EXTERNAL LIGHTING MASTER PLAN

for

SAINT HELENA ISLAND

South Atlantic Ocean

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Milky Way Photo by Nick Glover

South Atlantic Island of Saint Helena
Dark Sky Community Status

External Lighting Master-Plan

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1 Preamble

The, then uninhabited, island location was first discovered by Portuguese Admiral Joao da Nova and announced on 21st May 1502, the anniversary of Emperor Constantine's mother, Saint Helena, so giving the little secret island its name today. But it was not until 1659, when Captain John Dutton was commissioned to settle, fortify and plant the island that the English East India Trading Company was given a Royal Charter to colonise St Helena. It is Britain's second oldest Overseas Dependent Territory situated in the South Atlantic Ocean, between West Africa and South America on the mid Atlantic Ridge.

Historically it is probably best known as the island upon which Napoleon Bonaparte was exiled in 1815 but astronomically more important for Edmond Halley (1677), Neville Maskelyne (1761) Lieutenant Manuel Johnson (1826), Thomas Henderson (Scotland's first Astronomer Royal 1834) and General Sir Edward Sabie (1840)

It already has exceptional views of the night sky and the Island Government is seeking Dark Sky status as a means of acknowledging this and providing a framework of improvement and maintenance of such an asset.

Dark Sky Status is seen as a means of:-

Managing all external lighting through promotion of local awareness, education and appropriate legislation as required.
Promoting Astronomical tourism.
Improving the nocturnal environment for a variety of local wildlife which includes birds and marine mammals.
Helping to manage electrical power and fuel usage on the island.

The award of Dark Sky status is subject to meeting a number of criteria set out by the International Dark Sky Association (IDA), whose headquarters is in Arizona USA. Around the World, they identify five distinctive types of Dark Sky Places, namely:-

1) Dark Sky Communities.
2) International Dark Sky Parks.
3) International Dark Sky Reserves.
4) International Dark Sky Sanctuaries.
5) Dark Sky Developments of Distinction.

Details of all these Places can be found on the IDA web site (www.darksky.org), but the nature of St Helena, its isolated location and its Island Government system means that an application for Dark Sky Community status seems to be the most appropriate.

Part of such an application is the preparation and submission of a Lighting Management Plan (LMP), identifying all the factors involved in the identification and management of external lighting. The application sets out strategies for immediate and ongoing long-term light control, together with periodic audits to ensure that the IDA criteria are met and the award status is maintained.

This document is the Lighting Management Plan of the Dark Sky Application.

It sets out the nature of the present situation for St Helena, the IDA requirements for an appropriate Dark Sky Award and the proposals for achieving it, including Legislative and technical requirements.

1.1 Definition of an IDA 'Community'

An IDA Dark Sky Community is a town, city or municipality that has shown exceptional dedication to the preservation of the night sky through the implementation and enforcement of quality lighting codes, dark sky education, and citizen support of dark skies.

The IDA guidelines for Dark Sky Communities were amended in October 2015 and this master plan is designed to incorporate the new light control issues. The IDA rules are produced here for ease of reference, together with the related master plan section number in brackets.

For all Communities (circa 2015) the minimum IDA requirements are

i) The use of fully-shielded or full-cut-off light distribution for all lighting fixtures over 1,500 lumens initial lamp output (or equivalent wattages), *(see section 2.4)*

AND;

ii) The establishment of a threshold of $3,000^0$ Kelvin (K) for the allowable correlated colour temperature (CCT) of all lighting fixtures, *(see section 1.6)*

AND;

iii) Restrictions on the total amount of unshielded lighting, such as a limit on lumens per acre or total site lumens in unshielded fixtures, *(see section 3.4)*

AND;

iv) A policy to address over-lighting, such as energy density caps, lumens/acre caps, or maximum illuminance specifications, *(see section 3.3)*

AND;

v) A provision that clearly:
(1) indicates where, when, and under what circumstances new public outdoor lighting (street lighting and lighting on other public property and rights-of-way) is warranted and will be permitted, *(see section 1.6)*
and
(2) requires that adaptive controls be employed in all future installations of public outdoor lighting. *(see section 2.2)*

These IDA requirements should be recognised as providing a clear statement of intent for future management of stray light.

Future Goals for a Dark Sky Community

- **Promote eco-tourism and astro-tourism.**
- **Promote the protection of human health, nocturnal habitats, public enjoyment of the night sky and promotion of the area for professional or amateur astronomy.**
- **Promote the ideals of the International Dark Sky Association by encouraging other communities to identify a dark sky as a valuable community and tourist asset.**
- **Promote dark sky and neighbourhood friendly lighting.**
- **Promote the continuing maintenance of the night sky darkness quality via the production of an annual account of lighting improvements.**

1.2 Introduction to Saint Helena

This Section contains extracts from several web sites but has been reordered and interspersed with information relating to the general introduction and needs of the widespread readership of this dark sky application.

Saint Helena is located in the South Atlantic Ocean on the Mid-Atlantic Ridge and is therefore composed largely of rugged volcanic terrain. The nearest landmass is 2,000 kilometres (1,200 miles) distant but the island is associated with two other British Territories in the Atlantic namely Ascension Island (about 810 miles due northwest) and Tristan da Cunha (1,510 miles to the south). Despite this remote oceanic location the islands are classified by the United Nations as being in West Africa.

Saint Helena has a total area of 47 square miles (sq mi) (121 square kilometres (km^2) with a household population of around 4,349 (circa 2016) giving it an overall population density of 35.6 residents per square kilometre (/km^2), however, the residential area of Half Tree Hollow has the greatest density at 1640 per sq mi followed by the island capital, Jamestown, at 419 per sq mi. These two residential areas together with the adjacent commerce and cargo storage in Ruperts Bay are therefore the most likely sources of possible light pollution on the island. (for locations see Figure 1.1 following)

The recent Census shows that 98.9% of the occupied properties are connected to the electrical main distribution, however 0.7% of the remaining properties use candles for lighting, 0.2% use bottle gas, 0.2% use battery lights. 0.1% have private generators.

There are 110km of roadway maintained by the Government and although there are 4 island specific categories (main, secondary, minor and unclassified (private)) the norm is single track with passing places. Over 2,300 vehicles are registered on the island and the development of community transport is now seen as a development tool to slow down the rapidly increasing growth in car ownership. Some of the island roads have street lights, however, with a total less than 250 public lighting units this lighting is limited to strategic locations and does not cover the complete island roadways. **From sound environmental policies in the past, public street lighting is by exception rather than the rule**.

There are no sports grounds or car parks and the like floodlit, however, the airport parking apron has been equipped with mast mounted floodlights even although night flights will not be considered for several years to come. This lighting and the associated new Bulk Fuel Installation in Ruperts Valley and the Satellite Communication Station in Briars was not installed when the original sky quality measurements were taken in 2012.

Conservation of nature has been at the forefront of recent development decisions and the latest Development Plan includes defined boundaries for National Parks, Nature Reserves, Heritage Conservation Areas and Important Wirebird Protection Areas (Wirebird is the local name for the Saint Helena Plover). There are also three areas for future coastal villages, two of which are set in National Park areas. One coastal village area (Sandy Bay) has a shore line where Turtles have recently succeeded in hatching young.

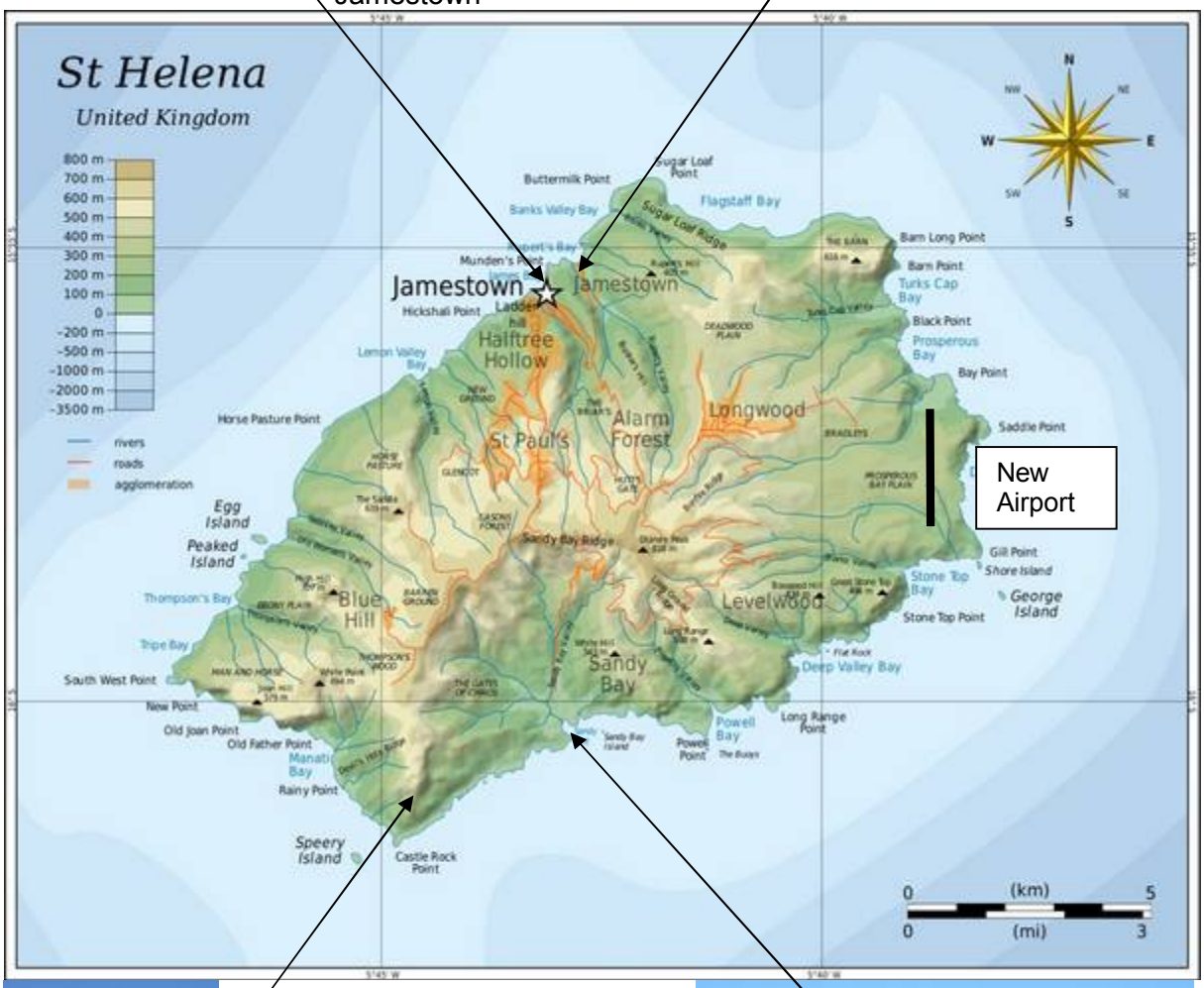
The outline of these nature boundaries together with superimposed night time environmental zone boundaries within each area will be identified later (see Section 2).

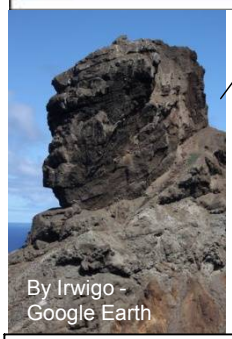
Half Tree Hollow

Jacob's Ladder - 699 steps to Half Tree Hollow

Ruperts

Jamestown





Gorilla Rock

Sandy Bay

Sea Turtle eggs hatch here each year

Figure 1.1 – General Layout of Saint Helena

Figure 1.2 – Aerial view from the West overlooking Ruperts, Jamestown and Half Tree Hollow

Amateur astronomy now forms part of the tourism outreach to attract more visitors as is now recorded in other parts of the UK and the protection of the dark night sky is crucial in this objective. Just as important in promoting tourism, astronomy and the physics of space forms an increasing engagement in secondary school curriculums.

The development of an airport is also critical in increasing tourism and the new construction is now operational.

1.3 Regulation Issues

1.3.1 External Lighting Master Plans

The provision of an external Lighting Master Plan is one of several essentials of the International Dark Sky Association when considering the initial merits of an application for a Dark Sky Award. Although the basic requirements are set out in the previous page the full set of IDA requirements can be found at http://darksky.org/idsp/. Achieving an award from the IDA is not the end of the story but the beginning of a dark sky maintenance programme for years to come. The continued working within the LMP ordinance on new or replacement of old existing lighting units together with the future monitoring of the night sky quality is also a very essential element in promoting the dark sky story.

In the USA lighting regulation differs across the country with the use of light generally governed at municipal level. Where this exists it is often based on reference to the Illuminating Engineering Society of North America (IESNA).

Although Saint Helena is an island in the South Atlantic Ocean this LMP is based on an application relating to the parallel framework which exists within the UK since the island is a British Dependent Territory with its own elected Executive and Legislative Council.

To this end this LMP provides a base document of lighting ordinance to mitigate the effects of stray light into the night sky, generally referred to as **'light pollution'**, from all exterior lighting whether it is intended for residential, public or commercial use. Since light is not a chemical pollutant equivalent words such as **'light intrusion'** or '**light obtrusion**' are often used within the UK to describe the unwanted outward and upward transmission of stray light.

This LMP's principal aim is to provide practical advice on mitigating stray light, which astronomers, and others, may find generally obtrusive.

Reducing upward obtrusive light to assist in a better view of the night sky is of prime importance in this document. To continue allowing light to spill beyond its intended objective also has a direct relationship with poor utilisation of island generated electrical energy.

Although the energy saving content may be perceived as a very small part of the recent climate change agreement in Paris, reducing the obtrusive element of light at night can be physically seen as a visual improvement and appreciated by the general public.

When well designed outdoor lighting is installed in harmony with the environment of a dark sky place, visitors to the area will leave with a positive impression such that the experience is taken home and demanded where they live and work, not just where they take their holidays.

The next section contains the framework of regulation through various Acts of Parliament, tables of professionally approved technical parameters and lighting values contained in British Standards, lighting parameters from the International Lighting Committee (CIE) and other UK Lighting Professional Institutions all of which have been used, at times, in the UK Judiciary.

1.3.2 External Lighting Regulation in the UK

Dark Sky Awards, via the International Dark Sky Association (IDA) in America, are based on the control of upward light into the night sky, however, the wider anti-social effects of obtrusive light in the United Kingdom are not limited to the vision of the night sky.

