens small playground.	Low	E3	6.51	0.00	6.51		Zero
13	Near steps to roof terrace.	Low	E4	17.97	0.00	17.97		Zero
14	Near rear entrance and steps to roof terrace bar on right looking towards building.	Low	E3	6.48	0.00	6.48		Zero
15	Rear service yard.	Low	E2	1.60	0.00	1.60		Zero
16	Near square arch.	Low	E2	1.09	0.00	1.09		Zero
17	Southern side of Lodge (Previously referred to as: On golf course approx 120 m out)	Low	E1	0.02	0.26	0.28	1	Moderate Adverse
18	Sited inside Lodge (Previously referred to as: 200 m away from golf club.)	Low	E1	0.01	N/A	N/A	1	N/A
19	Northern side of Lodge (Previously referred to as: 300 m away from golf club.)	Low	E4	0.01	17.30	17.31	1	Moderate Adverse
20	Rear of service yard - along access lane.	Low	E1	0.07	0.00	0.07		Zero

Note 1: These positions are now part of the development.

Table 1.4

Legend to colour coding
Measured illumination
Calculated additional illumination
Resultant illumination

4.0 Results - Horizontal Spill Light (no mitigation allowed for in calculations).

Sensitive receptor - horizontal								
Survey location	Location name	Sensitivity	Environmental zone	Peak illuminance measurement (Lux) horizontal (H1) @ ground	Peak illuminance additional calculated (Lux) horizontal (H1) @ ground	Peak illuminance resultant (Lux) horizontal (H1) @ ground	Note	Significance of effect
21	Junction of Stableford Lane and A4095.	Low	E1	0.00	0.00	0.00		Zero
22	Outside Stableford House.	Low	E1	0.09	0.01	0.10		Negligible
23	Hotel main entrance.	Low	E4	15.00	0.00	15.00		Zero
24	Penrose Gardens entrance.	Low	E2	1.06	0.00	1.06		Zero
25	Chesterton village near phone box.	Low	E1	0.55	0.00	0.55		Zero
Note 1: These positions are now part of the development.								
Table 1.4								

Legend to colour coding
Measured illumination
Calculated additional illumination
Resultant illumination

Summary - Table 1.4

Positions 1 to 16 inclusive - Zero impact from the Proposed Development.

Positions 20 & 21 - Zero impact from the Proposed Development.

Positions 23 to 25 inclusive - Zero impact from the Proposed Development.

Position 22 - Negligible impact from the Proposed Development, however the additional level of light is well within natural background levels.

Position 17 - Minor adverse impact from the Proposed Development, however the additional level of light is within natural background levels.

Position 19 - Minor adverse impact from the Proposed Development, this position is in close proximity to the proposed lighting on the Site.

All calculations are based on a worst scenario, i.e. all external lighting is operational simultaneously, a Maintenance Factor 1.0 is applied to represent the maximum adverse condition from initial installation, also as per standard industry practise existing and proposed landscape bunding and planting / trees have not been included within the assessment calculations. These results therefore represent the scenario on day one of the installation without any mitigating landscaping features.

Mitigation such as landscaping will reduce the visual impact and light spill from the Proposed Development.

4.0 Results - Vertical Spill Light (no mitigation allowed for in calculations).

Sensitive receptor - vertical								
Survey location	Location name	Sensitivity	Environmental zone	Maximum existing vertical illuminance (Lux) (1.5m AFFL)	Calculated Max. vertical illuminance (Lux) (maximum value to elevation)	Resultant calculated Max. vertical illuminance (Lux) (maximum value to elevation)	Note	Significance of effect
1	Eastern side of tennis courts.	Low	E4	49.00	0.08	49.08		Negligible
2	South eastern side of tennis courts.	Low	E4	61.40	0.01	61.41		Negligible
3	South western side of tennis courts.	Low	E4	43.30	0.09	43.39		Negligible
4	Western side of tennis courts.	Low	E3	34.40	0.10	34.50		Negligible
5	Northern side of tennis courts.	Low	E4	54.60	0.10	54.70		Negligible
6	Tennis car park (southern).	Low	E4	84.50	0.10	84.60		Negligible
7	Tennis car park (middle).	Low	E4	17.72	0.20	17.92		Negligible
8	Tennis car park (northern).	Low	E3	18.54	0.10	18.64		Negligible
9	Main car park.	Low	E4	40.30	0.00	40.30		Zero
10	Main car park.	Low	E4	34.80	0.00	34.80		Zero
11	Inbetween feature lit trees.	Low	E1	1.98	0.00	1.98		Zero
12	Near Accessible bays and childrens small playground.	Low	E3	4.65	0.00	4.65		Zero
13	Near steps to roof terrace.	Low	E4	30.06	0.09	30.15		Negligible
14	Near rear entrance and steps to roof terrace bar on right looking towards building.	Low	E3	9.08	0.10	9.18		Negligible
15	Rear service yard.	Low	E2	18.00	0.10	18.10		Negligible
16	Near square arch.	Low	E2	2.16	0.00	2.16		Zero
17	Southern side of Lodge (Previously referred to as: On golf course approx 120 m out)	Low	E1	0.11	0.56	0.67	1	Moderate Adverse
18	Sited inside Lodge (Previously referred to as: 200 m away from golf club.)	Low	E1	0.04	N/A	N/A	1	N/A
19	Northern side of Lodge (Previously referred to as: 300 m away from golf club.)	Low	E4	0.00	4.71	4.71	1	Moderate Adverse
20	Rear of service yard - along access lane.	Low	E1	0.48	0.16	0.64		Negligible

Note 1: These positions are now part of the development.

Table 1.5

Legend to colour coding
Measured illumination
Calculated additional illumination
Resultant illumination

4.0 Results - Vertical Spill Light (no mitigation allowed for in calculations).

Sensitive receptor - vertical								
Survey location	Location name	Sensitivity	Environmental zone	Maximum existing vertical illuminance (Lux) (1.5m AFFL)	Calculated Max. vertical illuminance (Lux) (maximum value to elevation)	Resultant calculated Max. vertical illuminance (Lux) (maximum value to elevation)	Note	Significance of effect
21	Junction of Stableford Lane and A4095.	Low	E1	0.01	0.10	0.11		Moderate Adverse
22	Outside Stableford House.	Low	E1	0.76	0.26	1.02		Negligible
23	Hotel main entrance.	Low	E4	28.51	0.00	28.51		Zero
24	Penrose Gardens entrance.	Low	E2	0.92	0.00	0.92		Zero
25	Chesterton village near phone box.	Low	E1	1.17	0.00	1.17		Zero

Note 1: These positions are now part of the development.

