BURO HAPPOLD

Land south of Warren Lane, Long Ashton

Lighting Assessment

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Revision 04

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00	Final document for review	KM	14/11/14	LP
01	Revised to include comments	LS	27/11/14	LP
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03	Updated Masterplan	XF/JG	14/05/20	FJR
04	Updated scheme for submission	EG	09/08/21	FJR

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Glossary

Term	Definition
Ave	Average value
Colour Rendering (Ra)	An indicator of how accurately colours can be distinguished under different light sources. The colour rendering index (measured in Ra) compares the ability of different light sources to render colours accurately. This measures the ability of a light source to render colours naturally, without distorting the hues seen under a full spectrum radiator (like daylight). The colour rendering index (CRI) ranges from 0 to 100. Colour rendering index CRI
Colour Temperature	The colour temperature provides an indication of the light colour and is expressed in Kelvin (K). Lamps are generally rated between 2700K (warm), 4000K (neutral) and 6500K (cool). Unit: kelvin, K.
Control Gear	A 'package' of electrical or electronic components including ballast, power factor correction capacitor and starter. High frequency electronic control gear may include other components to allow dimming, etc.
Curfew	A time defined by the local authority when outdoor lighting is reduced or switched off.
Glare	The uncomfortable brightness of a light source against a darker background which results in dazzling the observer or may cause nuisance. Condition of vision in which there is discomfort or a reduction in the ability to see significant objects, or both, due to an unsuitable distribution or range of luminance.
Glare Rating (GR)	Glare Rating values may be calculated for sports and area lighting applications to indicate the amount of glare present for an observer within the lighted area. GR values range from 10 to 90 (regardless of US or Metric units), where a value of 10 indicates unnoticeable glare and a value of 90 indicates unbearable glare. For most applications, the CIE (International Commission on Illumination) recommends that the maximum amount of glare allowed should be less than 45 to 55, depending on the application.
Horizontal Illuminance (E, Eh)	Illuminance incident on the horizontal surface. Unit: lux (lx) = lm/m^2 Symbol: E, Eh
Illuminance	The amount of light falling on a surface of unit area. The unit of illuminance is the lux, equal to one lumen per square metre. Unit: lux (lx) = lm/m^2
LED	Light Emitting Diode used as a light source. Solid-state semiconductor device that converts electrical energy directly into light of a specific colour or even white light.
Light Output Ratio (LOR)	Ratio of the total light emitted by a luminaire to the total light output of the lamp(s) it contains measured at standard operating conditions.
Light Spill	The unwanted spillage of light onto adjacent areas which may affect sensitive receptors, particularly residential properties and ecological sites.
Light Trespass	The spilling of light beyond the boundary of a property which may cause nuisance to others, particularly when spilling into windows of neighbouring properties.
Lumen	Unit of luminous flux, used to describe the amount of light produced by a lamp or falling on a surface.
Lumen Depreciation	The decline in the light output of a light source during its lifetime.
Luminaire	The correct term for a light fitting. An apparatus which controls the light from a lamp and includes all components for fixing and protecting the lamps or light source, as well as connecting them to an electrical supply.
Maintained Illuminance (luminance)	Value below which the average illuminance on the specified surface is not allowed to fall. The maintained illuminance is specified at the end of the maintenance cycle, taking into consideration the maintenance factor. It is one of the main specification elements for the lighting designer. In the various slighting standards the maintained illuminance is specified for various areas/activities. Unit: lux. Symbol: Em. (Eave)
Maintenance Factor	Correction factor used in lighting design to compensate for the rate of lumen depreciation, caused by lamp ageing (lumen depreciation and lamp failure) and dirt accumulation (luminaire and environment). It determines the maintenance cycle needed to ensure that illuminance does not fall below the maintained value.
Sky Glow	The 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.
Source Intensity	This is the brightness of the source of the luminaires and applies to each source in the potentially obtrusive direction, outside of the area being lit.

Term	Definition
Ave	Average value
Uniformity Ratio	Ratio of the minimum over the average illuminance for a specified area (Emin/Eave). When defined as such, the uniformity ratio is also the ratio of the minimum over the maximum illuminance for a specified surface area (Emin/Emax).
Vertical Illuminance	Illuminance incident on the vertical surface. Unit: lux (lx) = lm/m^2 Symbol: Ev

1 Executive summary

Buro Happold have been commissioned by Long Aston Land Company to provide an Artificial Lighting Impact Assessment for the proposed development of 35 residential properties located in Long Aston for purposes of obtaining outline planning permission.

The purpose of this report is to review the proposed lighting scheme and lighting environmental impact of the Proposed Development against the current best practice, regulations and guidelines for the reduction of Obtrusive Light.

This assessment follows an update on the previous application with amendments to provide a compliant scheme, which addresses the necessary considerations and incorporates the required measures for approval.

The artificial lighting assessment provides details on the artificial lighting strategy proposed for the Gatcombe Farm development, together with the design criteria, recommendations and mitigations measure to avoid undue light pollution or adverse impact on the existing site conditions, to include ecology, environment, the night-time sky and adjacent surrounding areas.

This document shall form the basis, of which the final designs and implementation of the artificial lighting are to be addressed. The lighting strategy sets out the recommendations, applicable regulations and best practice, to be adopted for the Proposed Development. Parameters are provided, to limit obtrusive light and light pollution onto adjacent and surrounding areas of the proposed development, together with considerations for protection of ecology and the environment.

The Proposed Development consists of 35 residential properties with associated vehicular and pedestrian access roadways and parking facilities. Site (collectively referred to as the Project Site) as further described below and in section 3.1 in more detail.

2 The Proposed Development

2.1 2.1 The Proposed Development's location

The proposed site is located south west to Long Ashton village centre, and north of Weston Road adjacent the Wild Country Lane junction.

The illustrative site plan below in Figure 2.1.1denotes the sites (red line) boundary and proposed layout of dwellings, parking and access routes. An area of allotments is located to the north of the site.

Figure 2.1.1 **Site Location Plan –** Image curtesy of Nash Partnership.

Figure 2.1.2 **Street view of site boundary** - Image curtesy of Nash Partnership.

2.2 2.2 Project description

The proposed development is for the construction of 35 residential dwellings together with allotments and associated access, parking, landscaping and a new access road off Weston Road.

Figure 2.2.1 **Illustrative Masterplan -** Image curtesy of Nash Partnership.

2.3 2.2 Existing baseline artificial lighting conditions overview

The existing artificial lighting conditions are established via site surveys to determine the day and night-time characteristics for the area of the proposed development and immediate surrounding areas.

The following section provides information on the existing artificial lighting conditions present within the areas of the Proposed Development, upon which the base line existing lighting conditions are established.

The bases of the external lighting strategy within this document take into consideration the existing lighting conditions and context of the broader environmental and social impacts.

The existing site area is an area of greenfield land and currently unilluminated during hours of darkness with no artificial lighting infrastructure present.

2.4 2.3 Baseline Conditions

The following provides details of the existing lighting conditions within the proposed development and surrounding areas.

There are currently no artificial lighting provisions within the site and illumination levels during hours of darkness generally consisting of contributions from moon light and night-time sky glow.

Full moon illumination contributions for the area are generally not expected to exceed beyond 0.1lux.

The sky glow for the site is assessed to be within a Bortle Dark Sky scale of Class 5 – Suburban area, with visibility of clouds greater than sky.