In **2005** HM Government published the findings of their Science and Technology Committee study on 'Light Pollution' and have now declared some forms of artificial light as a statutory nuisance in the '**Clean Neighbourhoods and Environment Bill**' for England and Wales. In it Clause 102 states that the nuisance is defined as "**artificial light emitted from premises so as to be prejudicial to health or a nuisance**". Similar words can also be found in the Statutory Nuisance provisions of the "**Public Health Etc (Scotland) Act** of **2008**. Although there are several exemptions included in the England & Wales Bill, due to health and safety regulations taking precedence, it is important to note that many of the safety issues in exempt installations can be accommodated, technically, with careful engineering of the artificial light application. Both of these Acts of Parliament have introduced a need for more information on stray light effects presented at planning application stage in the form of lighting impact assessments. These assessments assists in showing the degree of light obtrusion mitigation and include the control of upward light, at the design stage, before it becomes a possible 'nuisance' at installation stage.

In **2007** the Scottish Government published a Planning Guidance Note in which the author of this lighting master plan had an input commission. It contains a lighting design methodology plan to provide designers with a coherent approach to appraising the implications of their lighting design principles together with environmental planning principles. The guidance note also provides local authority planners with the controls necessary to ensure that all new lighting design is carried out and presented in a consistent manner and that the design is in keeping with, or improving, the surrounding environmental conditions. (see www.scotland.gov.uk/Publications/2007/03/14164512/0)

In March **2012** the UK Government introduced the control of 'light pollution' through planning procedures in their National Planning Policy Framework. Although the document applies to the English planning framework paragraph 125 could be adopted, in the absence of an other equivalent model, as good planning practice. The paragraph states "***By encouraging good design, planning policies and decisions should limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation***."
Additionally an associated publication, National Planning Practice Guidance (2014), provides local authorities with a defined link between planning and lighting see http://planningguidance.planningportal.gov.uk/blog/guidance/light-pollution/

Of prime importance here is guidance for all local authorities to set up their own night time environmental zones applicable to all new planning design work.

Plan Statement Number 1

The allocation of night time Environmental Zones is a fundamental aspect of Planning, Engineering and Managing the control of stray light.
Light control limits will then be set by the zone allocation (see section 2.3, 2.4 & 2.5)

As an Oversees Territory of the United Kingdom the island of Saint Helena has its own legislature and empowered to make local laws known as Ordinances.

As a dark sky lighting ordinance suitable for Saint Helena this LMP provides the technical background to the External Lighting Ordinance. It embodies the UK Clean Neighbourhood Acts for planning application control, together with other Professional Institution prepared task lighting values to work within the combined framework of the International Dark Sky Association, the National Policy Planning Framework, and any Statutory or non-Statutory Planning Guidance which has been produced as part of the Saint Helena Land Development Control Plan with strategies of best working lighting practice to follow in:-

- **Planning for lighting at the design stage with appropriate design and planning guidelines before it becomes a statutory nuisance.**
- **Protecting the natural and historic environment including wildlife.**
- **Maintaining or improving the existing dark sky attributes.**
- **Reducing the carbon emissions associated with external lighting.**
- **Preventing glare to respect the amenity of neighbouring properties through the appropriate choice of lighting fixtures and correct lighting installation practice.**

As well as promoting neighbourhood friendly lighting the LMP objectives can be followed to protect, maintain or even, hopefully, improve the existing dark sky attributes synonymous with the low district brightness associated with the local rugged landscape.

EXISTING LEGISLATION in SAINT HELENA

In Saint Helena the proposal to introduce Dark Sky legislation has already been accepted by the Economic Development Committee.

Policy E7 and E8 on page 19, in the Energy Section, of their Land Development Control Plan (2012) infers the need for minimal visual impact and zero light pollution.

1.3.3 Summary of Saint Helena Plan Statements

Plan Statement Number 1

The allocation of night time Environmental Zones is a fundamental aspect of Planning, Engineering and Managing the control of stray light. (See section 1.3) **Light control limits will then be set by the zone allocation** (See section 2)

Plan Statement Number 2

Light sources with a colour temperature greater than 3,000^{o}K or an S/P ratio greater than 1.3 shall not be used within the boundary of a Dark Sky Place. (See section 1.6)

Plan Statement Number 3

Where there are no safety issues involved all new public lighting will be fitted with adaptive light control which operates at a lower lumen output when areas are not occupied. All Public buildings will extinguish feature lighting at an Energy Saving Time of 10pm
(See section 1.6...)

Plan Statement Number 4

Within the boundary of any Dark Sky application it is important to note here that if there is "NO TASK" in operation there should be "NO LIGHT" after 10pm and that the recommended values given could be reduced if "white" light sources are used.
(See section 2.2...)

Plan Statement Number 5

Any existing lighting within the E0-0 Zone shown in Figure 2.2 should be "Fully Cut-Off" (Fully Shielded (IDA term)) regardless of light source lumen output. (See Section 2.3)

Plan Statement Number 6

Residents in the E0 Zone will be encouraged to limit the visual perception of light output by adapting or modifying existing units to this end. (See Section 2.3)

Plan Statement Number 7

The Authority will endeavour to ensure that no lighting will be allowed to be projected from the adjacent light permitted Zones into the E0-0 Zones and any overspill lighting from properties to be no greater than 0.05 lux (horizontal) at ground level or 0.05 lux vertical at 1 metre (or higher) above ground on the E0-0 side of the property boundary. (See Section 2.3)

Plan Statement Number 8

Residents in the E1 communities will be encouraged to limit the overspill light at their property boundary to no more than 1.0 lux.
(See Section 2.4)

Plan Statement Number 9

Through this LMP it will be possible to encourage developers, when required, to adopt and provide a lighting industry professionally prepared submission for planning consideration. (See Section 3.1)

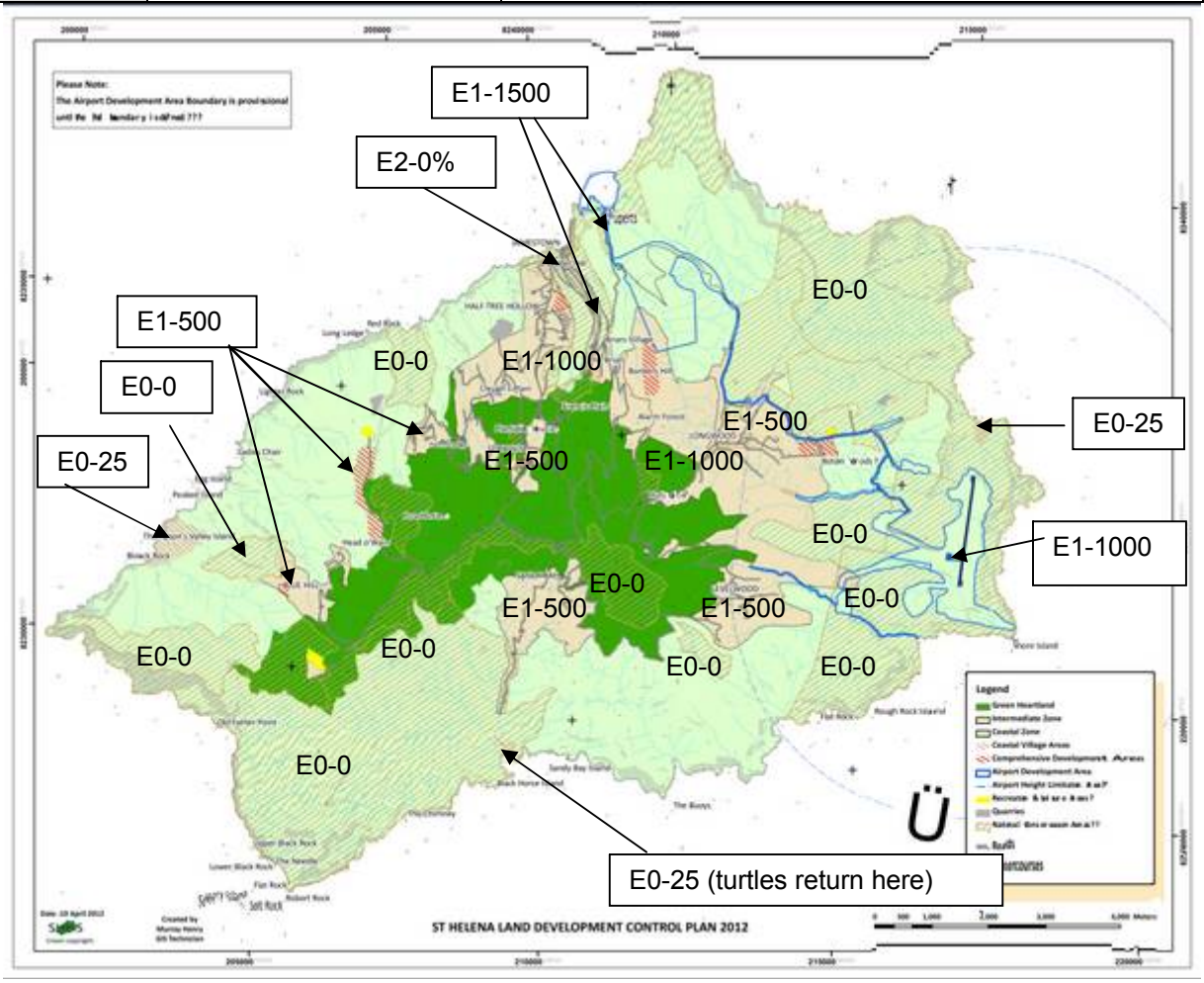
Plan Statement Number 10

All design submissions for new non-residential lighting will be required to show evidence of compliance with the zero candela intensity at 90^0 and above for luminaires in their proposed installed condition and encourage domestic luminaires to be selected from units having some form of upward light control.
(See Section 3.2)

1.3.4 Summary & Plan of Saint Helena Night Environmental Zones

(See Section 2 for a full explanation of the night time environmental zones)

Zone Index	Typical Environment	Light Control Description
E0-0	**National Parks, Nature Reserves & Wirebird Protection**	**No new lighting**
E0-25	**Coastal Village Area or existing property in E0-0 area**	**Fully Cut-off regardless of wattage and no source intensity perceived beyond 25 metres of unit.**
E0-50	**Property in E1 area but just beyond boundary of E0-0 area**	**Fully Cut-off regardless of wattage and no source intensity perceived beyond 50 metres of unit.**
E1-500	**Residential area close to E0-0 area**	**All luminaires with a light source greater than 500 lumens to be horizontal and fully cut-off.**
E1-1000	**Generality of residential area like Half Tree Hollow**	**All luminaires with a light source greater than 1,000 lumens to be horizontal and fully cut-off.**
E1-1500 E2-0%	**Jamestown and Ruperts only**	**All luminaires with a light source greater than 1,500 lumens to be horizontal and fully cut-off.**



1.4 The Astronomers' Viewpoint

Astronomy on Saint Helena has important historical links. In 1675 Edmond Halley, later to become The Astronomer Royal, visited the island and set up an observatory with a large sextant with telescopic sights. While cataloguing the stars in the Southern Hemisphere he observed a transit of Mercury and realised that a transit of Venus would also be possible and thereby determine the size of the Solar System. In 1679 Halley published the results of his observations which included details of 341 southern stars.

Just less than 100 years later the Royal Society sent Nevil Maskelyne and Robert Waddington to Saint Helena in 1761 to witness that year's transit of Venus and make accurate measurements to calculate the actual, rather than relative, scale of the solar system. Unfortunately bad weather prevented vision of the transit but Maskelyne used the journey to trial a method of determining longitude. On 26 February 1765 Maskelyne was appointed Astronomer Royal.

The 1990 Ordnance Survey map of the island shows the location of 4 other later locations of observatories, regrettably, none of the 6 former sites are in use today.

More than 20 years ago the British Astronomical Association (BAA) forged links with the Institution of Lighting Engineers (now the Institution of Lighting Professionals (ILP) to open discussions on the plight of amateur astronomers. The problem was that views of the stars at night were being diminished by stray upward artificial light from outdoor lighting. This included elements such as old style street lighting and poorly installed floodlighting installations, as well as other commercial, advertising and domestic lighting.

This document has been commissioned with the prime objective of promoting the use of the intrinsic darkness to view the stars in the night sky. With careful use of light at night the plan also has an energy saving content on an island which generates its own electricity.

It therefore concentrates on mitigating any obtrusive light elements which could cause a nuisance, from **both** the astronomers' and residents' viewpoints, by:-

- **Creating** a benchmark to achieve International Dark Sky Status from the International Dark-Sky Association (IDA) .
- **Maintaining** or improving the night sky darkness as a background to view the star constellations.
- **Providing** a practical working document for the communities commercial and agricultural use, and be accessible to residents, hoteliers and any other tourist related promotional material.
- **Introducing** the use of good quality lighting equipment with good light control.
- **Adopting** improvement, adaptation or changing outdated existing lighting equipment.

The sky quality over Saint Helena was measured by Steve Owens in 2012 during an 8 day stay. Figure 1.3 shows a summary of the measurements with the full report included in the application preamble. In Figure 1.3 the greater the number in the text box the darker the sky overhead with the darkest area interestingly being near the location of the four disused observatories near Hutts Gate.