Table 1.5

Legend to colour coding
Measured illumination
Calculated additional illumination
Resultant illumination

Summary - Table 1.5

Positions 9 to 12 inclusive - Zero impact from the Proposed Development.

Position 16 - Zero impact from the Proposed Development.

Positions 23 to 25 inclusive - Zero impact from the Proposed Development.

Positions 1 to 8 inclusive - Negligible impact from the Proposed Development, however the additional level of light is well within natural background levels.

Position 20 - Negligible impact from the Proposed Development, however the additional level of light is within natural background levels.

Position 21 - Negligible impact from the Proposed Development, however the additional level of light is within natural background levels.

Positions 13 to 15 inclusive - Minor adverse impact from the Proposed Development, however the additional level of light is within natural background levels.

Position 17 - Minor adverse impact from the Proposed Development, however the additional level of light is within natural background levels.

Position 19 - Minor adverse impact from the Proposed Development, this position is in close proximity to the proposed lighting on the Site.

Position 21 - Minor adverse impact from the Proposed Development, however the additional level of light is within natural background levels.

All calculations are based on a worst scenario, i.e. all external lighting is operational simultaneously, a Maintenance Factor 1.0 is applied to represent the maximum adverse condition from initial installation, also as per standard industry practise existing and proposed landscape bunding and planting / trees have not been included within the assessment calculations. These results therefore represent the scenario on day one of the installation without any mitigating landscaping features.

Mitigation such as landscaping will reduce the visual impact and light spill from the Proposed Development.

4.0 Results - Residential Calculations & M40 Roadway Calculations (no mitigation allowed for in calculations).

Overview

V1 to V4 - vertical calculations.

This data is represented in **Table 1.6**. It is relevant to identified residential locations where vertical illuminance is the recognised key indicator.

R1 to R6 - calculations.

This data is represented in **Table 1.7**. A series of calculations have been carried out in accordance with BS EN 13201-2 2003 (Performance Requirements). Whilst this standard was replaced in 2015 the 2003 version calculates parameters not covered in the later version.

For the purposes of this assessment only veiling luminance & threshold increment are required for compliance with ILP "Guidance Notes for the Reduction of Obtrusive Light GN01:2011".

Given the topography of the site the M40 motorway has been positioned 4m below the level of the Proposed Development. All calculations are performed with no mitigation in place, e.g. trees, planting & fencing.

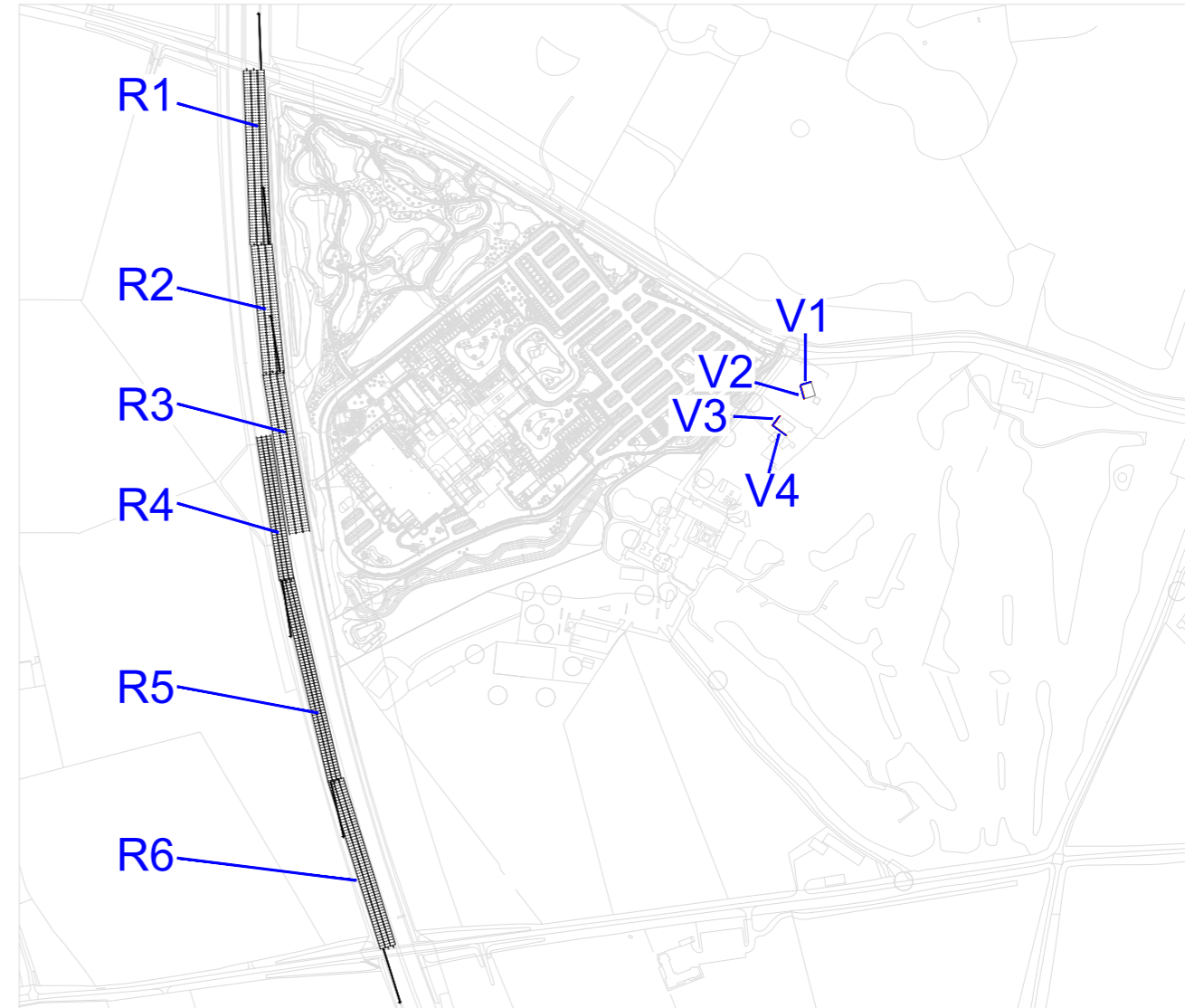


Figure 2.2 Image taken from CAD plans supplied - Showing calculation points.