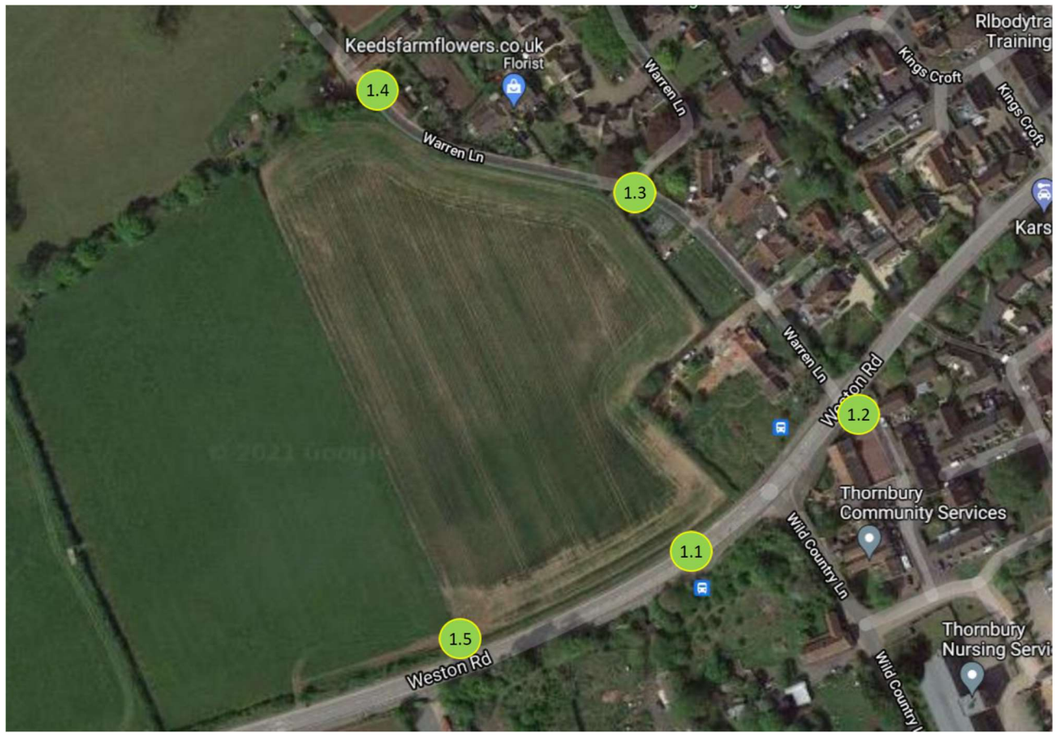


Figure 2.3.1 Photograph Viewpoint Reference Plan.

The viewpoint locations as per indicative reference points noted on figure 2.3.1 include for the direction of view noted for the following site images, i.e., Reference Viewpoint 1.1 East, indicates the site photograph taken is at location 1.1 facing towards the east.

Figure 2.3.2 Viewpoint 1.1 East

The section of Weston Road approach towards Long Ashton from the east is illuminated with LED street lighting columns from approximately 200m east of the Wild Country Lane junction, at which the road speed limit reduces from 50mph to 30mph. This section of Weston Road adjacent to the site is assessed to be within a Road Lighting Classification of Class C2 - Mixed vehicle and pedestrian on same surface (BS 489-1:2020) with an average illumination level of 20lux and 0.4 minimum uniformity.

Figure 2.3.3 Viewpoint 1.1 West

The section of Weston Road leading west at which the road speed limit increases to 50mph is unilluminated.

Figure 2.3.4 Viewpoint 1.2 North Image capture: Mar 2021 © 2021 Google

Warren Lane run north of Weston Road and parallel to the east development boundary. Warren Lane is unilluminated.

Two residentail properties are located on the west of Warren Lane with other residetnail properie sinign the east of Weston Road. Direct views from the west towards the proposed development are generally shielded by dense cover of foliage, trees and srubs.

Figure 2.3.5 Viewpoint 1.3 North West Image capture: Mar 2021 © 2021 Google

Warren Lane divides 100m North from the Weston Road junction with a section leading north west and north east. Properties are located on the east of Warren Lane with foliage and shrubs located to the west.

Figure 2.3.5 Viewpoint 1.4 South Image capture: Mar 2021 © 2021 Google

Warren Lane viewing south illustrate the tree lined perimeter running parallel to the development boundary to the east.

2.5 2.4 Sensitive receptors

In order to establish the parameters by which spill light from artificial lighting is to be assessed, all relevant sensitive receptors must be identified.

The proposed development is assessed to be within a Lighting Environmental Classification of Zone E2, with ecological receptors identified in the surrounding areas (e.g., bats) this assessment will focus on the potential impact wildlife corridors to the east of the development boundary and perimeter hedging to the west of the boundary.

Sensitive receptors in this case are:

1. **Wildlife Corridor:** The wildlife corridor shall be maintained as an unilluminated area with light contributions from adjacent areas to be limited.
2. **Perimeter Hedging:** Impact of light on the water surface and surrounding areas. Lighting impact to be assessed to avoid potential conflict between vessels from navigational signalling using the River Thames. Lighting impact to be assessed as bats are often roosting near shores or wet environments – refer to Ecological Report for habitat information.
3. **Neighbouring residential:** Residential buildings near the Proposed Development. The wider neighbourhood will be considered within the lighting computational analysis detailed further within this document.

Figure 2.4.1 Viewpoint 1.5 North

Weston Lane viewing north illustrates the western edge of the development boundary to be maintained for wildlife habitat and foraging bats. A lining of trees is proposed to along the eastern perimeter of the boundary providing additional visual shielding of the proposed development when viewing from the west of the proposed development.

Figure 2.4.2 Areas designated as residential sensitive receptors

As can be seen from the site plan above (Figure 2.4.2), there are neighbouring properties to the North and East of the development boundary.

Warren Lane running parallel with the east boundary line of the proposed development is lined with hedges, foliage and shrubs, providing visual shielding from direct view of the development from adjacent properties at street level.

The addition of hedging and trees lining the western boundary perimeter provides additional shielding further limiting direct views of the development and maintain a green tree lined perimeter for the residential properties viewing westward. The residential properties with high viewing points (first floor windows) facing west are likely to have some visibility of the development.

Figure 2.4.3 Plan view of wildlife sensitive receptors

The plan illustrated on figure 3.4.3 indicates the area of potential foraging and commuting bat areas. The lighting scheme shall ensure these areas are carefully considered and any undue light spill from the development mitigated to ensure the preservation of these areas for wildlife habitats.

The bat survey 'Interim Bat Survey Summary and implications for lighting strategy' conducted by Tyler Grange which indicates bats to the north/ west/south and eastern corner boundaries of the site. The proposed lighting design also takes into account the recommendations of the Institute of Lighting Professionals (ILP) 'Guidance Note 08/18 – Bats and artificial lighting in the UK – Bats and the Built Environment series'. The ILP Guidance Note 08/18 is co-authored with the Bat Conservation Trust.

Although there are no identified bat roosts, the bat survey indicates the potential of foraging and commuting bats in the local vicinity. With respect to the proposed development, it is anticipated that bats and other wildlife will use the hedging and planting along the perimeter of the development, and a dedicated 'wildlife corridor' route on the eastern boundary for foraging/commuting.

3 Lighting standards, guidance, legislation, and legislative framework

3.1 3.1 Planning policy

The National Planning Policy Framework (NPPF) by the Ministry of Housing, Communities and Local Government which seeks to minimise the negative effects of artificial lighting.