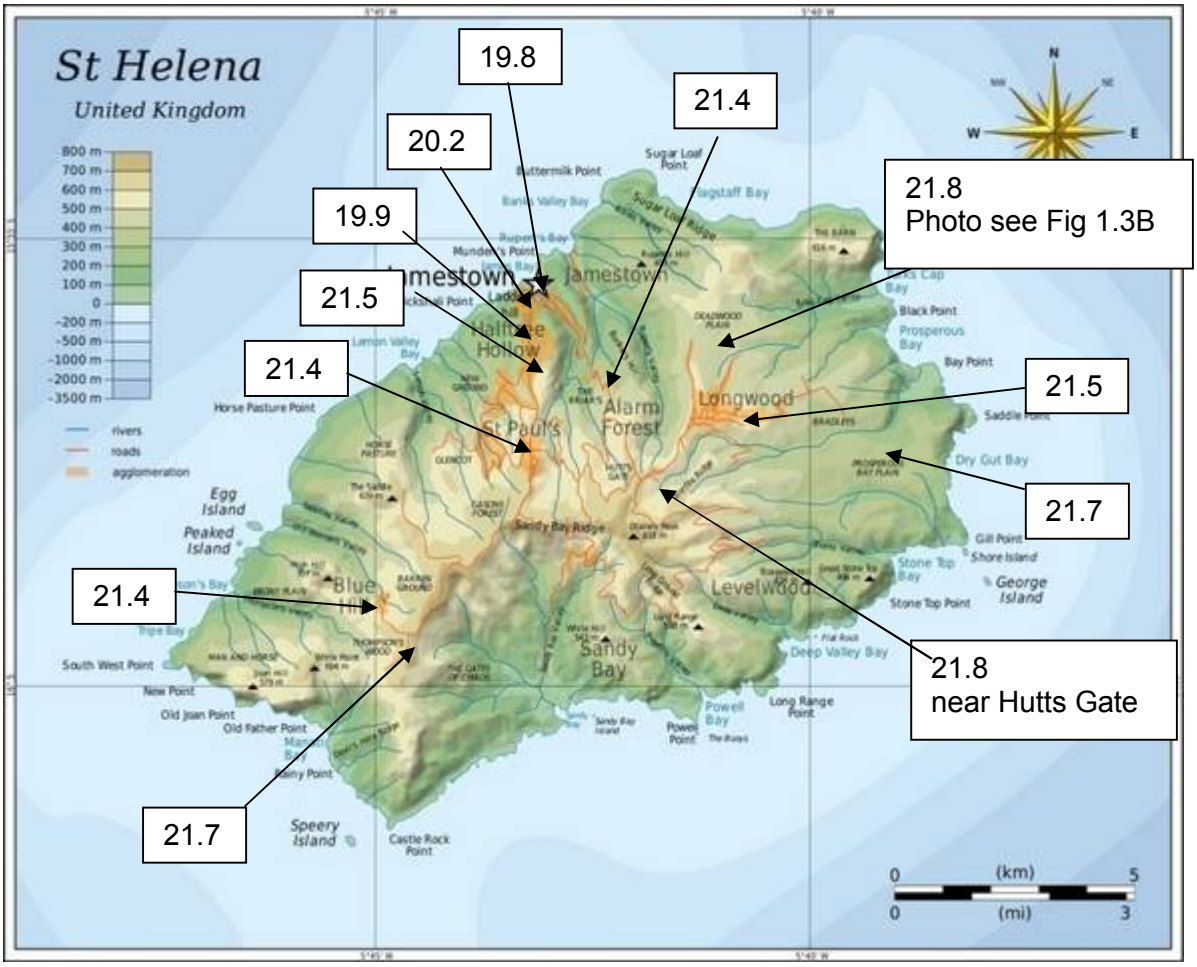


Figure 1.3A
Sky Quality Average measurements (in Magnitudes per square arc second)

Figure 1.3B Sky Quality in Deadwood Plain

Photo by Steve Owens

Figure 1.3c Sky Quality over the Ocean & over High Knoll Fort

Unlike some other countries the UK and Saint Helena have no regulatory governing body which provides exterior lighting. Professional Institutions such as the ILP, the Society of Light and Lighting (SLL), the Commission Internationale de l'Eclairage (CIE) and British Standards all provide illuminating engineering background for engineers to follow and adapt to suit different geographic locations.

Likewise it is important to understand that apart from the Saint Helena Government owned property the authority had no previous statutory powers to change or alter lighting conditions or standards on existing private or commercial property. This role lay in the hands of residents, farmers, commerce and local authority managers to work in partnership and adopt the light control objectives outlined herein.

A future Saint Helena Lighting Ordinance will address this control as a statutory instrument on the island following the testing of the new concepts in this LMP.

Through this LMP future new development designs will be monitored via the planning approval process and developers will be required to follow the principles outlined later. Improvement of poor private lighting will also be encouraged.

1.5 Technical Lighting Data

It is not possible to produce a document on light control without introducing some light technical parameters and when used they will be defined as required with an appendix summary of technical definitions. Detailed explanations of basic lighting terms can be found in Appendix A but in this document the three lighting terms most commonly used for expressing values of light are:

TERM	DESCRIPTION
lumen	Describes the total amount of light given off by a bare lamp. (abbreviation: lm - sometimes klm for 1000 lm))
candela	Describes the intensity (I) of light in a particular direction. (abbreviation: cd)
illuminance	Describes the amount of light falling on a surface area in lumens / square metre. (abbreviation: lux)

Table 1.1 Basic Lighting Terms

This LMP has been devised, principally, to control different forms of stray light. First, and foremost, is upward light which can obscure night-time astronomical observations when it reflects off air- borne particles of water or dust. The effect is commonly known as **sky glow**. However, direct light sources close to any field of observation are also problematic and are discussed later.

In addition to sky glow, astronomers do not like to see a visible source of light either and luminaires with a light source larger than 500 lumens, in a Dark Sky Park, and 1,500 lumens, in a Dark Sky Community, should be what the IDA call "**fully shielded**", ie a completely flat glass window **mounted horizontally**, as shown in Figure 1.4.1 (right). Non-technical terms like this will be explained and mixed with technical descriptions later.

Figure 1.4.1 Fully "Shielded" luminaire

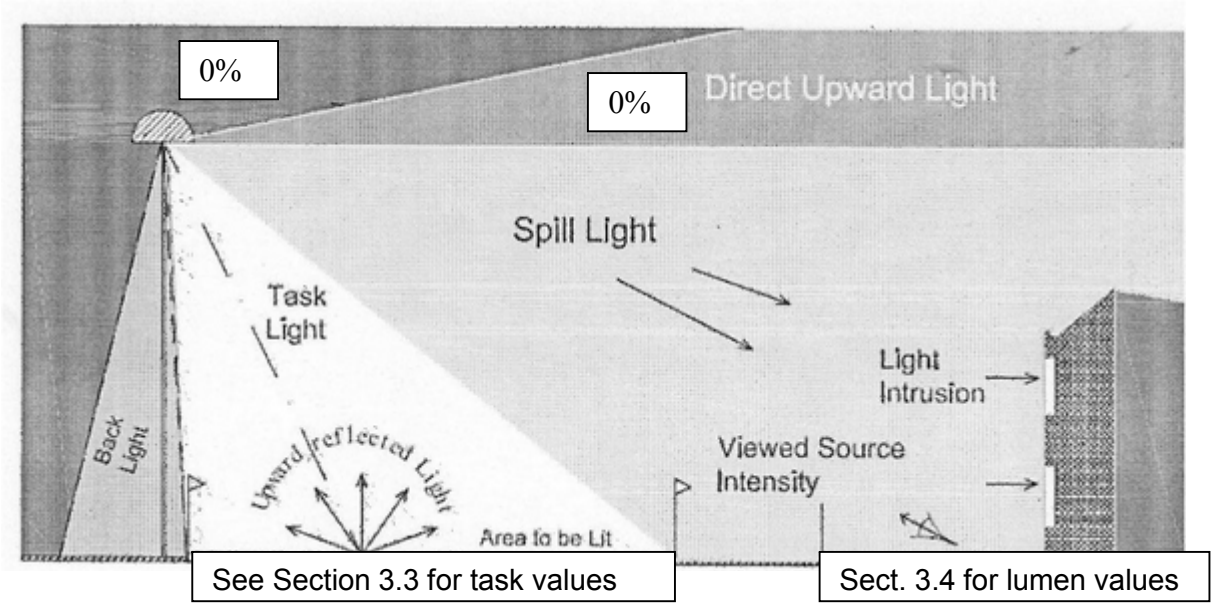


Figure 1.4.2 showing diagrammatic representation of additional types of obtrusive light taken from ILP Guidance Note 01:2011

As shown in Figure 1.4.2 on previous page Direct Upward light and Source Intensity limitation are only two of four aspects of stray light control explained in two complementary technical publications on the limitation of obtrusive light namely:-

- The Institution of Lighting Professionals (**ILP)** 'Guidelines for the Control of Obtrusive Light' GN01:2011
  and
- The Commission Internationale de l'Eclairage (**CIE**) Technical Report 150:2003 'Guide on the limitation of the effects of obtrusive light from outdoor lighting installations'.

Both documents support the concept of setting out environmental zones based on the night time ambient light in the area. They then go on to recommend differing degrees of stray light control for each of 5 environmental zones. The most onerous limitation is in the zone of darkest ambience namely Environmental Zone E0 where no new light presence will be permitted. Both documents also support the concept of creating subset zones to meet specific environmental needs and this LMP adopts this variation in three of the environmental zones.

Table 1.2 - Typical Environmental Zones in the UK (Table 1 in ILP GN01:2011)

Zone Number	Surrounding	Night Environment	Typical examples
E0	Protected	Dark	Starlight Reserves, Dark Sky Parks *or Islands, Typical of Dark Sky Reserve Core Zones*
E1	Natural	Intrinsically dark	UK National Parks, Areas of Outstanding Natural Beauty *or Dark Sky Park Buffer or Island Core*
E2	Rural	Low district brightness	Village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Suburban residential / commercial or small town centre locations
E4	Urban	High district brightness	Large town, commercial area or city centre with high levels of night time activity

Saint Helena has a very diverse environment and from Table 1.2 there is a possibility that, Environmental Zone E0, E1 and possibly E2 may be the norm, however, reference to GN01 shows that an upward light ratio of 2.5% is typical in the E2 zone. This is **not** an attribute expected in a dark sky application. Variations and adaptations of the CIE / ILP zones with typical light limiting factors to promote this Dark Sky application will follow in Section 2.

In addition to direct upward light limitations Dr Christopher Baddiley has shown in 'Towards Understanding Skyglow' (ILE:2007) that obtrusive glare from street lighting units, at or near the luminaire horizontal axis, can also diminish the astronomers' observations so the source horizontal intensity is also used in this LMP as a further means of providing both public nuisance reduction and better astronomical observations.

The simplistic polar diagram in Figure 1.5 is a traditional way of illustrating a line of maximum intensity through the major and minor axis of a street lighting luminaire. For clarity Figure 1.5 shows only the major axis distribution for a street lighting luminaire ie the intensity of light emitted out of each side of the luminaire together with three angles where intensity limitations will be later applied to control horizontal and upward light, and a further two downward angles which are used in BS 13201 to control disability glare on the public road network. Recent research has also shown that downward intensity values at an angle of 70 degrees has an effect on the amount of light reflected upwards, off hard surfaces eg. highway / footpaths.

Regardless of luminaire light distribution characteristics recent research has also, more importantly, shown that off highway light absorbing landscape such as natural grass can reduce, by half, the upward reflected light of the installation and the use of asphalt surface lowers by half the upward light reflected off concrete.

Throughout this LMP Upward light control limitations are stated for the luminaire in its designed or "as-installed" condition on site and is not a factory measured parameter.

For industry consistency all photometric light distribution intensity values are based on the candela / 1000 lamp lumens method (sometimes abbreviated to cd/klm). The values shown in Figure 1.5 are typical of the most onerous light control values with the values at and above 90^0 equalling zero candelas. This condition is ideal in mitigating unwanted upward light.

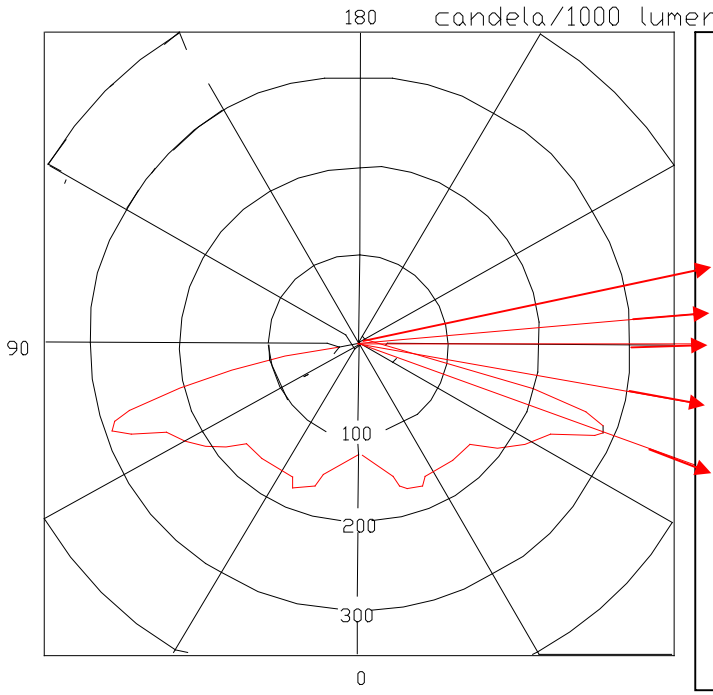


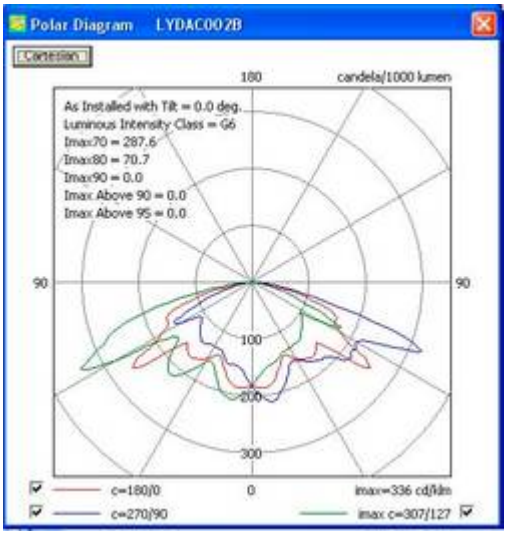
Figure 1.5 - Polar Diagram of typical street lighting luminaire

Also shows the angles and maximum intensity values for a "fully shielded (cut-off)" luminaire
Imax above 95^0 = 0 candela
Imax above 90^0 = 0 candela
Imax at 90^0 = 0 candela

Imax at 80^0 = 100 cd/klm

Imax at 70^0 = 350 cd/k/lm

Tables extracted from BS publications will show all 5 angles with restrictions relative to glare control but in this LMP the important angles will be the intensity of **zero** at 90^0 and above.



Industry standard design software like Lighting Reality can be used to check luminaire "as installed" intensity values in a dynamic format as shown in Figure 1.6 at any stage in the lighting design process.

Another technical way of describing the limitation of upward light from luminaires is called the Upward Light Output Ratio and the ILP are considering the values of upward zonal flux in future editions.

Fig 1.6 Polar and Glare Class output example from Lighting Reality

In addition to the IDA term of "fully shielded" other non-technical terms like high beam, semi cut-off, cut-off, fully cut-off and aero-screened have, in the past, been used in the UK to categorise a luminaire's light distribution. These luminaire category terms disappeared from the lighting industry usage in Europe and the UK some 30-40 years ago but sometimes still appear in UK planning publications. These old terms have therefore been combined, in this LMP, with more accurate technical descriptions with recommended limitations on intensity values in Section 2.

1.6 Colour Temperature

Although monochromatic low pressure sodium light is simple to filter out of astronomical observations a well controlled, zero upward light, white light source should be a more acceptable compromise with some energy saving advantages. Filtering out certain wavelengths of artificial light, however, has the effect of reducing the visibility of low magnitude stars by a factor of at least 4 (equivalent to 2 F-stops in a camera aperture).

