

Petersham Nurseries
Artificial Lighting Impact Assessment

P062153

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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 lighting 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
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

The purpose of this report is to evaluate the lighting conditions associated with the evening operation of Petersham Nurseries and assess the potential impact of these on surrounding sensitive receptors in order to respond to the points raised by the London Borough of Richmond upon Thames in relation to enforcement case reference 18/0025/EN/BCN.

The site at Petersham Nurseries comprises an existing Garden Centre with ancillary café and restaurant located on Petersham Road, Richmond, London. The Nurseries comprise three glass greenhouse structures, separate brick and timber buildings, and outdoor areas, which together accommodate the plant and shop sales, display areas, seating areas, the kitchen, toilets, and staff office. The site is surrounded by a high brick wall, which clearly creates a physical boundary between the site and surrounding area.

The café and restaurant have been operational in the evenings for over 10 years, and as such, the night time lighting environment and conditions have been established for a substantial period of time.

With regard to the wider context, the site is evaluated to be within a lighting environmental classification of Zone 3, which is a suburban area of medium district of brightness, based on the sky glow and classification of the ILP GN01:21.

A site survey of the existing baseline artificial lighting conditions has been undertaken when the Nurseries were operational during the hours of both daylight and darkness and the lighting has been assessed in accordance with the recommendations and parameters stated within the Institute of Lighting Professionals (ILP) Guidance Note GN01:21 'The reduction of obtrusive light'.

Our assessment demonstrates that the both the internal and external lighting falls within the permitted parameters stated in ILP GN01:21 with regard to light spill and obtrusive light emitted from the site and beyond the immediate site boundary. The artificial light emitted from the site is therefore considered to be of negligible impact onto the surrounding residential properties and the area of Petersham Meadows to the north of the site.

The light emitted from car head lights using Church Lane has also assessed (although it is noted that Church Lane is a publicly accessible road and not all vehicle movements are associated with Petersham Nurseries). The illumination of car heads light does not impact directly onto any known residential window openings and therefore does not constitute a nuisance to occupiers. The light emitted from car headlights onto Petersham Meadows is also assessed as being of negligible impact.

1 Project Description

1.1 Project Site Location and Context



Figure 1.1 - Illustrative Site Masterplan

The site is located approximately 1 mile south of Richmond town centre and 200m adjacent south of the River Thames. The site is situated with an area of Metropolitan Open Land (MOL) and is predominantly surrounded by open land and woodlands to the north and residential properties located to the south in both east and west directions.

The Petersham Nurseries currently supports interior lighting for the restaurant, cafe, and catering faculties. Exterior lighting of the site includes for festoon lighting within the entrance courtyard and the section of Church Lane adjacent the north and east of the site boundary.

The internal and external lighting at Petersham Nurseries has been assessed to check conformity with the parameters of permissible light spill and obtrusive light based on the Institute of Lighting Professionals (ILP) Guidance notes for the reduction of obtrusive light (document GN01:21) to ensure the impact of light onto ecology and the environment is within permissible levels appropriate for the site's assessed lighting

environmental classification of Zone 3.

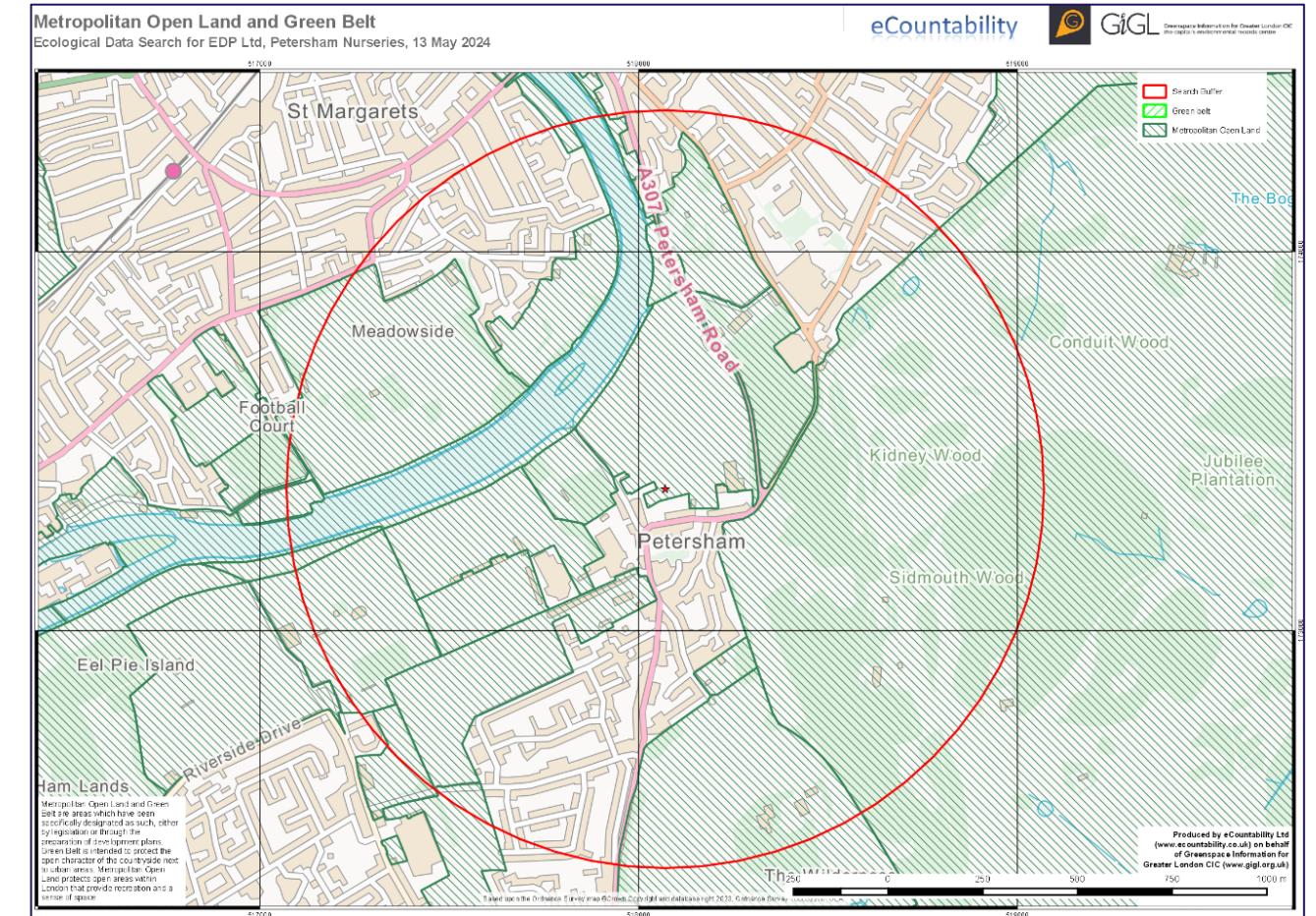


Figure 1.2 – Plan of areas of MOL and Green Belt Land.

1.2 Role of Buro Happold Specialist Lighting Services

The following report provides a Lighting Impact Assessment to evaluate the lighting conditions associated with the evening operation of Petersham Nurseries and assess the potential impact of these on surrounding sensitive receptors in order to respond to the points raised in by the London Borough of Richmond upon Thames in relation to enforcement case reference 18/0025/EN/BCN.

