Malvern Hills Area of Outstanding Natural Beauty Guidance on Lighting

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Front cover image credit: Malvern Hills AONB Unit

EXECUTIVE SUMMARY

The purpose of this guidance on lighting is to protect the night sky over the Malvern Hills Area of Outstanding Natural Beauty (AONB) by promoting good practice in external lighting and internal light spill. As satellite mapping and on-the-ground data show, the Malvern Hills AONB has good dark skies across the landscape, where the Milky Way and other astronomical objects can be seen clearly with the naked eye. To help protect this special quality[1], the AONB Management Plan (2019-2024) policy BDP5 seeks to avoid harm to the night sky by requiring that lighting and glazing schemes be kept to a minimum and only installed where absolutely necessary. Light pollution (skyglow, glare, intrusion and presence) should be avoided through adherence to good design, practice and relevant standards. In achieving dark skies, we will also save energy (thereby mitigating against the effects of climate change) and minimise the detrimental impact of light pollution on wildlife, people and our natural landscape. This guidance is aimed at three main users;

- For those seeking to install minor lights, who need general advice on lighting and glazing.
- Non-domestic schemes which may need planning permission and a more thorough design led by professional principles.
- Planning officers who need guidance on assessing lighting designs.

EXTERNAL LIGHTING

Best Practice Principles

Lighting should follow the main best practice principles:

Useful: Light should be justified with a clear benefit.

Targeted: Light should be only directed where it is needed and upward light is avoided.

Controlled: Lights should only be on when needed.

Colour: Light should be the right colour and avoid white/blue spectral emissions.

Designed: Professional designers should be consulted for larger and more complex non-domestic schemes to ensure obtrusive light is minimised and plans adhere to relevant standards.

Planning Permission

In general, light itself and minor domestic fittings are **NOT** subject to planning controls. When lighting is part of a new development, requires additional structures or has a sufficient visual intrusion, planning permission may be required. Many commercial, industrial, sports and roads will need planning permission due to the use of pole mounted lights and the level of material intrusion.

External Lighting Designers

A lighting designer is not normally needed for most minor and single use external lights for homes or small businesses. The domestic lighting advice should be sufficient to follow in these cases. A qualified lighting designer is generally needed when lighting needs are complex, and where it is essential to meet a specified level of illuminance. Designers will ensure that the luminaires achieve all the necessary requirements to satisfy both lighting needs and dark sky compliance. Larger scale sports, commercial, industrial, road lighting or public realm lighting should employ the services of a competent lighting designer. A lighting designer should;

- Undertake an environmental lighting impact assessment that covers the lighting needs within its setting, and any residual impacts on the landscape. It should identify the quality of dark skies over the development, the ambient lighting level (E-zone) and any sensitive receptors that surround it.

[1] Special Qualities are those aspects of the area's natural beauty, wildlife and cultural heritage, that make the area distinctive and are valuable, particularly at a national scale. The Special Qualities of the Malvern Hills AONB are defined in the Malvern Hills AONB Management Plan.

- Produce a lighting plan and luminaire schedule that clearly shows how the lighting complies with relevant guidance's and standards, such as British Standards for roads or workplaces or Sports England guidance for sports lighting.
- Show that key obtrusive lighting metrics comply with the Institution of Lighting Guidance on the reduction of Obtrusive light. GN01 2021 for the location. Care should be taken to clearly show planners who should then be able to assess key dark sky metrics that include;

    - Upward Light Ratio of luminaires and the overall scheme. It should be zero.
    - Colour Temperature (K). It should be less than or equal to 3000 kelvins, although bat advice (GN/23) states colour temperature should be ideally 2700 kelvins.
    - Task Illuminance (Lux). It should meet the relevant illuminance standards.
    - Light Spill and intensity on human and natural receptors.
    - Building Luminance.
- Show any mitigations that have been used to reduce the impact. This would include proximity controls, reduced illuminance levels throughout the night or additional shielding.

Good and Bad Best Practice

This guidance will provide graphic examples on good and bad best practice on a number of lighting scenarios and suggest whether a lighting designer is needed. It will highlight the main issues, considerations and technical requirements for;

- Domestic and minor lights purchasing recommendations.
- Small commercial lighting - where minor lights will mostly be used.
- Farms lighting and internal spill.
- Sports Lighting including equestrian.
- Large commercial lighting - where standards should be used.
- Road lighting.

INTERNAL LIGHT SPILL

Internal light can also a significant landscape impact through glazing and other transparent surfaces. Designers can reduce the impact of internal light spill by;

- Using an appropriate visible light transmission solution for the glazing purpose.
- Limiting the scale, continuity and size of the glazing.
- Using automated black-out blinds on rooflights, particularly on commercial greenhouses.
- Using curtains and blinds to reduce internal spill.

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1. Introduction

1.1 The Malvern Hills Area of Outstanding Natural Beauty (AONB) is renowned for its landscape and scenic beauty, but it is not just the daytime views which are an attraction. Visitors to the area can also enjoy the beauty of the night sky and a dark landscape. With few large towns, and with the Malvern Hills themselves forming a natural light barrier, the AONB offers opportunities to see stars and experience nature in a way which is not possible in more brightly lit areas.

Figure 1 - The Orion Nebula

1.2 However, inappropriate lighting, bad design and incremental development increases light pollution, reducing our ability to appreciate and benefit from our dark skies. Lighting on rural roads, village streets, houses and other developments have the potential to increase to light pollution. It also impacts on our experience of the landscape by altering the naturally changing light levels that occur at dusk and before dawn.

Furthermore, artificial light can have a subtle, cumulative effect on the character of rural landscapes, since brightly lit skies blur the distinction between urban and rural areas, as well as having potential adverse impacts on wildlife.

The Purpose of this Guidance

1.3 The purpose of this guidance is to protect our night sky by promoting good practice in external lighting and internal light spill. Its aim is to foster behavioural change and reduce light pollution by effective design using industry standard best practice – it does not call for an outright ban on lighting but rather the right light in the right place at the right time. Effective design for dark skies will enable us to see the stars more clearly whilst also saving energy, reducing nuisance and minimising the impact of lighting on wildlife, people and on our natural landscapes.

This guidance will also complement existing guidance used within the AONB, such as the Worcestershire Street Lighting Design Guide.

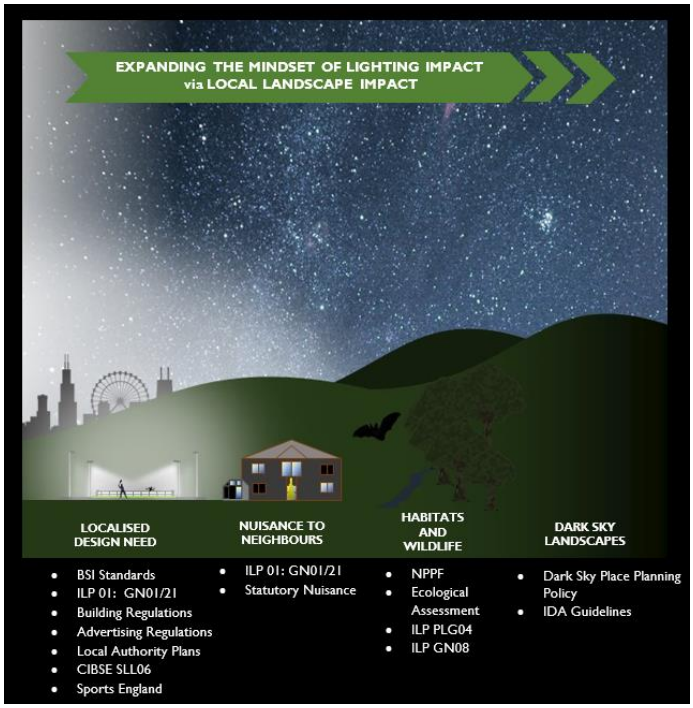


Figure 2 - The relation of standards and guidance to local and landscape needs. From Towards a Dark Sky Standard

More fundamentally, this guidance aims to change behaviour within the Malvern Hills AONB and its setting, by establishing a proactive dark sky 'mind-set'. This means looking at the impacts beyond the immediate areas to be lit and ensuring that relevant standards, legislation, landscape assessments and other professional guidance's are followed. As Figure 2 shows, to protect our dark skies properly, we need to expand our 'mind-set' from the local need to the wider landscape impact using appropriate guidance and standards that should be referenced at different spatial levels. The documents listed in Figure 2 are more applicable to non-domestic installations where public, employee or other user safety is an essential consideration and industry standards should be used in lighting design. Domestic users may still need to reference these documents particularly with designs requiring planning permission.

Who is this guidance for?

1.4 This document provides guidance for anyone who is using, replacing, or installing new external lighting in or around the Malvern Hills AONB. This includes householders, businesses and developers. It also is for those installing new glazing and windows. Achieving good lighting and glazing design is essential when protecting the rural setting of the landscape. Due to the contrast against a darker landscape setting, the impact of lighting at night will have a larger relative visual impact than daytime views. As such, development that may be many miles from the AONB boundary can have a significant visual impact on the landscape.

1.5 This guidance is primarily aimed at three mains users;

- Those seeking to install minor lights or glazing for mainly domestic purposes who need general advice.
- Non-domestic schemes that may need planning permission and a more thorough design led by professional principles.
- Planning officers who need guidance on assessing lighting and glazing designs.

For all users, the basic external lighting principles are the same. They differ only in complexity and users.

1.6 This guidance is also targeted at those with responsibility for setting the framework for development and for making decisions about individual planning applications; this includes planning staff and their colleagues in local authorities. As such, this guidance along with Worcestershire Street Lighting Design guide, provides planners with the necessary information to assess most small lighting designs.

1.7 Everyone can help reduce light pollution, reduce energy use and save money, by improving the type of outdoor lighting they use. There are many simple and cost-effective solutions which can reduce the impact of outdoor lighting on the environment whilst still providing a feeling of safety and

comfort, by delivering the right amount of light only when and where it is needed. Sometimes all it needs is turning the light off or avoiding the light in the first place. By increasing our awareness and following some simple principles, we can all help to minimise light pollution and protect dark skies.

The Status for this Guidance

1.8 The Malvern Hills AONB derives much of its beauty from its tranquillity and rural character. In order to help protect these special qualities the AONB Management Plan (2019-2024) contains the following policy: BDP5: Lighting schemes should be kept to a minimum and only installed where absolutely necessary. Light pollution should be avoided through adherence to good design and practice, for example, dimming or turning light off wherever possible.

1.9 This guidance document has been produced to help implement this policy and to help deliver the Malvern Hills AONB Management Plan which 'formulates local authority policy for the management of the AONB and for the carrying out of their functions in relation to it' (Section 89 of the Countryside and Rights of Way Act, 2000).

1.10 The AONB Management Plan is a material planning consideration in relation to decision-making within development management and forward planning. Using and adhering to the landscape guidelines within this document will also help public bodies to meet their statutory duties to have regard to the purposes of conserving and enhancing the natural beauty of the AONB in exercising or performing any functions in relation to, or to affect AONB land (Section 85 of the Countryside and Rights of Way Act, 2000).

Do I need Planning Permission for external Lighting?

1.11 A common question with lighting is whether you need planning permission. Using the guidance within the UK Planning Portal, in general, light itself and minor domestic fittings are **NOT** subject to planning controls. This means that if you need to light your garden path, doorway or driveway and purchase appropriate low level off-the-shelf luminaires, you do not need planning permission. You can use the advice in this guidance to help you do this.

1.12 However, when your lighting is part of a new development or requires additional structures or has a sufficient visual intrusion, you may need planning permission. Many commercial, industrial, sports and roads will need planning permission due to the use of pole mounted lights and the level of material intrusion. External lights require planning permission in some circumstances:

- Existing domestic buildings which have a condition removing permitted development rights is included on a decision notice relating to the building.
- Listed buildings – these require planning permission and listed building consent.
- New residential developments
- Non-domestic buildings if the installation of a lighting design requires a material change in the appearance of a structure or engineering operations.
- Advertisements illuminated or otherwise which are subject to the Town and Country Planning (control of Advertisements) regulations 2007.

Do I need a Lighting Designer?

1.13 You do not normally need a lighting designer for most minor and single use external luminaires for your homes or small business - this guidance should be sufficient to follow. You may also wish to refer to the ILP Guidance Note 9 on 'Domestic Exterior Lighting: Getting it right (GN 09/19).

1.14 A qualified lighting designer registered with the ILP consultant register, SLL or LIA, is generally needed when lighting needs are more complex, and where there is a need to achieve a specified level of illuminance. Designers will ensure that the luminaires achieve all the necessary requirements to satisfy both lighting needs and dark sky compliance. Larger scale sports,

commercial, industrial, road lighting or public realm lighting should employ the services of a competent lighting designer. It is noted that occasionally, it may be necessary to carry out a separate technical assessment of the effects of lighting on both landscape character and views/visual amenity. In which case, a qualified landscape architect with experience in the subject should be engaged to work in close collaboration with the lighting designer/effects assessor. This is in accordance with the 3rd Edition Guidelines on Landscape and Visual Impact Assessment (GLVIA3) - see paragraph 6.12 of GLVIA3.

1.15 In any circumstance, you will probably need some form of lighting design if your development is new and needs planning permission.

2. Dark Skies over the Malvern Hills AONB

What Is a Dark Sky?

2.1 A dark sky is a place where the darkness of the night sky is relatively free of interference from artificial light. Under these conditions you should be able to see the Milky Way and other astronomical features such as the Andromeda Galaxy with the naked eye. Light domes from sky glow are small and confined to the horizon and the landscape is continuous in darkness with few light sources.

2.2 Sky quality is usually expressed on the 'Bortle Scale' (Figure 3), which shows the level of stellar visibility. Under the best skies, this being 1, the Milky Way will be clearly visible, whereas a suburban rural sky in the UK, this being 4, will just be dark enough to see the Milky Way.

2.3 As everyone's eyes are a little different and as we get older our sight fades, we cannot depend on our own perception of sky quality. To improve the consistency of experience between all places worldwide, sky quality is normally measured using a hand-held Sky Quality Meter (SQM), such as the Unihedron SQM, which is a standardised requirement of an International Dark-sky Association place application. The SQM will return a value of the brightness (magnitudes) of an area (arcsecond^2) of the sky expressed as a number from 0 to 22 – the higher the number, the darker the sky. To see the Milky Way, a sky measuring 20.5 and above is needed. 21 and above is rare in the UK. The Malvern Hills AONB has measured 21.1 in some places.

Figure 3 - Bortle Scale using Stellarium Software. The scale is named after John E. Bortle, who published it for the first time in the February 2001 issue of the Sky and Telescope magazine.

Dark night skies over the Malvern Hills AONB

2.4 The Malvern Hills is designated as an Area of Outstanding Natural Beauty (AONB) for its distinct landscape, which is rich in biodiversity and cultural heritage. As a typically rural landscape, the Malvern Hills skies will be of regional importance to residents within and surrounding the AONB. While the Malvern Hills does not yet have an International Dark-Sky Association (IDA) place status, in which other UK protected landscapes have achieved such designation, it is still important to protect skies that could qualify for this accreditation at a later date.

2.5 The Countryside Charity CPRE campaigns to raise awareness about light pollution. In 2015 they worked with Land Use Consultants (LUC) to create a Night Blight map showing the relative darkness of the night sky across England (Figure 4). The mapping is based on remote satellite sensing and shows light emanating from the ground and upward facing lights that unnecessarily pollute.

2.6 As the map shows, the Malvern Hills suffers with light pollution from some rural towns and from the larger towns of Ledbury and Great Malvern but has continuous areas of darkness across the landscape.

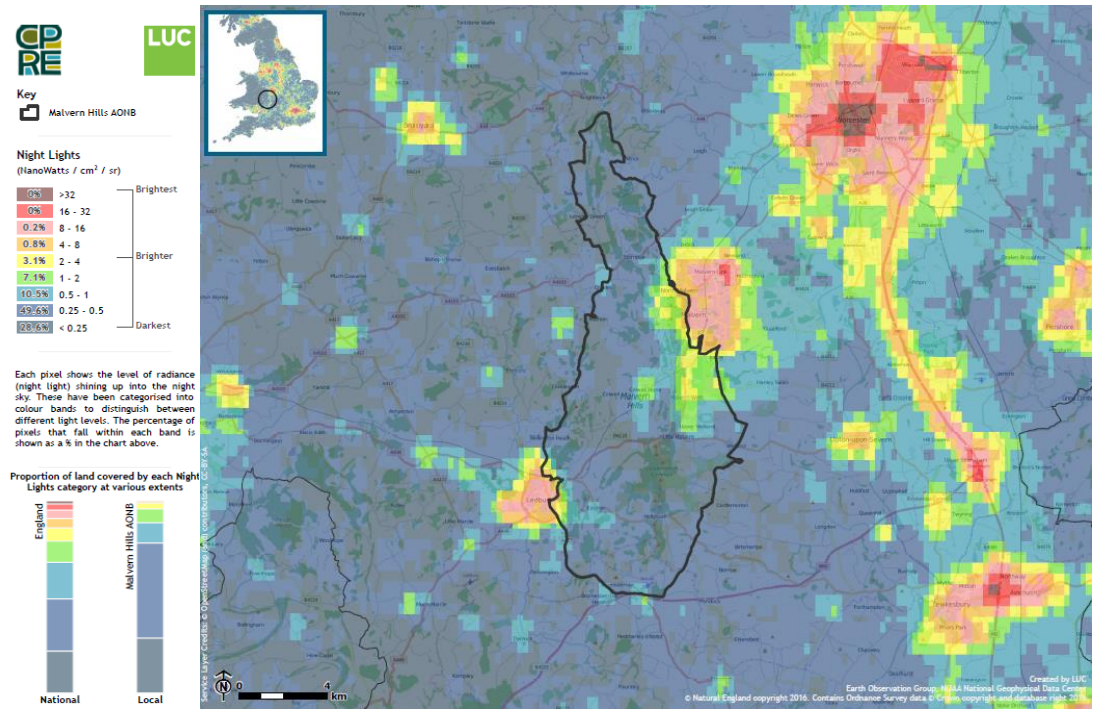


Figure 4 - CPRE Night Blight Data - 500m sq resolution. Earth Observation Group, NOAA National Geophysical Data Center. Data processed by LUC on behalf of CPRE.

2.7 Light is an issue from the surrounding urban areas in the 'setting' (as per the AONB JAC Position Statement) of the AONB. However, almost 15 per cent of the sky over the AONB is as dark as any in the country, and another 57.9 per cent falls into the next darkest category (there are nine categories altogether). This represents significant areas of quality dark skies worth protecting now; it is very difficult to regain dark areas once they are lost to light pollution.