The colour rendering index (R_a) of a standard high pressure sodium lamp (SON) (yellow coloured light) is about 20 but the colour rendering index of ceramic metal discharge lamp (CMD) (true white light) is better than 65 and some newer light sources are achieving >80.

Various research projects, carried out over several years (see ILP PGN 03:2013), have proved that human vision works better with high order colour rendering and in some tasks the illuminance design target value can be reduced by the Photopic / Scotopic (S/P) ratio if 'white' light is used instead of 'yellow' light. This S/P ratio varies with different light sources and different colour temperatures and the proportional reductions for possible light sources in this application are shown in Table 1.5. Different luminaire manufacturers publish their own S/P ratios and the values shown in Table 1.3 have been set to suit solar powered ISL Escafeld luminaires currently on test in Saint Helena and **should not be taken as generic**.

Table 1.3 Reduced Target Illuminance depending on S/P Ratio

Baseline Target Values in BS13201 $R_a < 60$		S/P = 1.2 ISL Escafeld					
Eav (lux)	**Emin** (lux)	**Eav** (lux)	**Emin** (lux)				
15.0	5.0	**13.40**	**2.70**				
10.0	3.0	**8.60**	**1.70**				
7.5	1.5	**6.30**	**1.30**				
5.0	1.0	**4.00**	**0.80**				
3.0	0.6	**2.20**	**0.40**				
2.0	0.4	**1.40**	**0.40**				
		Values above derived by linear interpolation from base values published in ILP PGN 03					

Light sources achieving an R_a > 80 are often in the Correlated Colour Temperature (CCT) range of 6000^{0}K and although ocular vision research has proved a case of improved visual acuity with "white light" current health research in the UK and the USA is studying the possible disturbing effect on the human circadian rhythm from "blue rich" white light and on the mental well being of humans and animals. (See Appendix A for Warm or Neutral White LED light source recommendations)
Until more information is available the IDA are adopting the use of 3,000^{0}K colour temperature or an S/P ratio of no more than 1.3.

Plan Statement Number 2

Light sources with a colour temperature greater than 3,000^{o}K or an S/P ratio greater than 1.3 shall not be used within the boundary of an IDA Dark Sky Place.

Although BSEN 13201 recommends that average values should not be reduced lower than 2 lux there is no visual reason why 1 lux cannot be used on private paths or roads in rural locations, where appropriate, and only if lighting is found to be absolutely necessary.

Typical street lighting Design Objectives shown on the following tables have been compiled from information in BSEN13201 - 'Code of practice for the design of road lighting' (parts 1 and 2). It has been designed for the limited use on Saint Helena to provide a simple selection process for typical light levels and quality criteria. The road lighting solution is derived from assessment of environmental zones, user types, user volume and other criteria via a points system.

Table 1.4 Values Typical of Jamestown

Criteria	Measure Words	E-average	E-minimum
Speed	low / ~~very low (walking)~~		
Night Volume	~~busy /norma~~l / quiet		
Traffic Composition	Pedestrians, cyclists and motorized traffic		
	~~Pedestrians and motorized traffic~~		
	Pedestrians and Cyclists only		
	Pedestrians only		
	Cyclists Only		
Parked Vehicles	present ~~/ not present~~		
Ambient Luminance	~~high / moderate~~ / low		
Facial Recognition	essential /~~ not essential~~		
	LED S/P=1.2	4.0lux	0.8lux
P4	warm white metal halide	4.0lux	0.8lux
	SON	5.0lux	1.0lux

Table 1.5 Values Typical of Ruperts

Criteria	Measure Words	E-average	E-minimum
Speed	low / ~~very low (walking)~~		
Night Volume	~~busy~~ /~~normal~~ / quiet		
Traffic Composition	~~Pedestrians, cyclists and motorized~~ traffic		
	Pedestrians and motorized traffic		
	~~Pedestrians and Cyclists only~~		
	~~Pedestrians only~~		
	~~Cyclists Only~~		
Parked Vehicles	present / ~~not present~~		
Ambient Luminance	~~high~~ / ~~moderate~~ / low		
Facial Recognition	essential / ~~not essential~~		
	LED S/P=1.2	2.2lux	0.4lux
P5	warm white metal halide	2.2lux	0.4lux
	SON	3lux	0.6lux

Table 1.6 Values Typical of Half Tree Hollow

Criteria	Measure Words	E-average	E-minimum
Speed	low / ~~very low (walking)~~		
Night Volume	~~busy /normal~~ / quiet		
Traffic Composition	Pedestrians, cyclists and motorized traffic		
	~~Pedestrians and motorized traffic~~		
	Pedestrians and Cyclists only		
	Pedestrians only		
	Cyclists Only		
Parked Vehicles	present / ~~not present~~		
Ambient Luminance	~~high / moderate~~ / low		
Facial Recognition	~~essential~~ / not essential		
	LED S/P=1.2	2.2lux	0.4lux
P5	metal halide		

Table 1.7 Values Typical of Longwood

Criteria	Measure Words	E-average	E-minimum
Speed	low / ~~very low (walking)~~		
Night Volume	~~busy /normal~~ / quiet		
Traffic Composition	~~Pedestrians, cyclists and motorized~~ traffic		
	Pedestrians and motorized traffic		
	Pedestrians and Cyclists only		
	Pedestrians only		
	Cyclists Only		
Parked Vehicles	present / ~~not present~~		
Ambient Luminance	~~high / moderate~~ / low		
Facial Recognition	~~essential~~ / not essential		
P6	LED S/P=1.2	1.4lux	0.4lux
	metal halide		

When new publicly-owned buildings and other facilities are constructed, or new public rights-of-way are established, the installation of new outdoor lighting fixtures shall be allowed only when
(1) a specific need related to a hazardous night time situation is identified by the local authority
And
(2) lighting is deemed necessary as a matter of ensuring public safety.

Plan Statement Number 3

Where there are no safety issues involved all new public lighting will be fitted with adaptive light control which operates at a lower lumen output when areas are not occupied. All Public buildings will extinguish feature lighting at an Energy Saving Time of 10pm

2 Dark Sky Community Concept and Basic Light Limitation Plan

2.1 Concept

As indicated in section 1.2 the natural landscape and land use on Saint Helena is very diverse throughout the island and in addition to providing various environmental zones this plan introduces different lumen caps to suit the diverse environment. The IDA lumen cap of 1,500 (see Section 1.1) may be acceptable in parts of the island like Ruperts or Jamestown but would not be a suitable light source output in, or close to, the environmentally sensitive areas on the island.

This LMP therefore introduces hybrid variations to the traditional CIE / ILP environmental zone settings and also the IDA lumen cap.

As such the area will require the application of, in whole or in part, fully cut-off (fully shielded) luminaires and the next section contains a method of describing the quality of light cut-off control in numeric terms for luminaires with a light source greater than 1,500, 1,000 and 500 lumens in different parts the island. These lumen caps relate to luminaires which are not fully shielded (IDA term).

Many domestic external lighting fittings use lamps less than 1,000 lumens and although many variations on a theme can be found there are principally 3 different luminaire styles: Heritage (Figure 2.1.1), Bulkheads (Figure 2.1.2), and Floodlights (Figure 2.1.3).

Figure 2.1.1

Figure 2.1.2

Figure 2.1.3

A few other styles may also be found but the important element is not the style of the luminaire but its associated lamp output and more importantly the distribution of light being emitted. Figure 2.1.4 (day and night) shows a typical eyelid bulkhead with a hood which could give the impression that the hood limits upward light, the night time shot shows almost zero upward light control.

Fig 2.1.4 day

Fig 2.1.4 night

Most of the tungsten halogen floodlights in residential use and many non-residential lighting units use lamps which have an output greater than the lumen cap of 1,500 lumens.

To be fully compliant with the IDA recommendations, the glass window must be totally horizontal (Fully Shielded) as shown previously in Section 1.5 (Figure 1.4). Floodlights which are tilted upwards can sometimes create a source of annoyance to residents in an intrinsically dark setting. (See Appendix G for a self audit improvement)

2.2 Energy Saving Time

Many commercial premises have labels attached to light switches to say “switch off lights when room is not in use” and some buildings have energy management systems which automatically detect occupation and adjust accordingly. External lighting should be similarly treated, not only to limit energy usage but also to reduce the impact on the night sky.

Many domestic exterior luminaires can be purchased with a combined passive infra-red (PIR) presence detector and photoelectric switch unit (PECU) to do the same work as the commercial building management system. A time delay switch is just as good and it has the added advantage over PIR detection in that the luminaires will not be turned on by cats, dogs or other wildlife movement and will ensure that lights are not accidentally left on overnight.

The Environmental Zone tables which follow gives intensity recommendations for Pre and Post - 22.00 hours.

All residential and business occupiers will be helped to recognise the benefits switching off unwanted lights or adopt some form of light reduction after the time limitation of 22.00 hours. Even if the luminaire is not fitted with presence or darkness detection some DIY stores supply programmable light switches which are designed to replace existing internal manually operated switches.

Plan Statement Number 4

Within the boundary of any Dark Sky application it is important to note here that if there is “NO TASK” in operation there should be “NO LIGHT” after 10pm and that the recommended values given could be reduced if “white” light sources are used.

2.3 Basic Light Limitation Plan - Environmental Zone E0's

The first UK Dark Sky Place, Galloway Forest Dark Sky Park contained an area of zero inhabitants and within that area the plan of no new lighting was sustainable within what is known in the IDA as a Core Zone and that was described as a possible E0 in 2009, prior to the CIE/ILP recognition in 2011 of the values shown in Table 2.1.

Table 2.1 E0 - CIE/ILP guidance

Environmental Zone	Sky Glow ULR %	Light Intrusion (into windows) $E_{vertical}$ (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m^2)	
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	
E0	0	0	0	0	0	0	-

There are now "Core Zones" in other Dark Sky Reserves where there are remote farms and residences within the "Core" boundary where the "no new lighting" concept is not sustainable. However, an equivalent effect may be achieved and can be sustainable if the visual perception of source intensity is limited to the immediate vicinity of the property or the property boundary.

Although there are areas of this application which have zero or very little habitation they are not cohesive as expected in an IDA Dark Sky Reserve "Core Zone". Although there are no "Core Zones" expected by the IDA in a Dark Sky Community application the protection of these uninhabited areas is just as important. In this application, therefore, Table 2.2 shows adaptations of the CIE/ILP published values to replace the words "Core Zone" with three assessment notes below (added by this LMP) to identify where "presence" can be measured depending on the property location. Within an E0 zone a distance limit of 25 metres is appropriate and in an immediately adjacent E1 zone location a measurement distance of 50 metres should be applied, assuming in both situations that the property boundary is more distant.

Table 2.2 Stray light control where residences are located in or adjacent to E0 Zones

Night Time Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) $E_{vertical}$ (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m^2)	Assessment Point Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre & Post -10pm	Ev or Eh (lux)
E0-0	No New External Lighting Units Permitted - see Figure 2.2 for boundary (excluding the need for red filtered navigation / marker lights)						
E0-25	0	0	0	0*	0*	0	0.25
E0-50	0	0	0	0**	0**	0	0.10
No street lighting in E0 Zones							
© LCaDS 2016							(IESNA = 0.5 lux)

(See following page for *ed assessment notes associated with Table 2.2)

Assessment Note 1 Measurement or calculation of light intrusion should be in the vertical plane and parallel with the window pane in its centre.

*** Assessment Note 2** Measurement or calculation of the source intensity should be based on a 1.5 metre high visual receptor placed at 25 meters beyond the new light source.

**** Assessment Note 3** Measurement or calculation of the source intensity should be based on a 1.5 metre high visual receptor placed at 50 meters beyond the new light source.

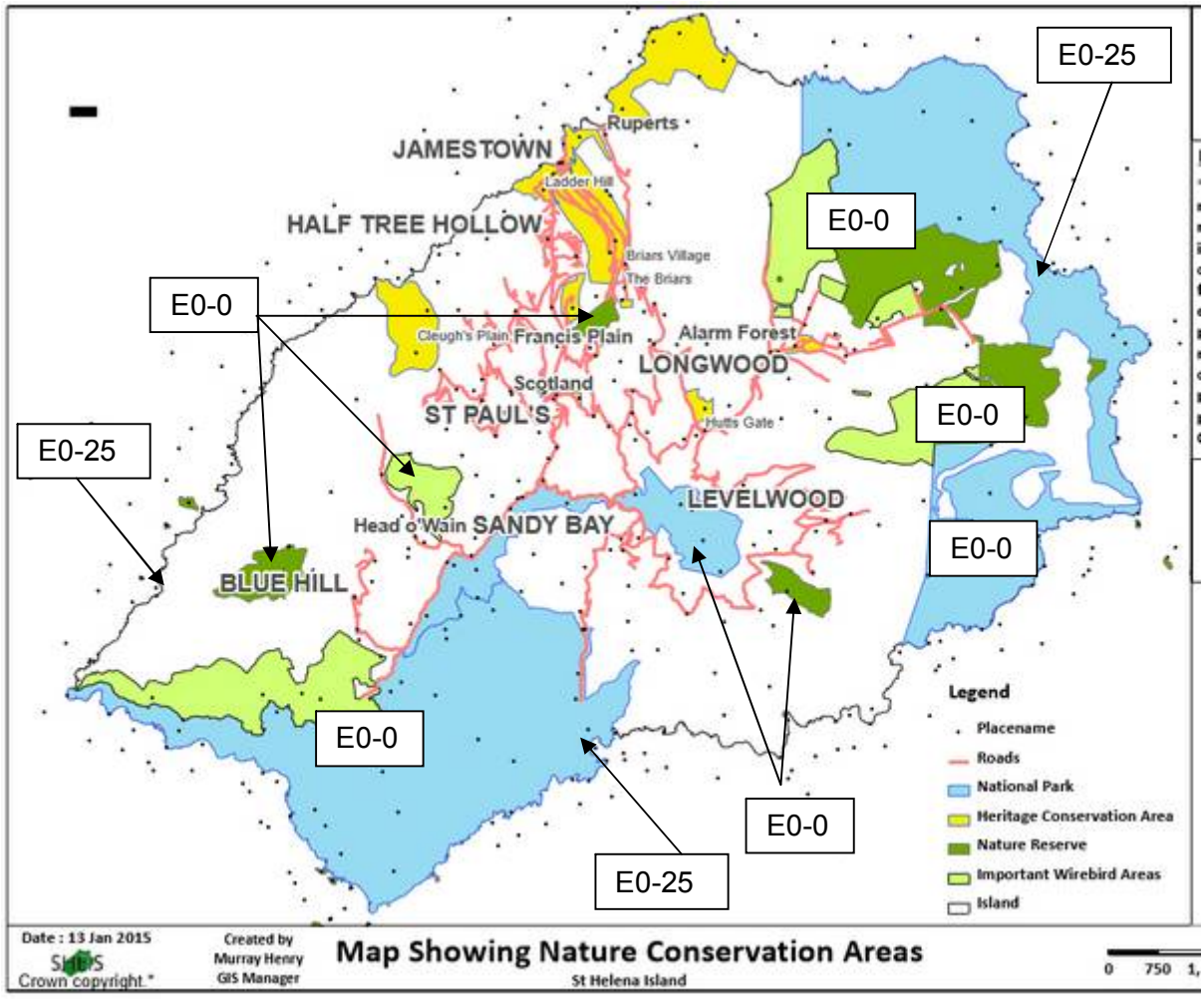


Figure 2.2 Environmental Zone E0-0 in areas coloured blue, light green and dark green

Within the boundaries shown in Figure 2.2 there are 8 residential properties of which 1 is lit by candle power and is only occupied for short periods. The residential properties are in the Sandy Bay National Park and there is a Church in the Peaks National Park.