1.3 Lighting Statement Objectives

The objectives of this environmental lighting statement are to:

- Support the client in responding to the issues raised in document STATEMENT OF CASE by Mr Edward Appah, BA (Hons), MA, MRTPI on behalf of London Borough of Richmond Upon Thames and the ENFORMENT REPORT REF:18/0025/EN/BCN, namely to provide a quantitative assessment of the interior and exterior lighting associated with the evening operation of Petersham Nurseries, and the impact of this lighting on the Metropolitan Open Land (MOL), Petersham Meadows, surrounding residential properties, ecology and environment.
- Assess the impact of the lighting in the context of current legislation, guidance, and planning policy.
- Provide details of mitigation measures if required to ensure compliance with legislation to be within the permissible levels of light spill or obtrusive light.

1.4 Sensitive Receptors

In the wider ecological sense, sensitive receptors include the occupants of an areas (whether there are people, animals, or vegetation) that are more susceptible to the adverse effects of exposure to pollutants.

For the purposes of this report, the sensitive receptors are all those human communities and animal and vegetation habitats upon which artificial lighting can cause impact or be a potential source of nuisance.

Sensitive receptors identified specific to the site are:

- Residential properties
- Petersham Meadows
- Potential bat foraging routes.

2 Regulatory requirements, Lighting Standards and Guidance

2.1 Regulatory requirements



The Clean Neighbourhoods and Environment Act 2005

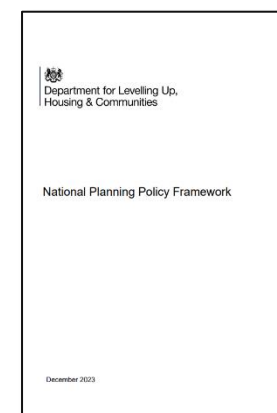
UK Government

This act provides local authorities and the Environment Agency additional powers to deal with a wide range of issues by classifying light pollution as a statutory nuisance.

The statutory nuisance regime does not include light emitted from light sources which are used for transport purposes and other premises where high levels of light are required for safety and security reasons.

It is expected that the following sources are those with greatest potential to generate issues relating to artificial lighting:

- Industrial and commercial security lights
- Industrial and commercial external operational lights
- External floodlit facilities
- Exterior lighting of buildings



The National Planning Policy Framework (NPPF) 2023

Ministry of Housing, Communities and Local Government

This framework 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.

2.2 List of Applicable Standards & Guidance

The external artificial lighting for the Proposed Development shall be based on British design standards and the relevant guidance and codes. These include:

- | | |
|---|---|
| British Standards | <ul style="list-style-type: none"> • BS EN 5489-1:2020 Road Lighting • BS EN 13201- 1/2/3/5 2015/2014 Road Lighting • BS EN 12464-2: Outdoor Workplace • BS EN 60598-1: 2004 – Luminaire General requirement • Electricity at Work Regulations • BS 8300-1, 2018 Design of an accessible and inclusive, Part 1 The Exterior Environment • Health and Safety at Work Act |
| Main Building Services Related Guidance Documentations | <ul style="list-style-type: none"> • CIBSE Lighting Guides LG6 – The outdoor Environment • CIBSE – SLL Code for Lighting • CIBSE LG14 – Control of electric lighting • BRE DG498: Selecting lighting controls. • BRE IP2/99: Photoelectric control of lighting design • CIE Publication 129 (1998) - Guide for lighting exterior work areas |
| Installation | <ul style="list-style-type: none"> • CIE Publication 154 (2003) - The Maintenance of outdoor lighting systems (2003) • CIE Publication 136 (2000) – Guide to the lighting of urban areas • CIBSE - SLL Code for Lighting 2023 • Construction Design and Management Regulations 2015 - HSE • Secured by Design – Guidance for lighting against crime. |
| Environmental guidance | <ul style="list-style-type: none"> • ILP GN01:2021 Guidance Notes for reduction of obtrusive light • ILP PLG05, 2014 The brightness of illuminated advertisements • ILP GN08/23, 2023 Bats and artificial-lighting and Bat Conservation Trust • International Dark Sky Association – Recommendation for the protection of night dark skies • CIE Publication 126 (1997) - Guidance for minimising sky glow • CIE Publication 150 (2017) - Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting • BS 42020, 2013 Biodiversity Code of Practice • PL G04 Guidance on undertaking Environmental Lighting Impact assessment. |

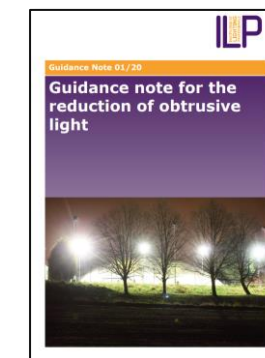


The Dark-Sky International

This 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.

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 always. 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.



Guidance Note for the Reduction of Obtrusive Light (Guidance Note GN01:21)

The Institute of Lighting Professionals (ILP)

The ILP have produced this guidance note 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.

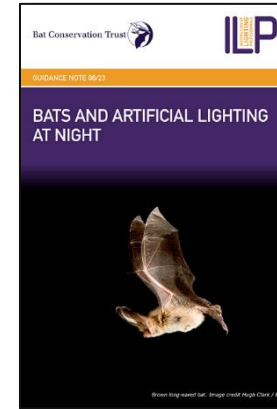
The main potential issues with artificial lighting within a site of this environmental context are:

- 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.

The different types of obtrusive light which should be properly controlled when the artificial lighting design for a development is developed.

- Sky glow - The brightening of the night sky.
- Glare - The uncomfortable brightness of a light source when viewed against a darker background.

- Light spill & light intrusion - The spilling of light beyond the boundary of the area being lit.



Institution of Lighting Professionals (ILP), Bats and Artificial Lighting at Night, 2023

National Bat Protection Guidelines

Greater horseshoe bat ecology and management Technical Advice Note, April 2021

Local Plans

The London Plan 2021

The overall strategic plan for London, it sets out an integrated economic, environmental, transport and social framework for the development of London over the next 20-25 years.

Adopted Local Plan for Richmond upon Thames 2018

The local plan applicable to Richmond.

Ham and Petersham Neighbourhood Plan 2018 - 2033

The local plan applicable to Ham and Petersham.

Please refer to Appendix for further details of above plans and policies relating to lighting.

3 Lighting Conditions and Assessment Results

3.1 General

This section provides information on the internal and external lighting conditions associated with the evening operation of the site. The existing artificial lighting conditions have been established from data obtained from daytime and night time site surveys, including visual observations and recording of lighting data (including illumination levels and intensity of light sources).

Aspects of environment, ecology, and human receptors have been taken into consideration during the survey. Full details of these potential sensitive receptors are discussed in detail later in this report.

3.2 Site survey details

Photographs and measurements were taken under the following conditions:

Sky conditions

The site visit was carried out between the hours of 18:30hrs and 22:30hrs on 4th May 2024.

Sky conditions: Clear with intermittent clouds.