2.8 On the ground measurements taken with a sky quality monitor in show that the Malvern Hills AONB has good dark skies across the rural landscape. Data shows that all-clear zenith[2] brightness readings can achieve 21.1 magnitude per square arc second (0.39 mCd/m2) and occasionally 21.4 magnitude per square arc second (0.30 mCd/m2). These measurements indicate that in the skies above the AONB, the Milky Way can be clearly visible at 20% contrast to background when overhead. There is

[2] Zenith is the point directly above the observer, in the opposite direction to the ground.

no significant variation in Zenith brightness across the AONB in the same conditions on the same night. This is because, with few large settlements, the zenith brightness is affected by light pollution from distant cities rather than from local light sources.

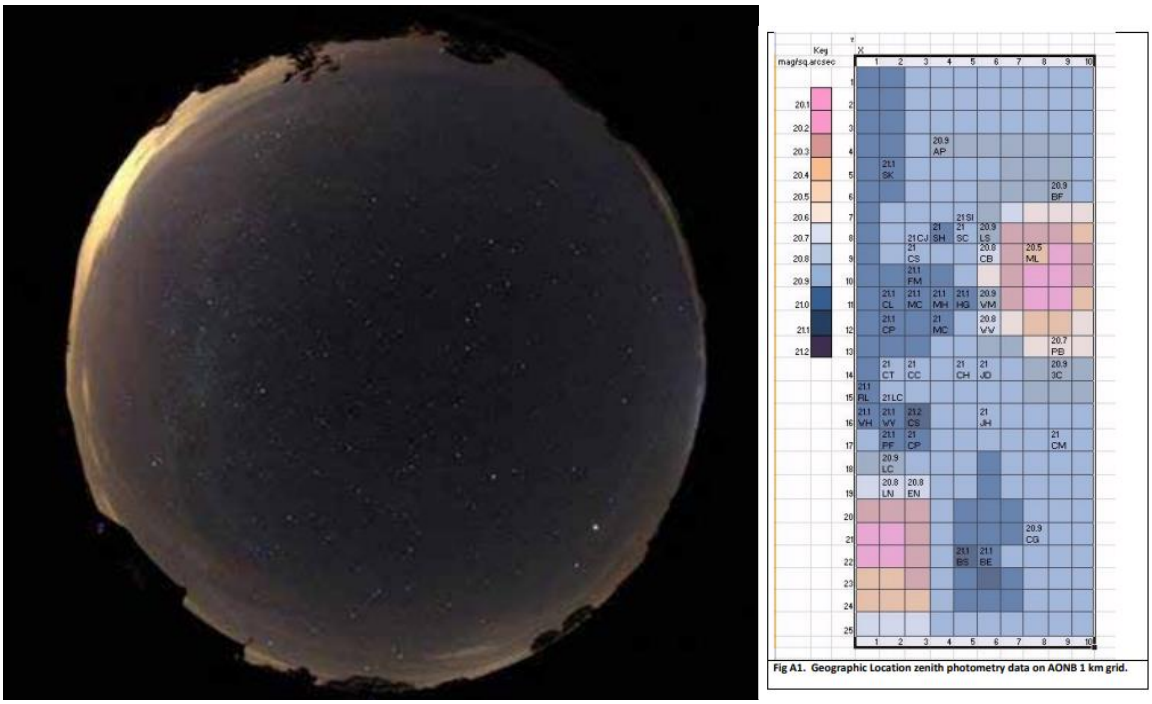


Figure 5 - Image of the Milky Way above the Malvern Hills AONB. Location of data points shown in grid with SQM values. Courtesy Chris Baddiley and from Malvern Hills State of the AONB report.

2.9 Figure 5 is an all-sky 360-degree fish eye photograph which shows a typical night scene with brighter skies visible on the horizon to the left (east) of the shot, close to light sources from Malvern, Worcester and the Severn Vale. The darker horizon is to the right (west). Some blue skyglow visible at approximately the 4 o'clock position is from bluish light reflected off the clouds over Hereford. If it reaches the sky, modern blue-rich LED lighting causes at least 8 times more scattering than pink-orange sodium lighting of the same visible ground brightness. Well-directed LED downward pointing lighting can avoid that.

Malvern Hills AONB Biodiversity

2.10 The Malvern Hills AONB encompasses large areas of nature-rich habitat. As a protected landscape with a high proportion of semi-natural habitats it is an important regional reservoir of biodiversity. Within the AONB, there are key ecological receptors that must receive the highest levels of protection from artificial light at night. These include the 16 SSSI's lying partly or wholly within the AONB – the majority of which are designated to protect biodiversity – and a range of Local Wildlife Sites.

2.11 In addition to protected sites, the AONB also has several rarer and protected species that are particularly sensitive to artificial light including barn owl, hazel dormouse, and badger along with species of conservation significance such as glow worm. All bat species can be negatively impacted by artificial light to a greater or lesser degree, but unfortunately those species that are particularly light adverse include all of the UK's rarest bat species. Those that are present in the AONB include lesser horseshoe, greater horseshoe, barbastelle, and Bechstein's bat. The guidance note '*Bat Conservation Trust and ILP: Bats and artificial lighting in the UK*' (updated to guidance note GN08/23)

should be used for these species. The AONB also has Barn Owls, Dormouse and other invertebrates which rely on darkness to survive.

2.12 It is important that key ecological receptor sites inform careful consideration of the need for lighting and the design of lighting schemes, particularly with justification, colour temperature and further mitigations, regardless of the ambient lighting zone. Since many nocturnal species, especially bats, will make use of the wider landscape of the AONB when hunting and when travelling between roost sites and foraging areas, this consideration is also important outside of sites designated for their nature importance. Habitats and species within the AONB have a vital role to play in helping to fulfil local and national conservation targets.

The Malvern Hills Nature Recovery Plan should be referenced when developing a lighting plan.

Malvern Hills AONB ambient lighting zones

2.13 The standard practice in external lighting design is to use ambient lighting environment zones (E-zones) to set different lighting requirements under different sky conditions. Due to the difference in ambient lighting between urban and rural settings, different levels of obtrusive light are allowed. The Institution of Lighting Professionals guidance on the reduction of obtrusive light (GN01 ILP: 2021) recommends lighting specifications based on these ambient zones. They state different levels of upward light, intensity, glare and building luminance for these zones which should be followed in any lighting design. The AONB will either be a rural zone incorporating E0/E1 or an urban zone E3 with an additional caveat on upward light.

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

Table 1 - Environment Zones. GN01 ILP The Reduction of Obtrusive Light. The Malvern Hills rural landscape will be E1. Refer to the guidance note for recommended limitations of lighting parameters in each zone for, property illuminance (spill), intensity, sky glow and upward light, and building luminance. (*) - This table refences ILP GN01 2021 and the sky quality relating to ambient lighting zones. To be consistent with IDA places minimum sky quality for Parks and Places (2018 guidelines), a lower value of 21.2 is required. ILP GN01 2021 has a lower limit of 20.5 reflecting earlier IDA guidelines.

2.14 Using the sky quality data, the Malvern Hills AONB has been categorised into two main rural and urban zones based upon the use of Council and Authority owned road street lighting. Street lighting has a clear and measurable impact on sky quality and is a useful demarcation between ambient lighting environments. The environment zones are set as follows;

A rural zone which includes areas of the AONB that has sky quality measurements satisfying.

- E0 – Rural landscape, open countryside, very little lighting, isolated buildings
- E1 – Rural landscape, small villages, very little street lighting

An urban zone to include,

- E3 – Urban/Suburban settlements, towns, villages using street lighting.

IMPORTANT: DESIGN COMPLIANCE

For all lighting development within the rural setting (not within urban areas using Local Authority streetlighting) it is expected that plans will aim to achieve E0 compliance under ILP GN01 2021 as a matter of principle. Use of E1 criteria instead of E0 should be clear in the design justification.

2.15 The need for E0 compliance particularly relevant to road, amenity, and sports lighting where residual effects are likely to cause significant adverse landscape impacts (refer to Table 7 in GN01 2021). Installations of these types using more than four luminaires are not expected in E0 zones due to the residual impacts.

2.16 E1 areas are expected to reside between the urban fringe boundaries and the darker rural setting. The E0 zone and 20.5+ measurements are likely to begin within 2km of the edge of the street-lit urban fringe (E3) boundary. If in doubt, you should consult with the Malvern Hills AONB Unit to determine zone compliance requirements.

IMPORTANT: UPWARD LIGHT RATIO (ULR)

In all zones an installed upward light level of **ZERO** is sought in all cases, irrespective of ambient lighting zone. This is in contrast to the ILP GN 01 guidance which allows positive values of ULR in E3/4. The Malvern Hills AONB seeks zero upward lighting in all cases and supersedes the ILP guidance in this technical respect.

2.17 Note that E2 zone is not used, as the Malvern Hills AONB prefers to give the landscape the maximum protection under the ILP GN01 guidance in relation to the protected status and its sky quality.

2.18 Note that E4 zone is unlikely within the Malvern Hills AONB.

Dark Sky Discovery Sites

2.19 In 2019, two Dark Sky Discovery sites within the AONB were approved by the UK Dark Sky Discovery Network. These sites, at Castlemorton and Mathon, have been recognised for the opportunities they offer to observe the night skies and are further proof of the importance of dark skies above the AONB. Special attention should be given to these sites to ensure that light pollution is avoided for both visitors and wildlife. This should be achieved with an appropriate environmental impact assessment methodology that ensures that the ecology surrounding these sites is given due regard.

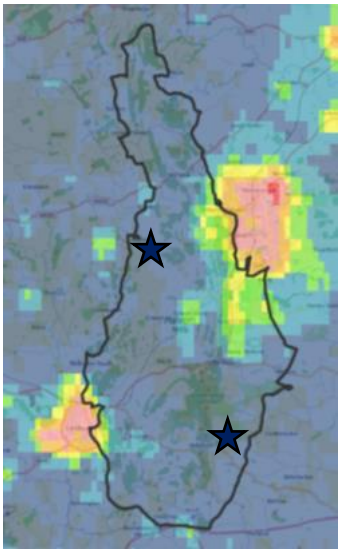


Figure 6 - Dark Sky Discovery Sites over CPRE data. Mathon (Top), Castlemorton (Bottom)

3. What is Light Pollution?

Light Pollution Definition and its effects

3.1 Light pollution is the presence of unwanted, inappropriate, or excessive artificial lighting. Whilst protecting dark skies is important, light pollution affects many different aspects of society. Poorly designed, badly installed, inappropriate and wasted light can affect nature and wildlife, increasing energy costs, and impair health and wellbeing especially if a nuisance to neighbours. It also affects the way we interact and live within our spaces by making us feel safe, connected and part of a community. Viewed as a wider society issue, it is important to ensure that lighting meets the needs of people but does not create inappropriate and unnecessary pollution.

Figure 7 - The impacts of light pollution on society.

3.2 As recent evidence in *Nature Ecology and Evolution (Nov 2020)* has shown, artificial lighting pollution is impacting the hormone levels, breeding cycles, activity patterns and predator-prey interactions of a broad range of species. Combined with the effect on humans, light impacts in many ways:

- Songbirds, amphibians, bats, insects and trees have all been shown to suffer under artificial light. Breeding patterns, foraging routes and pollinators are disrupted, with evidence showing a third of insects attracted to lights will die because of the encounter.
- The human cycle is disrupted by negatively affecting the production of Melatonin in the brain which helps regulate sleep, enhances the immune system, reduces cholesterol levels and the endocrine system.
- Glare can be highly dangerous to road users. It can cause accidents when motorists are distracted or blinded by lights.
- Lighting costs money and can create CO2. Unnecessary light pollution wastes power and money to householders, businesses, and the public sector.
- Natural capital and ecosystem services, such as pollination, can be undermined by artificial light at night.

Three main types of light pollution

3.3 Light pollution has three main sources: Sky glow, glare and light trespass. The strength and direction of any light source can exacerbate pollution. Blue-white light is particularly damaging as it able to penetrate the atmosphere at greater distances. It is also important to consider a 'fourth' source of pollution, which is due to the presence of lighting itself within dark areas.

Sky glow

3.4 This is the brightening of the night sky which can be seen emanating from the horizon, originating mostly in built-up areas. It is caused by badly directed light sent above the horizontal and scattered by aerosols and particles in the air. It can also be reflected from surfaces. Light that travels near the horizontal is the most damaging as it travels furthest through the lower, denser atmosphere. This can be avoided by ensuring that lights are directed downwards where the light is needed. Sky glow is made worse by blue-white light which penetrates the air more than warmer colours.

Glare

3.5 This is the uncomfortable brightness of a light source when viewed against a contrasting darker background. In less densely populated rural areas, glare will seem relatively more intense than in urban areas. This is particularly noticeable when looking from raised viewpoints into the darker landscape below.

Light trespass

3.6 Sometimes called 'light intrusion", this involves external light spilling beyond the property or area being lit. Although this pollution definition generally relates to windows and intrusion into private property, the term 'light intrusion' also applies to natural habitats and areas of high species interest. Light trespass can also occur from internal light that spills into darker places.

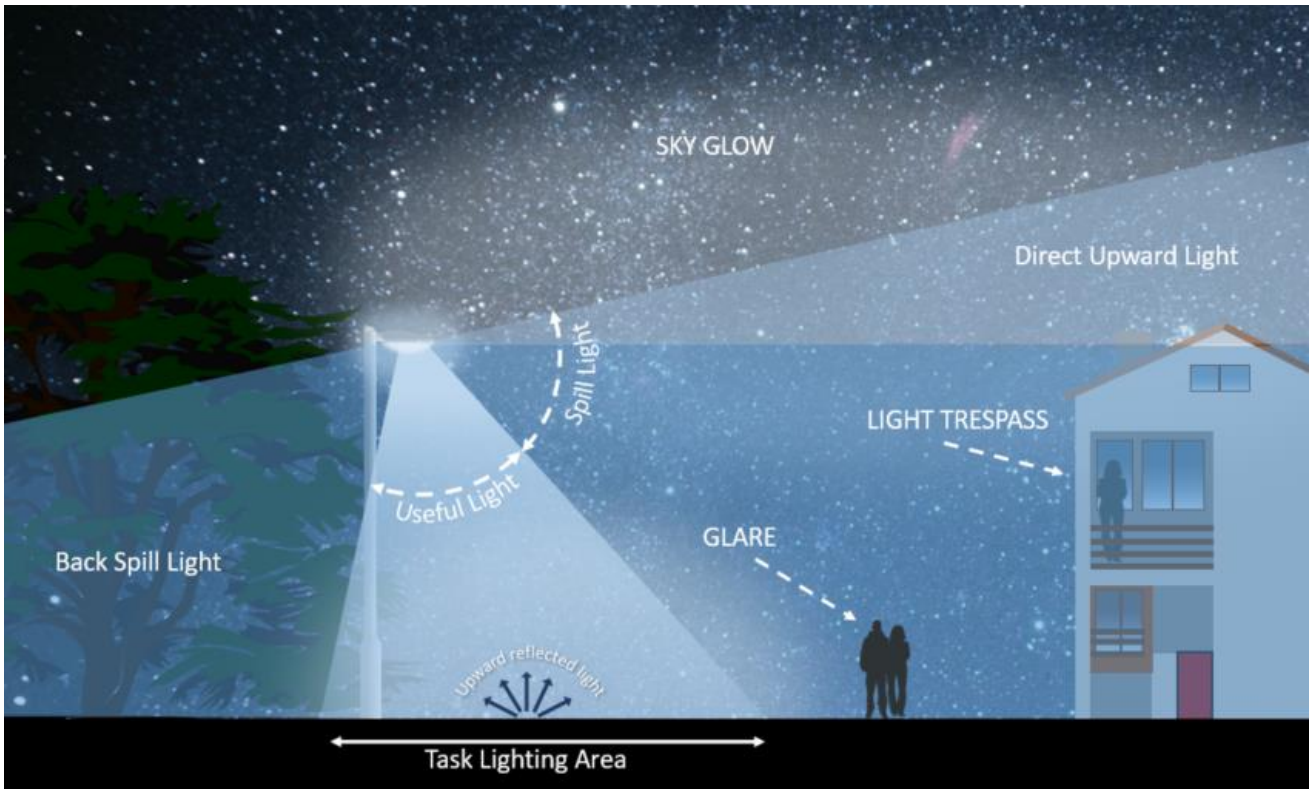


Figure 8 – Sources of Light Pollution.

Presence – a fourth consideration

3.7 Even if a lighting scheme were designed that avoided sky glow, trespass and glare, there still exists the possibility of significant impact on dark and sensitive landscapes and wildlife due to the presence of the lights and the illuminance it provides. This applies to impacts from both exterior and interior lighting. When the presence of lighting itself creates negative impacts, alternatives and re-siting should be considered or avoiding the proposed development. This is relevant for more brightly lit places, such as sports pitches or greenhouses that pose a greater threat.

3.8 Light pollution is made worse by blue-white light which can be found in many (Light Emitting Diode) LED lamps. The blue-white light can penetrate the atmosphere much further than yellow and orange lights.

Figure 9 - Light Pollution in the form of glow, glare and trespass from a development at the edge of a village in the Malvern Hills AONB.

Light Pollution and the Law

3.9 In 2005, Clean Neighbourhoods and Environment Act 2005 – Statutory Nuisance (para 79-fb) was extended to include light nuisance,

"*fb – artificial light emitted from premises so as to be prejudicial to health or a nuisance*"

3.10 Local authorities must take reasonable steps to investigate complaints of artificial light nuisances. If a nuisance exists or may occur, an abatement notice to cease will be issued within a set timescale. For any resident, it is important not to be a nuisance by reducing pollution and good lighting practice.

3.11 It is important to note that the threshold and process for nuisance lighting is different from planning. A nuisance requires a 'victim' who can show that they are being negatively impacted by lighting that has probably not received any obtrusive light reduction design. The harm is quantified by directly measuring obtrusive light spill metrics that fall into internal spaces by Environmental Health Officers. In contrast, planning control requires that light spill is reduced, ideally before the lights are installed, and to comply with obtrusive light requirements.

Light Pollution and National Planning Policy Framework (NPPF)

3.12 The National Planning Policy Framework (NPPF) provides local authorities with a baseline when developing planning policy. Paragraph 185 is particularly relevant in that:

"*185 – Planning policies and decisions should also ensure that new development is appropriate for its location, taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and*

the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should: c) limit the impact of light pollution in local amenity, intrinsically dark landscapes and nature conservation."