Figure 2.2 also contains the light limitation (E0-25) for properties in the future coastal village developments namely Thompson's Bay, Sandy Bay and Prosperous Bay.

The E0-0 protection area boundaries may reduce in size through time as new development areas are required to meet the needs of the island.

Plan Statement Number 5

Any existing lighting within the E0-0 Zone shown in Figure 2.2 should be "Fully Cut-Off" (Fully Shielded (IDA term)) regardless of light source lumen output.

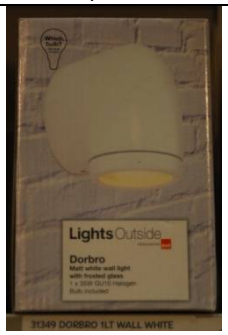
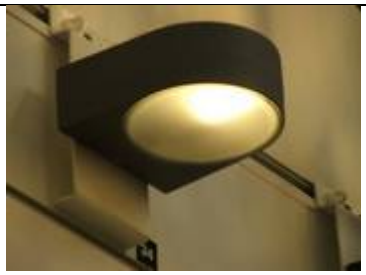
Plan Statement Number 6

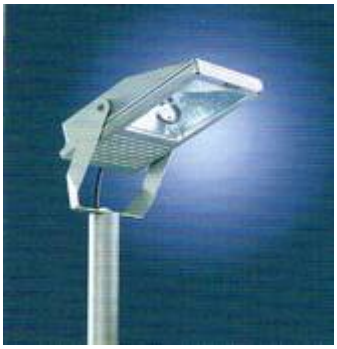
Residents in the E0 Zones will be encouraged to limit the visual perception of light output by adapting or modifying existing units to this end.

Plan Statement Number 7

The Authority will endeavour to ensure that no lighting will be allowed to be projected from the adjacent light permitted Zones into the E0-0 Zones and any overspill lighting from properties to be no greater than 0.05 lux (horizontal) at ground level or 0.05 lux vertical at 1 metre (or higher) above ground on the E0-0 side of the property boundary.

Figure 2.3 Typical external domestic fittings which can provide the fully cut-off objectives of Plan Statement Number 5 and 6 when mounted correctly

 Deltalight	 LED Deltalight	 Zumtobel -
 Kont Smide + others	 Kont Smide - Torino	 Kont Smide - Modena
 liteCraft Stainless Wall Light + B&Q & others	 liteCraft Dacu 2x1 watt LED	 liteCraft Savona (shielded version)
 B&Q Solar Power 330 lumens	 B&Q Solar Power Sirah	
 B&Q Midas LED		 B&Q Merak

<table>
<tr>
<td>  </td>
<td>Sitco + Others - Double Asymmetric Mini Flood

All floodlights like this are designed to be mounted horizontally (not as shown in manufacturer's illustration)

Additional shielding as illustrated right can limit light at task area boundary</td>
<td> 
  </td>
</tr>
<tr>
<td>B&Q Canopus
 
</td>
<td> 
B&Q Bohm LED 1,100 lumens 3,000K warm white</td>
<td> 

B&Q led Telamon 2800, 1,800 or 800 lumens but must be horizontal
DANGER
Currently only available in 5,000K cool white and not suitable in dark sky area</td>
</tr>
</table>

Figure 2.3 Typical external domestic fittings which can provide the fully cut-off objectives of Plan Statement Number 5 and 6 when mounted correctly

2.4 Basic Light Limitation Plan - Environmental Zone E1

As indicated in Section 1.1 the first and foremost rule the IDA have set to limit 'light pollution' is the insistence that all lighting units which use a light source greater than 1,500 lumens must be installed horizontal and emit no light at and above the horizontal. This lumen cap is applicable in Jamestown and Ruperts where the general location is lower than the surrounding countryside.

With the exception of Jamestown Centre (see Section 2.5) and the protected nature zones the remainder of the island falls within the E1 Environmental Zone, however , to reduce the visual impact close to the environmentally sensitive areas identified in section 2.3 a further two level lumen cap should be applied to the requirement of fully shielded lighting. As previously indicated 1,500 lumens, 1,000 lumens and 500 lumens would fit in with the island's varying diversity.

These lumen caps relate to the maximum lumens permitted in non-conforming luminaires with poor light control. If the design and installation of the luminaire limits light distribution to completely below the horizontal plane there is no need for a cap limit on the lumen output.

The map shown in Figure 2.4 shows the residential locations close to environmentally sensitive areas where the lumen cap of 500 should be applied (see E1-500) and other less sensitive areas where the lumen cap of 1,000 can be applied.

E1-500 means that all luminaires in that area with a light source greater than 500 lumens must be fully cut-off (fully shielded IDA term)

E1-1000 means that all luminaires in that area with a light source greater than 1,000 lumens must be fully cut-off (fully shielded IDA term)

E1-1500 means that all luminaires in that area with a light source greater than 1,500 lumens must be fully cut-off (fully shielded IDA term)

For luminaires with a light source greater than the respective lumen cap the CIE and ILP classify upward light as one segment above 90^0 but may consider upward light ratios in two segments in a future publication. This document therefore uses a modified derivative of the glare restriction table in BS13201 until new UK data is published.

With the exception of most domestic style luminaires (like those shown in Appendix C) the luminous intensity from a luminaire is derived from photometric information, which has been measured under laboratory conditions. These measured values describe the luminaire's light distribution in numeric electronic format (commonly known as I-tables in IES, TM14 or any other software recognised format).

From the I-table for a particular luminaire and its installed angle of elevation the intensity of light at different elevation angles can be computed and classified in glare classes, namely G1 to G6, as shown in Figure 1.6. G1 is the most relaxed and G6 is the most restrictive. G6 is the recommended restriction which should be applied throughout the E1 areas as shown in Table 2.3 (following page).

Appendix D contains photographic profiles of some luminaires with light sources greater than 1,500 lumens and complying with the upper (and some lower) intensity limits of table 2.3.

Table 2.3 - Intensity limitation in E1 Zone

Dark Sky Requirements	Glare Class	Maximum luminous intensity in cd/klm				Non technical description of luminaire light control in installed location
		at 70^{0} up	at 80^{0} up	at 90^{0} up	above 95^{0} up	
Rural landscape	G6	350	100	0	0	Fully Cut-off (fully shielded) installation for all luminaires with source > lumen cap

Note ^{up} Table 2.3 restrictions apply at the luminaire's installed angle of zero upwards tilt

The application of zero intensity at and above the horizontal (90^{0}) in an E1 environmental zone is essential. The values of intensity below 90^{0} are not as essential but will provide good glare restriction if achieved.

Although it is not part of the IDA 'light pollution' limitation the application of additional intensity controls presented in Table 2.5, following, will mitigate any obtrusive lighting elements in an E1 Environmental Zone. This table should be considered in tandem with the task design stage for all new exterior lighting and can play an important presentation attribute when presented at planning application stage to show that neighbourhood friendly lighting as well as dark sky friendly lighting is being proposed.

Table 2.5 Obtrusive Light Marker Points

E1-DSC Adaptation							
Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) $E_{vertical}$ (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m^2)	Property Boundary Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	Ev or Eh (lux)
E1-500 area	0	0.5	0.25*	500	0	0	0.50
E1-1000 area	0	2	0.25*	1,000	0	0	1.0 (IESNA)
E1-1500 (Residential)	0%	2.5	1	2,500	0	0	1.0
© LCaDS 2018							

* light from street lighting if installed - otherwise 0

Plan Statement Number 8

Residents in the E1 communities will be encouraged to limit the overspill light at their property boundary to no more than 1 lux.

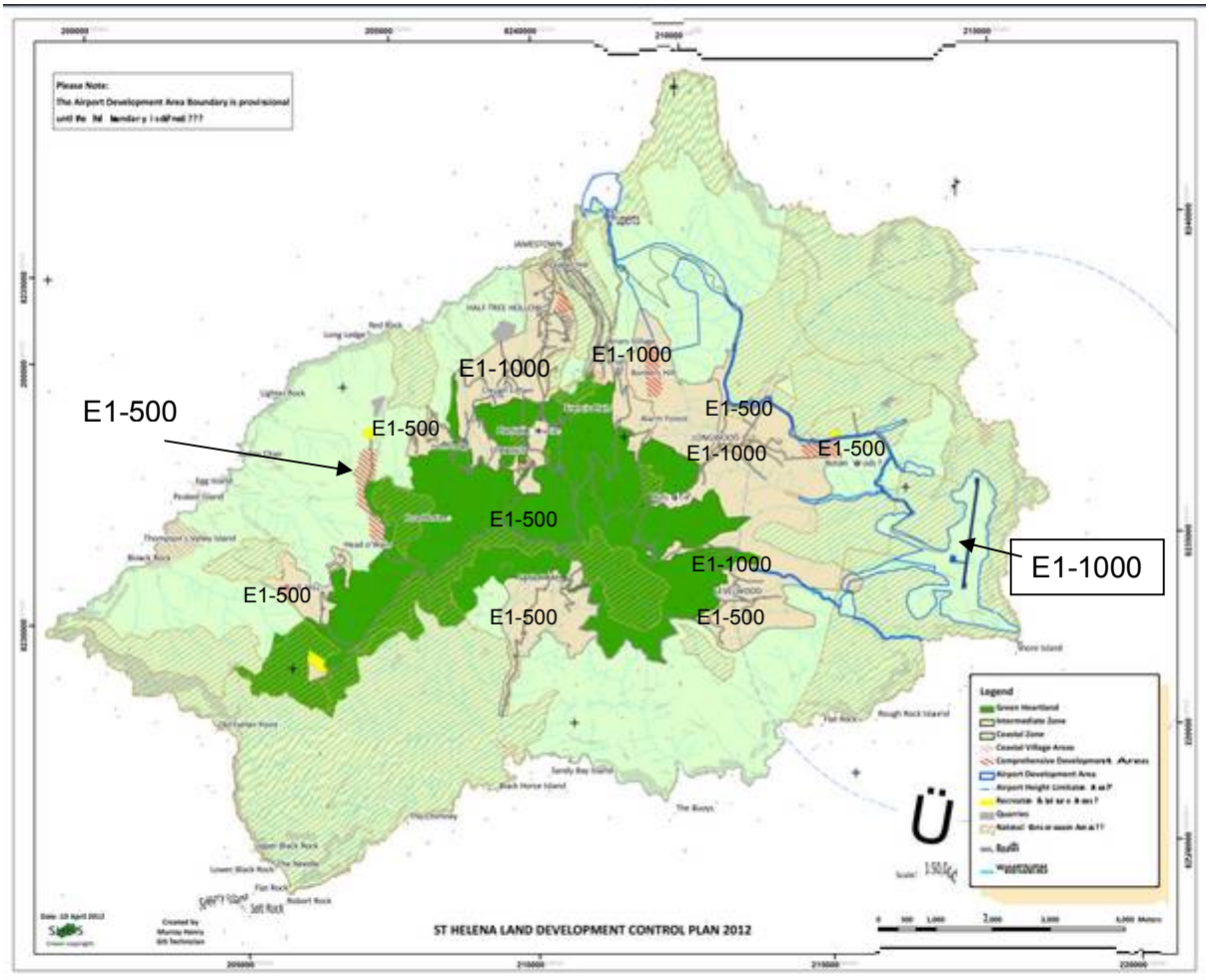


Figure 2.4 General location of the split between 1,000 and 500 lumen caps

See larger scale A3 map for better definition

2.5 Basic Light Limitation Plan - Environmental Zone E2

Fig 2.5 Showing the only two areas suitable to be defined as E2 with 0% upward light

All luminaires with a light source greater than 1,500 lumens within the areas shown in Figure 2.5 must be fully cut-off (fully shielded). These two areas are on the valley floor, the centre of commerce and industry for the island and are almost part shielded by the geological mass on either side.

The intensity distribution previously shown in Table 2.3 and 2.4 equally apply here, however, the obtrusive marker points for an E2 and an E1-1500 area are as follows in Table 2.6

Table 2.6 Obtrusive Light Marker Points

E2-DSC Adaptation							
Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) $E_{vertical}$ (lux)		Viewed Intensity I (cd)		Maximum Luminance L (cd/m^2)	Property Boundary Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	Ev or Eh (lux)
E1-1500 (Residential)	0%	2.5	1	2,500	0	0	1.0
E2-0% (Town Centre)	0%	5	1	2,500	500	3	3.0
E2-2.5% (ILP guideline)	2.5%	5	1	7,500	500	5	(IESNA = 3.0 lux)
© LCaDS 2018							

3 Planning Requirements

3.1 General

In order to avoid a combination of light polluting the night sky and also possible light nuisance problems by residents the previous section contains definitive numeric objectives to this end. This Section explains how planners and engineers need to work in partnership, both internally and externally, to help maintain or enhance the sky darkness at night.

As indicated in the Preamble the guidance given in this document will assist in the defence of the existing night sky. However, within the UK there is a national problem with obtrusive and nuisance light. Part of the problem emanates from the random standards of some planning applications containing external lighting proposals.

The previous lack of a published lighting design & assessment methodology has resulted in planning applications, being presented in a variety of formats, sometimes with a few extracts from manufacturers' catalogues and scant calculation techniques. This has created major difficulties in appraising applications both subjectively and technically. Whilst it may not be necessary for new residences it is certainly needed for sports complexes or container / warehouse distribution centres as examples but not limited to these two applications.

A new ILP document (PLG04:2013 "Guidance on Undertaking Environmental Impact Assessments") focuses on the lighting aspects of creating a Lighting Impact Assessment. Whilst most of these are effects on people and their perception of the surroundings, assessments must also include effects on flora and fauna. A summary of some of the sections covered are included below.