Sunset: 20:29 hrs

Moon conditions



Phase: Waning crescent; Illumination: 18%

Moon Age: 26 days; Moon Angle: 117.29o; Moon Distance: 379,846.17km

Sun Angle: 0.54; Sun Distance: 147,319,339.99km

Camera settings

Make: Nikon D90 Digital SLR

Lens: Nikon AF-S 18-105mm f/3.5-5.6, f/22-36.

Aperture: F5.6

Mobile Phone: Samsung Galaxy S21 FE, Auto Setting.

Light meters

Make: Konica Minolta Luminance Meter LS-100,

Type or meter: T-10;

3.3 Site conditions

The following provides details from visual observations and light measurements both within the site and from outside the perimeter.



Figure 3.1 – Illumination and luminance measurements

Figure 3.1 denotes the illumination and luminaire measurements recorded during the site survey during hours of darkness. Table 3.1 denotes the illumination measurement and permissible levels beyond the site boundary.

Location Reference	Light Measurement	ILP Permissible limit
1 (beyond Petersham Meadow fence)	0.3lux	2lux
2	1.2lux	10lux
3	2.5lux	10lux
4	4.3lux	10lux
5	8.0lux	10lux
6	9.2lux	N/A
7	8.0lux	N/A
8	13.2lux	N/A
9	6.2lux	N/A
10	3.0lux	N/A
11	7.0lux	N/A
12	0.5lux	N/A
13	12.4lux	N/A
14	14.8cd/m2	25,800cd/m2

Table 3.1 – Recorded Illumination Levels

Roadway lighting

Festoon lighting treatment is located on the north and east site boundary along Church Lane, supported on the perimeter hedge rows. This lighting provides illumination to assist road users with navigation and parking and ensure safe passage for pedestrians, cycles, and vehicles during the hours of darkness.

The illumination levels recorded on Church Lane do not exceed those of parameters set out by the ILP criteria and are within the permissible levels of light spill for the site. Illumination levels are noted on figure 2.12 and within the table 3.1.

With regard to the levels of illumination on Petersham Meadows, the maximum levels permissible within the guidance for an ecological sensitive receptor are 2lux. The results demonstrate that the levels of illumination onto Petersham Meadow are 0.3lux, which is considered to be entirely appropriate.

Car headlights

Church Lane is a publicly assessable roadway with unrestricted access and as such is not within the control of Petersham Nurseries. It is not possible to attribute all vehicle movements (and associated car headlight emissions) to the operation of the Nurseries, but notwithstanding this, an assessment of light emitted from car headlights travelling along Church Lane was undertaken as part of this assessment.

The results demonstrate that illumination levels of 1.6lux were recorded adjacent to the fenced perimeter onto Petersham Meadow from car head lights traveling north on Church Lane. These illumination levels are within acceptable limits in accordance with the ILP GN01:21 for a Lighting Environment Zone 3 classification.

Restaurant Interior lighting

Festoon lighting is used for the illumination of the interior spaces within the Petersham Nurseries restaurant. Due to the translucent material of the greenhouses, the upward distribution of light and the intensity of light is shielded and there is no direct light emission on to the night time sky.

A light intensity of 14.8cd/m² was recorded emitting from the top of the restaurant roof which is within acceptable limits in accordance with the ILP GN01:21, which allows for an intensity of 25,800cd/m² from light sources at this location within the site.

It is understood that the outdoor restaurant area is used seasonally. This area includes festoon lighting, however the majority of upward light from these lights is shielded by foliage located on the pergola structure. A light intensity of 3,449cd/m² was measured from the cafe festoon lighting, which is within permissible levels.

In summary, the lighting emitted from within the site is within the permissible levels within the ILP GN01:21.

Site Images

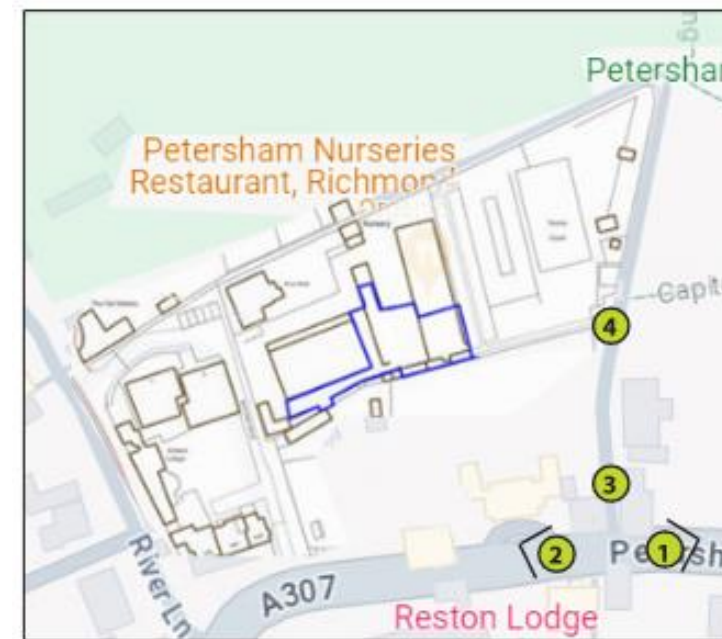


Figure 3.2 – Site Photograph viewpoint locations 1



Figure 3.3 - Viewpoint 1: Entrance to the site from Petersham Road (A307), looking East.



Figure 3.4 - Viewpoint 1: Entrance to the site from Petersham Road (A307), looking West.



Figure 3.6 - Viewpoint 4 - Service access for Petersham nurseries, looking North. The emission of light from vehicular headlight do directly penetrate into any window openings of the residential properties located adjacent to the site or via the use of Church Lane for access.



Figure 3.5 - Viewpoint 3 - Entrance to the site from Petersham Road (A307), looking North. Public road with vehicular and pedestrian usage, windows of residential properties adjacent.

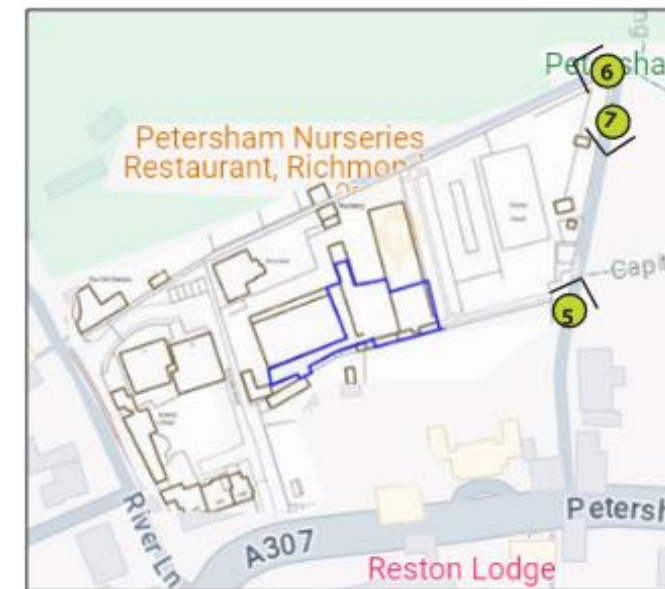


Figure 3.7 – Site Photograph viewpoint locations 2



Figure 3.8 - Viewpoint 4 (LHS) - Service access for Petersham nurseries, looking North. Viewpoint 6 (RHS) - Public road and adjacent MOL, looking North-West in daylight.