Paragraph 180 of the NPPF states, *"Planning policies and decisions should also ensure that new development is appropriate for its location considering 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: (excerpt C) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation".*

NPPF is supported by Planning Practice Guidance (PPG), which provides further guidance and makes the following references to light pollution:

- Paragraph 001 (Reference ID 31-001-20191101) states, *"Artificial light provides valuable benefits to society, including through extending opportunities for sport and recreation, and can be essential to a new development. Artificial light is not always necessary, it has the potential to become what is termed 'light pollution' or 'obtrusive light' and not all modern lighting is suitable in all locations. It can be a source of annoyance to people, harmful to wildlife, undermine enjoyment of the countryside or detract from enjoyment of the night sky. However, for maximum benefit, it is important to get the right light, in the right place and for it to be used at the right time".*

- Paragraph 001 (Reference ID: 31-002-20191101) states, *"Is a proposal likely to have a significant impact on a protected site or species? This could be a particular concern where forms of artificial light with a potentially high impact on wildlife and ecosystems (e.g. white or ultraviolet light) are being proposed close to protected sites, sensitive wildlife receptors or areas, including where the light is likely to shine on water where bats feed".*

- Paragraph 002 (Reference ID: 31-001-20191101) states, *"Light intrusion occurs when the light 'spills' beyond the boundary of the area being lit. These adverse effects can usually be avoided with careful lamp and luminaire selection and positioning".*

- Paragraph 003 (Reference ID: 31-001-20191101) states, *"The use of lighting only when the light is required can have a number of benefits, including minimising light pollution, reducing energy consumption, reducing harm to wildlife and improving people's ability to enjoy the night sky. Impacts on sensitive ecological receptors throughout the year, or at particular times (e.g. during bird migrations) may be mitigated by the design of the lighting or by turning it off or down at sensitive times".*

- Paragraph 005 (Reference ID: 31-001-20191101) of the PPG considers the character of the area and surrounding environment with reference to how these may affect what is an appropriate level of lighting for that type of development proposed. It cautions to avoid glare and an appropriate selection of lighting so that it fulfils its purpose without over-lighting.

3.2 3.2 International Dark-Sky Association

The International Dark-Sky Association is an organisation that provides guidelines for the creation of dark-sky reserves around the world. Its aim is to preserve and protect the night-time environment and our heritage of dark skies through environmentally responsible outdoor lighting. Although it is not the aim of the Principal Development to obtain recognition from International Dark-Sky Association (IDA), it is important to follow the principles established by this organisation in order to generate a night-sky friendly environment.

The general lighting principles of the IDA should be followed to ensure good lighting that reduces light pollution and its impact on dark skies. Some of the principles established are as follows:

- New lighting should not adversely degrade the sky quality beyond the immediate area to be lit.
- Angle light downward. No unnecessary light above or near the horizontal.
- Luminaires should be aimed towards where the light is needed, carefully considering the spill on the natural environment and neighbouring properties.
- Luminaires should be switched off when not needed. The use of smart control systems is highly recommended.
- Do not over illuminate
- Avoid bright white and cooler temperature LED's (anything above 3000K)
- Install luminaires at lowest possible height to achieve lighting levels

Figure 3.2.1 Example of luminaire types approved by the IDA - (Source IDA)

3.2.1 3.3 Impact of light pollution

The IDA guidance notes also contain information about the impact of light pollution in other areas. The impact of light pollution is not only confined to the visibility of stars at night and obtrusive light. It also affects the following animals.

3.2.1.1 3.4 Bats

As nocturnal specialists, most bat species are susceptible to artificial light. Due to the decline in numbers, all bat species are protected by the Wildlife & Countryside Act (1981) and the Conservations Regulations (1994). This makes it illegal to kill, capture or disturb bats, obstruct access to roosts or damage/destroy roosts. Lighting in the vicinity of bat roosts causing disturbance could constitute an offence. For planning applications developers should:

- Refer to Ecological report for identification of sensitive locations for bat habitats and roosting
- Not directly illuminate bat roosts
- Avoid illuminating foraging areas and route

3.2.1.2 3.5 Birds

Evidence shows that artificial light can reduce sleep in birds, which disrupts the long-term circadian rhythm that dictates the onset of breeding. Birds are likely to be disrupted by changes to insect behaviour due to artificial lights. In general:

- Do not directly illuminate important areas for nesting birds – probably wildlife sites

3.2.1.3 3.6 Invertebrates

Moths attracted to lights are a familiar sight. Artificial light, particularly blue UV rich, significantly impacts invertebrates, disturbing feeding, breeding and movement which may reduce and fragment populations. It is estimated that a third of insects that are attracted to lights will die as a result of their encounter. Evidence also shows that pollination rates in illuminated plans can be reduced by 62% - (Knop et al 2017. Nature 548). In general:

- Avoid illuminating water or reflective surfaces
- Do not illuminate ecologically sensitive areas
- Use colour temperature, CCTs of less than 3000K
- Use narrow band minimal UV source

Figure 3.7.1 Precedent images of different rural areas using warm and low-level luminaires in the public realm for the preservation of the dark sky and protection of the surrounding environment

3.3 3.7 The ILP (Institute of Lighting Professionals) notes for the reduction of obtrusive light GN01:21.

The Institute of Lighting Professionals (ILP) has produced the '*Guidance Notes for the Reduction of Obtrusive Light* (Guidance Note GN01:21), along with the '*SLL Code for Lighting 2012*' provide guidance for local authorities with a recommendation that they are incorporated at the local plan level. The guidance defines various forms of light pollution and describes a series of environmental zones and how to provide external lighting in each of these zones to mitigate unwanted light. The ILP guidance notes provide suitable criteria against which the effects of artificial lighting can be assessed and have been used in this assessment

The main potential issues with artificial lighting within a site of this environmental context are:

- poorly controlled sources;
- where light is not directed into the required area and is lit with excessive amounts of light; and
- where an area is lit too brightly for its purpose, and excess light is reflected upwards.

Figure 3.8.1 illustrates the key characteristics of how the artificial lighting design for a development should be implemented – 'Useful Light' (as required for functional use), 'Spill Light', and 'Light Trespass' (Light that is not wanted or required. This light may be a nuisance to others, a waste of energy, and an unnecessary source of greenhouse gases).

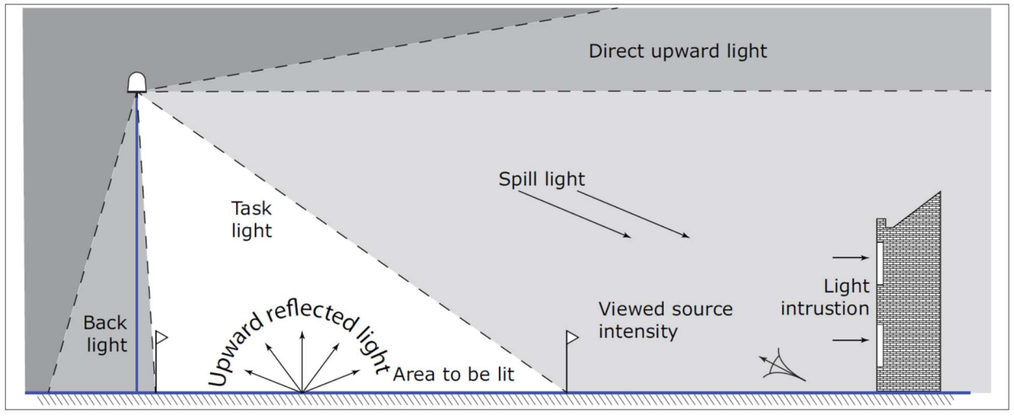


Figure 3.8.1 Types of obtrusive light – (Source: ILP GN01/20)

3.4 3.9 Lighting Environmental Zones

The classification of Lighting Environmental Zones, in the UK, are established within the documents GN01/21, 'Guidance notes for the reduction of obtrusive light' published by the Institute of Lighting Professionals (ILP).

As with any new development, there is a risk that the proposed lighting strategy may have a negative impact on the surrounding environment and residents, in terms of light spillage, brightness or glare. The identification of four environmental zones have been established as a basis for outdoor lighting regulations.