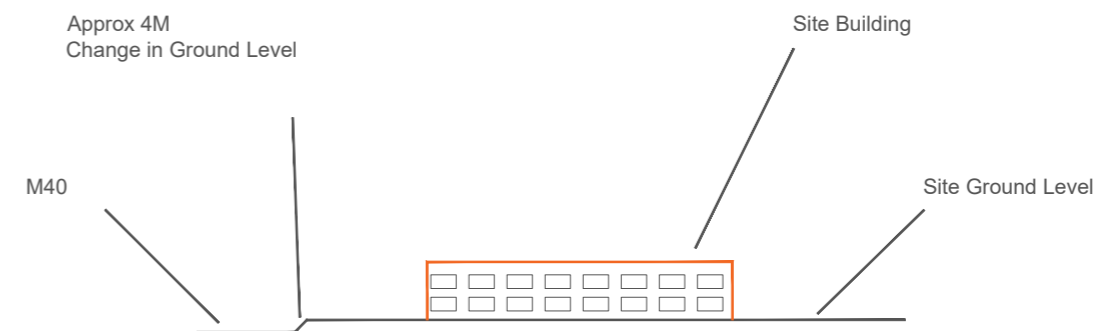


Figure 2.3 Approximate section through site.

4.0 Results - Residential Calculations (no mitigation allowed for in calculations).

Sensitive receptor - vertical (residential)				Light trespass						Glare	
Survey location	Location name	Sensitivity (Human)	Environmental zone	Vertical illuminance Max. into windows (ILP guidance notes 2011) (Lux). Post curfew	Maximum existing vertical illuminance (Lux) (1.5m AFFL)	Calculated Max. vertical illuminance (Lux)/ ((maximum value to elevation)	Resultant calculated Max. vertical illuminance (Lux) (maximum value to elevation)	Note	Magnitude of change	Source intensity Max. (ILP Guidance notes 2011) (cd) Pre curfew	Calculated Max. peak viewed source intensity (cd)
V1 Lux	Vicarage facing north-west	Low	E1	2	N/A	0.10	0.10	1	Negligible	N/A	N/A
V1 Cd	Vicarage facing north-west	Low	E1	N/A	N/A	N/A	N/A		Moderate adverse	2500	75
V2 Lux	Vicarage facing south-west	Low	E1	2	N/A	0.10	0.10	1	Negligible	N/A	N/A
V2 Cd	Vicarage facing south-west	Low	E1	N/A	N/A	N/A	N/A		Moderate adverse	2500	87
V3 Lux	Stableford facing north-west	Low	E1	2	N/A	0.00	0.20	1	Negligible	N/A	N/A
V3 Cd	Stableford facing north-west	Low	E1	N/A	N/A	N/A	N/A		Moderate adverse	2500	88
V4 Lux	Stableford facing south-west	Low	E1	2	N/A	0.00	0.00		Zero	N/A	N/A
V4 Cd	Stableford facing south-west	Low	E1	N/A	N/A	N/A	N/A		Moderate adverse	2500	84

Note 1: Starlight is typically measured at 0.1 lux & a full moon at 1 lux, these levels of illumination fall in line with natural background levels.

Table 1.6 (Refer to figure 2.2 for locations of calculation positions. Calculation grids are 1m x 1m facing towards site, length as shown, height 9m.

Summary - Table 1.6

Two different calculations are performed at each position. The positions are shown previously in this document in **Figure 2.2**.

1) Illuminance is calculated as the density of lumens per unit area and is expressed using lux (lumens/square meter). Illuminance can be measured using a light meter.

2) Luminance is a photometric measure of luminous intensity. 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. This is expressed in Candelas (Cd).

Lux

Position 4 - Zero impact from the Proposed Development.

Positions 1 to 3 inclusive- Negligible impact from the Proposed Development, however the additional level of light is well within natural background levels.

Candelas

Position 1 to 4 inclusive- moderate adverse from the Proposed Development, note it is not possible to easily ascertain a baseline reading to define the significance of effect, however the calculated results are well within the guidelines for this type of area, even before any mitigation is allowed for.

All calculations are based on a worst scenario, all external lighting is operational simultaneously, a Maintenance Factor 1.0 is applied to represent the maximum adverse condition from initial installation, also as per standard industry practise existing and proposed landscape bunding and planting / trees have not been included within the assessment calculations. These results therefore represent the scenario on day one of the installation without any mitigating landscaping features.

Mitigation such as landscaping will reduce the visual impact and light spill from the Proposed Development.

4.0 Results - M40 Roadway Calculations (no mitigation allowed for in calculations).

Sensitive receptor - Transport						
Survey location	Location name	Sensitivity	Environmental zone	Road Classification	Threshold Increment (TI) Limit = 15% based on adaptation luminance of 0.1cd/m ² Pass/Fail	Veiling Luminance (Lv) Limit = 0.04 cd/m ²
R1	M40 - Section 1 - Southbound.	High	E1	No road lighting	Pass	Pass
R2	M40 - Section 2 - Southbound.	High	E1	No road lighting	Pass	Pass
R3	M40 - Section 3 - Southbound.	High	E1	No road lighting	Pass	Pass
R4	M40 - Section 4 - Northbound.	High	E1	No road lighting	Pass	Pass
R5	M40 - Section 5 - Northbound.	High	E1	No road lighting	Pass	Pass
R6	M40 - Section 6 - Northbound.	High	E1	No road lighting	Pass	Pass
Calculation surfaces are taken as being 4m below the level of the Proposed Development.						
Table 1.7						

Summary - Table 1.7

To assess safety two different calculations are performed at each position. In very basic terms both deal with aspects of glare to road users. The M40 for the purposes of this assessment was calculated in 6 sections as noted on the drawing in **Figure 2.2**. Three calculations in a southerly direction and three in a northern direction. The topography of the site was allowed for in shown in **Figure 2.3**.