Figure 3.9 - Viewpoint 7 (LSH) : Public road, looking South at dusk with car headlights. Viewpoint 6 (RHS) - Public road and adjacent MOL, looking North-west at night with car headlights.



Figure 3.10 – Site Photograph viewpoint locations 3



Figure 3.11 - Viewpoint 8 (LHS) : Public road and adjacent Petersham Meadows, view West during daytime. Viewpoint 9 (RHS) : Public road adjacent to Petersham Meadows, viewing East during daytime.

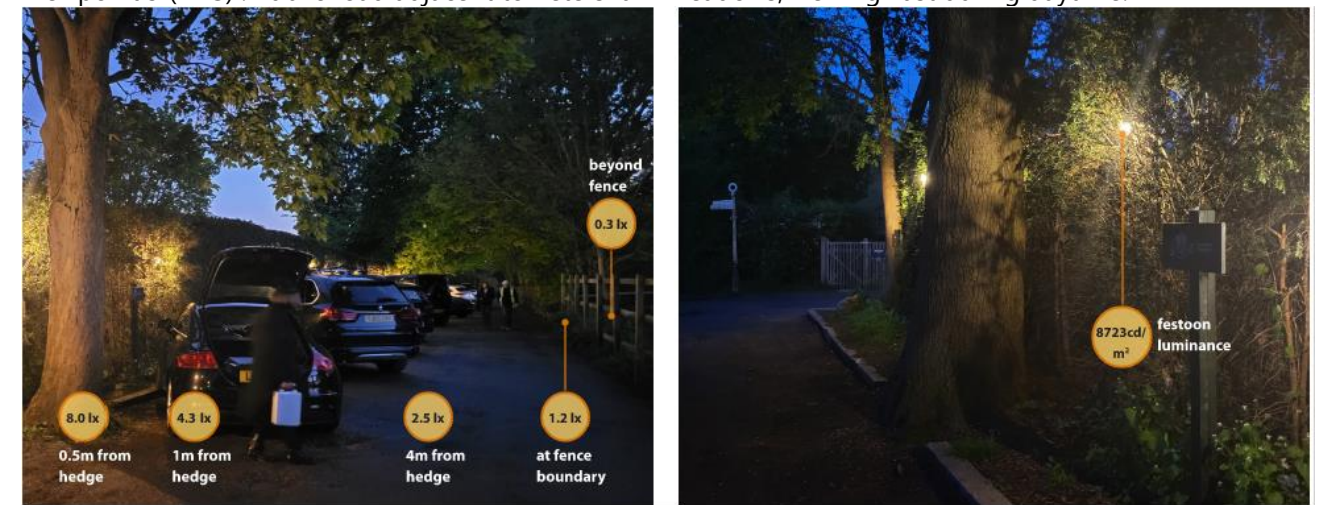


Figure 3.12 - Viewpoint 8 (LHS) : Church Lane adjacent to Petersham Meadows illuminated utilising festoon lighting, view West at dusk. Viewpoint 9 (RHS) : Church Lane adjacent to Petersham Meadow illuminated utilising festoon lighting, viewing East at dusk.

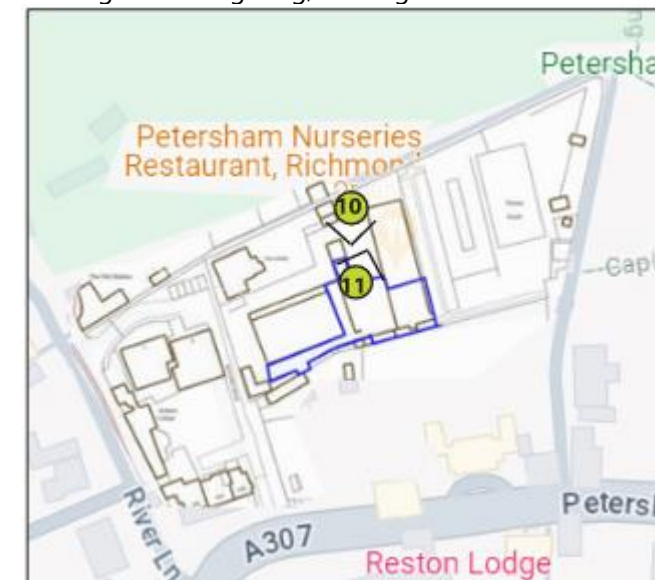


Figure 3.13 – Site Photograph viewpoint locations 4



Figure 3.14 – Viewpoint 10 (LHS): Petersham nurseries entrance view South.



Figure 3.17 – Viewpoint 12: Petersham Nurseries Teahouse, view south. Viewpoint 13 (RHS).

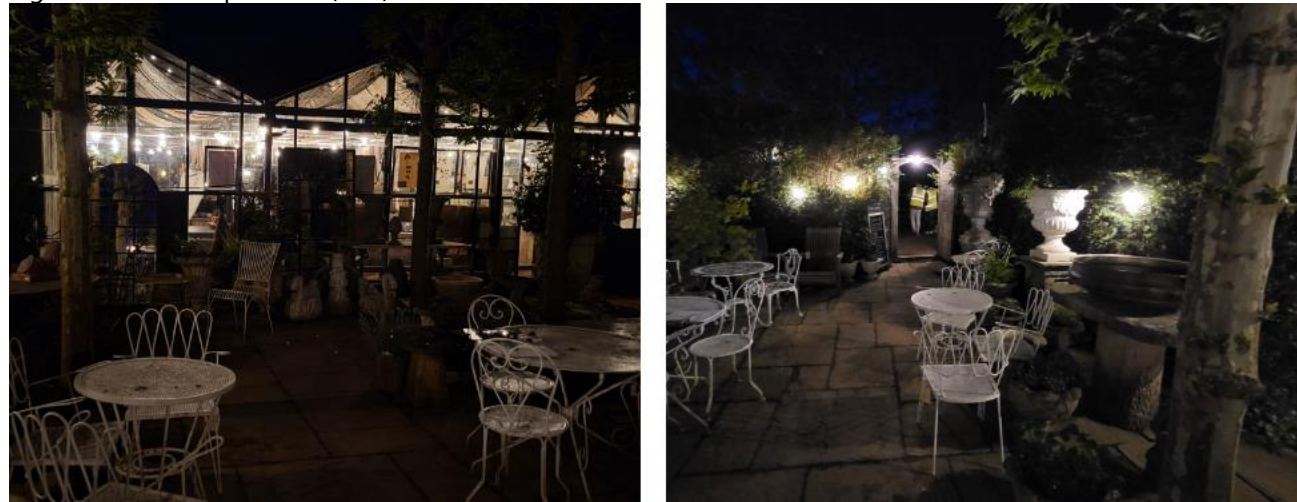


Figure 3.15 – Viewpoint 10 (LHS) : Petersham nurseries entrance view South at night. Viewpoint 11 (RHS): Petersham nurseries entrance view North at night.



Figure 3.18 – Viewpoint 12: Petersham Nurseries Teahouse, view south. Viewpoint 13 (RHS).