Light Pollution and Wildlife sites and species

3.13 The Wildlife and Countryside Act 1981 is the principal mechanism for the protection of wildlife in Great Britain. Under the Act, it is illegal to disturb certain species, including bats, and artificial light can constitute an offence. While some species are particularly sensitive to artificial light, all wildlife and their habitats can be disrupted by artificial light. When developing or assessing a planning application that includes lighting, it is important to be aware of any designated (statutory and non-statutory) wildlife sites and protected species nearby. An assessment of any potential impacts should be undertaken, and a plan made to remove or mitigate these. The Institution of Lighting Professionals and the Bat Conservation Trust created an updated Guidance Note on Bats and Artificial Lighting at Night (GN 08/23), to help guide lighting assessments of bat species.

How Light is Measured

3.14 Light is composed of individual wavelengths across the electromagnetic spectrum that give lamps their colour and strength. To ensure lighting designs are effective in reducing light pollution, it is useful to understand the different measurements of light – Lumens, Lux, Candela and Colour (Kelvins and spectral wavelength) and how they impact on light pollution.

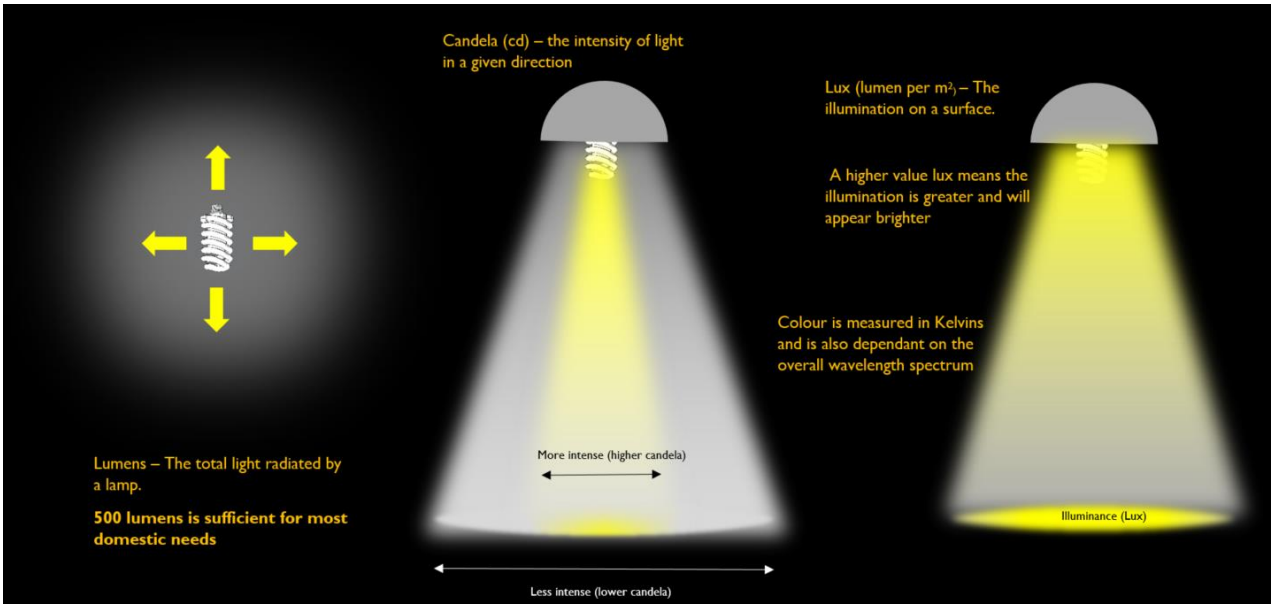


Figure 10 The properties of light. Credit Darkscape/South Downs National Park Authority Technical Advice Note

3.15 ***Lumens*** is how much light is emitted in all directions. Bulbs – or **lamps** – used to be sold according to the watts, which is the amount of energy the lamp used, but now as LEDs are much more energy efficient than older incandescent bulbs most retail options list the lumen output. Hardware or electrical retailers will often stock off-the-shelf lamps from 200 to 1,500 lumens. As it is important to avoid over-light by using higher lumen levels, **500 lumens** and less is appropriate for most domestic purposes – you should not need more than 1500.

3.16 ***Lux*** is the amount of light that falls on a surface and represents the illuminance (E) on the ground. Illuminance is the right amount of light needed to do certain tasks and activities. For most non-domestic purposes or where a developer has a 'duty-of-care' to users, illuminance levels should comply with existing standards for illuminance. Using the right average illuminance (E_m) is key to user safety and not over lighting.

3.17 ***Candela*** is the intensity of light in a given direction and describes luminous intensity. It shows how bright the light source is and how far away the object can be seen. High levels of intensity in any direction could contribute to neighbour's obtrusion and glare issues. The Internal optics and lenses of the whole light – the **luminaire** - will direct lamp light into a beam direction. Luminaire is the general term for a complete electric light unit.

3.18 ***Colour Correlated Temperature*** (CCT) which is measured in Kelvins (K) describes the colour appearance of light. The higher the colour temperature the bluer the light will appear. It is blue-white light that is particularly damaging to dark skies and should be avoided. Many lamps will state their colour temperature with some abbreviating as 'cool' (5000K or more) or 'warm' white (3000-4000K). 3000K and less is important for dark skies, ideally achieving 2,700K for most uses. For lighting near key ecological receptors such as wildlife sites, further reductions in CCT are recommend, ideally achieving <2200K where appropriate.

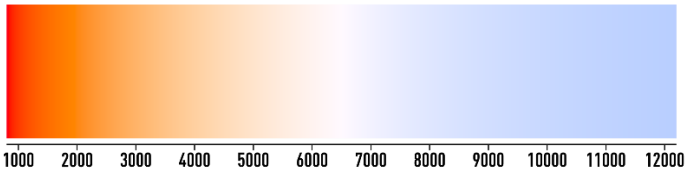


Figure 11 - The Kelvin Scale (K)

3.19 The colour of light will also change the way we perceive objects under its light – the colour rendition. Some lighting applications, such as sports or rail platforms, require a certain colour rendition quality which precludes the use of lower colour temperatures. It is important to ensure that the colour temperature (CCT) and the colour rendition index (CRI) are compatible.

Figure 12 - Different colour temperature lamp types

3.20 ***Colour Spectrum*** represents the distribution of wavelengths across the electromagnetic spectrum in the visible, ultraviolet and infra-red range. White light will be composed of many underlying wavelengths of different colour. It is the blue wavelengths <500nm, within LED lighting that can cause greater impact. The first LED lights tended to have power spectrums with a high degree of blue light, which increases the impact of light pollution. However, newer LEDs now filter out damaging blue light without changing the overall colour temperature (CCT) or the Colour Rendition Index (CRI). Some manufacturers show the spectrum, within their product specifications but this is not common.

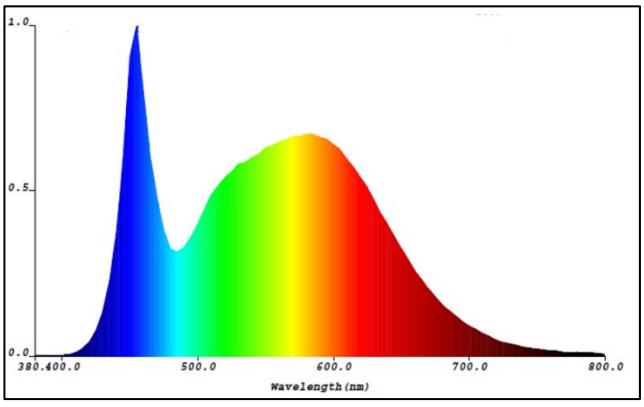


Figure 13 - The colour spectrum from a 5000K lamp with a prominent blue peak which exacerbates light pollution.

3.21 ***Colour Rendition Index*** *(CRI)* is a measurement of how natural colours render under an artificial white light source when compared with sunlight. The index is measured from 0-100, with a perfect 100 indicating that colours of objects under the light source appear the same as they would under

natural sunlight. Some lighting uses, such as sports pitches will need specific colour rendition levels to achieve safe and natural play.

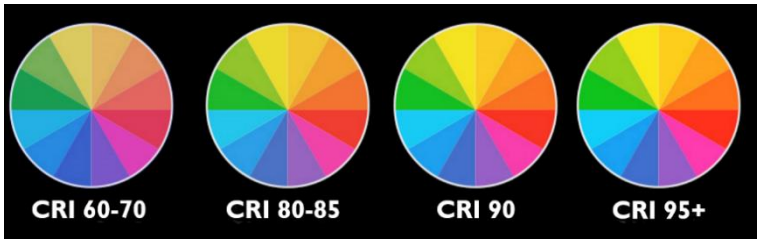


Figure 14 - Colour Rendition Index (CRI).

Uniformity:

3.22 Uniformity (U) is the ratio of the minimum light level to the average in a specified task area. It relates to the evenness of light across a surface and is the appearance of light to dark 'blotches'. Lighting with good uniformity has less blotchy light-to-dark areas and a fairly consistent level of light, whereas less uniformity is where there are greater differences between light and dark patches. Often, better uniformity can lower the overall illuminance needs. Different places have different uniformity needs and may not be required in design. Standards will define the uniformity level need, such as sports lighting guides where high levels of uniformity across a playing surface are needed.

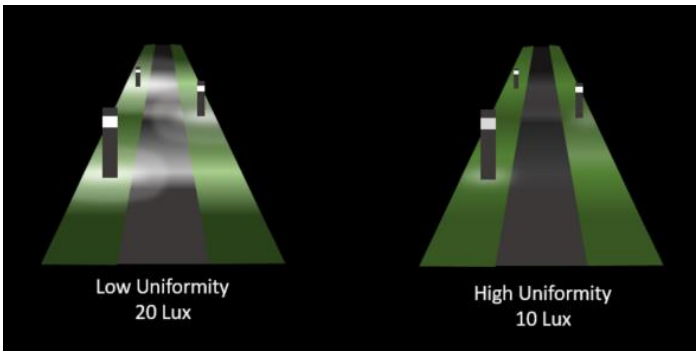


Figure 15 - Uniformity and illuminance

Measuring Sky Quality

3.23 Sky Quality can be measured either by looking down at the Earth from above and measuring the upward light or by measuring the brightness of the sky from the ground. Most ground measurements use a Sky Quality meter (see section 2) either with a Unihedron meter, or a TESS photometer which cost around £150. More complicated options are available, such as data loggers or all-sky units, but for quick measurements, the simple hand-held button operated units are acceptable.

3.24 You can also get a rough estimation of sky quality by counting the number of stars in the constellation of Orion which can be seen in the winter months. Observers can get a rough estimation of sky quality by counting the number of stars within the rectangle formed by the shoulders and feet. The number of stars you can see will give you the indication.

CPRE (Figure 16) used this method for their star count. In a city centre you will be lucky to make out 10 stars whereas under a good Milky Way dark sky in the UK you should be able to see around 25-30. Theoretically, there are 40 stars visible to the naked eye within Orion, but you need to be in a very dark place and have very good eyes to see them all.

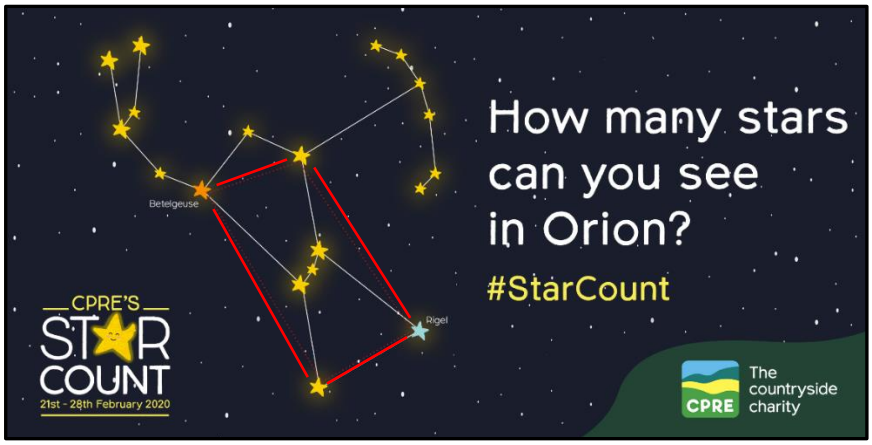


Figure 16 - CPRE Star Count

Figure 17 - First Quarter Moon in the Malvern Hills AONB

4. Dark Sky Design Lighting Principles

4.1 With any installation, domestic or otherwise, the *right light, in the right place at the right time,* should be the aim. The following best practice design principles should be followed to ensure good lighting that reduces light pollution and its impact on dark skies. They are the corner stone of good lighting for dark skies and can be found in many of the referenced guidance's including, ROLAN Manifesto for Lighting Professionals which sets out ten core principles for external illumination and a plan of action to implement positive change in the lighting community to lead to a more sustainable, healthier, and safer future for all.

Useful

4.2 Any light should be justified with a clear purpose and benefit. The overall lighting impact should be appropriate for the task and the local setting, regardless of the design.

Targeted

4.3 Light should be directed to where it is needed and not spill into neighbouring spaces. All light above the horizontal should be avoided. **Zero upward light is essential.**

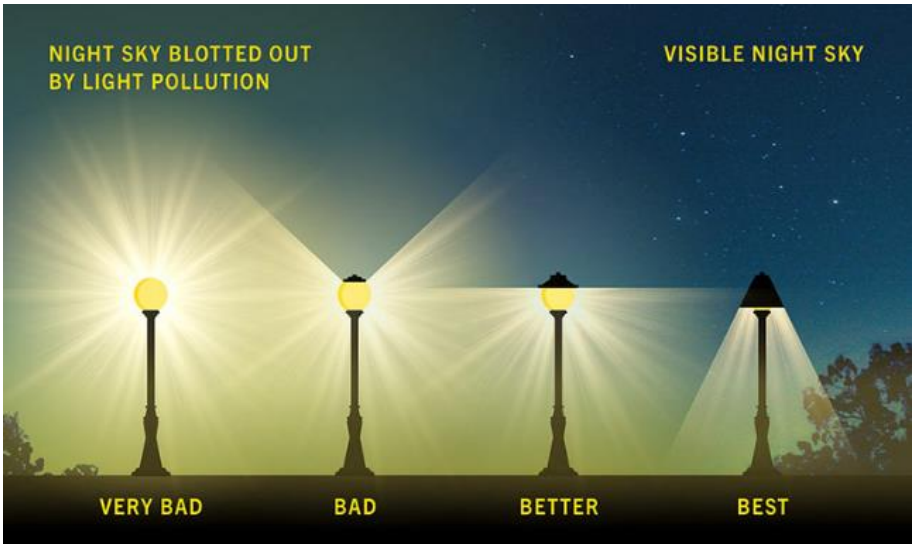


Figure 18 - The impacts of upward light - The International Dark Sky Association

4.4 Asymmetric lights should be used where possible. These are lights where the internal optics bend the light within the luminaire so that is more targeted to specific areas giving a symmetrical beam pattern. This helps reduce light spill, lower mounting heights, improve efficiency and eliminate upward light.

Low light

4.5 Lights should provide the right illuminance referenced against design standards where appropriate. Do not use needlessly over-bright lights as there will be more pollution and unnecessary glare. Use **500 lumens** and less for domestic lighting. Lights should be installed at their lowest practical height.

Controlled

4.6 Turn off when not needed with manual switches, timers or proximity (PIR) sensors. Ensure lights are dimmed or selectively activated when activity is low, to reduce light and energy use.

Designed

4.7 For larger non-domestic installations, professional designers should be consulted to ensure that illuminance, and control of spill light and glare, are appropriate for the task. Use the minimum possible number of lights and adhere to relevant standards.

Colour

4.8 Lamps should be less than or equal to **3000K** although ideally **2700K**. These are sometimes described as 'warm white'. Lamps above 4000K described as 'neutral' and 'cool' should be avoided as they generally have more blue light within the spectrum. Lower CCTs of <2200K may be required for lighting near sensitive ecological receptors. Spectral emission should avoid blue-wavelengths of **<500nm**.

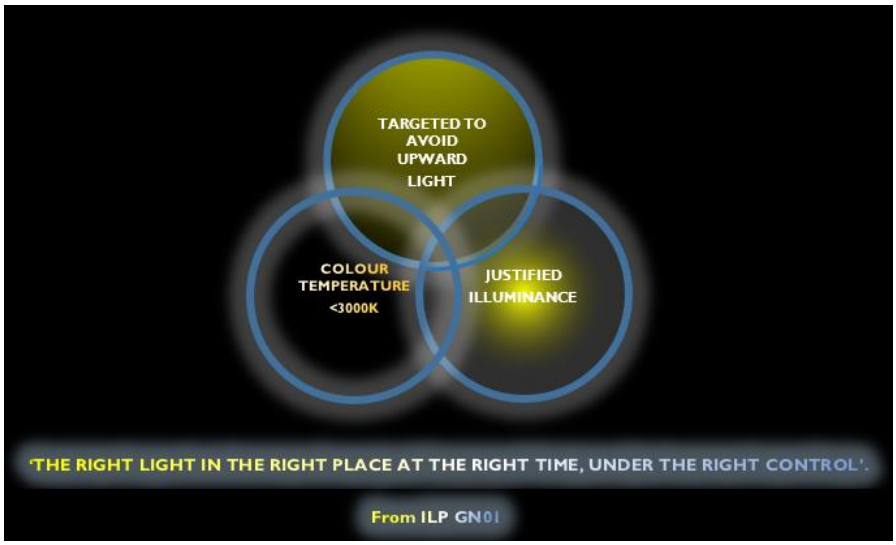


Figure 19 - The essentials of good lighting - taken from 'Towards a dark sky standard' and referencing GN01 ILP.