All calculations are based on a worst scenario, i.e. all external lighting is operational simultaneously, a Maintenance Factor 1.0 is applied to represent the maximum adverse condition from initial installation, also as per standard industry practise existing and proposed landscape bunding and planting / trees have not been included within the assessment calculations. These results therefore represent the scenario on day one of the installation without any mitigating landscaping features.

Mitigation such as landscaping will reduce the visual impact and light spill from the Proposed Development.

4.0 Results - Direct Sky Glow.

Natural Receptor – Direct Sky Glow (SG1)

Sky glow is often seen above areas with high levels of illumination. It is 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. For this type of area (E2) a figure of 2.5% of the total light used is allowable as direct upward light. By utilising flat bed LED optics the Proposed Development will have 0% direct upward light and will therefore comply with the ILP guidelines. The following 2 pages show the formula for calculating direct sky glow and demonstrate 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.

The sample area reflects the overall site and provides assessment for all types and variants of luminaire types.

In accordance with CIE 150 Section 5.5.2 the Upward Direct Light Ratio is calculated as follows:

The direct ULR for the installation is calculated from the following equation:

$$ULR = E_{up} / (E_{down} + E_{up})$$

- E_{up} – Resultant average illuminance taken from a grid 1.0m above the highest luminaire

- E_{down} – Resultant average illuminance taken from a grid 1.0m below the lowest luminaire

For the purposes of direct sky glow assessment the Proposed Development and surrounding area will be classed on average as an E2 Zone classification, low district brightness - Village or relatively dark outer suburban locations. This classification is derived from assessing the light levels calculated on the Proposed Development and light levels in the surrounding area. Further detail is shown in **Section 6.0**.

In maintaining a no change / improved environment the ILP Guidance Notes for the Reduction of Obtrusive Light (2011) provides a limiting sky glow percentage of 2.5%.

Figure 3.1 illustrates the pre curfew horizontal illuminance levels (E_{down}) at 1.0m below the lowest luminaire within the Application Site.

Figure 3.2 illustrates the pre curfew horizontal illuminance levels (E_{up}) at 1.0m above the highest luminaire.

$$ULR = E_{up} / (E_{down} + E_{up})$$

$$ULR = 0 / (1.0 + 0)$$

$$ULR = 0.0\% < 2.5\%$$

4.0 Results - Direct Sky Glow.

Direct Illuminance down @1.0m below lowest luminaire.

Figure 3.1 - The downwards light element as horizontal illuminance levels 1.0 m below the lowest external luminaire (0m)

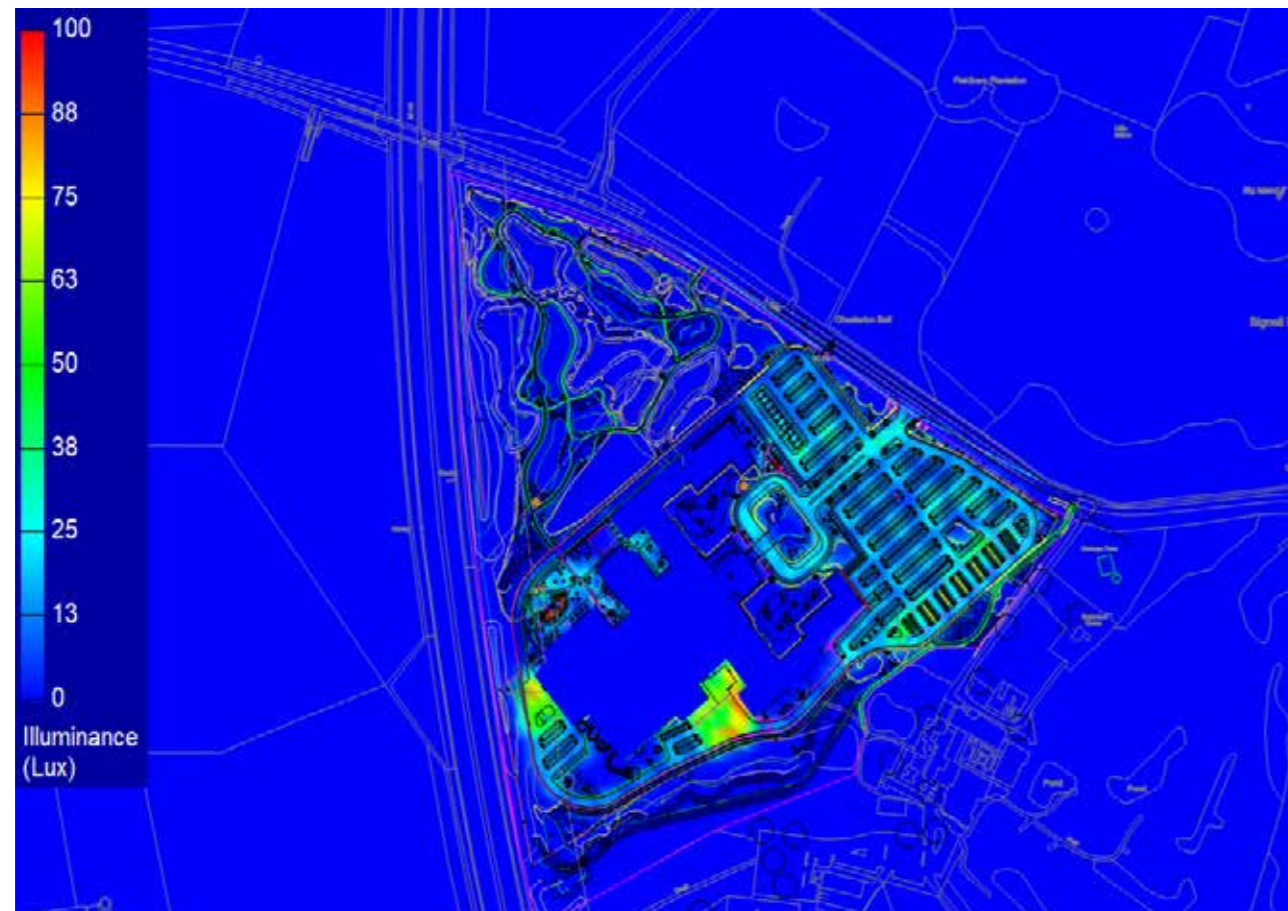


Figure 3.1 Light levels at 0m - calculation points facing upwards.