Figure 3.12 illustrates the light emitted onto Petersham Meadow to be low (0.3lux) which is within those permissible with the ILP GN01:21 for the site and deemed to be of negligible impact onto bats and wildlife.



Figure 3.16 – Site Photograph viewpoint locations 5

4 Assessment of Impacts upon Sensitive Receptors

The following chapter provides an assessment of the potential impact of the lighting associated with the evening operation of Petersham Nurseries upon sensitive receptors which are located in proximity to the site. These receptors include environmental, ecological, and human receptors, all of which may be impacted by lighting. The identification of ecological receptors has been informed by the Ecological Technical Note prepared by EDP.

The site has a lighting environmental classification of Zone 3, which is a suburban area of medium district of brightness based on the sky glow, and this classification has informed the permissible levels of light, in accordance with the ILP GN01:21.

Sensitive receptors identified specific to the site are as noted on Figure 4.1 and below: -

- Petersham Meadows located to the North of the site (Fig 4.1 - 1).
- Tree canopy along the Northern side of Church Lane, which has potential to accommodate bat foraging routes (Fig 4.1 - 2).
- Residential properties located near the North perimeter of the site boundary (Rosebank) (Fig 4.1 - 3&4).
- Residential properties located to the Southeast of the site adjacent to Church Lane (Fig 4.1 - 5&6).

Petersham Meadows located to the North of the site.

Petersham Meadows located to the north of the site and is considered an ecological sensitive receptor supporting wildlife, with the potential for bat foraging along the tree lined sections of the meadow. The ILP GN01:21 guidance recommends a limitation of no more than 2lux to ensure the area is maintained for the preservation of the existing ecology and limitation to the upward distribution of light onto the sky.

Petersham Meadows has the potential to be impacted by light from both the operation of the Nurseries and car headlights travelling along Church Lane. As set out within the results section of this report, the levels of illumination onto Petersham Meadow as results of the external roadway lighting are 0.3lux. The levels of illumination from car headlights driving north on Church Lane has been measured as 1.6lux.

The levels of lighting recorded within Petersham Meadows are within the permissible limits set out within ILP GN01:21 and the potential impacts of the evening operation of Petersham Nurseries are considered to be negligible.

Tree canopy along the northern side of Church Lane used by bats for foraging.

The tree canopy which runs along the northern section of Church Road has been identified by EDP as having the potential to be a bat foraging route.

Festoon lighting is currently located along the northern site boundary, on the southern side of Church Lane. The results demonstrate that the levels of illumination at the northern boundary of Church Lane (under the tree canopy) is 1.2lux, which is within the permissible level of 2lux identified for ecological receptors within the ILP GN01:21. The potential impacts of the evening operation of the Nurseries on the tree canopy are considered to be acceptable.

It is noted that festoon lighting emits a disproportionate quantity of upward light. The shielding of this lighting or replacement with alternative provision would enhance the lighting environment in this location, while still maintaining illumination of this section of roadway to ensure road user safety. The use of shielded low level lighting bollards or other lighting application to avoid upward light emissions and direct visibility of light sources could be considered. These recommendations are considered further in Section 7 of our report.

Residential properties located near the North perimeter of the site boundary.

The property known as Rosebank adjacent to the north of the site does not have any unobstructed windows facing directly east onto Church Lane and is therefore unlikely to be impacted by light emitted from car head lights or the festoon lighting.

It is noted that this property does have south facing first floor windows which look directly into the site. The main source of light to these windows will be from the internal lighting from the restaurant. The level of lighting has been measured to be 14.8cd/m² emitting from the top of the restaurant roof, which is within acceptable limits in accordance with the ILP GN01:21, which allows for an intensity of 25,800cd/m² at this location within the site. The most prominent form of light on to this property is potentially from the street lighting columns located within the public pedestrian pathway located to the south of the property.

Residential properties located Southeast of the site on Church Lane

There are two residential properties located at the entrance to Church Road. The potential for these properties to be impacted by car headlights associated with the evening operation of Nurseries has been considered and it is concluded that car headlights from vehicles travelling along Church Lane do not impact on to either of the residential properties as the height of window opening are below those of the light distributed from car headlights.



Figure 4.1 – Plan of sensitive receptors.

5 Lighting Objectives



Specific Objectives	Lighting Strategy Objectives
Extending the restaurant opening hours to the public.	<ul style="list-style-type: none"> Avoid over illuminating and light spill onto the adjacent natural environment. Provide a secure and safe environment, accessible and easy to navigate through illumination of turning points and junctions.
Provide guidance to ensure the amenity of residents of the local area is not harmed by light pollution generated from the site.	<ul style="list-style-type: none"> Avoid direct upward light emissions onto the sky and unshielded exterior lighting.
Evaluate the existing lighting application for the site and assess in line with legislation.	<ul style="list-style-type: none"> Obtain illumination and luminance measurements. Visual assessment of lighting applications. Evaluate survey finding with legislation and codes.

5.1 Environmental impact

Good lighting can bring both social and economic 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, excessive glare and over illumination all of which can have a detrimental impact on the well-being of neighbouring occupant and existing ecology. 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.

Obtrusive light

As permanent and construction lighting will influence the ecological designations' areas, including flora and fauna, strict mitigation measures should be considered for all future lighting installations throughout the proposed development. Buro Happold Lighting Team has recommended that all exterior lighting elements should follow the guidance of the relevant documents from the Society of Light and Lighting (SLL-CIBSE) and in compliance with the Institution of Lighting Professionals (ILP) Guidance Notes for the Reduction of Obtrusive Light - GN01:2021, deemed as international best-practice for projects of this type.

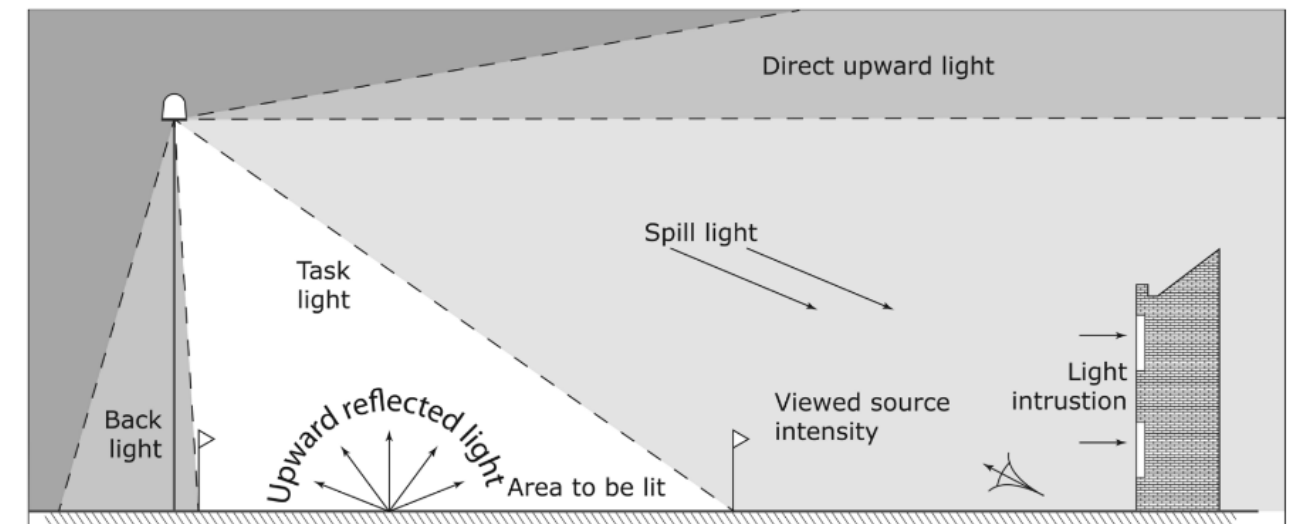


Figure 4—1 Different types of obtrusive light

The following elements must be considered:

- Light sources:** The lighting proposal should minimise the blue light spectral power of the light source and carefully balance the needs of task lighting with its impact on fauna, flora, and the night sky.
- Luminaires:** The selection of luminaires with the right optical distribution and shielding to be located at the right mounting height is critical to minimising light spill and obtrusive light effects while providing the right lighting performance on the exterior task areas. Orientation of each luminaire should also be considered, as the right aiming angle will determine the amount of spill light received by the surrounding areas.
- National and local planning frameworks:** the consideration of national and local policies will aid with the correct selection of a lighting strategy that meets the needs of a particular area within its local context.

Light pollution is caused by poorly implemented lighting sources that emit excessive or unnecessary artificial light. This can happen during the day or night¹².

It includes various forms of unwanted illumination, such as sky glow, glare, and light trespass.

Types of Light Pollution:

Sky Glow: This is the brightening of the night sky, primarily over urban areas, due to electric lights from cars, streetlamps, offices, factories, outdoor advertising, and buildings. It turns night into day for people who work and play long after sunset. Unfortunately, people living in cities with high levels of sky glow often struggle to see more than a handful of stars at night.

Glare: Glare occurs when excessive light directly enters our eyes, causing discomfort and reducing visibility. Examples include overly bright streetlights or car headlights.

Light Trespass: This occurs when unwanted light spills over from one property or area into another. For instance, if a neighbour's floodlight shines into your bedroom window, that's light trespass.

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 present on site.

5.1.1 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. When working in an area where there are bat habitats, 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.

The lighting strategy takes this into consideration, avoiding any impact on this area.

5.1.2 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.
- Avoid construction works near nesting sites during nesting season.

5.1.3 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 because 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.

5.2 Social impact

Effective and safe lighting can help create a positive environment for people and the natural surroundings. Appropriate lighting can help create greater interaction between the local communities and the proposed development by promoting a respectful use of lighting that is not obtrusive into any neighbouring community. Careful consideration of the lit character of each part of proposed development will also benefit the whole site, by example providing areas of greater activity by night within the areas surrounding the building and areas of low activity within the natural zones.

Social impact issues to consider:

- **Safety:** The lighting should be designed to keep a safe environment by allowing 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.
- **Security:** The lighting development for the proposed development should be designed to provide an overall sense of security supporting both active and general passive surveillance. Lighting should provide adequate recognition of people where required.
- **Accessibility:** The design of the lighting must support the needs of all staff and people visiting the proposed development. Design measures shall avoid high contrasts, direct and reflected sources of glare, and confusing upward lighting.
- **Legibility:** Key physical elements such as beacons and other parts of the urban realm should be careful and positively illuminated to aid wayfinding and create a mental map in visitors and staff. The lighting of key feature elements such as paths, meeting places, boundaries, gateways, and landmarks will also help to enhance people's sense of safety and security.
- **Identity:** The experience of the proposed development at night will play an important role in forming the image and memory of it in all its visitors and staff. 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.

6 Recommended Lighting Design Criteria

6.1 Summary

The following lighting criteria for sites is informed by the Lighting Environmental Zone Classification.

The classification of Lighting Environmental Zones, in the UK is established within the documents GN01:21, 'Guidance notes for the reduction of obtrusive light' published by the Institute of Lighting Professionals (ILP). These Zones have been established as a basis for outdoor lighting regulations.

The Environmental Zone rating of a site can be used to help ensure that the lighting goals are appropriately defined and met, considering the context and relevant surroundings.

6.2 Lighting Environmental Zones for Petersham Nurseries

The site is evaluated to be within an Environmental Lighting Classification of Zone 3, a suburban area of medium district brightness based on the prevalent sky glow above the site.

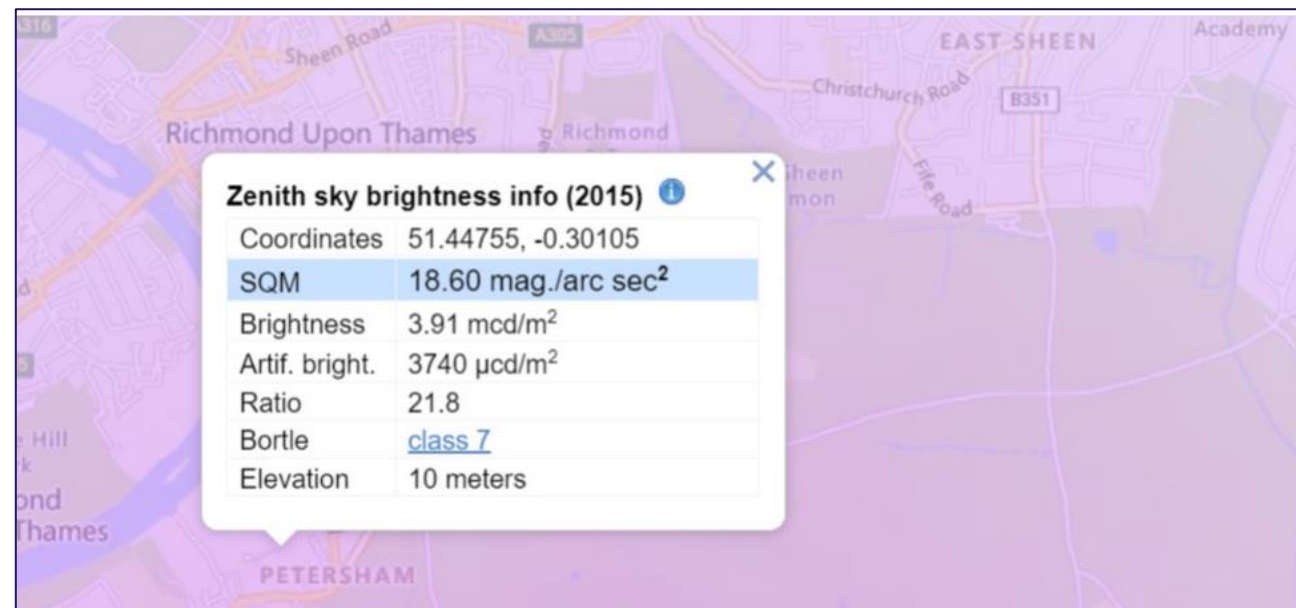


Figure 6.1 – Map of Petersham depicting sky brightness data and associated Bortle Scale (Source: Light Pollution Atlas 2022).