The environmental zone rating can be used to help ensure that the lighting goals of an environment are appropriately defined and met, considering the context and relevant surroundings.

Table 2: Environmental zones

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

Note 1 Where an area to be lit lies close to the boundary of two zones the obtrusive light limitation values used should be those applicable to the most rigorous zone (see comment below)

Note 2 Rural zones under protected designations should use a higher standard of policy

Note 3 Zone E0 must always be surrounded by an E1 Zone

Note 4 Zoning should be agreed with the local planning authority. Due to local requirements a more stringent zone classification may be applied to protect special / specific areas

Note 5 SQM (Sky Quality Meter) is referenced by the International Dark Skies Association (IDA). SQM is an instrument used to measure the luminance of the night sky. It is typically used by astronomers to quantify skyglow, using units of magnitudes per square arcsecond. the scale is between 16:00 (a bright night sky) and 22:00 (the least light pollution). The criteria for zone E0 was revised in mid 2019, with the new requirements not being made retrospective

Note 6 Astronomical Observable Dark Skies will offer clearer views of the Milky Way and of other objects such as the Andromeda Galaxy and the Orion Nebula

Note 7 Although values of SQM 20 to 20.5 may not offer clear views of astronomical dark sky objects such as the Milky Way, these skies will have their own relative intrinsic value in the UK

Figure 3.9.1 Extract table on guidance for the reduction of obtrusive lighting – (Source: ILP GN01/20)

The area of proposed development is assessed to be within Lighting Environmental Classification of Zone 2 – Rural area.

Figure 3.9.1 - Table 2 from the GN01:21, denotes the corresponding Lighting Environmental Zone applicable to the type of surrounding and areas, classified into 5 zone (E0 to E4). Each classification of environmental zone dictates the lighting criteria and parameter to which the lighting performance for each is required to adhere. The parameters include measure for permissible light spill and obtrusive light as well the relevant criteria's applicable within code and standards to include the British Standards for Design of Road Lighting (e.g. BS5489, BS EN13201 & BS EN 12464) and CIBSE SLL Lighting Guides (e.g. LG7).

The final confirmation of Environmental Zones is to be determined by the Local Planning Authorities. The above provides an indication of zone classifications based on the review of existing areas.

Figure 3.9.2 Environmental lighting zones

Environmental Zone	Sky Glow ULR (Max %)	Maximum values of vertical illuminance on properties		Luminaire Intensity I (cd)		Building Luminance (pre-curfew)
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew	Average L (cd/m2)
E0	0	0	0	0	0	0
E1	0	2	0	2500	0	0
E2	2.5	5	1	7500	500	5
E3	5	10	2	10,000	1000	10
E4	15	25	5	25,000	2500	25

Table 3.9.1 Lighting design criteria for environmental lighting zones – (Source: ILP GN01/20)

The ILP has produced guidance on the maximum permissible light spill into windows of adjacent properties, before and after the curfew time, based on which environmental zone the development is located. above illustrates the various lighting design criteria associated with meeting the recommendations set out in achieving lighting compliance.

3.4.1 4.0 Objective of lighting environmental lighting zones

The objective of the lighting environmental zones is to ensure appropriate levels of permissible light spill and

4.1 Environmental Zone E2

The E2 environmental zone is applied to the proposed development, upon which the lighting criteria as per Table 3.9.1 applicable for the maximum permissible levels of illumination and light intensity specific to each of the characteristic noted.

4 Lighting strategy and impact assessment

4.1 4.1 Lighting strategy objectives

The lighting design for the street lighting and car park lighting utilises luminaires fixed permanently on 6 Metre columns to illuminate the main access road and 4 Metre columns to parking areas as well as 1 metre bollards to pedestrian pathways to provide a lighting connection through to all building entrances. The specification of the lighting masts and luminaires has been carefully selected to ensure that the required lighting conditions are delivered with minimal impact to the surrounding areas. The lighting approach is to provide minimal lighting for a safe and secure ambiance while also control of light spill condition within the site and surrounding area due to the presence of the commuting and foraging bats.

Landscape Design Objectives	Lighting Strategy Objectives
A Destination Landscape • *Create a world-class, exciting resort landscape with a bold and innovative concept based around riverine and estuarine principles;* • *Planting to be based on native species and local habitats, designed to have seasonal impact and create beautiful vistas whilst creating positive micro-climates;* • *Hard and soft landscape design detailing to be climate and micro-climate resilient*	Lighting should help by enhancing all soft and hard scape areas at night by a careful consideration of a design narrative that follows and complements the landscape objective.

Landscape Design Objectives	Lighting Strategy Objectives
A Biodiverse Landscape • *Existing and retained habitats to be maintained and light contributions emanating from the proposed development to be limited.*	Lighting should respect, enhance and protect the existing and retained natural environments by the careful use of lighting only where it is required. Lighting should also be controlled both digitally and physically to avoid excess of illumination, glare, high contrast.

Landscape Design Objectives	Lighting Strategy Objectives
An Accessible Landscape • *Footpath and cycle routes to improve connectivity* • *Development of a way-finding strategy to provide clear directional guidance and orientation information for all users.*	The lighting proposal should support the needs of all people accessing the site.

4.2 5.0 Lighting design criteria

4.2.1 5.1 Environmental impact

Good lighting can bring both social benefits, but the use of artificial lighting comes with environmental consequences. This not only includes power consumption, but also the risk of light spill, light pollution and over illumination all of which can have a detrimental impact on the well-being of neighbouring residents and existing wildlife habitats. Therefore, the quantity of light and the equipment is kept to a minimum in those areas that need the least amount of light. The specification of the luminaires should consider optical control, efficacy and whole lifetime cost to keep energy consumption to a minimum and the light distribution only to where it is needed.

4.2.2 5.2 Safety

The lighting should be designed to keep a safe environment. The positive definition of potential hazards such as level changes and borders, and the adequate illumination of areas where pedestrians are likely to encounter moving vehicles should take priority in the lighting design for the external areas.

4.2.3 5.3 Security

The lighting development should be designed to provide an overall sense of security supporting both active and general passive surveillance. Lighting should provide adequate recognition and modelling of people where required.

4.2.4 5.4 Accessibility

The design of the lighting must support the needs of all people visiting after dark. Design measures must include the avoidance of high contrasts, direct and reflected sources of glare, and confusing upward lighting. Accessibility through the development can also be aided through the creation of a legible environment and the use of light to promote movement and aid intuitive wayfinding.

4.2.5 5.5 Character

Lighting can help to define the overall character of the development at night, as well as making distinction between the different requirements within the development. Light can be used to reinforce and enhance the character of individual spaces being by light colour temperature, intensity and mounting height.

4.2.6 5.6 Identity

The experience of the development at night will play an important role to integrate with the existing surroundings. A proper identity can be created by the careful and considered lighting approach that helps to enhance the character and legibility of the whole area.

4.2.7 5.7 Technology

Light sources, luminaires, control technologies, efficiencies are all rapidly changing due to the latest technological advancements. The development of digital lighting controls promises new flexibility and ease of management together with greater energy saving measures. It will be important for each area within the Development to utilise the latest technology available at the time of design and procurement to ensure the best benefit for the whole project. In this way the associated positive effects on management of the lighting and the social and environmental aspects can be properly managed.

4.3 6.0 Lighting Principles

4.3.1 6.1 Colour Temperature and colour rendering index

Colour temperature defines the colour appearance of the light. It is a quality to which people are subconsciously sensitive. The warmth of a fire or candle fame speaks at a very deep level of safety, history, and communion. Cooler light, as experienced on a clear night with a bright moon and sparkling stars, for example, has a more open, magical and dramatic quality. Warm light comes forward in the visual scene whereas cool light often recedes and creates depth.