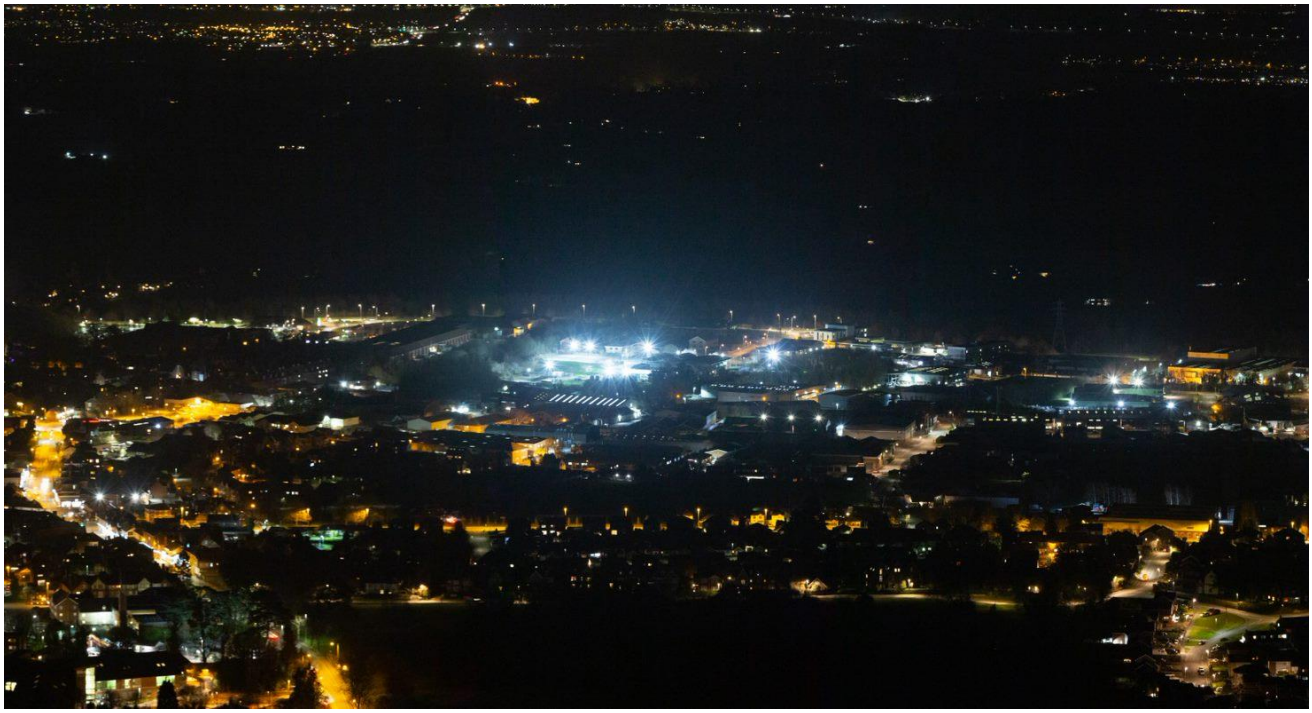


Figure 20 – Malvern Hills Science Park. Note the higher white colour, glare, and upward light compared to the street lighting.

5. Advice for Minor and Domestic Lights

5.1 The first consideration is whether lighting is needed at all – light should be avoided unless it has a clear and necessary purpose. As minor fittings (see bottom of page for definition) are not generally subject to planning control or need a lighting designer, it is important that users and homeowners installing domestic lights understand the difference between good and bad lighting. What can seem an enticing deal at the retailers can turn out to be inappropriate and a nuisance to neighbours and overly pollutes. Moreover, it may negatively affect the night sky and the near environment. Residents often buy and install lighting that is more powerful than a streetlight which can have a significant negative impact.

5.2 Follow these simple steps from the International Dark-Sky Association to ensure good-neighbourly lighting that protects dark skies. They are relevant in all (domestic and non-domestic) lighting.

Minor Lighting Principles

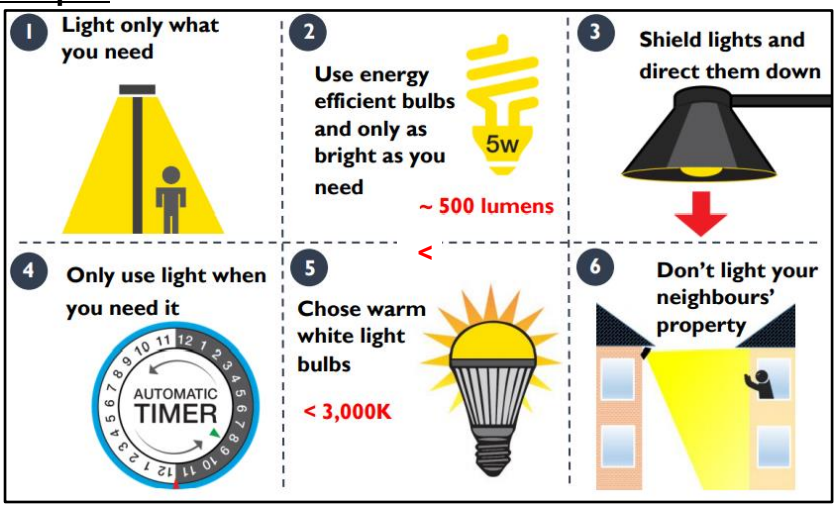


Figure 21 - Best principles for minor and domestic lighting – International Dark-Sky Association and South Downs National Park Authority

Minor lights

- Lamps of less than 500 lumens (~5W LED) are fine for navigating the garden path, and 1,000 lumens (11W LED) is acceptable for those requiring a little extra light for most uses, like parking the car and getting the keys in the door.
- You should not need a light greater than 1,500 lumens (~15w LED) for most domestic uses. Multiple low-powered lights in the right places are better than one bright light.
- Anything above 500 lumens, where this is justified, should be fully shielded so that the light goes downwards. LED lights are best to achieve downward light.
- Proximity sensors such as infra-red (PIR) should be used to light only when needed. Try and use separate sensors so you can angle the light without comprising its function (vice versa)
- Check that your lights do not spill into surrounding vegetation or natural areas.
- You should not need a lighting designer.
- The box or packaging will usually state the lumens, watts and colour temperature.

Internal Light

- Use your curtains and black out blinds to reduce internal light spill.

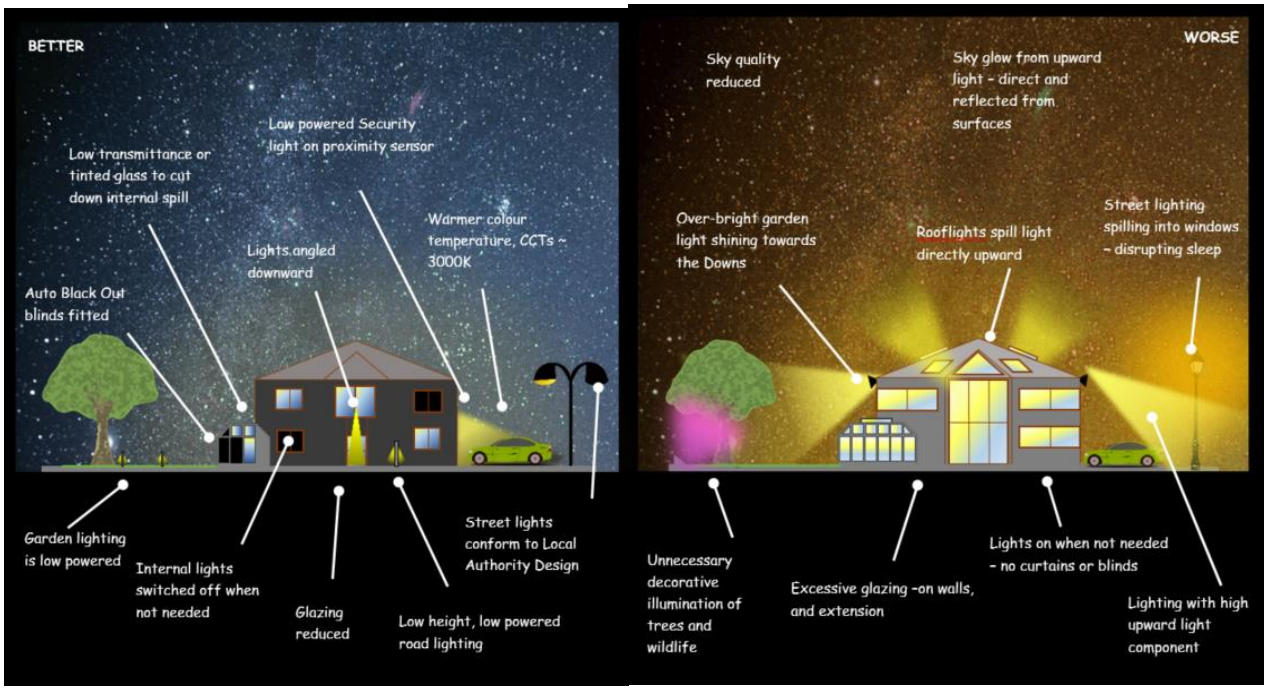


Figure 22 - Credit South Downs National Park Authority/Darkscape Consulting

Domestic and Minor Lighting Best Practices

5.3 Domestic lights and internal spill can be relatively un-obtrusive provided they are low powered and installed correctly. If done well – even with streetlights – you could get a good view of the sky and constellations.

5.4 In addition to the advice above, the Institution of Lighting Professionals has produced further domestic guidance. ILP - GN09: Domestic exterior lighting: getting it right!. This leaflet advises on appropriate lighting for the task in hand, providing the level of illumination required but not becoming a cause for concern to adjacent residents or affecting the natural environment surrounding your property.

Key Considerations

Nuisance to neighbours

5.5 Badly installed lighting will always annoy your neighbours. To avoid this, ensure you purchase lights under 1500 lumens, point them downwards and away from other properties, and use proximity sensors to turn off when not needed. Install them at the lowest practical height to reduce nuisance.

Over lighting in domestic luminaires

5.6 While it is tempting to get the best bang for your buck many domestic options are over bright and too powerful for most domestic purposes. You do not need anything more than 1500 lumens and 500-1000 will be sufficient. County Council Street lights operate at their lowest setting around 3000 lumens, so bear this in mind.

If you need more light to illuminate an area, it is better to use more lower powered lights rather than one over-bright luminaire.

Domestic glazing, roof lights and conservatories

5.7 As roof-lights don't generally need planning for existing dwellings, it is important to have some personal regard for the internal spill from glazed surfaces. It is recommended to use black-out blinds on roof lights and upward facing glazing. As the heat retention efficiency is good with glazing, you may find that having blinds will also naturally cool the room on sunny days. Remember to use your curtains at night to prevent internal light spill.

Using minor domestic style lights for commercial needs

5.8 Commercial lighting needs are often guided by illuminance standards and require a lighting designer but there may be circumstances where domestic and minor lights installed by the owner without using a lighting designer are more appropriate. For example, office doors, farm-shed entrance or a small pathway may require one single luminaire rather than a complex design. In these circumstances, this section on minor lighting and the following section on small commercial lighting should provide sufficient guidance to install the right light.

Luminaire Advice

5.9 Avoid Coach Lanterns with hanging cool white lamps. Coach lanterns with a warm white LED in the top which reduces upward light can be used, but due to the internal reflection of the luminaire, straight down-wall lighters are preferred where building character allows.

5.10 Avoid up-down wall lights. Use down wall-lighters instead.

5.11 Avoid halogen security lights with a fixed PIR sensor, as they cannot be tilted sufficiently and detect movement. Use tiltable lights with separate PIR Sensor so you can position the triggering point and tilt the luminaire properly.

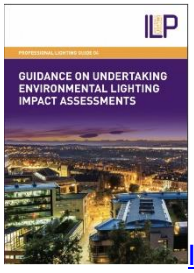
6. Advice For Non-Domestic and Larger Lighting Uses

6.1 Non-domestic lighting is different from normal domestic lighting because it tends to have a greater impact and you may be obligated under a 'duty of care' or insurance needs to provide lights for other users than just yourself. It will also often be on a larger scale, use multiple light sources and be more complex. This means that you need to consider a professionally led design because you may need to achieve more precise levels of illuminance, reduce pollution and light to meet the needs of your users. This can be more complicated than ordinary 'off the shelf' domestic lighting and may need professional input from a qualified lighting designer. For some small low-level schemes where domestic lights of around 500 lumens are used in small numbers and small areas, the domestic lighting guidance may be sufficient.

6.2 Information on good lighting practice is provided on these areas in the following sections. Further advice from Planning officers can also be sought. Non-domestic lighting will generally include (but not limited to):

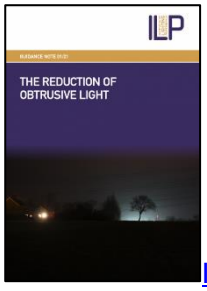
- Roads and walkways
- Public areas
- Sports
- Small Business Commercial
- Offices
- Farms
- Car Parks
- Larger Commercial

6.3 While exact lighting specifications can be found in relevant standards within the following sections, key documents that should be considered in all designs will include:



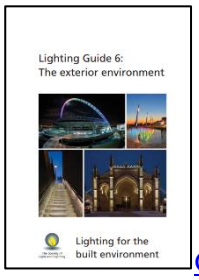
Institution of Lighting Professional Guidance on Undertaking Environmental Lighting Impact Assessments PLG04

This document describes the steps and industry standard methodology to conduct a lighting impact assessment. It includes sections on establishing a baseline of existing lighting levels, viewpoints and identification of critical receptors such as windows and wildlife areas. There is also a section on the residual impacts which should be taken into account throughout the planning decision process.



Institution of Lighting Professionals GN01/21 The Reduction of Obtrusive Light

This widely used and referenced guidance note specifies limitations and recommendations for lighting to prevent obtrusive light. It also considers industry comment regarding the assessment and definition of obtrusive lighting. It establishes upward light, intensity and illuminance criteria for lighting zones.

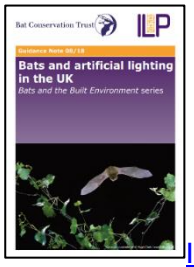


CIBSE: SLL: LG06: The exterior environment (2016)

The guide aims to provide readers with a firm foundation from which to approach exterior lighting design. Since light source technology is advancing rapidly, the guide provides a holistic approach to the design of the exterior environment, rather than concentrating on product performance, which quickly becomes out of date.

Towards a Dark Sky Standard

As a precursor to the planning process and as an extra resource for applicants, "Towards A Dark Sky Standard" is a general guide and overview of the key considerations needed for good lighting design and the protection of dark skies. While it is not a formal planning document, the information within it will help applicants, developers, lighting professional and the general public to install lighting that does not unnecessarily impact on dark skies.



ILP GN08/23 Bats and Artifical Lighting at Night

This document is aimed at lighting professionals, lighting designers, planning officers, developers, bat workers/ecologists and anyone specifying lighting. It is intended to raise awareness of the impacts of artificial

lighting on bats, and mitigation is suggested for various scenarios. However, it is not meant to replace site-specific ecological and lighting assessments.

Non-domestic Lighting principles

6.4 The important principles to consider on non-domestic lighting and luminaires in addition to those used for minor and domestic lights.

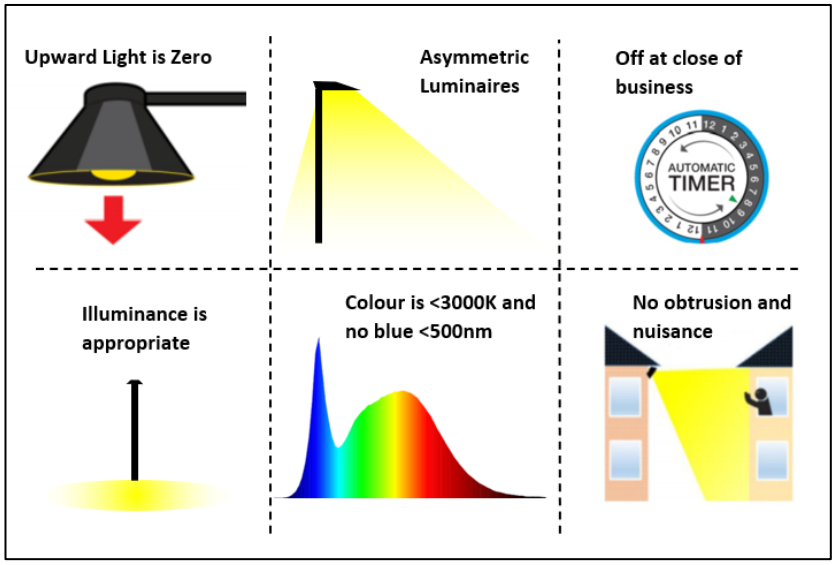


Figure 23 - Good lighting principles for non-domestic lighting. Credit Darkscape

Asymmetric luminaires

6.5 Asymmetric luminaires are very useful in controlling lighting, particularly in all non-domestic settings. These luminaires have optics that internally bend the emitted light from the lamp and directs it to specific areas reducing waste light, for example on long thin paths. Symmetric luminaires have no directing optical controls which means that the light is distributed more evenly over wider angles, usually 120 degrees. The benefit of asymmetric lights is that they can be installed flat so upward light, and spill is reduced. They can also be installed at a lower height as the light is more efficient in illuminating the right area. Many new LEDs in streetlights and floodlights have asymmetric beams to achieve more efficient illuminance standards. Asymmetric domestic lights are much harder to find as they are more general in use.

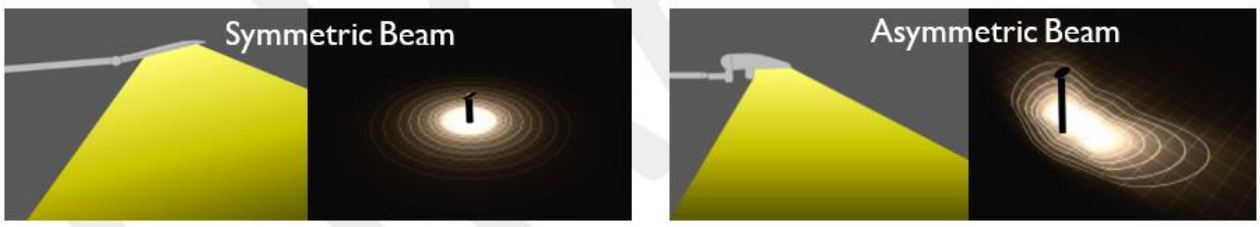


Figure 24 - Asymmetric and symmetric beam patterns. Credit Darkscape Consulting

Illuminance and Visual Impact

6.6 Higher levels of illuminance will be more prominent in darker landscapes and will introduce more significant levels of visual landscape impact. Regardless of the efficiency of the lighting scheme to reduce obtrusive light, the residual level of luminance (the light coming from a surface) which cannot be avoided, may still present an inappropriate visual impact for the setting.

6.7 Generally, illuminances levels (light shining on a surface) of over **10 lux** will begin to create a noticeable luminous landscape impact. While much depends on the size, extent and intensity of a lighting scheme, illuminances requirements over 10 lux may need to be avoided due to the inherent harm.