Number Code	Map Color Code	Label	Sky Mag.	Naked Eye Limit Mag.	320nm Limit Mag.	M52 visible?	M51 visible?	Central Galaxy visible?	Zodiacal Light visible?	Light Pollution	Clouds	Ground Objects
1	Black	excellent dark sky	22.00-21.99	≥ 7.5	> 17	obvious		casts shadows	striking	airglow apparent		visible only as silhouettes
2	Dark Grey	average dark sky	21.99-21.89	7.0-7.49	16.5	easy with direct vision		appears highly structured	bright, faint yellow color	airglow faint	dark everywhere	large near objects vague
3	Blue	rural sky	21.89-21.69	6.5-6.99	16.0	easy with averted vision		complex structure	obvious	LP on horizon	dark overhead	large distant objects vague
4	Green	rural/suburban transition	21.69-20.49	6.0-6.49	15.5	difficult with averted vision	obvious	only large structures	halfway to zenith	low LP	lit in distance	distant, large objects distinct
5	Yellow	suburban	20.49-19.50	5.5-5.99	14.5-15.0	easy with direct vision		washed out	faint	circulating LP	brighter than sky	
6	Orange	bright suburban	19.50-18.91	5.0-5.49	14.0-14.5	easy with averted vision	visible only near zenith			LP to 30°	fairly bright	small close objects distinct
7	Red	suburban/urban transition	18.91-18.38	4.5-4.99	14.0	difficult with averted vision	invisible			LP to zenith	brilliantly lit	
8	White	city sky	< 18.38	4.0-4.49	13					bright to 35°		headlines legible
9	White	inner city sky		≤ 4.0						bright at zenith		

Figure 6.2 – Bortle Scale (Source: Light Pollution Atlas 2022)

Figures 6.1 and 6.2 denote the values of sky glow and associated lighting environmental zone classification.

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

Table 6.1 - Permissible level of light spill beyond the site boundary – (Source: ILP GN01/21)

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)
E3	5	10 lux	2lux	10000cd/m² x 0.86d	1,000cd/m² x 0.29d	10 cd/m sq

The ILP has produced guidance on the maximum permissible light spill into windows of adjacent properties, before and after the curfew time, based on the environmental zone the development is located within. Table 6.1 above illustrates the various lighting design criteria associated with meeting the recommendations set out in achieving lighting compliance.

For areas of sensitive receptor, no more than 2lux shall be permitted onto these areas and addressed to the criteria applicable for an environmental lighting class of Zone 1.

6.3 Light colour temperature and colour rendering index

The light colour temperature defines the colour appearance of the light. It is a quality to which people are subconsciously sensitive. Colour Temperature is measured in the unit Kelvin and is the standard method for measuring the colour of light emitted from a lamp.

The suggested lighting enhancements at Petersham Nurseries include the use of warm light to respond to the adjacent sensitive receptors for the following reasons:

- Warm light is mentally associated with safety, history, communion, relaxation, and intimacy, which are pivotal elements in the natural visitor experience.
- 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 more powerfully as retina is more sensitive to blue light wavelength. Red light has very small impact on the melanopsin receptors, and they do no

stimulate wakefulness. Warm light has higher quantities of red light, therefore is the appropriate light to generate a relaxed environment.

- 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.



Figure 6.3 - Visual reference for light colour temperatures

6.4 Colour rendering index.

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.



Figure 6.4 – Variations in CRI levels

6.5 Light intensity and classification

The intensity of light is relevant to maintain suitable levels to provide for the functionality of spaces and avoid undue glare.

The different levels of light apply to each area within the site and are defined by the type of usage and classification of roadways for vehicular and pedestrian access. and appropriateness for task.

6.6 Mounting height

The mounting height of the lighting equipment will contribute to the perceived scale of spaces. The recommended lighting enhancements include the use of low-level lighting to limit the impact of lighting onto the environment and surrounding area to maintain its semi-rural character.

6.7 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.

In principle luminaires across the proposed development area should:

- Have integrated or integrated and additional external shielding.
- Always point downwards.
- Have forward-throwing light distribution with a reduced kickback.

Examples of Acceptable / Unacceptable Lighting Fixtures



Figure 6.5 - Example of luminaire types approved by the IDA - (Source IDA)

6.8 External shielding

Where lighting is required in close proximity to sensitive receptors light source shielding can be achieved using physical landscape and architectural barriers (such as: dense shrubs and trees and dense low-level vegetation, dunes, bunds, berms, etc.) and, furniture-integrated (or otherwise recessed) luminaires, solid balustrade, solid or very dense screens, and others, in combination with full cut-off fixtures. Figure 6.6 shows examples of luminaires with external shielding.