Warm light is proposed where applicable for the following reasons:

- Warm light is mentally associated with safety, history, communion, relaxation and intimacy.
- Any type of light could suppress the secretion of melatonin in human beings and different animals, however the exposure to blue light at night does so to greater effect as it suppresses the bodies release of melatonin, a hormone that assist with the human sleep cycle and impact on the body's circadian rhythm. Red light has very small impact on the melanopsin receptors, and they do no stimulate wakefulness. Warm light has higher quantities of red light.

- Red, amber and yellow light, and light up to 2200K have a shorter wavelength than 3000K, 4000K light. This is beneficial for the animals as they are less attracted to this type of light therefore generating less disturbance on the natural environment at night.
- According to different scientific studies and the International Dark Sky Association (IDA) blue light brightens the night sky more than any other colour of light, so it is important to minimize the amount emitted. Triple Bay and Amaala have the potential to become a dark sky reserve and a world class site to preserve the night sky turning this into an important part of the visitor's experience.

Figure 6.1.1 Range of light colour temperature across the site

- Lighting environmental zone E1: no light
- Lighting environmental zone E2: 3000K

Therefore, a colour temperature of 3000k has been adopted for the proposed development.

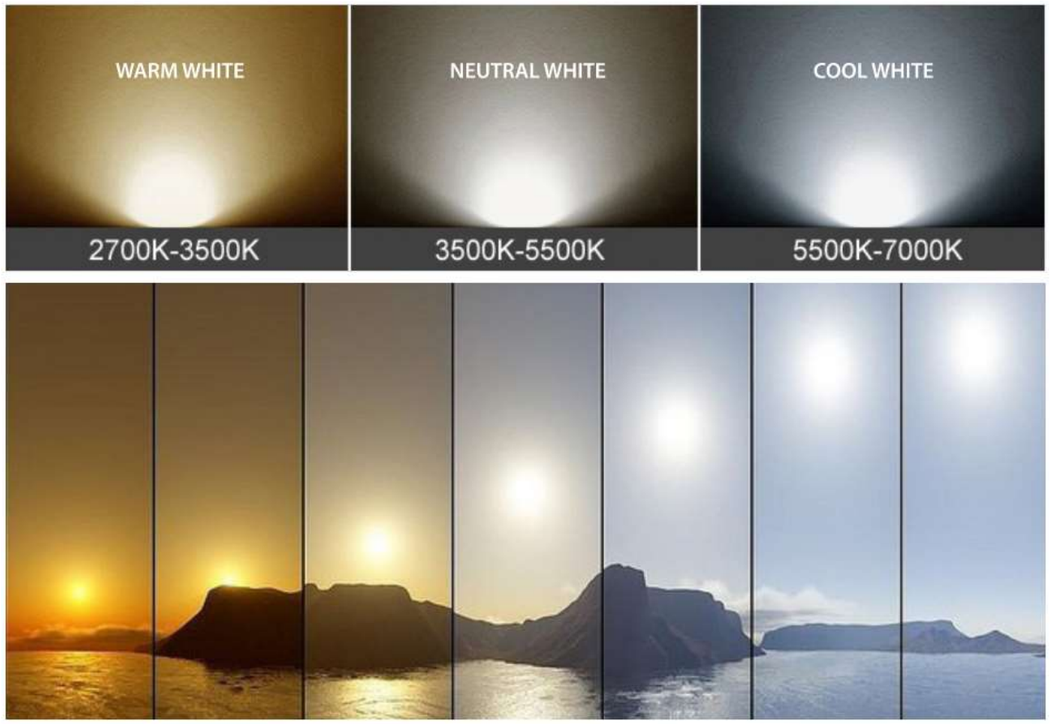


Figure 6.1.2 Light colour temperature example chart

The Colour Rendering Index provides an objective indication of the ability of a light source to render the colours of various objects faithfully, in comparison with a natural light source. The general colour rendering index Ra has been introduced to specify the colour rendering properties of a light source. The maximum value of Ra is 100. This figure decreases with decreasing colour rendering quality.

It is important for visual performance and the feeling of comfort and well-being that colours of objects and of human skin are rendered naturally, correctly and in a way that makes people look attractive and healthy.

In principle, exterior lighting applications do not have the same requirements as interior environments in terms of colour rendition. Over the last 20 years, 60-70 CRI value was commonly encountered in exterior lighting schemes. As technology progresses, the light quality of LEDs improves rapidly. Long-standing high-quality lighting manufacturers now provide a minimum of CRI 80 for outdoor products.

Figure X Differences between CRI levels

4.3.2 6.2 Intensity

The intensity of light across the site must be appropriately considered from the brightest thoroughfares to the dimmest landscaped areas, both for the area in question, and in relation to adjacent areas.

It is suggested that the levels of illumination should be at their highest when spaces are shared by vehicles and pedestrians, and when the speed of their movements are highest. When the movement of people is slower, though, or when there is less interaction with motorised traffic, the lighting levels can be much lower, while still providing an appropriate level of safety, and comfort.

4.3.3 6.3 Mounting height and shielding

The mounting height of the lighting equipment will contribute to the perceived scale of spaces. Mounting luminaires too high on columns or buildings risks creating an environment that feels unwelcoming and scale-less for pedestrians and an increased proportion of spilled and uncontrolled light on the natural environment. A carefully considered range of mounting heights appropriate to the form and function of the space under consideration will assist in achieving the right sense of scale and add to the legibility of the area after dark.

Figure 1 Comparison between high and low mounting scales. Image on the left shows large scale lighting column without any glare control and the image on the right shows a smaller column with controlled lighting distribution providing light to the path only

Shielding is required in certain lighting fixtures to help minimise the amount of light that can spill onto the night sky and the surrounding natural environment

4.3.3.1 6.4 Integrated shielding

A full cut-off shielded light fixture has an integrated solid barrier at the top, located over the light source (lamp) such that it is covered. The solid housing should not have any translucent parts or diffused materials which will allow for lighting escaping towards the dark sky. These luminaires allow light to be accurately cast downwards into the desired area without major levels of light spill. Spread lenses, snoots, internal/external louvres, honeycomb louvres and other glare mitigation and light control measures can be used in these luminaires to further limit the spread of light beyond a targeted area.

4.3.3.2 6.5 Integrated and external shielding

Areas within the Lighting Environmental Zones E1 and E2 need further mitigation measures to be adopted in order to fully shield the light from direct line of sight from the sensitive receptors. 100% light source shielding can be achieved using physical landscape and architectural barriers (such as: dense shrubs and dense low-level vegetation, dunes, bunds, berms, etc.) and, furniture-integrated (or otherwise recessed) luminaires, solid balustrade, solid or very dense screens, and dunes and others, in combination with full cut-off fixtures.

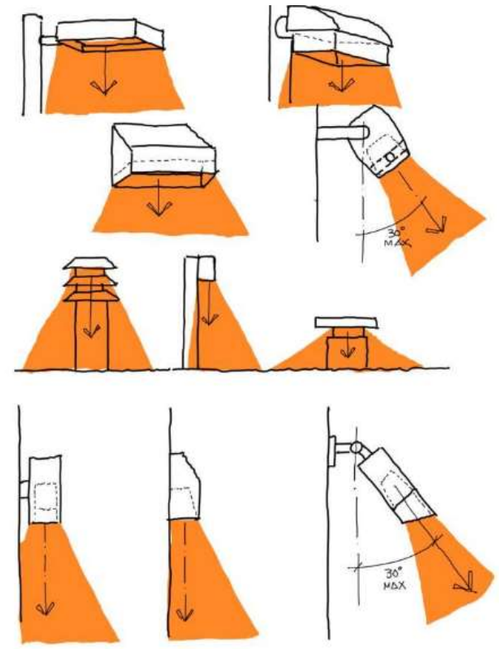


Figure 1 Sketches the above figure show examples of luminaires with integrated shielding and controlled distribution of light.