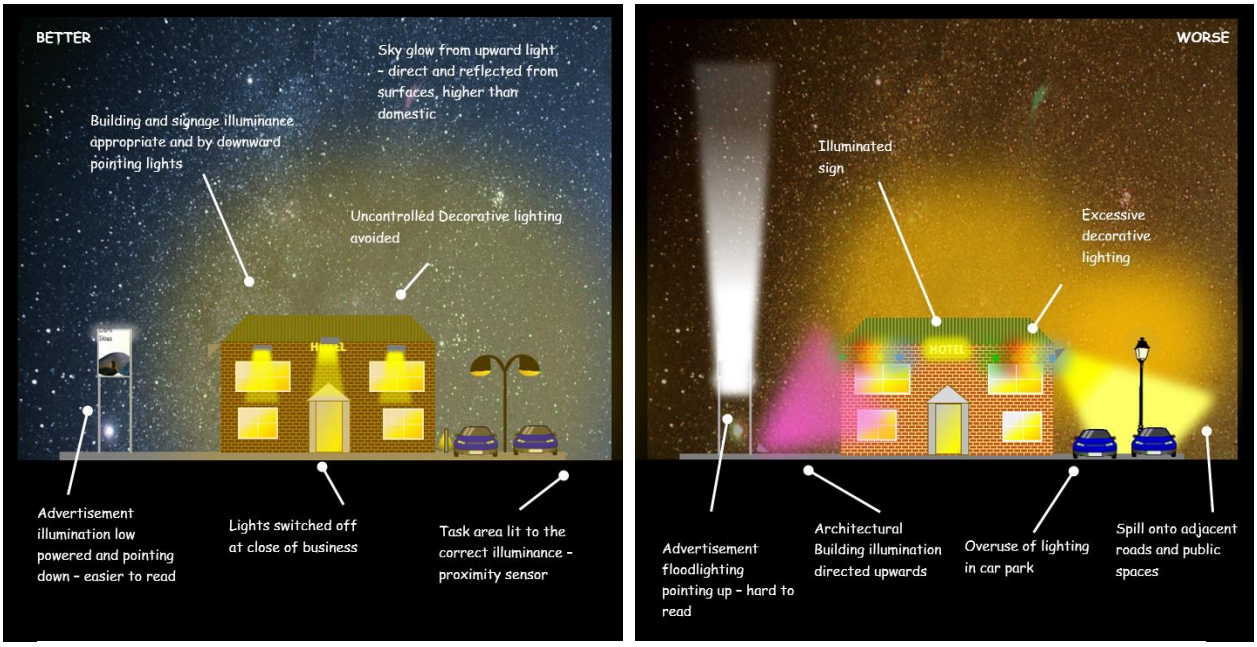


Figure 25 - Commercial Lighting examples – Credit Darkscape/South Downs Technical Advice Note

Small Commercial Lighting Good and Bad Practice

6.8 Small commercial lighting can include many development types; shops, hotels, pubs, offices, theatres and communal buildings like village halls. Typical lighting needs vary but will likely need to provide illuminance for doorways, car parks, pathways and advertisements.

Key Considerations

Car Parking, roads and paths

6.9 Car parks have different illuminance needs for different levels of use and locations. If lighting is justified, small, quiet car parks in rural areas should have a recommended 5 lux maintained average with larger car urban parks receiving 15 lux preferably using bollard lighting rather than pole mounted luminaires. Proximity sensors should be used to ensure lighting is off when not needed. For illuminance levels refer to BS EN 12464-2:2014. Road or path lighting may also be required which needs to comply with design requirements of road lighting, covered in BS 5489-1-2020: and BS EN 13201-2 – Road Lighting Performance requirements. See the section on Road Lighting within this document for more design information.

Advertising Regulations – Commercial

6.10 Although advertising is subject to regulations (Town and Country Planning 2017) steps should be taken to illuminate signs only when needed, using low powered downward lights, such as LED strips. The luminance of lights is addressed in ILP PLG 05: The Brightness of Illuminated Advertisements.

Architectural and aesthetic lighting

6.11 Architectural and aesthetic lighting choices such as festoon strings and fairy lights are popular with commercial lighting, so it is important that any 'mood' lighting leaves a minimal impact and does not try to compete with other lighting in the area. To do this:

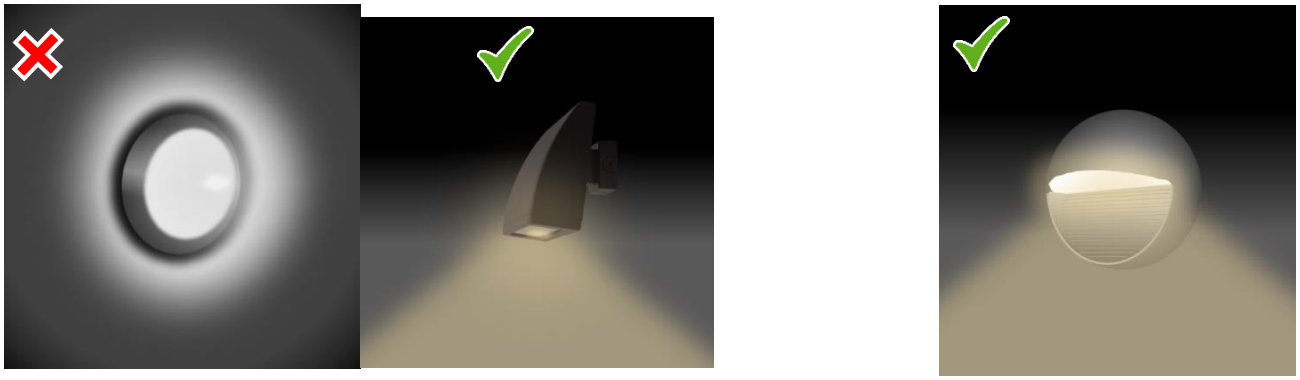
- Avoid up lighting buildings.

- Point downwards.
- Turn off at close of business.
- Avoid bright lights that create glare – this could create problem for your visitors.
- Minimise the number of fixtures.
- Mount at the lowest practical height

Internal Light Spill

6.12 Black-blinds and curtains should be used for properties with high levels of internal spill and prominent landscape visual impact. Blinds should be programmed to trigger on the onset of astronomical darkness which is approximately one hour after sunset.

Luminaire Advice



6.13 Avoid circular bulkhead lights that emit light upward. Use bulkhead lights that direct light downwards or have shielding. Try and ensure that emergency luminaires on batteries follow these principles.

Farms Good and Bad Practice

6.14 Farms have some permitted developments rights for lighting on existing buildings, which means that luminaires could be installed that have very little consideration for design. Due to their rural location, the contrast between a dark landscape and lighting means that the visual impact can appear relatively higher than urban settings. Principles of good lighting should be followed to avoid landscape impacts.

6.15 As a farm is a place of business owners must be careful to illuminate different areas of the farm properly. According to HSE Lighting at work HSG38 and British Standards BS EN 12464-2 2014 *Light and Lighting of workplaces*, farmyards have two general areas of varying illuminance;

- **Farm-yards**: with moving vehicle, machines and people – require 20 lux average
- **Equipment sheds** and **Animal sorting pens**: with movement in hazardous area – require 50 lux average.

6.16 Other lighting criteria such as uniformity, glare and CRI values are also recommended in BS EN 12464-2. This document provides some LED power purchasing recommendations for achieving different illuminance levels for simple applications where larger, complex and more hazardous areas may need a lighting designer.

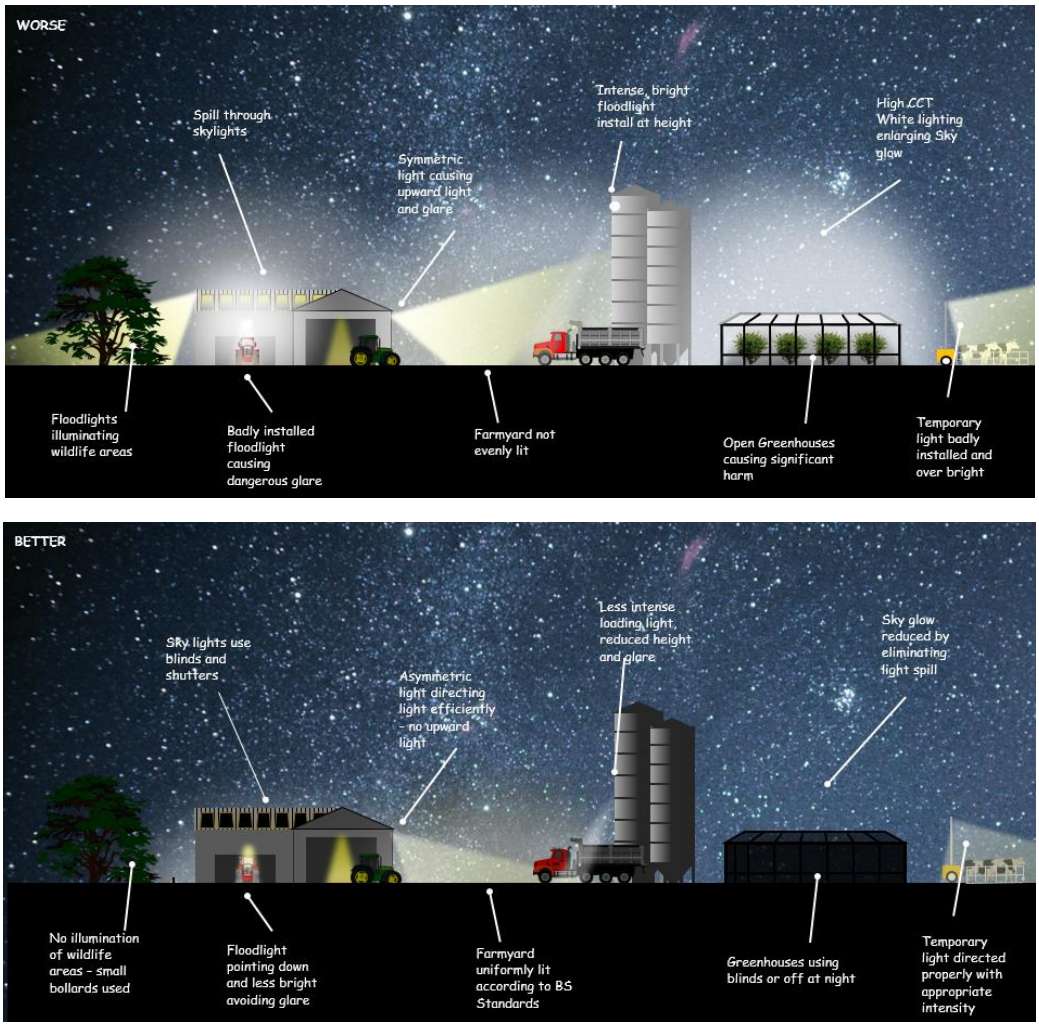


Figure 26 - Farm Lighting Examples – Credit Darkscape Consulting

Key Considerations

Farmyard Floodlighting

6.17 Lighting of farmyards is usually achieved with area floodlights. It is important to consider asymmetric luminaires to reduce upward light and ensure glare is not an issue. Badly installed bright lights can cause glare issues where unwanted visitors and workers can become hidden – this is a safety and crime issue. They can also cause significant visual intrusion in a dark landscape which can be detrimental to wildlife and visual intrusion. Areas that are more hazardous or have more conflicted uses with people and machinery should receive greater attention. Floodlights should be installed at the lowest practical height to achieve the illumination.

Farm Building Roof Lights and Greenhouses

6.18 Greenhouses, open barns, poly tunnels or sheds with large amounts of glazing and roof-lights can introduce significant impacts. While natural light and artificial light is important to operate in all hours, internally installed luminaires should be lower than roof lights to avoid direct upward light spill. For new buildings and improvements, black out blinds should be considered to activate upon the onset of darkness. This is particularly important for greenhouses as the internal light spill can reduce sky quality for many miles.

Wildlife Areas and Open Countryside

6.19 The rural location of farms means that they will be surrounded by wildlife and darkness where even the smallest lights can be more visually obtrusive than urban settings. As a growing amount of evidence is showing, light pollution disrupts wildlife just as much – perhaps even more – than people. Migration routes, circadian rhythm, pollination and even agricultural efficiency can be affected by light pollution. As such it is important that lights do not unnecessarily illuminate or shine into wildlife area, waterways and the open countryside and comply with the Wildlife and Countryside Act 1981. The use of asymmetric luminaires that reduce spill and appropriate illuminance are essential. For lighting in close proximity to ecological receptors, further reductions of CCT to <2200K should be considered, where appropriate.

Ecological and Landscape Impact Assessment

6.20 Due to the location of farms in the rural landscape, an ecological and landscape impact assessment such as the Institution of Lighting Professionals Guidance on undertaking environmental lighting impact assessments, should be taken. The contrast between light and dark, particularly in more remote rural farms, means that the impact of lighting is magnified compared with other higher ambient lighting areas. For more remote farms away from the urban fringe, consideration to the wider environment should be made and should include an assessment of the impact through ecological receptors and the view from the surrounding landscape. More consideration of the illumination levels, hours of use and intensity should be considered.

Lighting for Security

6.21 Security is an important consideration for a farm. While there is no direct evidence to show that lighting or lack of it has any effect on crime, the document Secured By Design – Lighting Guide by the Police gives general advice for this type of lighting. However, security lighting should be considered carefully and complemented by supplementary systems, e.g., smart alarms. Any lighting should still be of the right brightness, colour and avoiding upward light.

Other Considerations

6.22 Farms may also require lighting for car parks, roads, advertisements, small business premises or sports (menage) lighting. Other good and bad practices chapter should be referenced when considering these lighting schemes. Likely references will include small commercial lighting, parking and roads/paths.

Luminaire Advice

6.23 Avoid symmetrical halogen security lights with high colour temperatures and a fixed PIR Sensor. Use tiltable warm white LED lights with a separate PIR sensor. You can position the PIR sensor to trigger for people not wildlife.

Sports Lighting Good and Bad Practice

6.24 Sports lighting has a very high impact in dark sky places and **a lighting designer is needed**. These developments often reduce sky quality and can be seen for miles in the surrounding landscape. This is due to the high illuminance and colour needs to enable users to play safely. The luminaires are often installed at high levels to ensure correct illuminance even with asymmetric lights, which means the lamps can be very bright and visible. As such, the lowest practical mounting height should be used in achieving the designed illuminance. A qualified ecologist may also be required if near sensitive receptors.

6.25 Different sports require different levels of illuminance and colour depending on the skill level, intensity and ability to see play. Community level sports such as football tennis and hockey, will require illuminance levels of 300 lux with appropriate uniformity of around 0.7. Lighting requirements can be found in the Sports England Artificial Lighting Guide 2012.

6.26 Horse arenas and equestrian manège can have a significant impact on the dark rural landscape. The illuminances needed can range from 100 to 500 lux (BS EN 12193) and would be very prominent even if low reflectance material is used. A lighting designer should be used to ensure that luminaires are installed correctly, and suitable curfews used. Luminaires should not be erected 'ad-hoc' on existing structures as they will probably not achieve appropriate illuminances and limit obtrusive light. Using trees as fixing points should also be avoided. Temporary lighting should not be used as the luminaires are general in purpose and will not be appropriate for this type of activity.

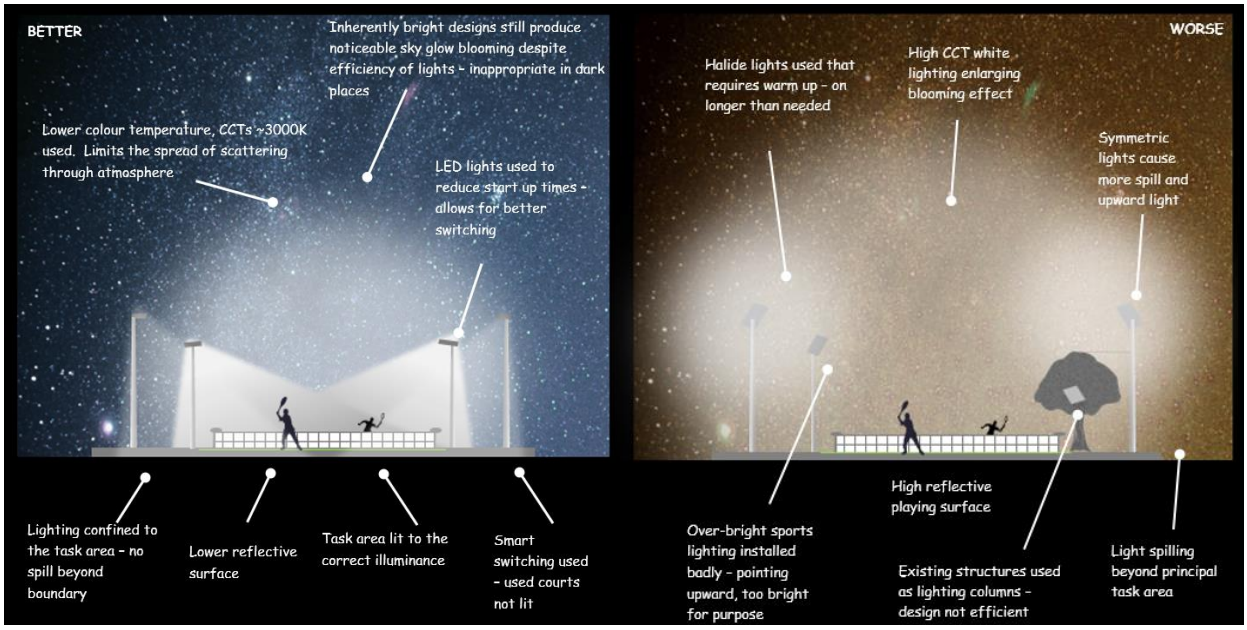


Figure 27 - Sports lighting examples – Credit Darkscape/South Downs NPA TAN

Key Considerations

Nuisance

6.27 Sports lighting near residential areas can cause nuisance due to their intensity and glare. It is important that light obtrusion is avoided and references the ILP GN01 (2021) *'The reduction of obtrusive light'* which recommends levels of intrusion into windows and boundaries.

Sky Glow – Asymmetric Sports Lights

6.28 High powered symmetric lights can cause significant sky glow, particularly if their main beam direction is points to the middle of the playing surface. Modern asymmetric LEDs should be used to direct light more efficiently without causing upward light. They are designed to be installed flat and at the correct lowest height to reduce intensity and upward light.

Colour in Sports Lighting

6.29 Sports illuminance needs a high level of colour rendition (CRI) to allow players to sight the play properly and pick a ball out from the background. This means that higher colour temperature LED (5000K+) are often used to achieve higher colour rendition which exacerbates the impact of skyglow as the light penetrates further into the atmosphere. This effect can be avoided. Modern LEDs have much better range of colour rendition with lower colour temperatures which is stated on the product spec. Colour rendition index levels of 60 are normally required for most community levels of play. The spectral range should also be checked to avoid blue colours with higher colour temperature needs. Where possible aim for 3000K or less lights, ideally achieving 2700K. For places near key ecological receptor sites, 2200K is preferred if it is achievable with CRI levels. Proximity to sensitive sites or species may prevent the approval of lighting regardless of design efficiency.

Landscape Visual Impact

6.30 Due to the higher levels of illuminance, sports pitches can have a significant impact on landscape even if the design of the lights is compliant with standards. For example, a tennis court may have compliant lighting in terms of illuminance, colour rendition and colour temperature but due to the light presence of the illuminated surface, it can create a significant visual landscape impact. There is very little you can do to mitigate against this and depending on the location, could harm darker skies. The residual impact could be of such significance that it may present a threat to dark skies and may need to be reconsidered or avoided. Illuminance levels above 10 lux will become prominent in dark landscapes.