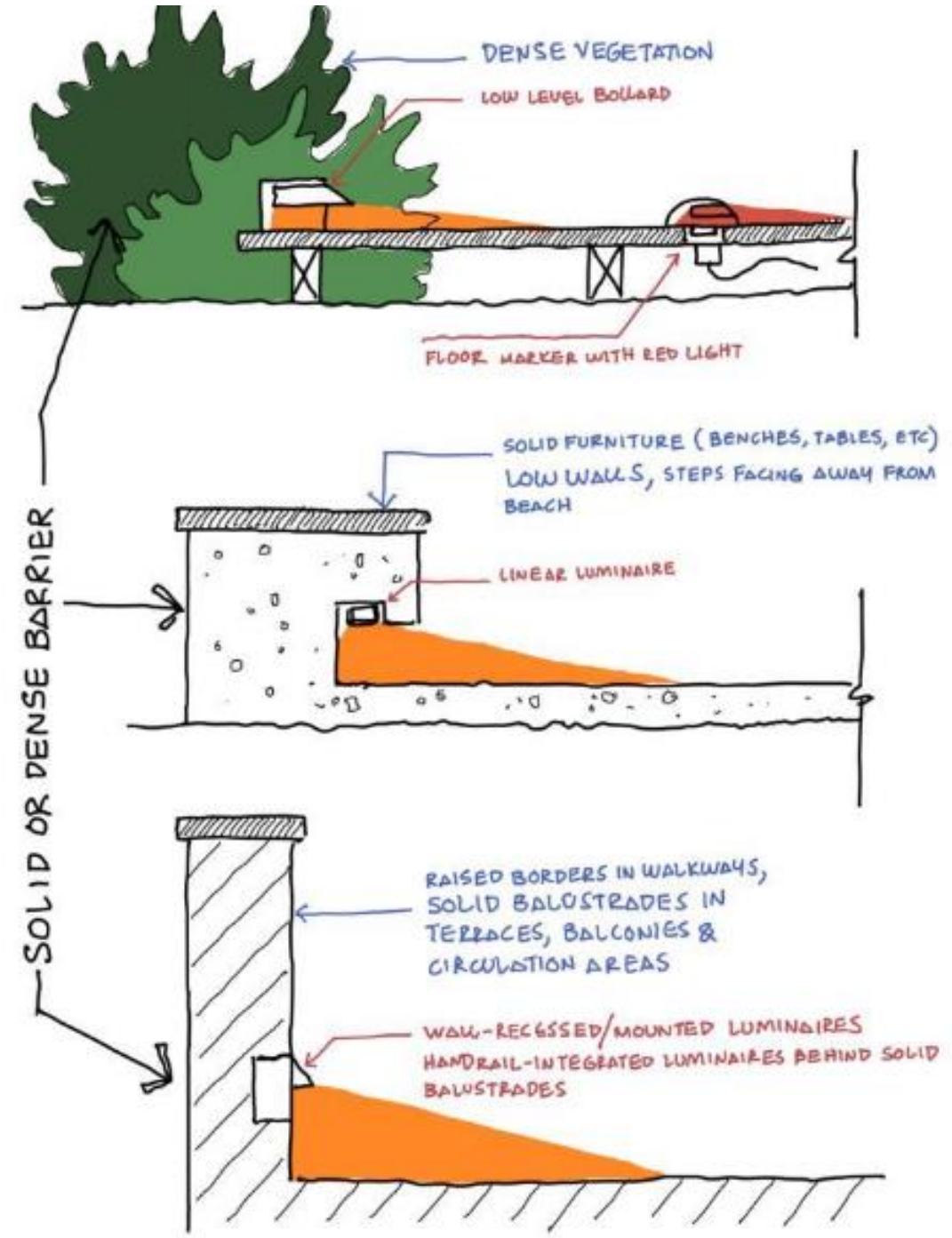


Figure 6.6 - External shielding methods

7 Proposed measures for enhancement of lighting

The artificial light emissions from Petersham Nurseries and the light from car headlights from vehicle movements associated with the evening operation of the site is compliant with the relevant requirements for permissible lighting spill and obtrusive light, as set out in the ILP GN01:21 guidance.

Notwithstanding this, it would be possible to enhance the lighting environment. The current light source (festoon lighting on Church Lane) is unshielded and emits uncontrolled light distribution with direct upward emissions of light onto the sky.

In order to reduce light emissions on Church Lane, it is suggested that this festoon lighting could be shielded or replaced with use of low-level lighting bollards with shielded light sources to limit illumination onto the ground surface. This would reduce any direct upward light spill onto the sky and limit any undue glare emitting from the light sources as illustrated below in figure 7.1.

Any replacement lighting should be carefully considered and well-designed in order to minimise intrusive lighting infrastructure and reduce light pollution while ensuring it is appropriate to address safety and security issues and make night-time activity areas and access routes welcoming and safe.

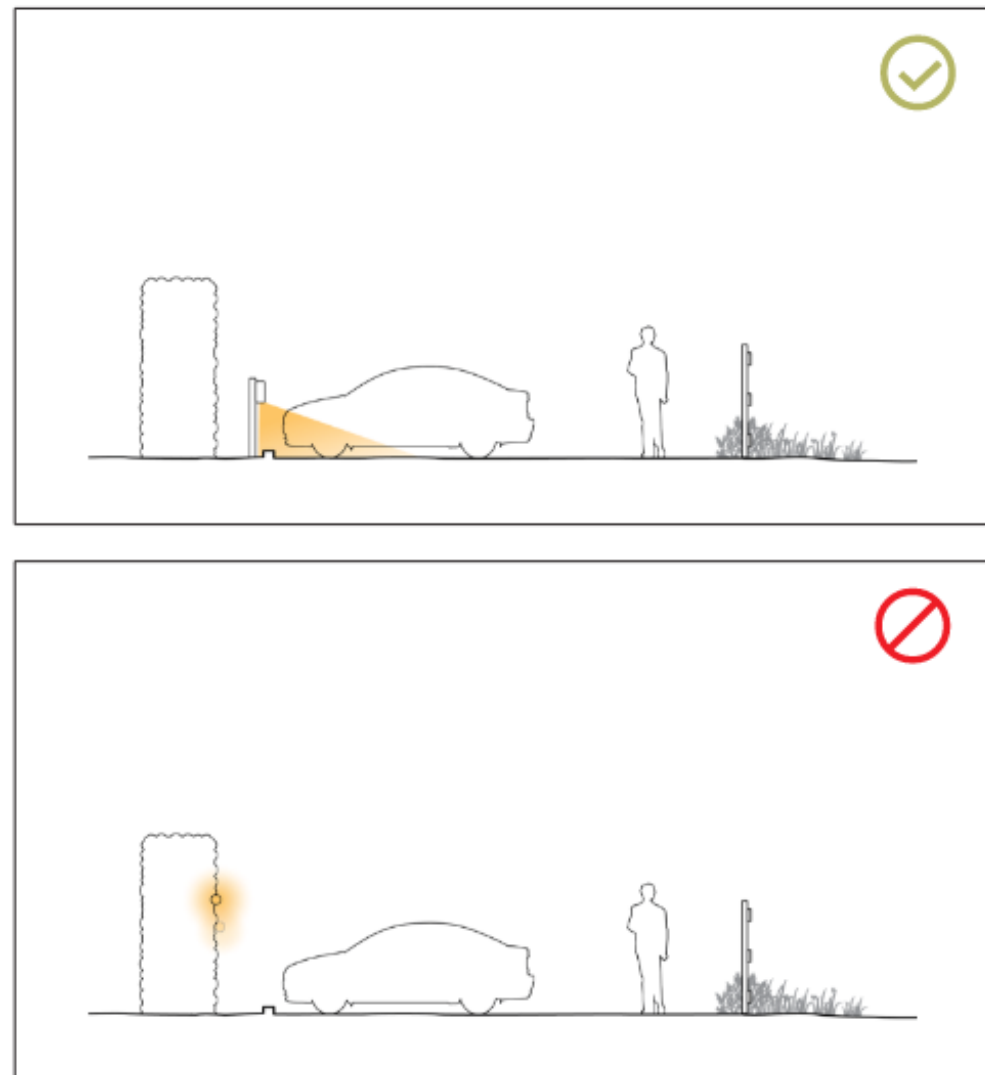


Figure 7.1 – Lighting enhancements.

8 Conclusion

The lighting conditions within Petersham Nurseries have been assessed to determine their impact on the surrounding environment and sensitive receptors. This assessment has considered both the exterior lighting on Church Lane, interior lighting from the main restaurant area and light from car headlights travelling along Church Lane from vehicle movements associated with the evening operation of the Nurseries.

Our assessment demonstrates that the both the internal and external lighting falls within the permitted parameters stated in ILP GN01:21 with regard to light spill and obtrusive light emitted from the site and beyond the immediate site boundary. The artificial light emitted from the site is therefore considered to be of negligible impact onto the surrounding residential properties and the area of Petersham Meadows to the north of the site.

The light emitted from car head lights using Church Lane has also assessed (although it is noted that Church Lane is a publicly accessible road and not all vehicle movements are associated with Petersham Nurseries). The illumination of car heads light does not impact directly onto any known residential window openings and therefore does not constitute a nuisance to occupiers. The light emitted from car headlights onto Petersham Meadows is also assessed as being of negligible impact.

While the festoon lighting located along Church Lane is compliant with permissible light spill in line with the ILP GN01:21 parameters, it is noted that this lighting emits unshielded light distribution upwards into the sky. In order to enhance the lighting environment, it is suggested that this lighting is shielded or replaced with alternative low-level lighting with shielded light sources to limit any upward light and ensure minimal impact on surrounding sensitive receptors.

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