Table 3.1 Typical Lighting Impact Assessment Checklist

Lighting Impact Assessment - Checklist

Baseline Descriptions

- **Baseline Assessment Procedures**
- **Day & Night time visit**
- **Viewpoint Schedule**
- **Location Plan**
- **Brief Description**
- **Viewpoint Pages**
- **Baseline Summary**

Proposed Development – Lighting Design

- **Design – General**
- **Preliminary Assessment**
- **Provisional Design**
- **Final Design**
- **Maintenance Factors**

In addition to the ILP rationale covering the process of carrying out Lighting Impact Assessments the Scottish Executive published a complementary Planning Guidance Note (**Controlling Light Pollution and Reducing Energy Consumption**) which provides a rationale to all lighting design proposals.

An abbreviated 12 point summary checklist of the design methodology is shown in Table 3.2 below but reference to the full document will provide the reasoning behind a 20 bullet point checklist. This LMP should encourage Development Control Committees to insist on a thorough design process by the developer before submitting proposals. Although only 12 points are included in Table 3.2 these should be treated as an absolute minimum requirement and there are no reasons why the full 20 point plan is not set as a standard requirement.

Table 3.2 Design Methodology Checklist

Good External Lighting Design Practice

- **Survey of surrounding area environment**
- **Identification of critical viewpoints or receptors**
- **Analysis of task lighting level recommendations and game level if sports lighting application**
- **Establish environmental light control limits**
- **New lighting design quality objectives**
- **Calculated measurement of Task working area(s)**
  Overspill area(s)
- **Obtrusive light calculation of Property intrusion**
  Viewed source intensities
  Direct upward light output ratios
- **Compare design achievement with baseline values**
- **Schedule of luminaire types, mounting height and aiming angles**
- **Schedule of energy usage and lumens per square metre**
- **Schedule of luminaire profiles**
- **Layout plan with beam orientation indication and site relationship with surrounding residential and commercial properties**

Plan Statement Number 9

Through this LMP it will be possible to encourage developers, when required, to adopt and provide a lighting industry professionally prepared submission for planning consideration.

3.2 Design Stage

Luminaires are designed to have light distributions which are appropriate for specific applications. Even though a luminaire has a Dark Sky Fixture Award it can produce sky glow, light intrusion or glare if it is installed incorrectly. By following the recommendations relating to viewed intensity and vertical illuminance limits at lighting design stage this should mitigate the obtrusive nature of stray light.

This assessment is not possible by inspecting luminaire catalogue information, however, industry standard software, complete with obtrusive light evaluation criteria, eg Philips Diallux, is essential and is available as a free download from their web site. Some luminaire manufacturers also provide a design service but this may be limited in application and may not include obtrusive light analysis.

All planning applications involving external lighting should be encouraged to follow the 12 point plan outlined in Section 3.1 to ensure that viewed intensity and obtrusion are mitigated accordingly at the design stage.

Over-lighting an area is just as obtrusive and wasteful as pushing light into the night sky. Designing for, and providing, the correct task illuminance on the ground is just as important as controlling stray light.

However, some luminaire manufacturers / suppliers, especially budget range DIY equipment, cannot provide photometric intensity tables. This precludes the use of computer algorithms to check either the essential information about fundamental illuminance values or check for obtrusive light situations.

At design and planning application stages the answer is simple, do not accept the use of such equipment and at installation stage do not substitute a non-photometrically measured equivalent look-a-like.

Although most of the commercial luminaires have photometric files many of the 1,000 lumen range of domestic residential exterior luminaires do not have photometric files and therefore require a non-photometric method. A lumen cap methodology is explained in the section 3.4.

Plan Statement Number 10

All design submissions for new non-residential lighting will be required to show evidence of compliance with the zero candela intensity at 90^0 and above for luminaires in their proposed installed condition and encourage domestic luminaires to be selected from units having some form of upward light control.

3.3 Area Density and Typical Task Illuminance for non-residential areas

Within any new design it is important to:-

- **Provide the correct lighting levels for the task or sport game and grade playing level.**
- **Provide the lighting only when needed (time limited).**
- **Recognise that providing light in excess of the recommendations not only increases an unnecessary addition to sky glow but it also wastes energy and increases the carbon footprint.**

As a direct result of the widespread use of sodium light sources, in the UK, over the past three or four decades there has been a steady move towards increasing task illuminance. This often results in wasting energy and also sending more ground reflected light into the night sky. At early planning application appraisal stage it is not often the place for detailed illuminance design, however, to assist in identifying and mitigating over-lighting at an early stage, the following table has been constructed from information in Table D of the Model Lighting Ordinance (MLO) produced by the Illuminating Engineering Society North America (IESNA) June 2011 and converted into metric scale.

Table 3.3 and Table 3.4 (following) are principally for luminaires for use in non-residential type projects and, as such, must be horizontal Fully Cut-Off (fully shielded IDA term) with pre-measured photometric intensity data. They are thereby termed compliant within the concepts of the environmental zone lumen caps explained earlier in Section 2.4. Table 3.5 (see later) gives the Site Lumen Density where the use of un-shielded equipment, with no photometric data, is proposed in residential areas.

In the IESNA MLO the equivalent of Table 3.3 feeds in to another table (Table E not copied here) which provides additional lumens to cover various tasks and only one is included as applicable to life in Saint Helena.

Night Time Environmental Zone	E0-0	E0-25 E0-50	E1-500 E1-1000	E2-0% E1-1500
Base lumens per site	no new lighting	**0 lumens** per site +	**3,500 lumens** per site +	**7,000 lumens** per site +
Allowed lumens per developed area		No new commercial development in this St. Helena zone	**50,000 lumens** per Acre of hard landscape + lumens below	**100,000 lumens** per Acre of hard landscape + lumens below
1 off 10 Examples from Table E applies to SH				
Building Entry/Exit per door.			1,000 lumens	2,000 lumens

Table 3.3.1 Modified IESNA Area Density extract – (not illuminance objective)

The metric shown in table 3.3.1 does not exist in any published documents on lighting design recommendations in the UK but has been included in the LMP as a dual purpose metric to suit a Trans Atlantic readership. Its use in Saint Helena is envisaged to give planners a methodology at preliminary design stage to determine whether the site will be over-lit, by island standards. It is not a task design objective metric.

In the case of developments wishing to use a combination of both shielded and non-shielded lighting units within the same site Table 3.3.2 provides the limitation point for unshielded lighting on all new build or refurbished properties or simply lighting improvements to existing properties. Unshielded lighting units must comply with the lumen caps in the respective night time environmental zone.

Night Time Environmental Zone	E0-0	E0-25 E0-50	E1-500 E1-1000 E1-1500	E2
Maximum percentage of lumens from non-shielded lighting units.	no new lighting	**0%**	**10%**	**20%**
Minimum percentage of lumens from Fully Cut-Off lighting 9fully shielded) units.	no new lighting	100%	90%	80%

New Table 3.3.2 Percentage Limitation on non-shielded lumens

In the UK and Europe over a period of time most working tasks, and sports activities, have been analysed and researched by lighting professionals with the British and European Standards recommendations now related to the quantity and quality of illuminance (in values of lux) required to carry out the task in comfort and safety.

The ethos for new planning applications in this Chapter is to encourage the designer to adopt a full design methodology and the planning permission methodology will be towards "NO DESIGN DATA - NO PLANNING PERMISSION"

The designer should therefore look towards design target values in lux in preference to lumens to show an area has not been over-lit. For task lighting illuminance value recommendations for outdoor work places reference should be made to BSEN 12464-2:2007 – 'Light and Lighting – Lighting of work places' (Part 2: Outdoor work places)

If different tasks, from that shown in Table 3.4, have been identified and are not in BSEN 12464 the equivalent specific risk assessment for safety and security has been included as basic values for a range of safety risks.

Most of the recommended values shown in Table 3.4 have been based on the premise that a lamp with a low colour rendering index will be used as shown in the column headed 'R_a'. See Section 1.6 and Appendix 3 for the reasoning behind dark sky light source colour temperature issues and the ensuing visual betterment when 'white' light sources are implemented.

Table 3.4– Illuminance for typical non-residential rural tasks (extract from BSEN 12464-2:2007)

Ref No.	Type of area, task or activity	Eav lux	Uo	GR_L	R_a	LMP Remarks
	Farms					
5.5.1	Farm Yard	20	0.10	55	20	
5.5.1	Equipment Shed (Open)	50	0.20	55	20	
5.5.3	Animals sorting pen	50	0.20	50	40	Not Permanent
	Equestrian (outdoor event)	100	0.50	55	20	Time limited
	Harbours					
5.4.1	Waiting quays at canals and locks	10	0.25	50	20	
5.4.2	Gangways and passages exclusively for pedestrians	10	0.25	50	20	
5.4.6	Coupling of hoses, pipes and ropes	50	0.40	50	20	Time limited
	Power, electricity, gas and heat plants					
5.11.1	Pedestrian movement within electrically safe area	5	0.25	50	20	
5.11.3	Overall inspection	50	0.40	50	20	Not Permanent
5.11.6	Repair of electric devices	200	0.50	45	60	Not Permanent
		Use local close up temporary lighting				
	Industrial sites and Storage					
5.7.1	Short term handling of large units and raw material, loading and unloading of solid bulk goods	20	0.25	55	20	
5.7.2	Continuous handling of large units, lifting and descending location for cranes	50	0.40	50	20	
5.9.1	**Parking Areas –**				20	no lit car parks in S.H.

Key to table abbreviations
Eav = Maintained average illuminance Uo = Overall uniformity R_a = min. colour rendering index
GR_L = Glare Rating limit (for internal work visibility benefit and not a visibility measure from outside the site)

Table 3.4 continued – (extract from BSEN 12464-2:2007)

Ref No.	Type of area, task or activity	Eav lux	Uo	GR_L	R_a	LMP Remarks
	Simple Summary for safety and security when no equivalent task recommendation can be found					
	Very low risk	5	0.25	55	20	
	Low Risk	10	0.40	50	20	
	Medium Risk	20	0.40	50	20	
	High Risk	50	0.4	45	20	

3.4 Non-photometric Lumen Cap method for residential exterior lighting

Budget range DIY equipment usually takes the form of a simple area floodlight with a high wattage tungsten halogen lamp. They are popular because they are cheap, easy to install, and are often combined with photo-electric (PECU) switches to prevent daytime operation and with passive infra red (PIR) detectors to switch on and off automatically during the hours of darkness.

In the majority of cases these fittings, or luminaires, are installed typically on garage or porch fascias at about 2-3 metres above ground level, and arranged to direct their main beams towards the property boundary to operate as vehicles or people enter. This high beam arrangement can result in glare to road users, light intrusion into adjacent property and a source of possible complaint.

This type of installation is not in keeping with the light control required in a rural setting and as from the effective date of implementation of this LMP no new floodlights of this type will meet the IDA Dark Sky requirements unless they are installed with the glass face horizontal.

As described previously a light source output limit of 1,000 or 500 lumens in luminaires with poor light control is considered to be a generalised rule of thumb marker. Table 3.3 provides a more accurate lumen density prescription, which is based on the overall area of the building structures on each plot of land.

Appendix C and E contains examples of exterior lighting equipment which should be considered when purchasing new exterior lighting. Appendix C could be made available to all the residents within each participating community group.

Lamp lumens is a consistent value and although difficult to find on some old lamp packaging it is gradually superseding the lamp wattage. Lamp watts can vary with the efficacy of the lamp. Table 3.5 (following page) has therefore been constructed using the metric of lumens as the base from which to start. If more than one lamp is used in each luminaire the total 'initial lamp lumens' should not exceed the value shown in Table 3.5's 'luminaire's lumens'

Appendix F contains a comprehensive list of domestic lamps with their wattage and equivalent lumen output. Lamps in Appendix F which are highlighted in green provide less than 500 lumens.

	Night Time Environmental Zone					
	E0-0	E0-25 E0-50	E1-500	E1-1000	E1-1500	E2-0%
Total Site Lumens for exterior lighting	No new light units	500 lm plus 4.5 lm / m^2 of site structures*	600 lm plus 4.5 lm / m^2 of site structures*	750 lm plus 4.5 lm / m^2 of site structures*	1,500 lm plus 4.5 lm / m^2 of site structures*	2,500 lm plus 4.5 lm / m^2 of site structures*
Baseline calculation Result =		Calculate	Calculate	Calculate	Calculate	Calculate
Single or twin unit on property and **no light control** luminaire's lumen maximum	No light units	Replace or modify to Fully Cut-Off and 500 lm	500 lm in existing unit	1,000 lm in existing unit	1,500 lm in existing unit	1,500 lm in existing unit
3 or more on property and **no light control** luminaire's fixed lumen up to optimised maximum	No light units	Replace or modify to Fully Cut-Off and Up to 420 lm	Up to 420 lm Total lm not to exceed baseline	Up to 500 lm Total lm not to exceed baseline	Up to 500 lm Total lm not to exceed baseline	Up to 630 lm Total lm not to exceed baseline
Single or twin unit on property and **Fully Cut-Off** luminaire's lumen maximum	No light units	630 lm (as is 2011 Table G)	750 lm	1000 lm	1,500 lm	1,500 lm
3 or more units on property and **Fully Cut-Off** luminaire's fixed lumen up to optimized maximum	No light units	Up to 500 lm Total lm not to exceed baseline	Up to 500 lm Total lm not to exceed baseline	Up to 630 lm Total lm not to exceed baseline	Up to 630 lm Total lm not to exceed baseline	Up to 750 lm Total lm not to exceed baseline
© LCaDS 2018						

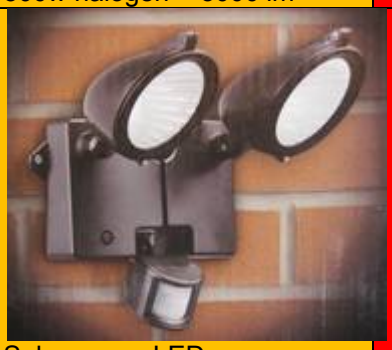
Table 3.5 - Lumen Cap for non-photometric measured / residential luminaires

* Site structures is the sum of the land area of residential buildings, habitable structures, garages, recreational buildings and storage structures within each property boundary.

From table 3.5 a total site structure in the Zone E1-1000 with say 255 m^2 would provide for a baseline calculation resulting allowance of 1,897 lumens which can be distributed as 1 or more luminaires up to this total lumen allowance. (see Appendix F for list of lower lumen and wattage lamps). In the case of developments wishing to use a combination of both shielded and unshielded lighting within the same site Table 3.3.2 (previous section) provides the limitation percentage for unshielded lumens on all new build or refurbishment properties.