Large Commercial Lighting Good and Bad Practice

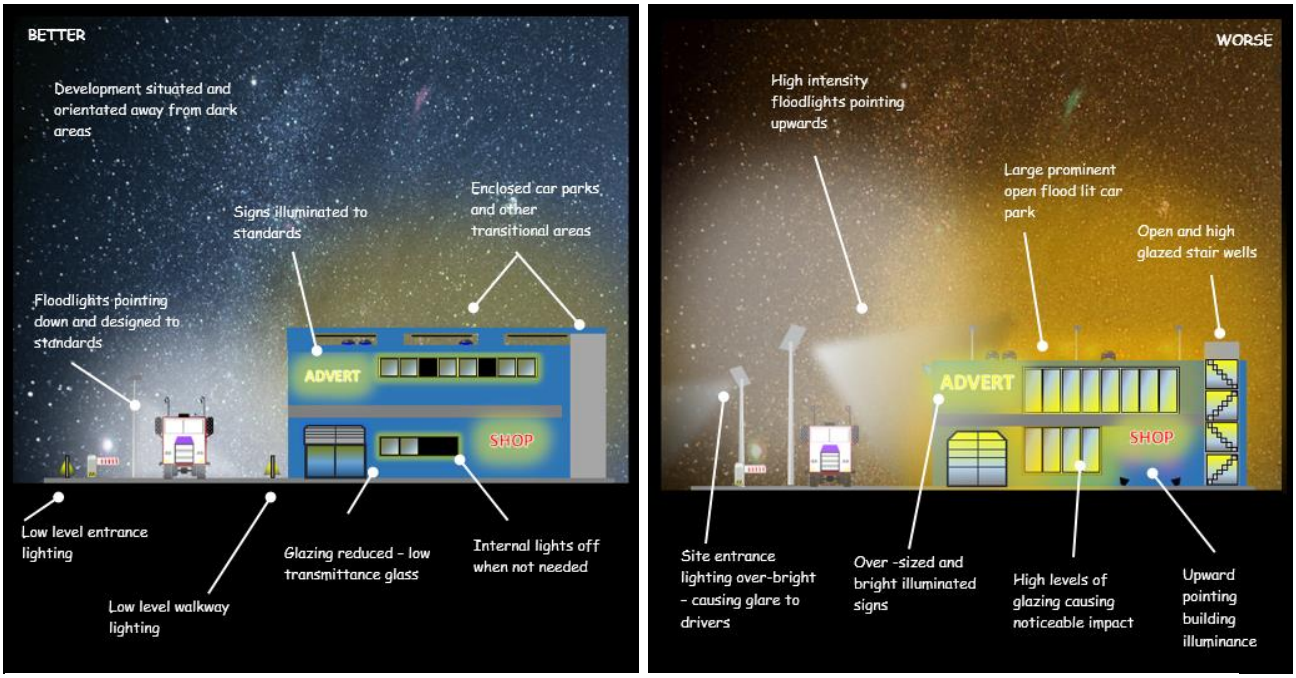


Figure 28 – Industrial Lighting examples – Credit Darkscape/South Down National Park Authority Technical Advice Note

6.31 Larger scale commercial lighting can have a large impact due to its scale, use and requirement – and **a lighting designer in is needed** in most cases. The luminaires used are often mounted at increased height (5 to15m) and will be more powerful to ensure illuminance levels under British Standards BS EN 12464-2 2014 *Light and Lighting of workplaces* are met. A qualified ecologist may also be required if near to sensitive receptors.

6.32 The levels of illuminance can be higher than most single commercial designs and over wider areas. This means that the generated sky glow is larger and more intense, and the visual intrusion of lights can have wider landscape impacts.

6.33 Large, glazed buildings and industrial complexes can generate significant internal spill, particularly if larger single elevations are used that appear as linear blocks of light in the landscape.

Key Considerations

Advertising Regulations

6.34 Although advertising is subject to regulations (Town and Country Planning 2017) steps should be taken to illuminate signs only when needed, using low powered downward lights, such as LED strips. The luminance of lights is addressed in ILP PLG 05: The Brightness of Illuminated Advertisements and should be relevant to the ambient lighting E-zone.

Mounting Height

6.35 The lowest practical mounting height should be used for all luminaires in achieving the required illuminances. High mounted luminaires that illuminate wide areas with over bright lights should be avoided. Using more lower powered lights than fewer high-powered lights is more preferable.

Car Parking

6.36 Car parks have different illuminance needs for different levels of use and locations. If lighting is justified, larger car parks will need 10 to 20 lux depending on usage and hazardous areas. Lighting with bollards is more difficult to it is important to reduce the column height to the minimum to achieve illuminances. For illuminance levels refer to BS EN 12464-2:2014. Road lighting may also be required which needs to comply with design requirements of road lighting, covered in BS 5489-1-2020: and BS EN 13201-2 – Road Lighting Performance requirements.

Asymmetric Luminaires and colour

6.37 Due to the large illumination area and larger sky impact, asymmetric lights should be used to avoid upward light where it is not needed. The lowest colour temperature should be sought ideally 3000K but 2700K where possible, with blue-rich LEDs avoided. CRI's of 0.7-0.8 should be achievable with modern LEDS of 3000K. For lighting in close proximity to ecological receptors, further reductions in CCT to <2200K should be considered.

Internal Light Spill

6.38 Large commercial buildings can have significant internal light spill. Extensive glazed elevations, sky lights or Perspex roofs can allow internal light to spill out and be visually intrusive. Large, continuous glazed elevations should be avoided, and black-out blinds should be considered for all glazed surfaces (glass or plastic) that have internally lit spaces throughout the night. For glass, a suitable visible light transmission should be used to reduce the amount of light passing through the material. Consideration may also wish to be given to recessed windows in designs, and overhangs, where feasible.

Roads and Paths Good and Bad Practice

6.39 The illumination of residential roads is generally the responsibility of the Local Lighting Authority (usually the County Council) or the Highways Agency for larger roads. New developments that require street lighting of roads should comply with and exceed the Local Lighting Authority's design guidance and are adopted by the authority for ongoing maintenance. Design guides within the Malvern Hills AONB are;

- Worcestershire County Councils Streetscape Design Guide
- Manual For Gloucestershire Streets July 2020, Appendix J and Developer Guide
- Herefordshire Highways Development Design Guide

6.40 The installation of street lighting for roads is not a legal requirement – you don't have to provide lighting unless there is a clear safety need. However, if lighting is installed, there is a legal responsibility for the owners to maintain it according to British Standards. As such **a lighting designer should be consulted.** As road lighting can be in close proximity to ecological receptors, an ecologist may be required where solutions with much lower CCT (<2200K) are considered.

6.41 Some commercial and industrial developments will also require road and path illumination and should follow the same design requirements.

6.42 The design requirements of road lighting is covered in BS 5489-1-2020: Design of road lighting and BS EN 13201-2 – Road Lighting Performance requirements - Lighting of roads and public amenity areas - Code of practice. The illuminance of roads depends on the traffic use and the mix of pedestrian needs, (road class). Both standards should be used to determine road class.

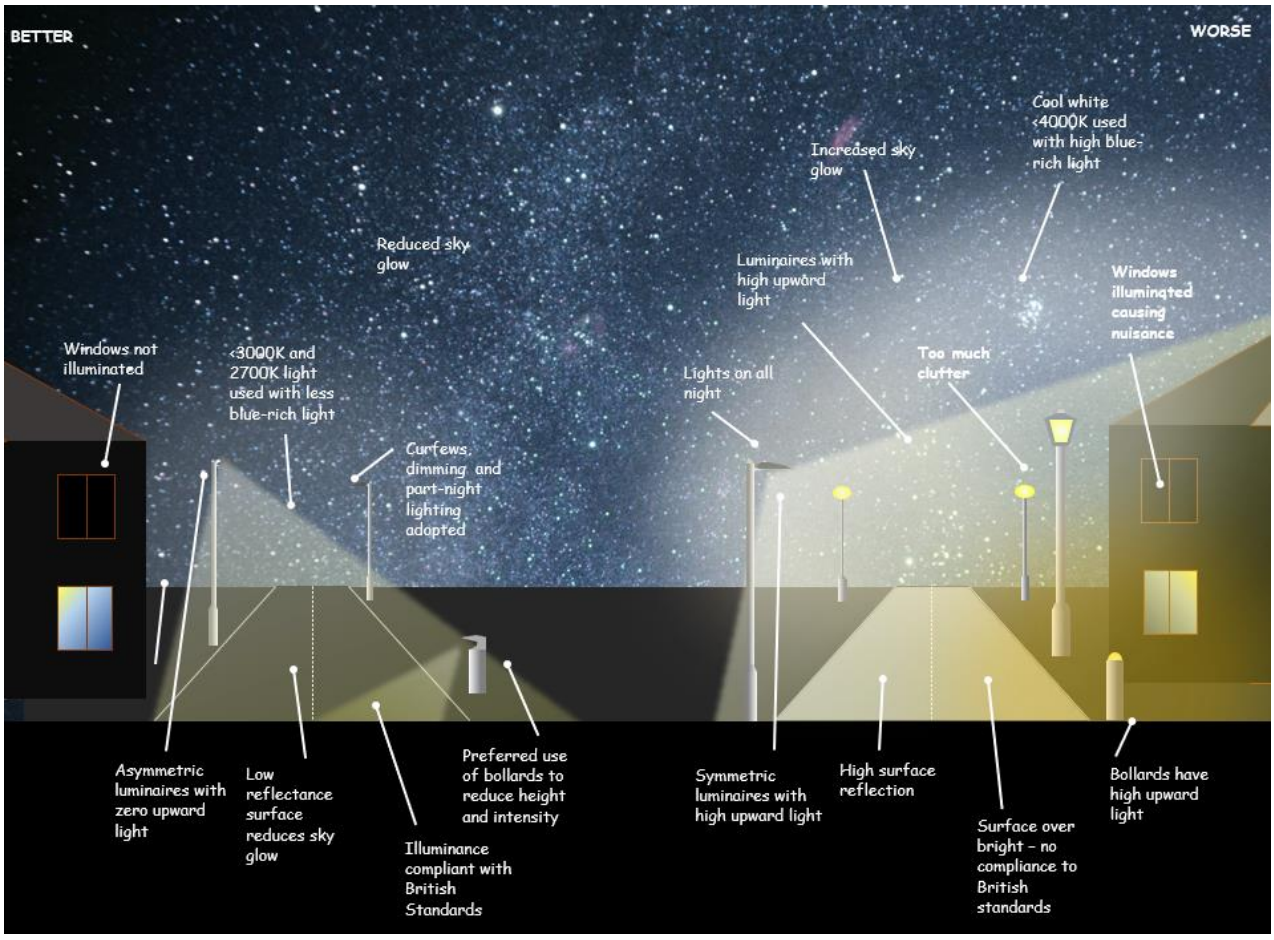


Figure 29 - Road lighting good and bad practice – Credit Darkscape Consulting

Key Considerations

Justification

6.43 Streetlights are a key determinant of sky quality, so it is important that there a clear and essential need for the lights. Adding streetlights is often an 'expectation' but this should be challenged and assessed for actual need especially in more rural areas. The need for lighting could be avoided with effective consideration at the initial development design phase.

Low Mounting Height

6.44 For quiet residential access roads low bollards could be used instead of higher column mounted streetlights. Bollards will help reduce the source intensity and visibility while keeping illuminance levels. They can also be fitted with asymmetrical lamps to prevent light spill. Low heights is always more preferable in terms of landscape impact. Bollards also reduce the generation of sky glow. Bollards may not be useful in places that are susceptible to vandalism. Low light way-markers (e.g. glow in the dark resin pads) could be used in some places to further reduce impact.

Illuminance Curfews

6.45 Modern LEDs can be dimmed down to achieve different levels of illuminance. As roads and paths will have a mixed level of use-age throughout the night, it is recommended that LEDs be dimmed to different road classes that reflect the changing use. Lights can also be subject to a part-night lighting regime where some lights are switched off when usage is very low. A consultation is often needed to achieve this, but it will reduce the night-time impact and save money. Curfews are particularly effective in rural parts of the AONB provided they are consistent with existing curfews, see Worcestershire Street lighting Design Guide.

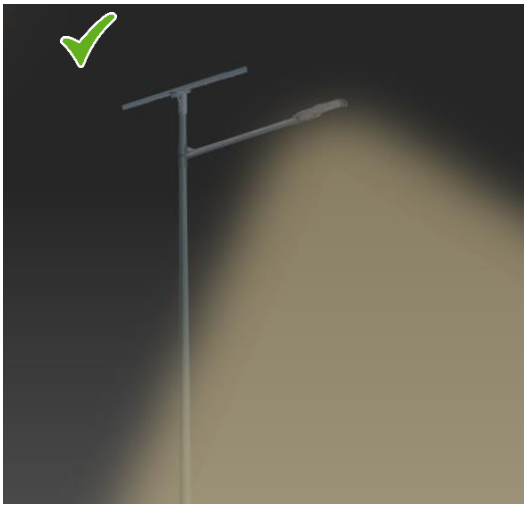
Colour Correlated Temperature

6.46 Some LEDs will have high colour temperature and a blue-white spectrum, which should be avoided as they contribute to the sky glow effect. The British Standards refer only to Colour Rendition levels (CRI) rather than colour temperature, as colour rendition can be achieved with different levels of colour temperature. In this respect it is recommended that colour temperatures of 3000K and 2700K, with low blue-light should be used in achieving British Standard CRI levels. CCT levels of <2200K should be considered for lighting in close proximity to sensitive ecological receptors. For example, red 1000K lights could be used in proximity to bat species (See Worcestershire County Council_Rapid LED Roll-out as an example of this type of lighting).

Low Reflectance surfaces

6.47 Different road and path materials reflect light different. To reduce the indirect scatter of lights, Low reflectance road and path surfaces should be used to reduce the light scattering into the atmosphere. Black and dark grey asphalt has a much lower reflectance (albedo) of around 0.05 to 0.1 new, compared to grey cement concrete, 0.35 to 0.4. Care should be taken in urban areas to ensure that low reflectance materials do not increase the heat retention to uncomfortable levels.

Luminaire Advice



6.48 White luminaires with a high amount of upward light should be avoided. Even with heritage area needs, street lighting should <3000K and direct light downward.

7. Lighting Purchasing Recommendations

7.1 You can't always trust 'Dark Sky Friendly' labels on products. Be careful when you shop for lights! Use the following guides to purchase the right lamps for your needs. Remember that 500 lumens is suitable for most domestic needs and to use warm white lamps

Minor Lamps: Brightness and approximate power

7.2 This table below, based on recent searches, provides the power wattages for different types of bulb brightness that you will find in most retailers. Some are being phased out, but you may still have some in the cupboard that you might want to use. For most minor domestic purposes, 500 lumens is normally more than enough. For lamps greater than 500 lumens, you should use shielding or luminaires that direct all the light downward.

BULB BRIGHTNESS (lumens)	220+	400+	700+	900+	1300+
Incandescent 	25W	40W	60W	75W	100W
Halogen 	18W	28W	42W	53W	70W
CFL 	6W	9W	12W	15W	20W
LED 	4W	6W	10W	14W	18W
LED GU10 	3W	5W	8W	10W	12W

Watts and Lumens: to achieve the right illumination (lux)

7.3 The table above recommends LED wattages (W) and lumen values (lm) to achieve approximate levels of illuminance for certain standardised tasks within an area. While they are more relevant to non-domestic installations, any householder should aim to purchase LEDs at the recommended level to achieve minimum lighting footprints. There are also special cases under Permitted Development, where non-domestic users are not subject to design controls. In these cases, the table should provide some guidance on correct purchasing. Note that when the area or the level of illumination increases and the potential impact is sufficiently high, a proper qualified and competent lighting specialist should be consulted for the design.

7.4 This table provides approximate values for areas listed in BSE and HSE documents, however, the user will remain responsible for the lighting and its use – if in doubt and to verify levels, consult a professional lighting consultant. Remember – try buy asymmetric and 3000K or less.

Area to be lit m^2	Approximate Target illumination levels (typical levels as listed in BSI and HSE documents)				
	(5 lux) DOMESTIC areas, walkways	(10 lux) DOMESTIC driveways, small car parks, traffic areas for slow moving vehicles	(20 lux) Farmyards, clearance and excavation	(50 lux) Loading and unloading, vehicle turning, construction areas, equipment sheds	(100 lux) Sports, fine detail and precision work*
25	**3w** 400lm	**6w** 500lm	**11w** 1000lm	**30w** 3000lm	CONSULT LIGHTING SPECIALIST
50	**5w** 500lm	**11w** 1000lm	**23w** 2500lm	**60w** 6500lm	CONSULT LIGHTING SPECIALIST
100	**11w** 1000lm	**23w** 2500lm	**50w** 5000lm	CONSULT LIGHTING SPECIALIST	CONSULT LIGHTING SPECIALIST
250	**30w** 3000lm	**60w** 6500lm	CONSULT LIGHTING SPECIALIST	CONSULT LIGHTING SPECIALIST	CONSULT LIGHTING SPECIALIST
500+	**60w** 6500lm	CONSULT LIGHTING SPECIALIST	CONSULT LIGHTING SPECIALIST	CONSULT LIGHTING SPECIALIST	CONSULT LIGHTING SPECIALIST

Low risk illumination. Suitable for domestic purposes, small businesses, and quiet working yards.

Medium risk illumination. Small businesses and commercial uses. A lighting specialist could be consulted, if in doubt.

High risk illumination. This lighting should be properly designed in consultation with a lighting specialist.

- Lighting using 11W or 1000 lumens is general a low risk
- Lighting above 11W and 1000 lumens but less than 60W and 6500 lumens is a medium risk
- Lighting above 60W and 6500 lumens is high risk. This lighting should be properly designed in consultation with a lighting specialist. It is not appropriate for households.
- The comparable lumens approximations within the table are valid as of 2020. The efficacy of lumens per watt depends on available technology.

  A specialist lighting consultant should be used for any fine detail and precision work, due to the inherent risk.

IDA Fixture Seal of Approval

The IDA's Fixture Seal of Approval program provides objective, third party certification for lights that minimise glare, reduce light trespass and don't pollute the night sky.

All products approved in the program are required to be fully shielded and to minimize the amount of blue light in the night-time environment. IDA does not sell lighting and is not endorsing any of the lighting within this document – the seal is for demonstration only.