Direct Illuminance up @1.0m above highest luminaire.

Figure 3.2 - The upwards light element as inverted horizontal illuminance levels 1.0 m above the highest external luminaire (7m)

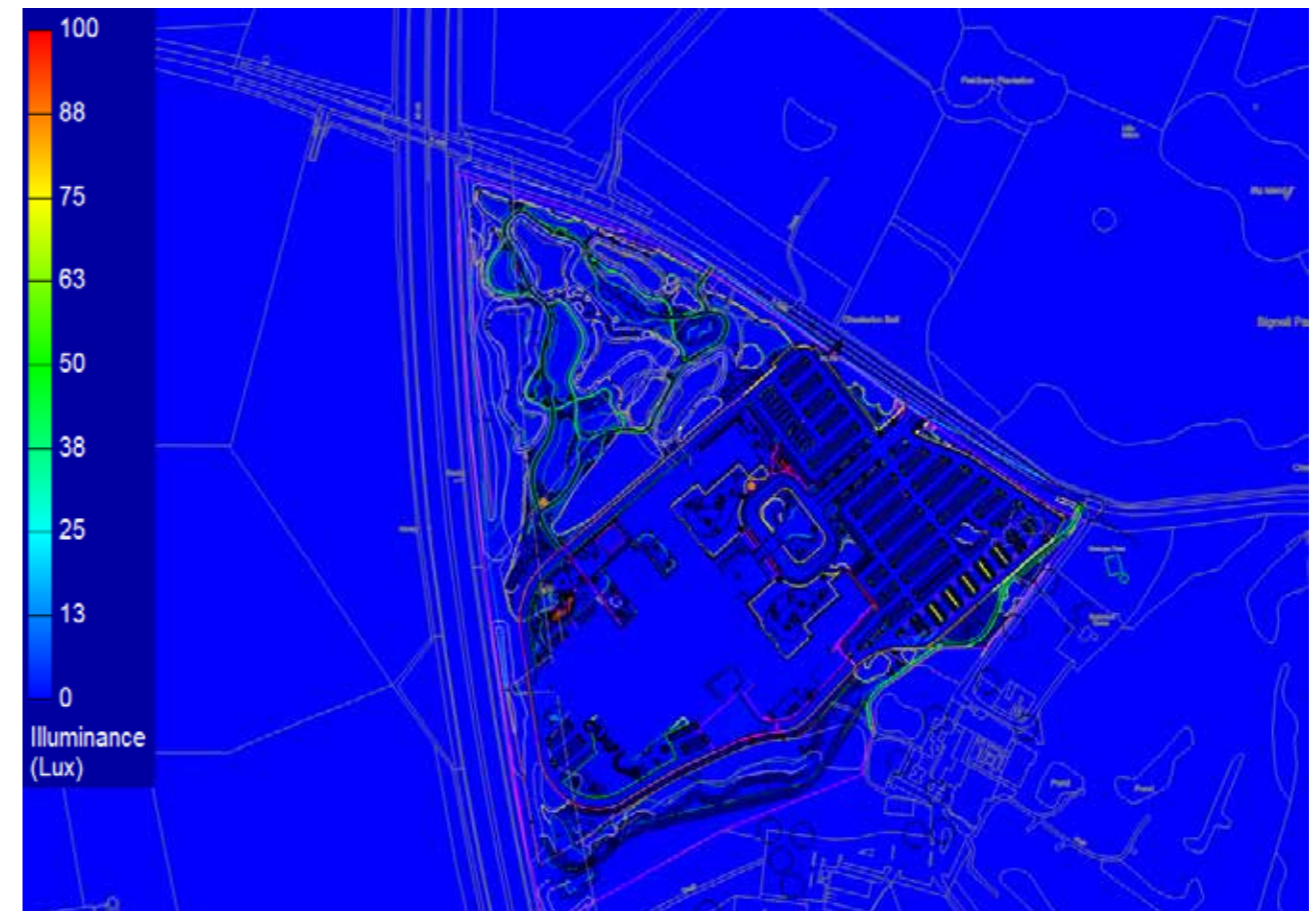


Figure 3.2 Light levels at 7m - calculation points facing downwards.

4.0 Results - Building Luminance.

Building Luminance

From CIE150, **Table 2.6** (cross referenced in ILP guidelines)

Table 2 - Obtrusive Light Limitations for Exterior Lighting Installations- General Observers						
Environmental Zone	Sky Glow ULR (Max%)¹	Light Intrusion (Into Windows) Ev (Lux)²		Luminaire Intensity I (candelas)³		Building Luminance Pre-curfew₄
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew	Average L (cd/m²)
E0	0	0	0	0	0	0
E1	0	2	0 (1*)	2,500	0	0
E2	2.5	5	1	7,500	500	5
E3	5.0	10	2	10,000	1,000	10
E4	15	25	5	25,000	2,500	25

Based upon an average building surface reflectance of 30% the building exhibits an average luminance in candelas per square metre (Cd/m²) within the guidelines for an E2 zone.

This specifically excludes glazed portions of the façades.

All calculations are based on a worst scenario, i.e. all external lighting is operational simultaneously, a Maintenance Factor 1.0 is applied to represent the maximum adverse condition from initial installation, also as per standard industry practise existing and proposed landscape bunding and planting / trees have not been included within the assessment calculations. These results therefore represent the scenario on day one of the installation without any mitigating landscaping features.

Mitigation such as landscaping will reduce the visual impact and light spill from the Proposed Development.

5.0 Baseline site and environmental zone classification.

To assess the Site we refer to the ILP guidance notes for the reduction of obtrusive light (2011) and CIE150.

In Figure 5 (adjacent map) areas would be classified as:

Green

- **E1 Natural, Intrinsically dark, National Parks, Areas of Outstanding Natural Beauty etc.**

The areas immediately surrounding the Site would be classified as E1. Examples of artificial lighting are restricted to domestic properties and few small scale commercial sites.