Table 3.6 on following page contains pictorial examples of fully cut-off (fully shielded), part cut-off (part shielded) and no light control luminaires (non-shielded).

Table 3.6 – Light Control Examples

Fully Cut-off Examples	Interim Examples	No light Control Examples
 SILL 420 Full range of compact fluorescent and low wattage metal halide	 100w halogen = 1650 lm 150w halogen = 2200 lm 300w halogen = 5000 lm	 no new units
 Zumtobel Bega 2489 18w PLC	 Solar power LED	 no new units
 ERCO Parscoop 42w fluorescent = 3200 lm 70w metal halide = 5000 lm Acceptable substitute for 300 or 500 watt tungsten halogen replacement	 limit to 40 watt tungsten or 6 watt compact fluorescent	 limit to 40 watt candle or 6 watt compact fluorescent
		 18 watts = 1200 lm and too large for E0's & E1 Dark Sky

3.5 Sports Lighting

There are no sports fields on Saint Helena with floodlighting and there are no immediate plans that this policy needs to change. The following has been included to show some of the pitfalls should a change in policy be made in the future.

In the UK many sports areas contain some of the worst cases of over-lighting and neighbourhood unfriendly lighting installations and it is essential that this does not happen in Saint Helena.

BS EN 12193:2007 “Light and Lighting. Sports Lighting” contains both indoor and exterior lighting recommendations for not just the players but also the audience, the referees, the cameras and last but not least the neighbours. It also contains recommendations for lighting designers in the form of typical calculation areas and the number of calculation points to include in any assessment.

The illuminance recommendations are based on the quality of the game. There are 5 levels of competition from National to Recreational, all with different illuminance requirements. Table 3.5 shows some of these extremes.

Some manufacturers provide free design outlines like the one shown in Figure 3.1 but that is only a very small part of sports lighting design considerations. It is essential to consider both light overspill and light intrusion, especially when the sports field is close to residential property.

In order to protect the existing dark sky it is essential to ensure the playing surface of any new sports facilities requesting floodlighting is not over lit.

Double asymmetric flat glass luminaires should be used with the luminaire window completely horizontal as shown in Figure 1.4.1.

On Saint Helena it may also be necessary to limit the average illuminance to that of recreational level (see Appendix A for the definition of ‘average’).

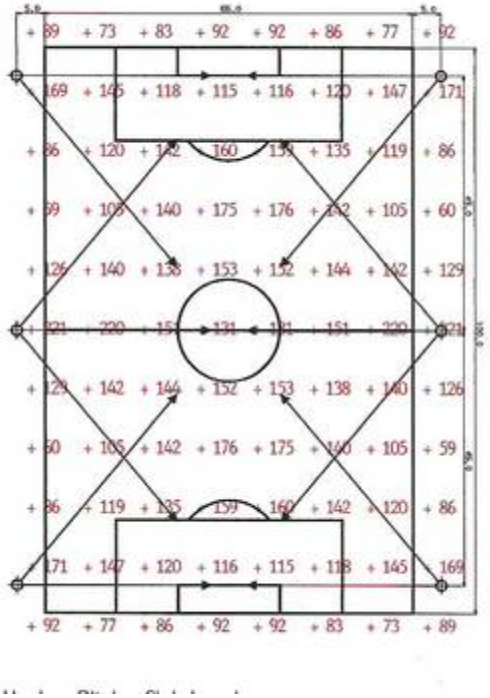


Figure 3.1 – Typical Football Area - Free Design

Note:- So called 'Free Design' like this never includes an impact assessment on the surrounding properties or landscape.

Table 3.7 - Game maintained average typical illuminance variations

Game	National				Recreational
Football, Rugby, Basketball, Netball, Volleyball	500 lux				75 lux
Equestrian and Cycle Racing	500 lux				100 lux

Figure 3.2 – Tennis Court lighting good example

This is a pictorial example of a fully cut-off luminaire installation.

The IDA term for this installation is "fully shielded" without applying additional external screens, hoods or louvers on the luminaire.

3.6 Advertising Sign Lighting

Reference to the ILP publication PLG 05:2014 provides a wide range of considerations when considering the brightness of illuminated advertisements. The difference between 'deemed consent' and 'express consent' varies for different parts of the UK, the Channel Isles and Ireland and a full description can be found in PLG05 Chapter 3.

The word 'brightness' is subjective but has been included in the publication title because the recommendations have been presented after extensive on-site visual appraisals and associated luminance measurements against different night time ambient backgrounds.

At planning application stage PLG05 Chapter 3.4 includes the following details necessary to assess the 'express consent':

- Details of the proposed location, orientation, positioning, mounting height and dimensions of the sign face;
- Type of illumination ie internal, external, halo, static, intermittent or moving;
- Details of the luminaires ie lamp type, including details of baffles, louvres or cowls;
- The designed maximum initial luminance / factory measurements.

Relating to the last point on this list PLG05 (Chapter 9) includes a methodology for sign manufacturers to follow when testing luminance measurements and the sign luminance gradient.

On Saint Helena the designed maximum luminance should not be greater than shown in Table 3.8 with down-lighting, halo or internal methods. Up lighting should be discouraged due to the production of uncontrolled upward light.

	Zone E0	Zone E1	Zone E2
Sign less than $10m^2$	no illumination permitted	100 cd/m^2 maximum	400 cd/m^2 maximum
Sign $10m^2$ or greater	no illumination permitted	no illumination permitted	200 cd/m^2 maximum

Table 3.8 Maximum luminance measurement on sign face

4 Special Lighting Application Considerations

4.1 Excluded Applications

The following applications will be prohibited from any part of rural landscape and other areas that are not designated as Environmental Zone E3 or E4:-

- Aerial Laser Shows
- Sky Tracking Searchlights
- High intensity light sources greater than 50,000 lumens
- Sports complexes requiring an average playing surface greater than 100 lux.

4.2 Temporary Applications

Typical lighting applications not excluded but requiring Short Time Planning Permission - but not limited to the following applications:

- Sports facilities with column mounted luminaires.
- Construction site lighting.
- Churches, public monuments or buildings.
- Travelling Fair Grounds - theme and amusement parks.

4.3 Planning Application

To obtain planning permission, applicants shall demonstrate that the proposed lighting installation application:

- (a) Contains an analysis of at least 12 essentials in the 20 point Good Design Practice Checklist produced by the Scottish Executive (see also Section 3.1)

- (b) A statement that shows every reasonable effort to mitigate Sky Glow and Light Intrusion has been addressed and accompanied by a computer calculation indicating average task illuminance, uniformity, horizontal values of overspill beyond the property line and vertical illuminance values of light intrusion on adjacent property windows.

- (c) Employs lighting controls to reduce the quantity of lighting at the project specific ‘switch-off’ time which has been established in the LMP.

- (d) Complies with all light limitation factors outlined in this LMP.

4.4 Lighting Applications Excluded from the Objectives of this LMP

- Temporary festive Christmas lighting switched on between the last Saturday in November and the following year's January 6th only.

5 Existing Lighting

5.1 General Domestic / Commercial

All existing lighting units within the application boundary, which utilise lamps greater than 1,500 or 1,000 or 500 lumens depending on the property location relative to the various environmental zones, should be brought into line with the light limitation recommendations in this LMP. Priority will be given to the correction shielding of luminaires with high wattage discharge lamps. Lower wattage (tungsten) luminaires like heritage, wellglass(s) and small bulkheads will form a longer term timescale. A provisional timescale has been included in the application prerequisites.

The existing street lighting infrastructure is currently being changed to LED luminaires as shown at the start of Appendix D. Any old luminaires remaining after the dark sky application submission shall remain as installed until the luminaires require to be replaced. As improvement budgets permit, each non compliant (not FCO) street will be equipped with new luminaire and bracket arm, where necessary, to meet the zero light intensity limitation at 90^0 and above as recommended in this LMP.

If a major addition occurs on a property, or street, lighting for the entire property, or street, shall comply with the recommendations in this LMP. The following are considered major additions:

- An addition of 50% or more in terms of residential houses, gross floor area, seating capacity, parking space or street length.

- Single or cumulative additions, modifications or replacement of 50% or more of installed exterior lighting luminaires.

If a property, with non-conforming lighting, changes ownership or usage a new external lighting application must be made. The application must include a complete lighting inventory and site plan detailing all existing and proposed new exterior lighting. If the existing exterior lighting is no longer required all non-conforming lighting shall be disconnected and removed.

Using images from the Earth Observation Group data from 2014 to 2016 (http://www.lightpollutionmap.info/#zoom=9&lat=7586922&lon=-414532&layers=B0TFFFF show a marked reduction in light pollution following the completion of the airport construction where in 2014 the contractors operated a 24 hour site construction programme.

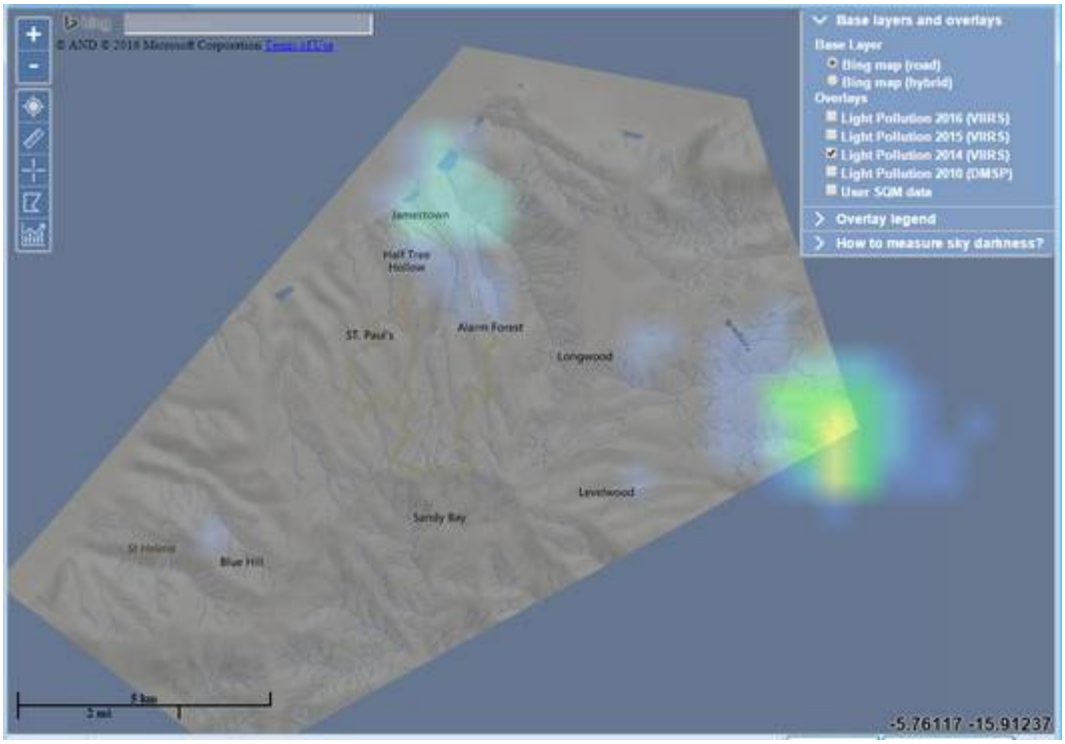
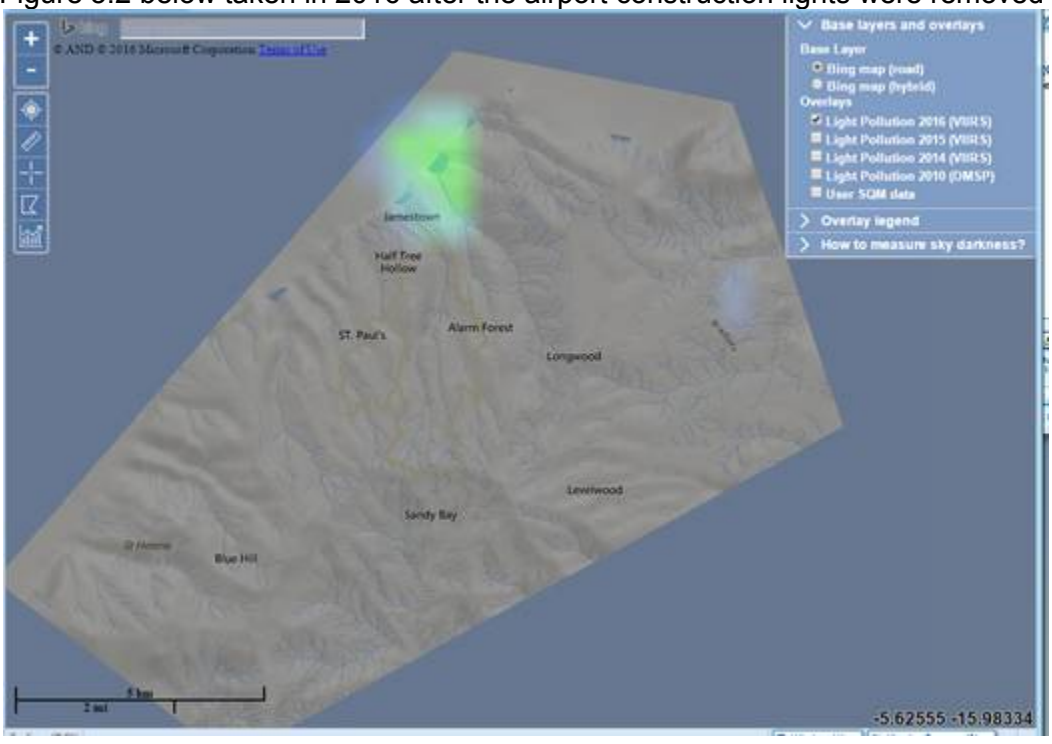


Figure 5.1above taken 2014 with the Visible Infrared Imaging Radiometer Suite (VIIRS)
Figure 5.2 below taken in 2016 after the airport construction lights were removed