To find Dark Sky recommended lighting for use in the UK and Ireland, please visit: www.darkskylighting.co.uk

8. Key Documents, Standards and Guidance for a Designed Lighting Plan

8.1 The following diagram illustrates the key documents used in non-domestic lighting plans and how they relate to the different spatial scales - from local to landscape. The diagram shows which metrics are important to each spatial consideration.

General Advice

8.2 Lighting designers should ensure that all relevant documents are referenced when creating a design with consideration to the wider rural environment and any key receptor sites. Lighting modelling should ensure that light spill on both horizonal and vertical planes of sensitive ecological and landscape receptors are fully considered, and that effects of fencing, vegetation and topology are included.

8.3 It is recommended that lighting installations that are close to or within key receptor sites consult with specialist ecologists, where appropriate, to ensure that biodiversity concerns are integrated into the design. Ecological Constraints and Opportunity Plans (ECOP)'s should be created to identify key and supporting species and priority habitats.

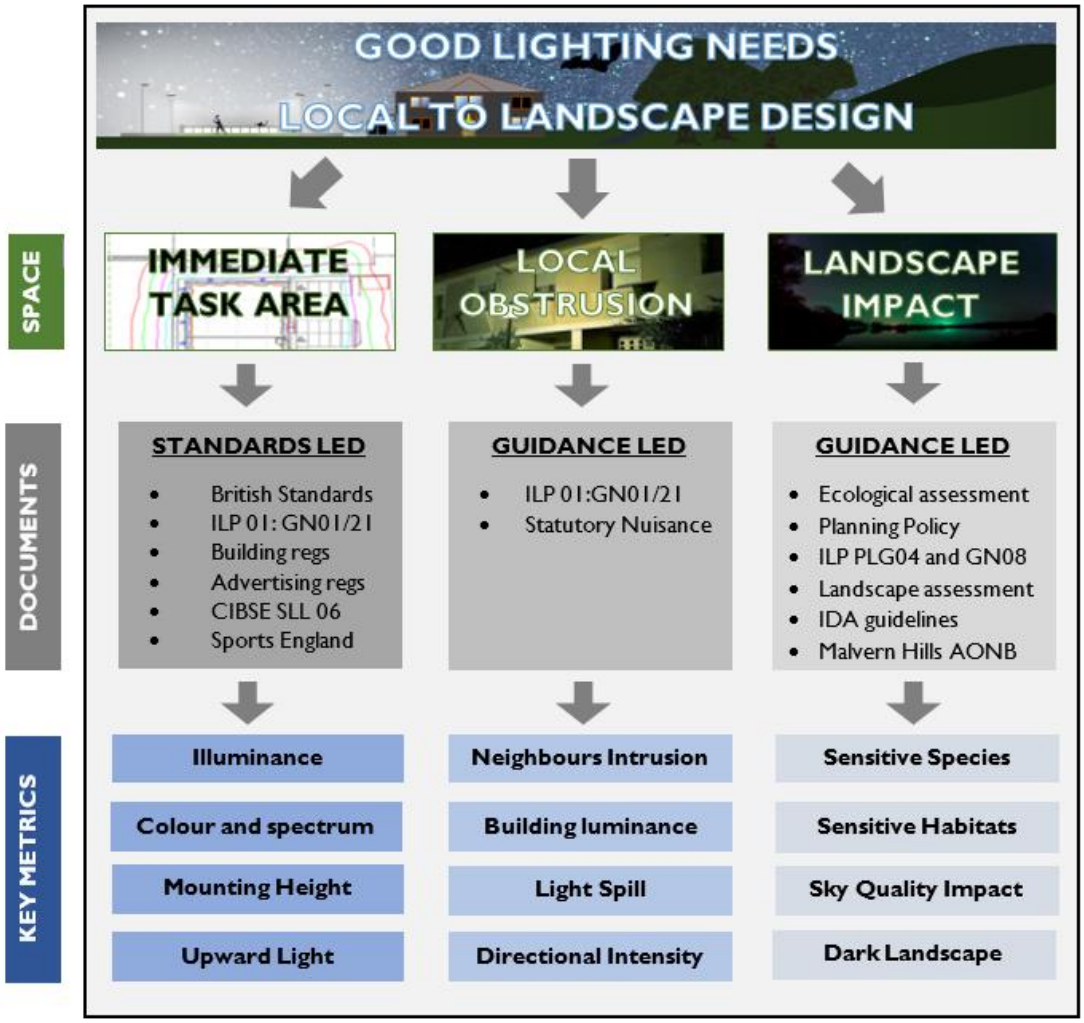


Figure 30 - The relation of British standards and other guidance's to local and landscape scales. Key metrics are shown relating to each area from the immediate task area to wider landscape impacts. Image credit Darkscape Consulting

Malvern Hills AONB Documents

8.4 The following documents are relevant to the Malvern Hills AONB. Any lighting design should aim to integrate these documents into the earliest phases of the design.

8.5 The Malvern Hills Nature Recovery Plan – provides information on the nature recovery plan and identified areas for recovery.

8.6 South Worcestershire Development Plan Review.
The South Worcestershire Development Plan (SWDP), also referred to as the local plan, was adopted in February 2016. Section 4 on Environmental Enhancement and Protection should be referenced, notably policies SWDPR 26 to SWDPR 31.

8.7 Local Lighting Authority street lighting guides specify lighting design requirements for road lighting and associated lighting furniture**.**

- Worcester Streetscape Design Guide.
- Manual For Gloucestershire Streets July 2020, Appendix J and Developer Guide
- Herefordshire Highways Development Design Guide

Lighting Impact Assessment

8.8 The ILP Professional Lighting Guide 04 – Guidance on undertaking environmental lighting impact assessments, has additional information on these elements. Particular care should be taken when considering the residual impacts – section 9. These are impacts that are often outside the control of a light designer and should be considered as part of a wider night landscape visual impact assessment.

8.9 CIBSE LG06: The exterior environment (2016) has further general guidance for lighting the exterior environment.

8.10 ROLAN Manifesto for Lighting Professionals. The Responsible Outdoor Lighting At Night (ROLAN) Manifesto sets out ten core principles for external illumination and a plan of action to implement positive change in the lighting community to lead to a more sustainable, healthier, and safer future for all.

Determining lighting for immediate task areas

8.11 BSI - Light and lighting of workplaces: BS EN 12464-2:2014 - This standard sets specific requirements for lighting of tasks in most outdoor workplaces and their associated areas in terms of quantity and quality of illumination. Section 5 provides the lighting requirements for various tasks, e.g. farmyards, pedestrian walkways.

8.12 BSI – Lighting of roads and public amenity areas. Code of practice BS 5489-1:2020 - This standard sets recommendations for general principles of road lighting and its aesthetic and technical aspects, including advice on operation and maintenance.

8.13 BSI – Lighting and Lighting. Sports Lighting BS EN 12193:2018 - This standard sets recommendations for illuminances and other lighting metrics for sports lighting.

8.14 HSE – Lighting at Work HGS38. - This guidance explains how lighting contributes to the health and safety of people at work. It deals with assessing and managing the health and safety risks attributable to lighting in the workplace, good practice and the minimum recommended illumination levels that meet H&S requirements.

8.15 Sport England – Design Guidance Notes: Artificial Sports Lighting
This Design Guidance Note considers artificial sports lighting for both internal and external sports activities and identifies those that have special requirements. Recommended illuminances for activities are provided.

8.16 Illuminated Adverts - The Illuminated Advert regulations covered by the Town and Country Planning (control of advertisements) (England) 2007, discuss the specifications for installation. Luminance and controls are recommended for different ambient lighting zones. The ILP has guidance for all of the UK and Ireland: PLG05: the brightness of Illuminated advertisements

Assessing and reducing the impact of obtrusive light

8.17 Institution of Lighting Professionals GN01/21 The Reduction of Obtrusive Light - This widely used and referenced guidance note specifies limitations and recommendations for lighting to prevent obtrusive light. It also considers industry comment regarding the assessment and definition of obtrusive lighting. It establishes upward light, intensity and illuminance criteria for lighting zones

8.18 Clean Neighbourhoods and Environment Act 2005 – Statutory Nuisance - This statutory legislation specifies that installations be avoided where 'artificial light emitted from premises (is) prejudicial to health or a nuisance.' (Section 102 (2)(fb)). To avoid enforcement by the local authority, lights should be pointing in the right direction and be appropriate for use.

Landscape Impact and Wildlife

8.19 ILP Guidance on Undertaking Environmental Lighting Impact Assessments PLG04 - In sensitive wildlife areas such as National Parks, AONBs, National Nature Reserves or protected landscapes, sufficient consideration should be given to appropriate lighting plans. This guidance provides advice on both rural and urban environmental impacts. This guidance also includes assessments on residual impacts that cannot be easily mitigated by designed.

8.20 CIBSE: SLL: LG06: The exterior environment (2016) - The guide aims to provide readers with a firm foundation from which to approach exterior lighting design. Since light source technology is advancing rapidly, the guide provides a holistic approach to the design of the exterior environment, rather than concentrating on product performance, which quickly becomes out of date.

8.21 Bat Conservation Trust and ILP: Bats and artificial lighting in the UK - This document is aimed at lighting professionals, lighting designers, planning officers, developers, bat workers/ecologists and anyone specifying lighting. It is intended to raise awareness of the impacts of artificial lighting on bats, and mitigation is suggested for various scenarios. However, it is not meant to replace site-specific ecological and lighting assessments.

8.22 Towards a Dark Sky Standard - As a precursor to the planning process and as an extra resource for applicants, "Towards A Dark Sky Standard" is a general guide and overview of the key considerations needed for good lighting design and the protection of dark skies. While it is not a formal planning document, the information within it will help applicants, developers, lighting professional and the general public to install lighting that does not unnecessarily impact on dark skies.

Energy, avoiding nuisance and crime.

8.23 Building Regulations - If you are installing an external light which is supplied from your electrical system, then you should ensure reasonable provisions are made to enable effective control and/or use of energy efficient lamps. One recommended option is to install a light **not exceeding 150W per light fitting** (which is excessive for most LED domestic uses) where the lighting automatically switches off, both when there is enough daylight and also when it is not required at night.

8.24 Secured By Design – Lighting Guide - This guide, produced by Police Crime Prevention Initiatives, aims to increase awareness of security, public safety and lighting. It recognises the need to balance different objectives and incorporates the requirement to avoid causing light pollution in the design of buildings, estates and public spaces.

9. Design Guidance Design Advice for Glazing

Light Spill from interiors

9.1 Light from inside dwellings and commercial properties can have a significant impact on night sky quality and the integrity of a dark landscape. It is pollution – it serves no purpose, nor benefits the external environment. While this pollution has received little attention in any specific guidance, this document aims to provide some mitigation and considerations.

9.2 For new developments or extensions to properties glazing should be designed to mitigate light spill.

General dark sky mitigations

- Use an appropriate visible light transmission (VLT) for the glazing (see next section)
- Consider automated blackout blinds and shutters:
    - Automated blackout blinds at night are a relatively low-cost and effective option for eliminating internal light spill without impacting on internal spaces.
    - Timers on blinds should be set for within one hour after sunset.
    - They can be used either in the design phase, or post installation.
- Break up continuous glazing by removal or use of external shutters and shields to keep the overall glazed area representative of the AONB's buildings character. An area less than 50% of the total elevation area is typical of Malvern characteristic domestic residences. See also Malvern Hills AONB Guidance on Building Design.
- Glazing should not exceed 25% of the floor area to meet energy efficiency building regulations (which does depend on thermal properties of the glass). See Building Regulations Part L1
- Turn off internal lights when not needed or at close of business.
- For new builds, design internal lighting away from windows.
- **Due to the significant landscape impact any commercial greenhouses should have zero light spill.**

Key documents to reference within a design:

- **BSI - Light and lighting of workplaces BS EN 12464-2:2011 Part 1: Indoor Work Places** This standard specific requirement gives information on lighting of tasks in most indoor work places and their associated areas in terms of quantity and quality of illumination.
- **CIBSE: SLL: LG Guides** - This library of guides provides information on lighting for a number of internal applications.

Using Visible Light Transmission (VLT)

9.3 Not all glass is the same. Depending on the internal space requirements, glazing will use different methods to control the transmission of visible light through the glass. This 'VLT' value of glass can be selected to minimise glazing impact while providing sufficient visible light for the purpose. (Tints provide a similar function). From a distance in a dark landscape, the impact from glazing spill can be similar to light emitted from an appropriately designed illuminated advertisement[3]. Glazing should aim to meet the 'target VLT' for typical glazing types shown below, especially in remote dark landscapes.

- Visible Light Transmission (VLT) is a ratio/percentage that indicates the proportion of light passing through. It is usually expressed as a number between 0 and 1, where the higher the value, the more light passes through**. The lower the number the less internal spill**.

- Glazing manufacturers provide a range of VLT and tint options for a variety of needs. The recommendations above have been cross-referenced against retail options for their intended purposes to ensure optimal function.

- All glazing has a potential landscape impact either by disrupting the dark landscape with point sources, or through the spill of light into the air. Generally, the smaller the glazing with lower internal illuminance levels will disrupt the landscape less and have a low impact. Larger glazed elevations with brighter internal illuminance will stand out more and pollute more.

- Black out blinds should be used where the lowest VLT targets are not available or practical. This will be more relevant to larger and more commercial uses of glazing where other considerations such as natural daylight or heating is important.

Glazing Type	**Potential Landscape Impact**	**Target VLT**
Normal Domestic Glazing	Low impact	~0.65
Large, continuous open domestic glazing	Medium impact	0.4 to 0.65
Domestic roof lights, conservatories and lanterns	Medium impact	0.4 to 0.5
Commercial sky lights	High Impact	~0.3
Small office and shoe fronts	Low Impact	~0.65
Structural glazing	Very high impact	~0.4

Notes:

For practical considerations of product options, the acceptable target and range is the **target VLT +/- 0.05**

The landscape impact of glazing will also depend upon the urban or rural setting which should be taken into account.

[3] As calculated in South Downs National Park Authority Dark Skies Technical Advice Note Glazing Appendix.

10. Lighting Assessment and Plans

10.1 Whether a lighting scheme requires planning permission or not, it may need the services of a qualified lighting designer to create an assessment or plan. A plan should contain essential information to show how the lighting is justified, what luminaires are used and where, how it complies with relevant standards and fully considers wider landscape and wildlife considerations. These aspects should be integrated into the very earliest stages of design.

10.2 Planners will need to quickly and clearly understand how a lighting plan complies with relevant standards and how it will not cause harm to the landscape by producing light pollution. A design should clearly summarise the justification, the tasks need, mitigations, local and landscape impacts. The more clearly you can show this information, the better.

A lighting assessment should include;

1	Site description	A summary of visual impact assessment description adapted for lighting, including indication of applicable environmental zone - which is assumed to initially be E0 compliance in developments outside urban (street-lit) areas
2	Assessment method	A description of the methodology for site visits, design and evaluation
3	Baseline Assessment	An assessment of the current lighting at site, identification of sensitive ecological receptors, viewpoints and general dark sky conditions. Malvern Hills AONB landscape and biodiversity documents should be used at the very earliest stages to integrate into design.
4	Proposed development	This is the main technical part of the plan. It should include • Design objectives • Task requirements • Relevant guidance, standards and legislation that relate from local to landscape • Task calculations • Obtrusive light calculations with appropriate consideration for key ecological receptor sites • Luminaire schedules and installation plans • Luminaire specifications (lumens, CCT, CRI, spectral distribution)
5	Residual effects	Assessment of the changes caused by the lighting, including construction and operational phases. This should also include effects to the dark landscape and wildlife and overall visibility after installation and mitigations.
6	Potential mitigation	A description of any potential mitigations used, including curfews, reduced illuminances, or shielding
7	Conclusions	A summary of the report covering installation and operational phases. This should summarise the main technical requirements and be clearly presented to a planner.

The ILP Professional Lighting Guide 04 – Guidance on undertaking environmental lighting impact assessments, has additional information on these elements.

CIBSE LG06: The exterior environment (2016) has further general guidance for lighting the exterior environment.

11. Planners Design Flow Charts

External Lighting

IS THE LIGHT NEEDED?

- In most cases the light will be needed and obvious, but the reasons should be clear and evident.
- Aesthetic or dramatic lighting serves little safety or security purposes, so should be avoided unless it is critical to the development.

DETERMINE ENVIRONMENTAL ZONE

- E0/E1 zones should have 'rural' levels of lighting, differing in mitigation schemes. High illuminance lighting should be avoided
- E3/4 zones might have street lighting and brighter 'urban' facilities and on later into the evening. High illuminance in these zones is more appropriate

IDENTIFY THE KEY METRICS

- **LUMENS** – The total output of the lights
- **CCT** – The colour correlated temperature, expressed in Kelvin (K)
  - **<3000K is the aim for all lighting**
- **ULR** – The Upward Light Ratio, expressed as a %-age or ratio.
  - **Zero upward light is the aim for all lighting**

IS THE ILLUMINANCE APPROPRIATE?

- **LUX** – This is the measure of light on a surface.

  Different areas need different Lux levels. Apart from domestic lighting, the Lux level should be referenced against the appropriate standard, e.g. Sports England Artificial Light.

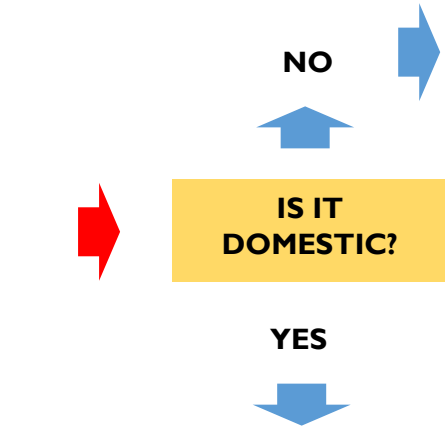
  This will be sometimes expressed as E(ave) or the average illumination (E)

ARE THERE ANY MITIGATONS?

- PIR: Lights for pedestrian and vehicle movements/access should have proximity sensors
- Timers: Business should use timers to prevent lights at close of business
- Illuminance curfews: Is there a reduction at quieter times?

CONSIDER THE LOCAL SETTING

- Does the local topography offer any shielding to view points?
- Does immediate surrounding vegetation act as a shield to the surrounding landscape? This is particularly effective for glazed elevations
- Are there any key protected wildlife sites directly adjacent to development requiring less lighting impact?