Cyan

- **E1 Natural, Intrinsically dark, National Parks, Areas of Outstanding Natural Beauty etc./E2 Rural, Low district brightness, Village or relatively dark outer suburban locations.**

The area within the red-line boundary is predominately undeveloped. There are elements of spill light from the neighbouring developments (Bicester Hotel Golf & Spa). These are more evident from vertical measurements facing those locations. Horizontally at ground level the spill light fades to natural levels within 30 to 40m. The vegetation along the A4095 and Green Lane provide a barrier to light exiting the Site. The combination classification for this area (E1/E2) is based upon predominately natural light levels being recorded, tempered by the fact that artificial light sources are often apparent within visual range.

Blue

- **E2 Rural, Low district brightness, Village or relatively dark outer suburban locations.**

The Bicester Hotel Golf & Spa building is lit utilising what appear to be metal halide light sources (white light) typically mounted. However some fittings are column mounted on the roof terrace. Several of the light fittings have high aiming angles which gives human receptors a near full view of the light source, this does create a source of glare against a dark sky. The access road from Green Lane is lit at the entrance with ground mounted uprights, the trees along the access road are also uplit to provide guidance rather than a road lighting standard of illumination.

Magenta

- **E3 Suburban, Medium district brightness, Small town centres or suburban locations.**

The car park is lit utilising what appear to be metal halide light sources (white light) on 6m columns. Several of the light fittings have high aiming angles which gives human receptors a near full view of the light source, this does create a source of glare against a dark sky. The levels of illumination are suitable for a car park with high levels of night time activity.

Orange

- **E4 Urban, High district brightness, Town/city centres with high levels of night-time activity.**

Around the tennis courts the light levels recorded were typical of an E4 environment. Although these are localised to the area, the tennis court lighting is evident from the bridge over the M40 along Green Lane.

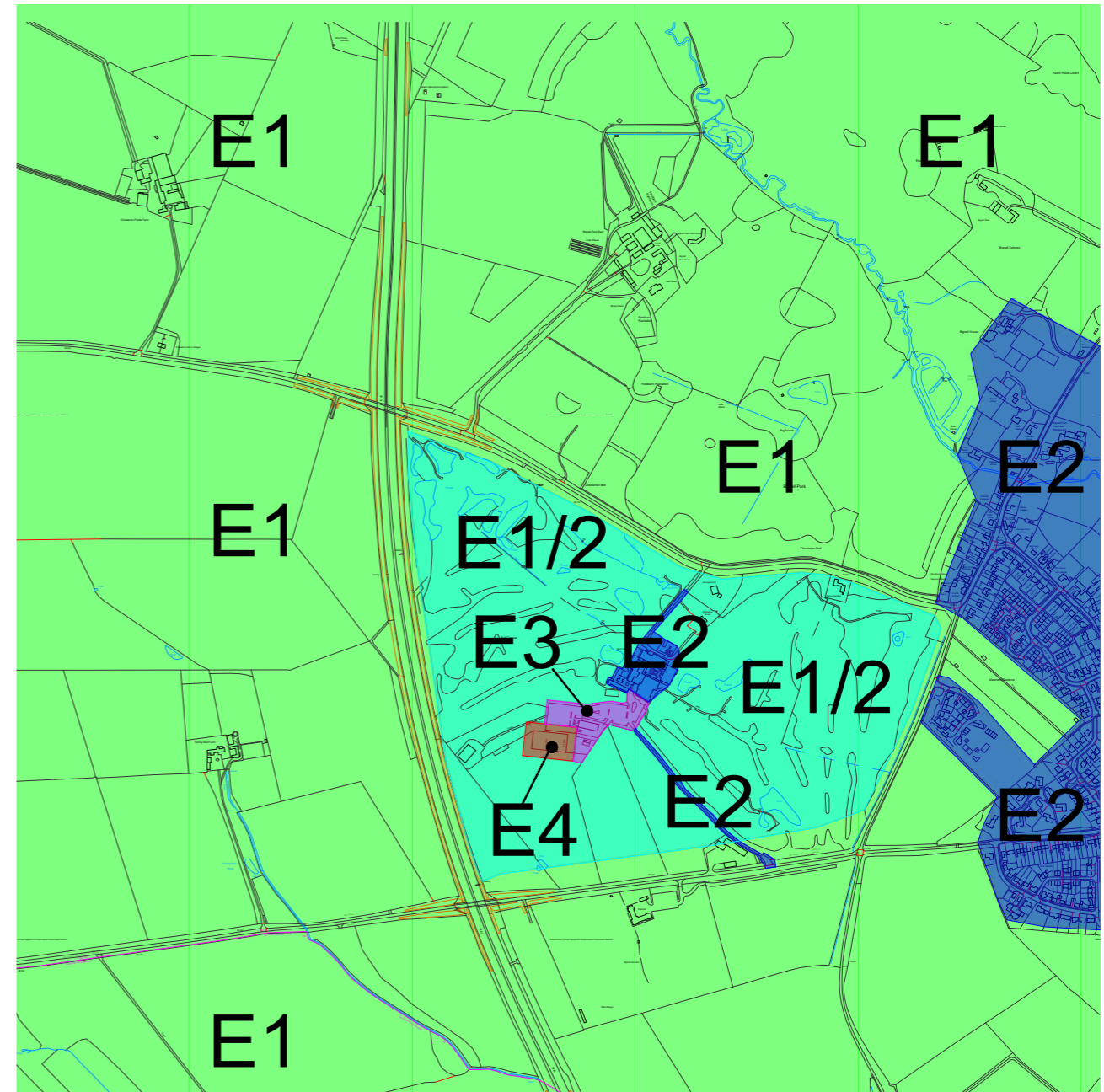


Figure 5. Map showing environmental lighting zones.

6.0 Proposed Site and environmental zone classification.

To assess the Proposed Development we refer to the ILP guidance notes for the reduction of obtrusive light (2011) and CIE150. For details of the baseline survey please refer to section 4.0.

In Figure 6 (adjacent map) areas would be classified as:

Green

- **E1 Natural, Intrinsically dark, National Parks, Areas of Outstanding Natural Beauty etc.**

The areas immediately surrounding the site would be classified as E1. Examples of artificial lighting are restricted to domestic properties and few small scale commercial sites.