If any of the development windows are reported to have light spill issues through further detailed calculation analysis during the architectural design process or reported post-installation, then a mitigation measure can be applied in the form of light shields applied onto the luminaires (where light is entering the windows of the properties affected).

Shields must be added to the luminaires in areas where backwards spill light is reached the residential properties within the Masterplan from the street lighting. This has to also be applied to the luminaires in the areas near the bat locations which would be to perimeter of the Masterplan, to decrease visual brightness of the source in the bat activity zones.

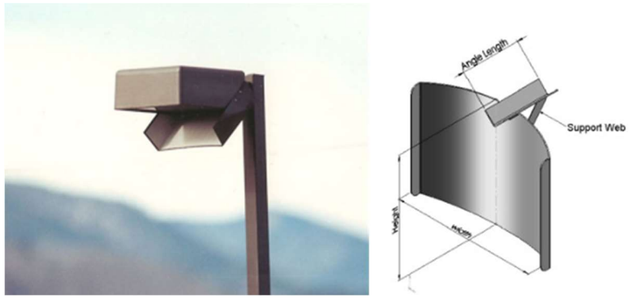


Image of a Shield type to prevent backward light spill.

4.4 6.7 Circulation strategy

The lighting design for the roads and circulation areas within the proposed development should seek to minimise the quantity and intensity of light applied to fulfil the various functional and aesthetic objectives demanded by each application. This will not only help to save energy and reduce light pollution, but more importantly it will contribute with the creation of a unique, appropriate, and legible character for each route.

The illumination of the external circulation routes for the proposed development are classified into two type, those for shared vehicular, pedestrian and cycles routes and those dedicated for pedestrians and cycles. Together with the illumination of parking bays.

Figure 6.7.1 Classification of illuminated circulation routes

4.4.1 6.8 Vehicular Routes

This main vehicular access road shared with cycle and pedestrian access (pavement) is illustrated in Figure 6.7.1 above, the route running centrally north and south of the site with junctions to access routes to the car parking bays.

The main roadway if assessed to be illuminated to a road lighting classification of P5, with an illumination criterion as noted in Table 6.8.1.

The use of 6M high street lighting columns is utilised to provide illumination of the main vehicular access routes.

Table 6.8.1 Comparative chart between different lighting classifications. Information is extracted from BS EN 13201-2:2015

Lighting classification	Average horizontal illuminance	Uniformity	Notes
P5	3.00 lux	0.6 lux minimum	The lighting for this classification shall be address with use of 6meter high street lighting columns.
Car park	5 lux	0.25	The lighting for this classification shall be address with use of 4meter high lighting columns or low-level lighting bollards in close proximity to sensitive receptors or potential light spill onto adjacent surroundings.

4.4.2 6.9 Pedestrian and Cycle Routes

The pedestrian access routes are illuminated utilising low-level bollards. This approach provides suitable illumination of the pedestrian route with minimal light distributed to adjacent areas. The light source being located at low level also assists to avoid viability of light source from the residential properties adjacent.

Figure 6.8 Low level bollards

6.10 Car parks

The car parks are illuminated utilising 4m high lighting columns and where in close proximity to sensitive receptors and also to reduce the direct visibility of lighting within the development from view from the east. The uniformity of lighting deviates for areas of car park close to sensitive receptors to provide suitable levels of illumination however mitigating any adverse light spill onto sensitive receptors as a higher president.

Figure 6.9.1 Precedent image of luminaires/columns used for car parks

7 Light Character Areas

By applying the principles of the Environmental Lighting zones in conjunction with a design ideal that follows the architectural and landscape language, light can be used as a tool to enhance the visual landscape by reinforcing these character areas.

The external lighting for the proposed development shall provide suitable illumination for safe use of the external spaces.

In respect of the existing lighting strategies, environmental sensitive receptors and surrounding areas. The pedestrian and cycle routes adjacent the sensitive receptors to include the cycle route leading North to Warren Lane to maintain the existing character of the area and also protect the nearby sensitive receptors.

This approach maintains illumination of primary access routes to the residential properties, whilst maintaining the natural environment of surrounding areas and minimise impact on to sensitive receptors.

The allotments located north of the development is maintained unilluminated during hours of darkness to ensure preservation of the sensitive receptor located nearby and in keeping with the character of the existing area.

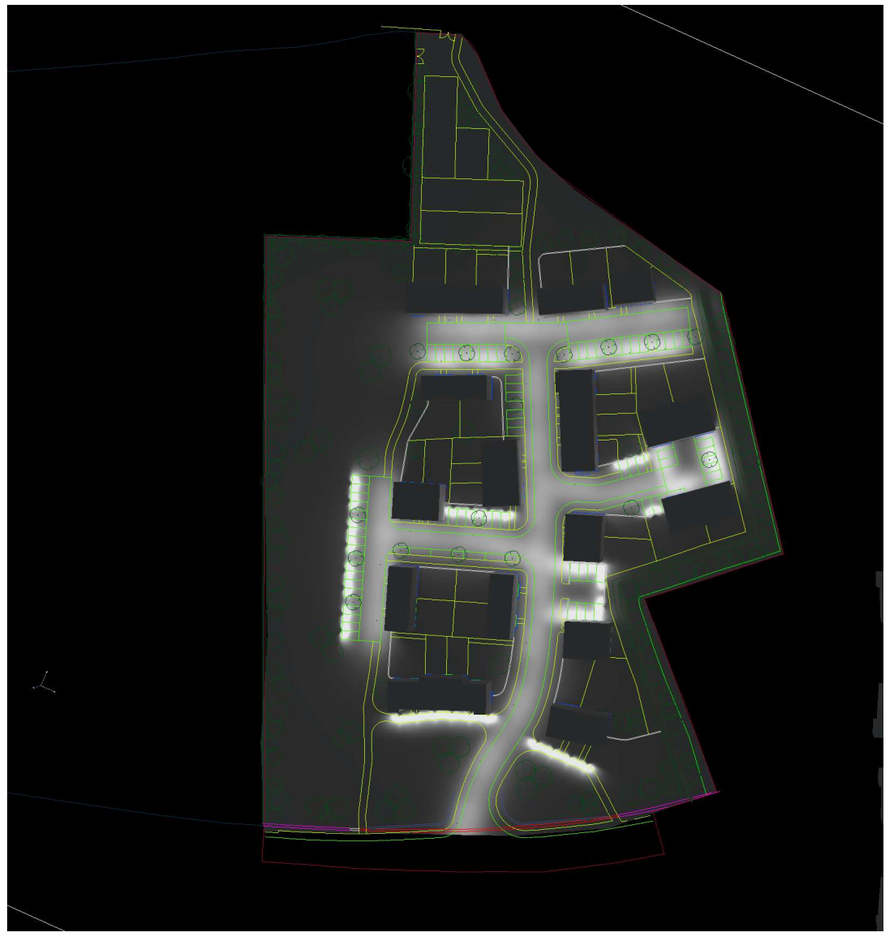


Figure 8.1 **Illumination Glow Plan**

The above lighting glow plans, illustrate the distribution of light, with illumination of the main assess routes, whilst maintaining minimal light spill onto adjacent areas and sensitive receptors.

8 Software lighting analysis

The following provide information of the illumination levels and lighting performance to illustrate illumination levels applicable to areas of sensitive receptors and demonstration of the function lighting requirement for access routes.