ENSURE:

- 500 lumens lamps are preferred
- Any lights above 500 lumens are fully shielded
- Single lamps exceeding 1500 lumens should be avoided
- Lamps should not exceed 3000K
- Proximity sensors or timed switching should be used
- Lights point downwards, below the horizontal
- Illuminance is justified

CATEGORISE NON-DOMESTIC LIGHTING SCHEME

PATHWAY AND STREETLIGHTING

- High impact potential regardless of design efficiency
- Illuminance levels will be high (20 lux+)
- Consistent with Local Authority Managed
- Bollard lighting preferred for small estates
- Should be avoided in E1 zones
- Often used in E3/E4
- Referenced against illuminance standards
- <3000K
- Downward Facing ULR= 0
- Use smart lighting to illuminate only used courts
- Timers such that Off when not needed
    - Consider sports availability in urban areas
    - Lumens operate within 3000-5000

ADVERTISEMENTS

- High impact potential regardless of design efficiency
- Refer to Advertisements Section Page

SPORTS

- High impact potential regardless of design efficiency
- Illuminance levels will be high (20 lux+)
- Should be avoided in E1 zones
- Referenced against illuminance standards
- Aim for <3000K (difficult to achieve in small-object sports)
- Downward Facing ULR= 0
- Use smart lighting to illuminate only used courts
- Timers such that Off when not needed
- Consider sports availability in urban areas
- Refer to standards for typical illuminance levels, e.g. football, hockey
- Lumens can be very high (10,000)

SPECIAL CASES

- High impact potential
- Lights have special purposes that may conflict with dark skies, e.g. Stage lighting,
- Illuminance reference guidance not often available
- Specific assessment will need to be made
- Examples;
    - Artistic installations
    - Light festivals
    - Temporary event lighting
    - Music festivals
- Lights to be avoided
    - Sky Scanners, Lasers, 3000K+
    - Upward light

PEOPLE AND VEHICLE ACTIVITY

- Medium impact potential regardless of design efficiency
- Illuminances vary from low (5 lux) to high (50 lux) depending on risk
- Will apply in all zones as rural businesses need lighting for employees/visitors
- Referenced against illuminance standards
- <3000K
- Downward Facing ULR= 0
- Use smart lighting to illuminate only used courts
- Timers such that Off when not needed
- Refer to standards for typical illuminance levels, e.g. car parks, walkways, vehicle movement
- Single light should not exceed 5000 lumens

BUILDINGS

- Non-Essential Lighting
- Useful in city centres/night life for economy
- Should be avoided in E0 and E1 zones
- <3000K
- Up lighters to be avoided
- Illumination of tree's to be avoided
- All light directed at surfaces
- Avoided in rural churches
- Off a close of business

Internal Glazing

DETERMINE THE GLAZING CATEGORY

ASSESS THE GLAZING EXTENT

- Is the amount of glazing appropriate for the use and location?
- The decision should be based on analysis of the development in the landscape taking into account
    - Landscape impact
    - Disruption to dark landscape continuity
    - Visible intrusion
    - Urban/rural density and remoteness
    - Shielding by vegetation and buildings

SET RECOMMENDATIONS FOR VLT

- Use the table to set recommended factors for visible light transmission

APPLY MITIGATIONS

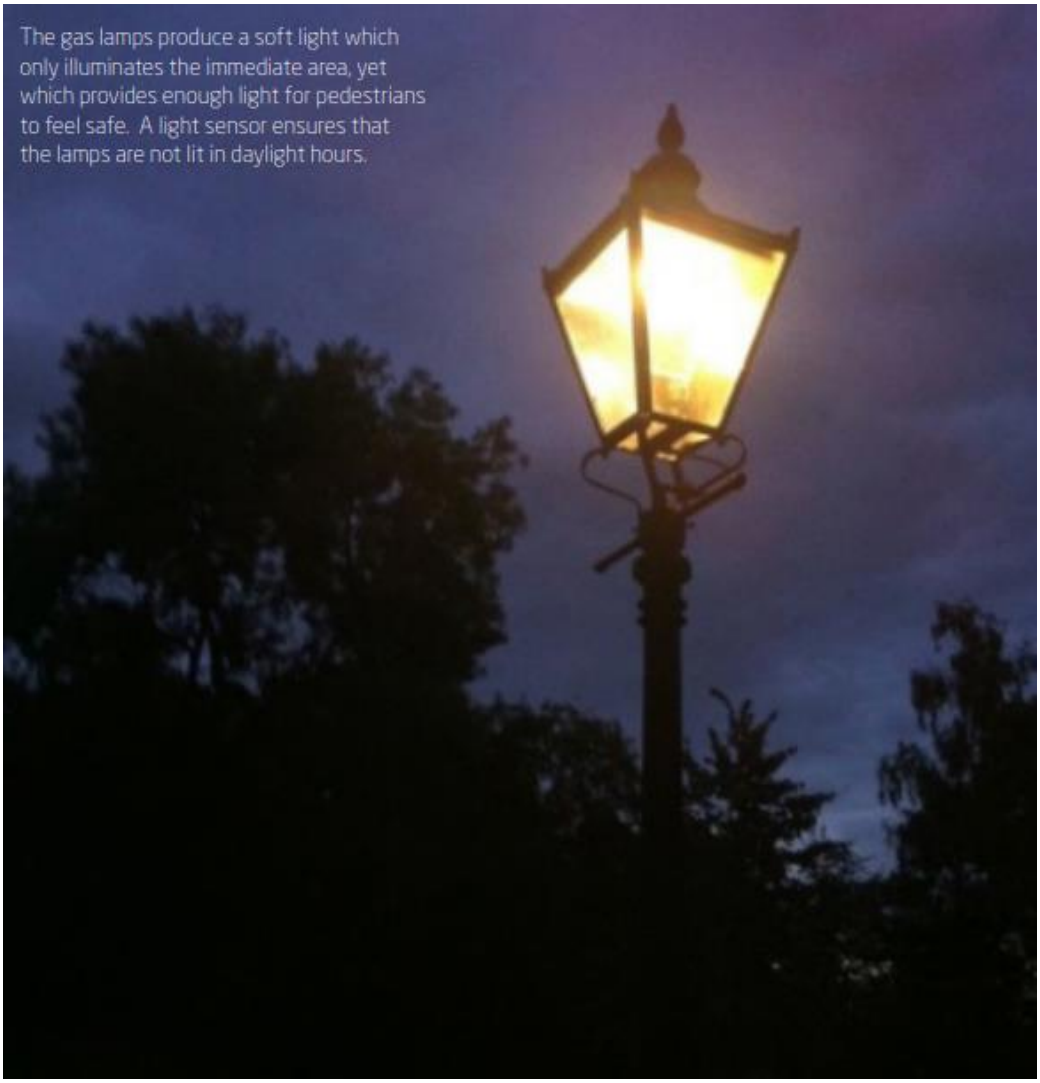
- Determine and set additional mitigations; black-out-blinds, hours of use,

12. Case Studies

12.1 Malvern Victorian Gas Lamps

Malvern's gas lamps are an important part of the town's Victorian heritage. There were once 1250 of them and 104 of the original lamps still survive. Since 2010 the Transition Gasketeers (part of Transition Malvern) have been actively refurbishing and improving them, funded by Malvern Town Council and with considerable volunteer effort.

An improved design has resulted in a brighter light range, an 80% reduction in maintenance costs and a 70% reduction in gas consumption. The lights are now up to 10 times brighter but the modifications have increased light intensity whilst producing near zero light pollution and retaining the characteristic soft glow of the lamps. The renovated lamps have been so successful that new electrically powered 'gas' lamps are now also being installed.



12.2 Street lighting, west Malvern

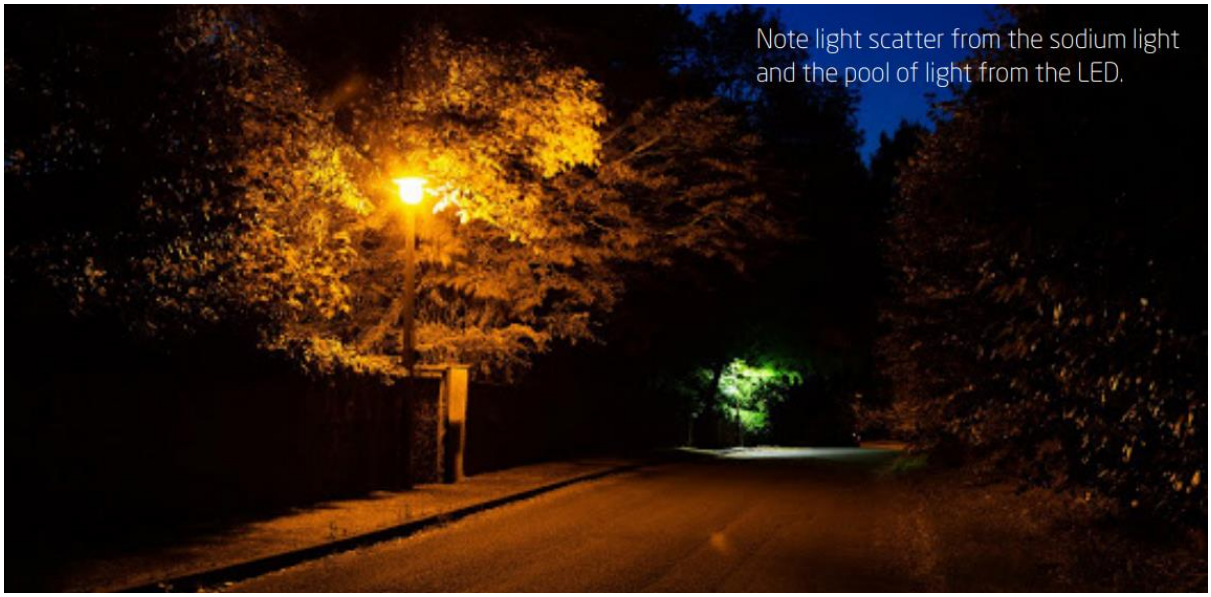


Figure 31 - Contrast between old style sodium street light in foreground and new LED light in background

Old style sodium street lights scatter light in all directions, including upwards to the sky where they cause direct light pollution. These street lights are being replaced throughout the AONB by new, efficient LED lights with full horizontal cut off to minimise glare and sky glow. Worcestershire County Council LED street lights have a colour temperature which is low in the blue light that can have a negative impact on wildlife.

12.3 Warehouse at Blackmore Park

Constructed in 2017/18, care has been taken to reduce the impact of outdoor lighting at this warehouse on the outskirts of Malvern. It sits in a rural setting and is part of the expansive eastern views which people enjoy from the ridge of the Malvern Hills. Lighting is restrained and has been sensitively positioned so that this large site, which is operational at night time, is not over-lit.

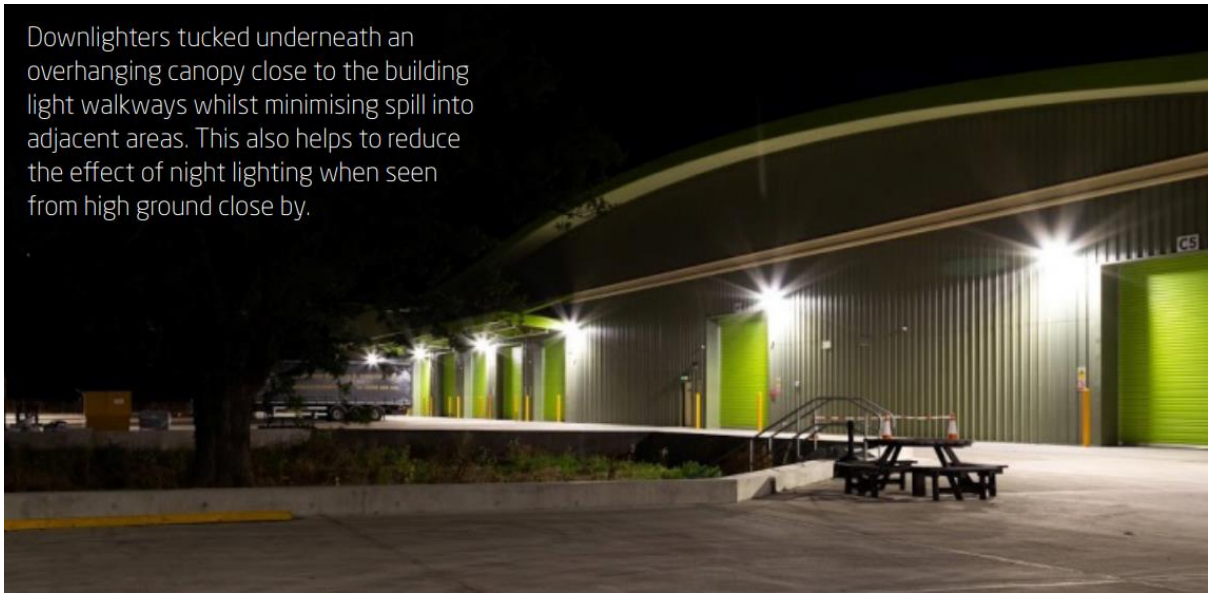


Figure 32 - Downlighters under canopy

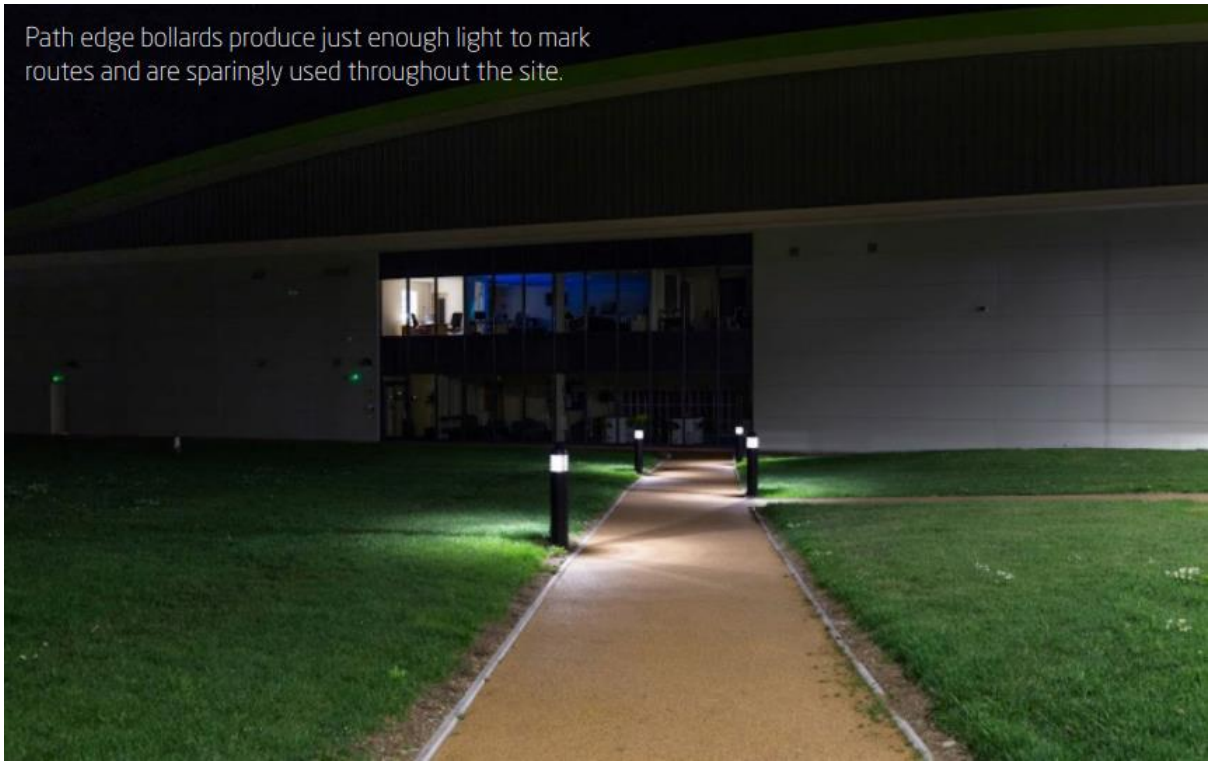


Figure 33 - Path bollards

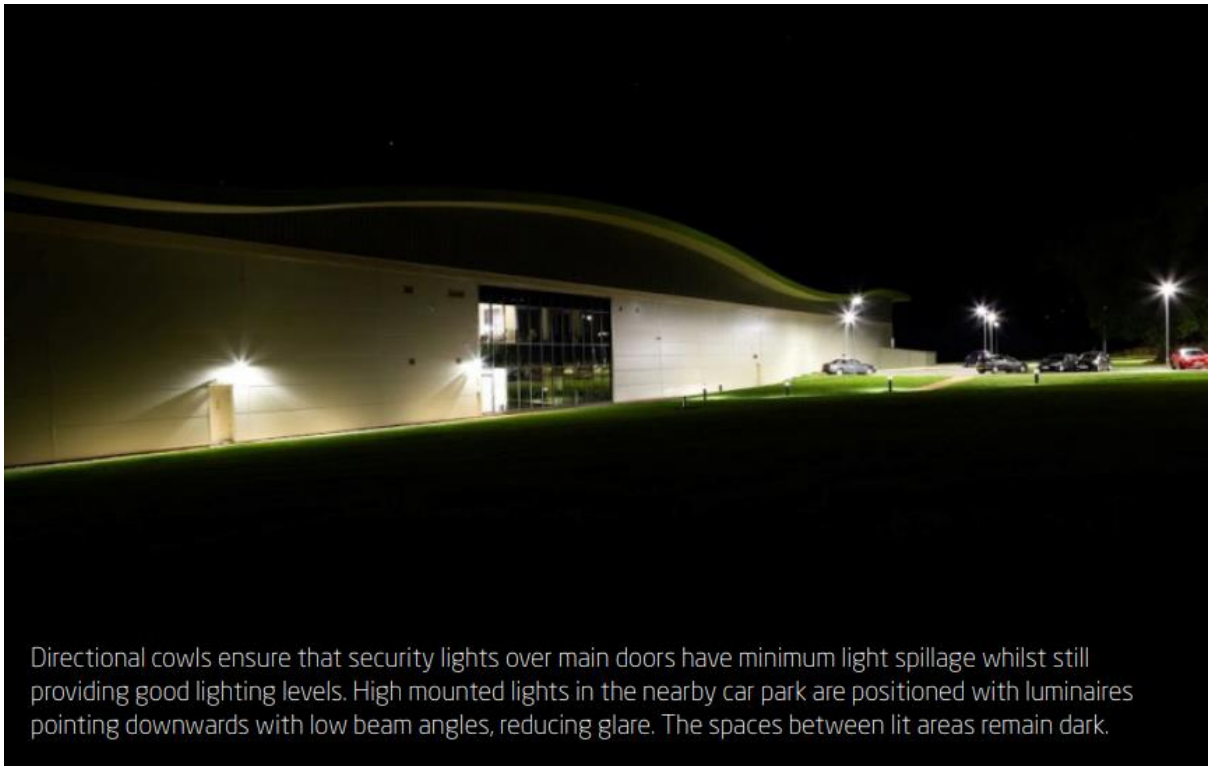


Figure 34 - Restrained site lighting