Cyan

- **E1 Natural, Intrinsically dark, National Parks, Areas of Outstanding Natural Beauty etc./E2 Rural, Low district brightness, Village or relatively dark outer suburban locations.**

Areas immediately adjacent to the existing hotel & the Proposed Development would be covered by this classification. Horizontal levels of illumination will fall away rapidly when moving away from these areas. The combination classification for this area (E1/E2) is based upon predominately natural light levels being recorded, tempered by the fact that artificial light sources are often apparent within visual range.

Blue

- **E2 Rural, Low district brightness, Village or relatively dark outer suburban locations.**

The access roads and service areas of the existing hotel & golf club are measured in-line with this classification.

Magenta

- **E3 Suburban, Medium district brightness, Small town centres or suburban locations.**

The Bicester Hotel Golf & Spa car park & majority of the Proposed Development would & do exhibit the characteristics of this classification. The Proposed Development proposes the use of flat bed LED optics for car park lighting, this type of optic helps minimise light spill off site & visibility from external areas.

Orange

- **E4 Urban, High district brightness, Town/city centres with high levels of night-time activity.**

The tennis courts at the existing hotel were typical of an E4 environment. Although these are localised to the area, the tennis court lighting is evident from the bridge over the M40 along Green Lane. The service yards to the hotel would not be at the same level of illumination as the tennis courts, however the E4 category is a wide band of illumination. Again in common with the proposed car park lighting the use of flat bed LED optics will help minimise light spill off site & visibility from external areas.

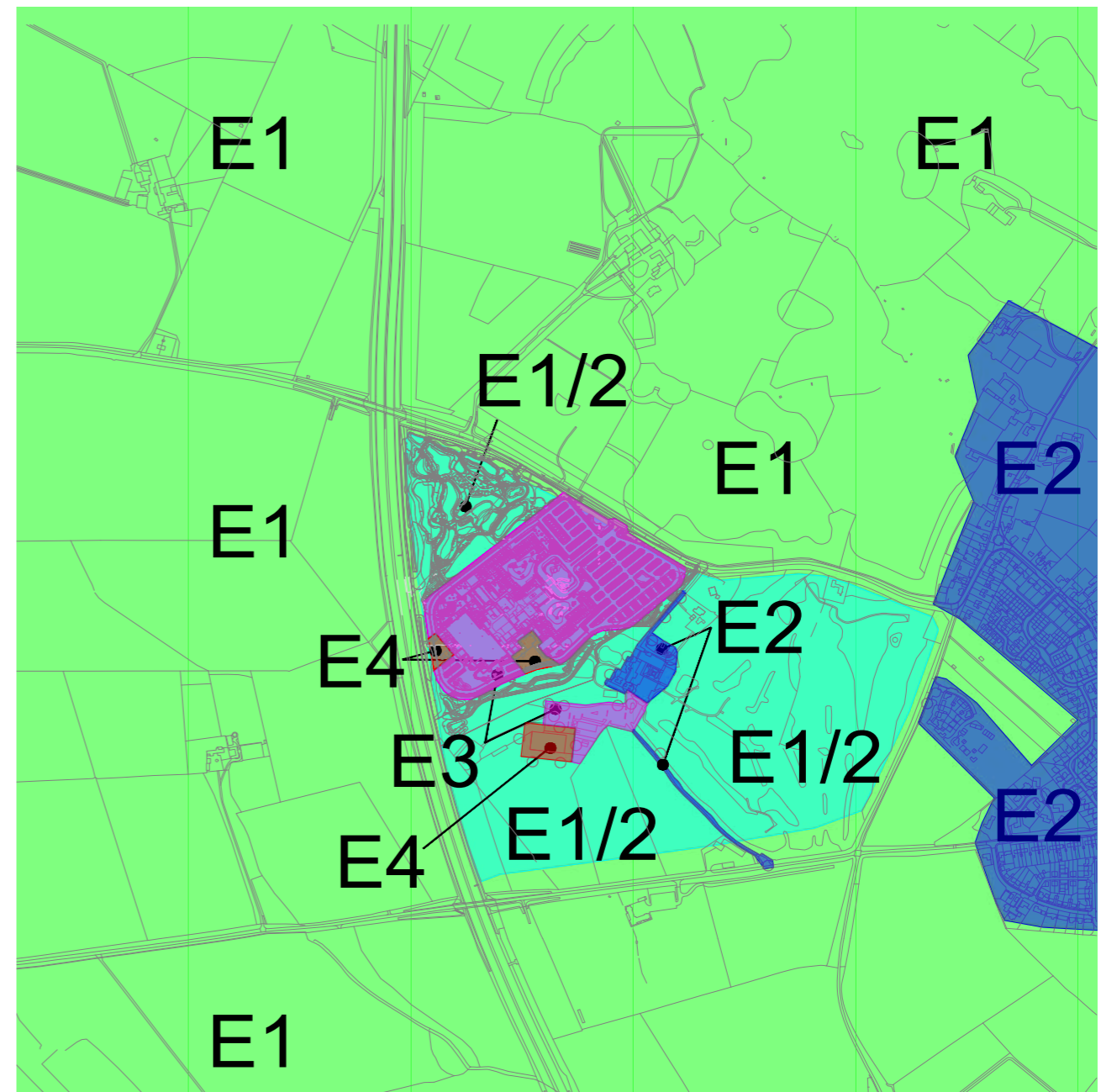


Figure 6. Map showing environmental lighting zones.

7.0 Summary.

With the types of luminaires and the general locations shown in the masterplan being utilised, the lighting levels required by the guidelines are achievable. Light spill outside the Proposed Development is also within the limits set by the recognised guidelines for this type of development. The plans specifically exclude feature lighting such as hand-rail or uplights. This is due to their small contribution to the overall cumulative effect.

The roads & car parks are lit utilising LED “flat bed” fittings with no upward light component. They are column mounted at 6m to ensure minimal spill to surrounding areas. The boundary area to the south eastern car park utilises a similar fitting but on 4m columns to minimise visibility from nearby residential properties. The service yards are lit to a higher level than the access roads and car parks, however provision will be made for PIR operation to ensure the additional level of light is only in use as is necessary for safety purposes. The pedestrian amenity areas to the north west are lit with bollard lighting, These provide low level path indication only. The typical height for these units is 900mm.