Using 3D lighting calculation (Dialux) and CAD software (AutoCAD) plans were utilised to create certain lighting conditions that would allow to demonstrate the effect of artificial lighting on the environment. The following factors and assumptions have been used in the calculation:

- Surrounding trees have not been included in the calculation as the various species and shapes cannot be accurately modelled. It is assumed most will be deciduous and the amount of cover offered will be reduced during the winter season. However, it should be noted that the old and new trees in this area will provide further reduction to any spill light and visual impact of the brightness to the Proposed Development;
- This assessment technique simulates and calculates the proposed combined total lighting lumen output (worst case scenario) of the Proposed Development. The assessment considers the street lighting, car park lighting and pedestrian and cycle route lighting. All lighting has been assessed at 100% output for evaluation of light spill;
- The result renderings have been shown in 'pseudo colour' format. This visually demonstrates where the lighting (illuminance) will potentially be distributed and by how much.
- Virtual light metres have also been exported to clearly identify lighting levels (lux) on specific areas of the site so a comparison can be made against the baseline study.
- All lighting calculation areas are set at 0.00m (unless stated otherwise), on the same plane as the luminaires, considering this the worst-case scenario. In real conditions, different sensitive zones are at different height levels to the luminaires across the site.
- Calculations for the performance lighting utilise a maintenance factor for luminaires of 0.57.

8.1 Calculation planes

Two different types of calculation planes are placed to measure the effects of light:

- The plane where the lighting class applies corresponds to the area being lit. This can be a shared path, a road or car park.
- The protected environment. This calculation plane is placed to measure the maximum levels of light that the protected environment areas can receive.

The below image illustrates the distribution of light onto areas of sensitive receptor as identified in Section 2.4.

The colour chart adjacent the plan denotes the illumination levels in lux. The lighting plan illustrates the distribution of light to provide the function illumination levels required for safe asses within the site, whist ensuring the light spill onto areas of sensitive receptors are maintained within permissible levels.

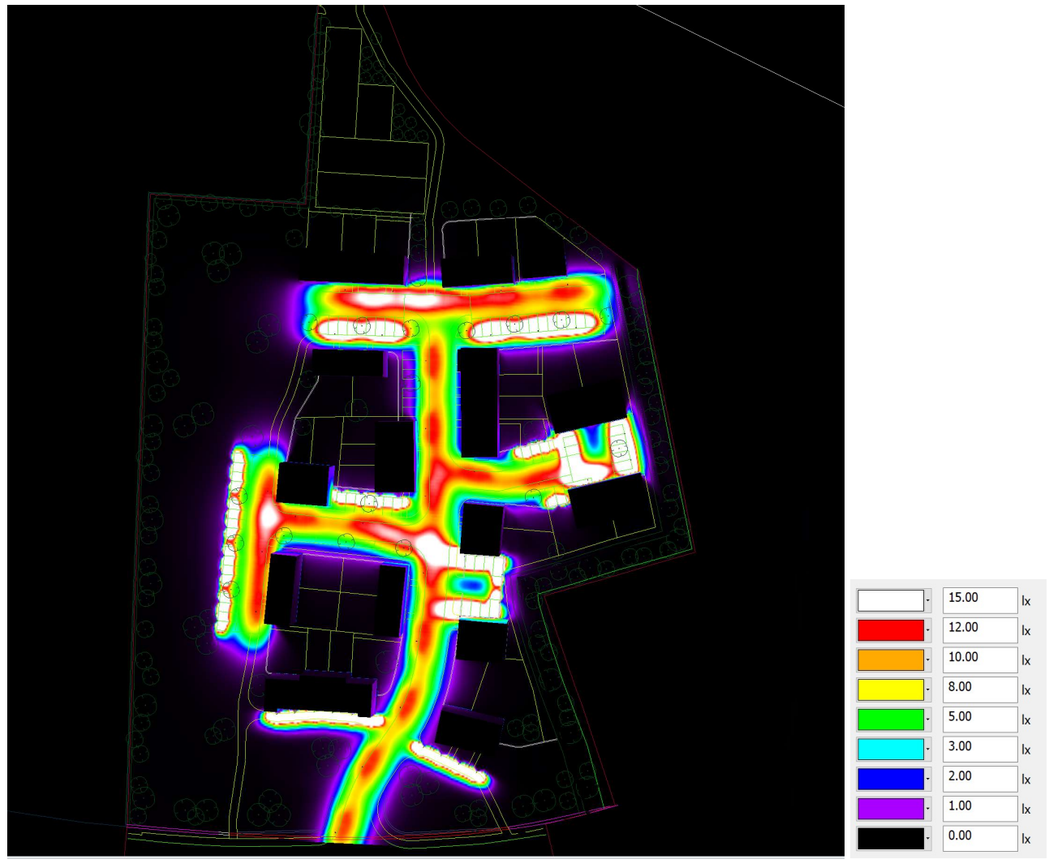


Figure 8.1.1 – Light dirstirbution plan

8.2 8.1 Lighting analysis - Sensitive Receptors

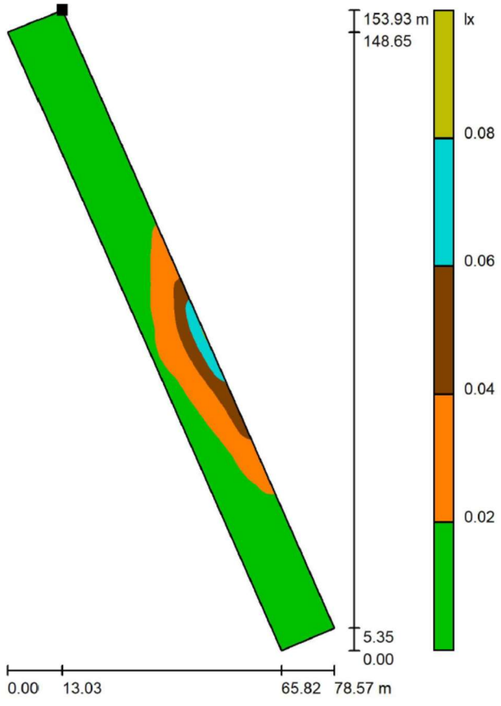


Figure 8.1.2 – Illumination plan 1

Figure 8.1.2 illustrates the light distribution onto the area of sensitive receptor east of the site.
The maximum quantity of light onto the areas being of 0.08lux and within the permissible levels for the environmental zone.