There may be future design revisions to concept design, however as long the general principles, quantities and positions of lighting reflect this concept, any changes to the results presented should be minimal.

This study is based upon a worst case scenario, that is all lighting within the new development will be in operation, and all light fittings at day 1 maximum output. No mitigation such as the existing or proposed planting has been included in our calculations.

The M40 motorway runs north to south adjacent to the Proposed Development. The level of the motorway is approximately 4m lower than the Proposed Development site and surrounding area. All calculations showed zero impact to the highway. As per all calculations this was without the mitigation of planting or fencing taken in account.

Signage into the site has not been calculated in this assessment, however it is expected that the guidance in ILP document PLG05 “The brightness of illuminated advertisements” and local planning documents will be followed.

All impacts from the Proposed Development are well contained within the site boundary. The Proposed Development would extend the boundaries of the current E2/E3 area into a portion of the E1/E2 zone.

Positions off site with a significance of impact that would fall into the category of “moderate adverse” are:

Vertical position 21. (**Table 1.5**). However the increase in light level would fall within the known referenced levels of natural moonlight and well within the ILP guidelines for obtrusive light.

V1cd to V4cd. (**Table 1.6**). Without the mitigation afforded by planting and other measures these positions may be able to view the brightness of some light fittings from positions on those properties facing the Proposed Development. While the magnitude of change is noted as “Moderate Adverse” This is due to the baseline reading being judged as zero (no artificial light in view). Therefore any percentage increase will automatically fall into the highest category. The levels calculated are well below the level recommended by the ILP guidelines. However the addition of mitigation such as landscaping will reduce the visual impact and light spill from the Proposed Development.

Therefore, following this exercise, it can be seen that following the construction of the Proposed Development there will be minimal light spill beyond the site boundary. The proposed levels of lighting are within the limits qualified by the ILP’s guidance and are commensurate with the relevant zones E1 to E4 as appropriate.

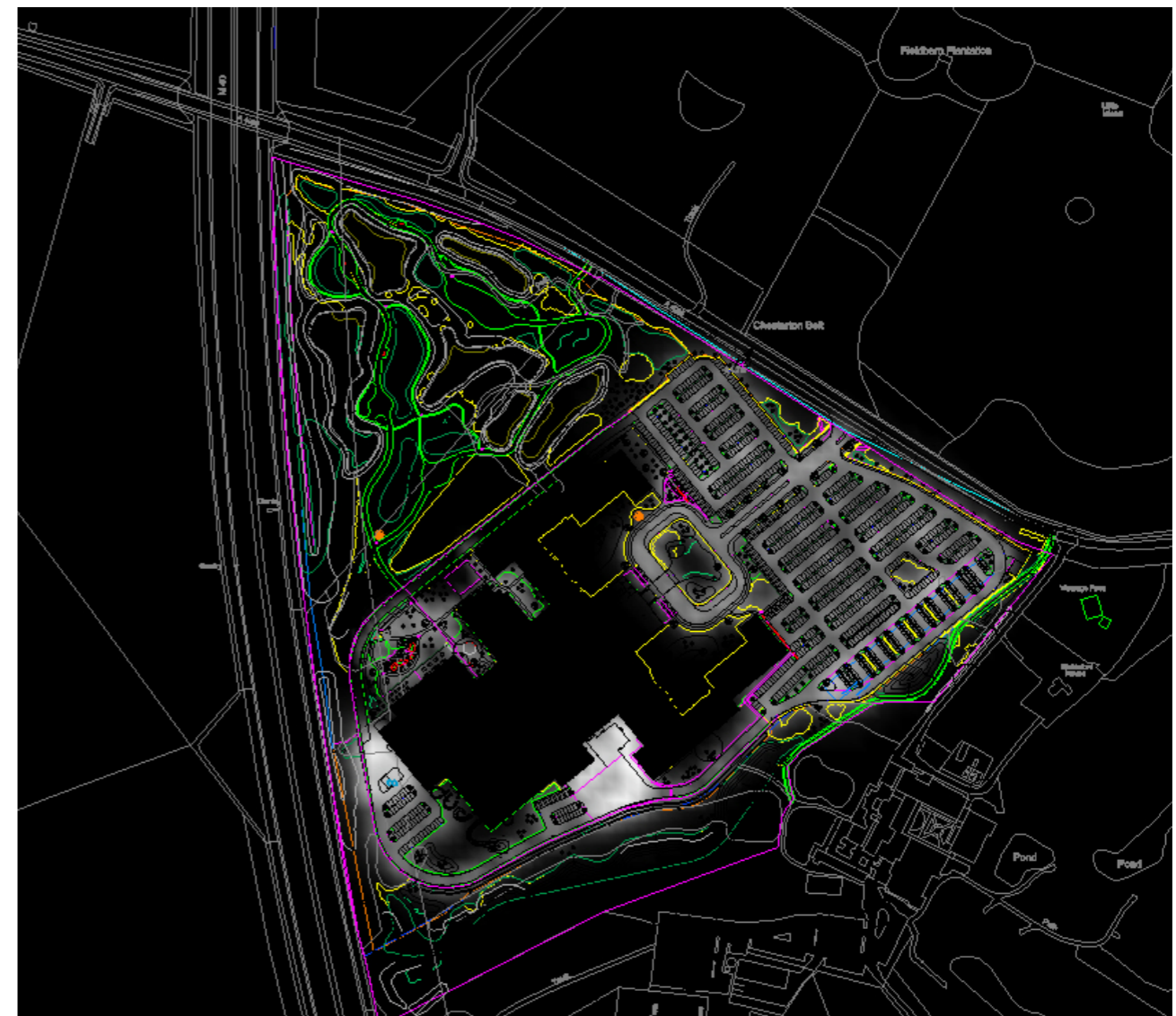


Figure 7 - Aerial rendered view.

8.0 Glossary of terms.

- AONB, Areas of Outstanding Natural Beauty
- BCT, Bat Conservation Trust
- 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, 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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