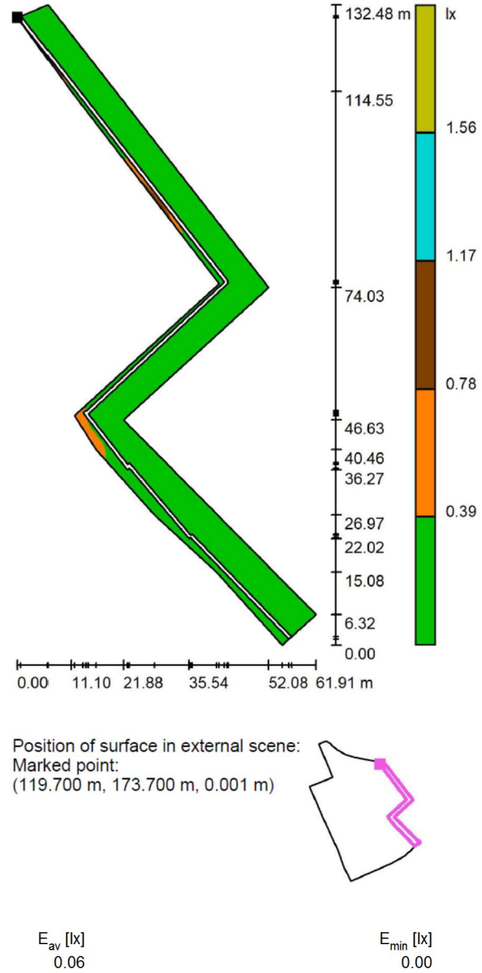


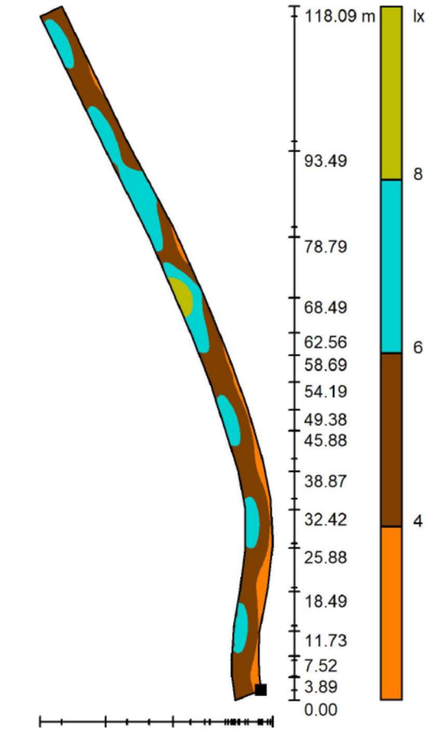
Figure 8.1.3 – Illumination Plan 2

Figure 8.1.3 illustrates the light distribution onto the area of sensitive receptor west of the site.
The maximum quantity of light onto the areas being of 0.1.98lux with the majority with an average of 0.39 Lux and within the permissible levels for the environmental zone. The results also indicate no light spill from the site impacting onto the adjacent existing residential properties.

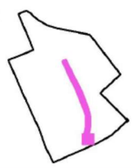
Figure 8.1.1 illustrates minimal light distributed onto the areas of sensitive receptor to the north and south of the site.

8.2.1 8.2 Lighting Analysis - Lighting Performance

The following provide details of the illumination results obtained for the access routes within the site.



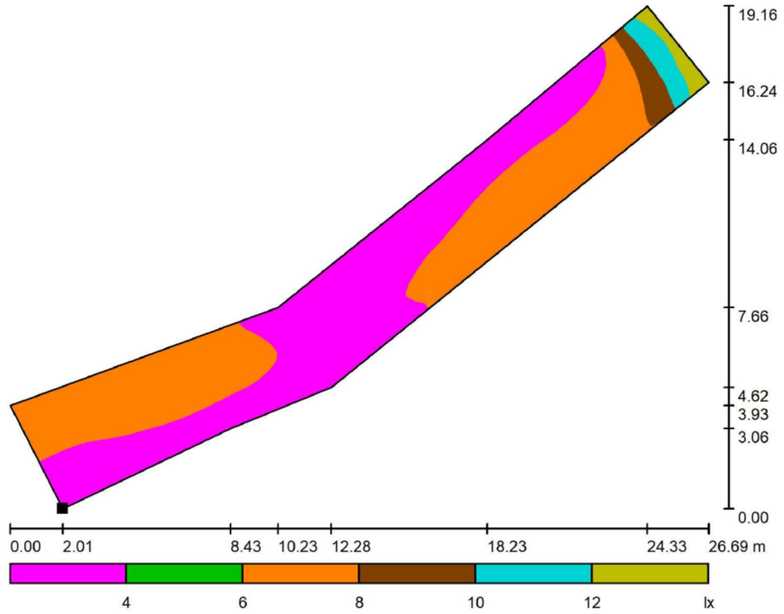
Position of surface in external scene:
Marked point:
(124.473 m, 21.694 m, 0.010 m)



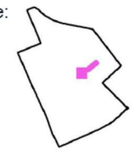
E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
5.61	2.65	10	0.472

Figure 8.2.1 – Illumination Plan 3

Figure 8.2.1 provides detail of the illumination levels obtained for provide suitable levels of illuminations for the classification of roadway.



Position of surface in external scene:
Marked point:
(109.182 m, 105.537 m, 0.010 m)

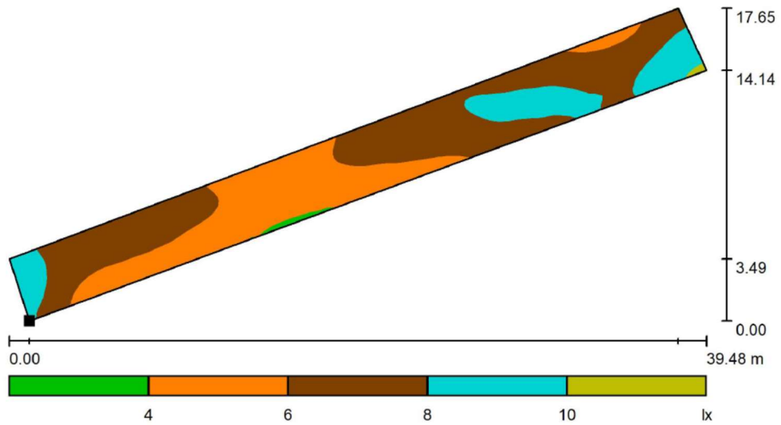


Grid: 128 x 64 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
6.32	3.96	14	0.627

Figure 8.2.2 – Illumination Plan 4

Figure 8.2.2 illustrates Illumination levels for the access road west from main route.



Position of surface in external scene:
Marked point:
(71.017 m, 75.110 m, 0.010 m)

Grid: 128 x 16 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0
6.67	3.84	10	0.576

Figure 8.2.3 – Illumination Plan 5

Figure 8.2.3 illustrates Illumination levels for the access road east from main route.

9 Conclusion and Summary

The basis of this report was to analyse whether the new Land south of Warren Lane, Long Ashton, development in regard to street, parking and amenity lighting complies with the ILP 'Guidance Notes for the Reduction of Obtrusive Light' with the respect to the surrounding sensitivity receptors, and is conducive to foraging/commuting bats and wildlife with respect to the ILP 'Guidance Note 08/18 – Bats and artificial lighting in the UK – Bats and the Built Environment series'.

The development is assessed to be within a Lighting Environmental Zone 2 (see chapter 3 for the corresponding assessment criteria) with residential properties and bats being the main sensitive receptors taken into consideration.

The performed 3D computer simulation calculations are purely based on the proposed street lighting designs effects onto the surrounding area of the site and residential properties.

The light spill to the residential properties within the development does not exceed the 5 lux requirement, therefore, a negligible effect within the Masterplan. Light spill will be further reduced due to the trees and potential fences.

Required mitigation measures are:

- Columns in the middle of the development are 6-metres tall, while nearing the perimeter condition and wildlife corridor, column heights are reduced to 4-metres tall or utilisation of low-level bollards. Thus, mitigating light spill impact to potential foraging/commuting bat and wildlife areas.

- Shielding on luminaires may be required in the development to prevent visibility if light sources from the existing residential properties within the development. This will be defined at a detailed design stage.

- UV filtered luminaires are proposed in order to minimise impact to sensitive foraging and commuting bats and invertebrates.

- A warm white light source is proposed in order to minimise impact to sensitive foraging and commuting bats and invertebrates.

- Illumination of allotments during hours of darkness (post occupation) for general use to be limited and localised lighting utilised if required (handheld touches).

The deduced conclusion indicates that the proposed exterior lighting scheme adheres to the mitigation measures stated within this report the overall lighting scheme should have a minimal effect on the surrounding sensitivity receptors and bat species surrounding the site.

However, care has to be taken when commissioning the lighting to ensure the luminaires are positioned and aimed in the correct direction as designed and not facing towards the surrounding landscape areas or within residential properties.

Currently there is no security lighting incorporated in the general lighting scheme, however if security lighting is to be introduced at a later phase in the scheme, this should be mounted so that the luminaires are to be faced downwards rather than outwards , especially where the luminaires would face trees or hedges.

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