The lighting audit concentrates on researching areas for future improvements

5.3.1 Summary of Environmental Zones

Section and Approximate Quantity	Lumen Cap	Enviro. Zone	Comments
01 Ruperts 44 buildings	1,500	E2-0%	Only 25% compliant
Ruperts Valley to Longwood Gate Section 02 - 03			
02 Dead Wood - 40 buildings	500	E1-500	75% Compliant - close to wirebird protection zone
03 Dead Wood - 34 buildings	1,000	E1-1000	
04 Colt Sheds - 40 buildings	500	E1-500	In or close to wirebird protection zone
05 Piccolo Hill - 36 buildings	1,000	E1-1000	
06 Ropery Field - 37 buildings	1,000	E1-1000	
07 Bottom Woods - 63 buildings	500	E1-500	90 units surveyed and 80% compliant
08 St Helena Airport and route approach	1,000	E1-1000	Security predominates
09 Longwood Avenue & Hangings - 52 Buildings	1,000	E1-1000	Longwood overall survey collected photographic data on 320 units and 85% are compliant with 1,000 lumen cap
10 Longwood Gate to Hutts Gate - 64 buildings	1,000	E1-1000	
11 Hutts Gate to Level Wood School - 48 buildings	1,000	E1-1000	
12 Kenedys - 46 Buildings	1,000	E1-1000	
13 Belstone - 27 buildings	1,000	E1-1000	
14 Sandy Bay Ridge and Unity Cottage Rd 60 buildings	500	E1-500	Close to National Park
Sandy Bay Ridge part 2 Unknown quantity	500	E1-500	In or close to National Park
15 West Lodge - 5 buildings	500	E1-500	In or close to National Park
16 Blue Hill - 38 buildings	500	E1-500	75 units surveyed and 81% compliant
17 The Saddle Mid - 14buildings	500	E1-500	
18 The Saddle End 15 buildings	500	E1-500	
19 Jamestown	1,500	E2-0% E1-1000	Seafront to Maldiva Road Remainder
20 Half Tree Hollow	1,000	E1-1000	

All existing properties in Wirebird, Nature Reserves or National Parks were surveyed individually and although all units contain lamps of 60watts or less (500 lumens) in the future all luminaires will be flat glass (or fully shielded) regardless of light source lumens. (Zero light beyond property boundary or 25 metres from luminaire whichever is closer to property. (Zone E0-25)

5.3.2 Typical Property by Property Spreadsheet Detail

Ref No.	Type of fitting	Qty	Building Type	Elevation Angle	Duty Cycle	< 500 lumens	Adaptable	Application	Fully Shielded
001	bulkhead	1	house	90	switch	yes	no	access	part
013	bulkhead	1	house	90	switch	yes	no	steps	no
016	bulkhead	1	house	90	switch	yes	no	access	part
021	bulkhead	3	house	90	switch	yes	no	access	no
0xx	bulkhead	2	house	90	switch	yes	no	access	no

There are only 5 inhabited properties within the environmentally protected area and the environmental zone plan for the future will be to replace these units with fully shielded equivalents within 5 years.

5.3.3 Typical Group Property Compliance for Environmental Zone E1-500

Residential Area Lighting Audit - Deadwood - Environmental Zone E1-500 (500 lumen cap)										
	5	10	15	20	25	30	35	40	more	Comply
Bulkhead	12									12
no cover bulkhead	3									0
Flood @ 45deg. PIR	2									
DSF Flood @ 0deg.	2									2
Contemporary <600lm	1									1
Total Collected	**20**				**Total Compliant**					**15**
									%	**75%**

Residential Area Lighting Audit - Blue Hill - Environmental Zone E1-500 (500 lumen cap)										
	5	10	15	20	25	30	35	40	more	Comply
Bulkhead	45									45
Bulkhead > 500lm circular or no cover	5									
Wellglass	2									2
Heritage	10									10
Flood @ 45deg. PIR	7									
DSF Flood @ 0deg.	4									4
PAR 38 @ 0	1									1
PAR 38 @ 45	1									
bowl street light	1									
Total Collected	**76**				**Total Compliant**					**62**
									%	**82%**

From photographic evidence it was difficult to establish the difference between 60w and 100w lamps and many would have required the cover removing to do this accurately. However many of the bulkheads were installed under building eaves which limit upward light. Residents will be encouraged to reduce lamp wattage in these areas.

5.3.3 Typical Group Property Compliance for Environmental Zone E1-1000

Residential Area Lighting Audit - Longwood - Environmental Zone E1-1000 (1,000 lumen cap)										
	5	10	15	20	25	30	35	40	more	Comply
Bulkhead	247									247
Emergency exit bulkhead	28									28
Circular Bulkhead > 1000lm	5									
Small Square Bulkhead	5									5
Wellglass	5									5
Heritage	27									27
Flood @45deg. switch	5									
Flood @ 45deg. PIR	39									
DSF Flood @ 0deg.	3									3
PAR 38 @ 0										
PAR 38 @ 45	5									
Contemporary <600lm	1									1
Solar LED	4									4
Opal Spheres / conical	3									
Total Collected	**377**				**Total Compliant**					**320**
									%	**85%**

5.3.5 Typical Group Property Compliance for Environmental Zone E1-1500

Commercial Lighting Audit - Ruperts - Environmental Zone E1-1500 (1,500 lumen cap)										
	5	10	15	20	25	30	35	40	more	Comply
Bulkhead < 1,000 lm	30									30
Bulkhead > 1,500 lm	32									
twin tube fluorescent > 1,500lm	37									
Heritage	1									1
Flood @45deg. switch	8									
Flood @ 45deg. PIR	3									3
DSF Flood @ 0deg.	2									2
Eyelid < 600lm										
Eyelid > 1,500lm	19									
Street LED @ tilted	4									
Street LED @ 0	14									14
Asymmetric @ 0	2									2
Asymmetric @ 45+	38									
Bi-symmetric @45+	11									
Circular Symmetric	4									
bowl street type	1									
Total Collected	208				**Total Compliant**					**52**
									%	**25%**

Upper Ruperts Fuel Storage area has the largest non-compliant quota of luminaires and this area has been selected as one of the ten lighting projects to convert into compliance.

5.4 External Public Lighting

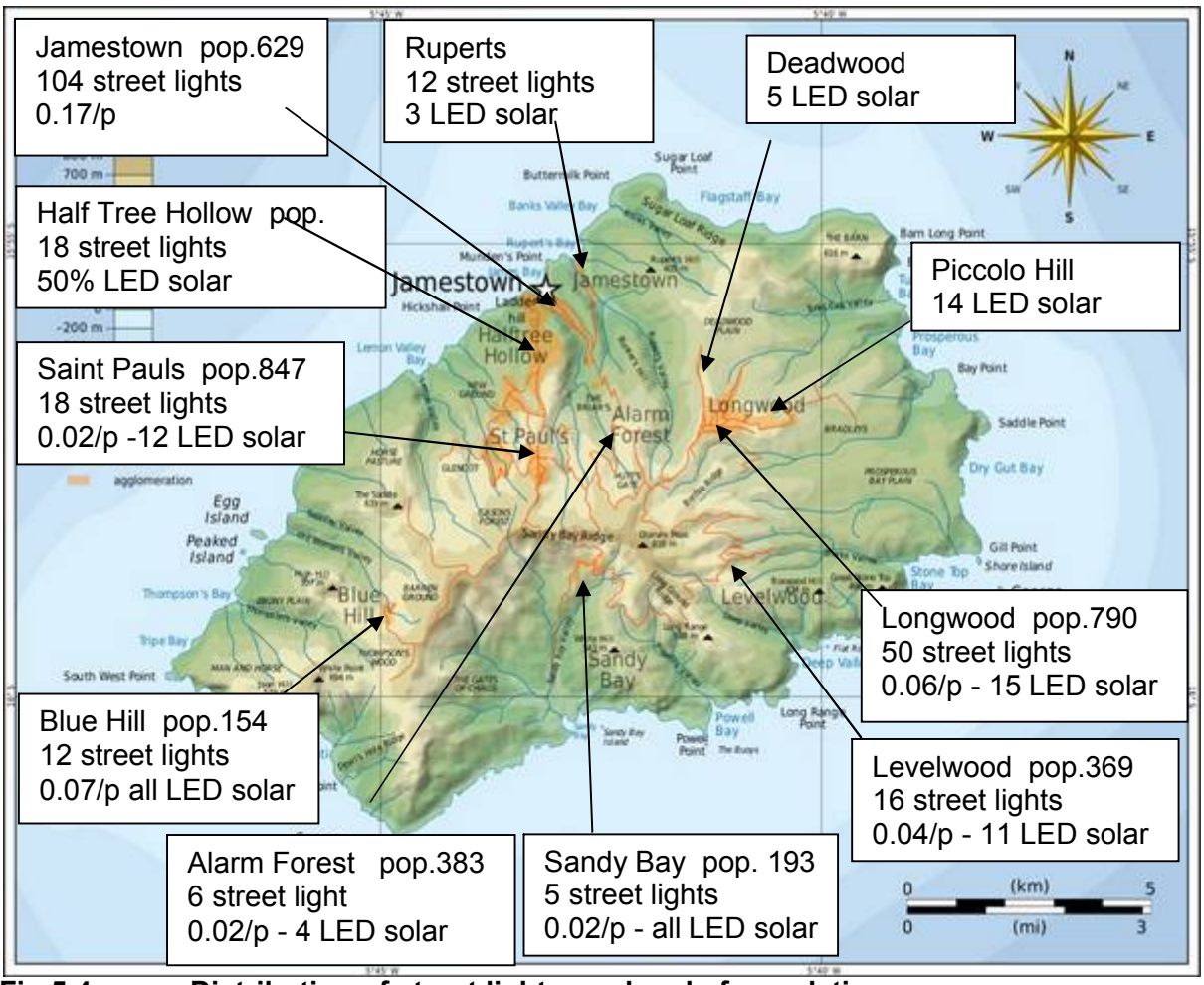


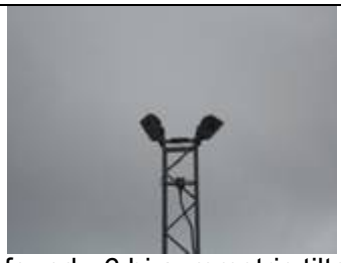
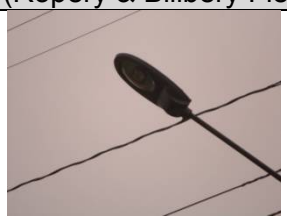
Fig 5.4 Distribution of street lights per head of population

For some years previous the island's public lighting system has been developed on an 'as needed' basis and as can be seen in Fig 5.4 the ratio of public lighting units per head of population varies considerably across the island. Additionally there are very few places where they have been installed with regular spacing. However, Fig 5.4 also contains recent improvement work in the form of removing old lighting units and replacing them with solar powered LED lighting units. Although these new units were purchased by the island on the understanding that they were "dark sky compliant" the manufacturers did not supply a mounting bracket to make them fully compliant with this objective. The correct mounting bracket is due to be delivered to the island shortly and they will be fitted thereafter.

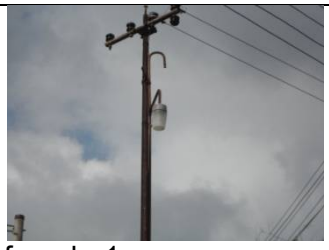
This new LED lighting is fully adaptive and operates in the reverse of normal adaptive lighting to conserve battery power. The lighting normally works at 70% reduced output (833 lumens) but when the streets are occupied with movement the output increases to 2,000 lumens.

There is a 5 year programme in place to replace all the old units with this new system and all will be fitted with the mounting bracket adaption to install them horizontally.

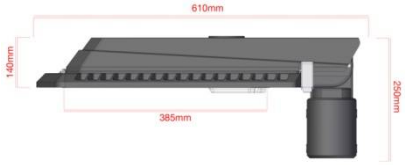
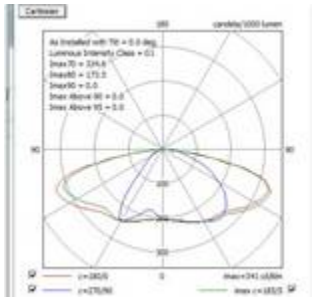
Figure 5.5 Profile of Public Street Lights found in various residential areas

Jamestown		
 found:- 47	 found:- 1	 found:- 3
 found:- 6	 found:- 14	 found:- 1
 found:- 1	 found:- 6 bi-symmetric tilted	 found:- 1 double asymmetric tilted up
Ruperts		
 found:- 3	 found:- 2	 found:- 7
Piccolo Hill (Ropery & Billbery Field		
 found:- 1	 found:- 1solar	 found:- 13 solar

Deadwood	Sandy Bay	
 found:- 5 solar	 found:- 7 solar	
Longwood		
 found:- 5	 found:- 4	 found:- 2
 found:- 1 flat glass	 found:- 3	 found:- 15 solar
Levelwood		
 found:- 1	 found:- 3	 found:- 11 solar
Alarm Forest		
 found:- 4 solar	 found:- 1	 found:- 1

Blue Hill		
 found:- 12 solar		
Saint Pauls		
 found:- 11 solar	 found:- 6 including lookalikes	 found:- 1 photo 965/66
Half Tree Hollow		
 found:- 9 solar	 found:- 1	 found:- 1 solar
 found:- 5 including lookalikes	 found:- 1	 found:- 1

Photometric Profiles
with typical intensity distribution of light emerging near the horizontal axis

2700K CCT - 1920 lumens **LKD 18L-350M-27K-8C**  **4200K CCT - 2504 lumens** **LKD 18L-350M-42K-8C**	File 183527MEC.IES  File 1835428MEC.IES	luminaire elevated 0^0 I max: Cd/klm Above 95^0: 0 Above 90^0: 0 √ 90^0: 0 80^0: 173.5 70^0: 334.6 Gives G3 overall -but G6 at 90 and above so OK at 2700K CCT with IDA

Escafeld ISL01 - 25w LED Solar powered Allinone

Only 3 installed

Initial on site tests elevated 15^0

Currently Non-Compliant due to upward tilt

All new units to be installed at 0^0 upward tilt

luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	43.1
70^0	328.8

√

G6 compliant @ 3,000K

Escafeld ISL03 - 25w LED Solar powered Allinone

About 60 installed tilted up and therefore all non-compliant at full output

Adaptor kit to reduce tilt to zero due to be delivered

Typical 70w / 100w SON – Polycarbonate Bowl

Non-Compliant

luminaire elevated 10^0

I max	Cd/klm
Above 95	3
Above 90	13
90^0	13
80^0	58
70^0	219

Make - type ??

Non-Compliant
Bottom Woods Location

luminaire elevated 15^0

I max	Cd/klm
Above 95	
Above 90	
90^0	
80^0	
70^0	

	**Typical Heritage Street Light** Only 1 exists in Jamestown	Pre-dates photometry Complies assuming lamp is maintained at less than 1,500 lumens

6 Other External Lighting Projects

6.1 Extract from IDA Guideline Requirements

- Item E) Success in light pollution control.
At least one of the following conditions must be demonstrated:

i) Examples of a minimum of ten projects built under the lighting code, demonstrating effective application of the local lighting code,

AND/OR;

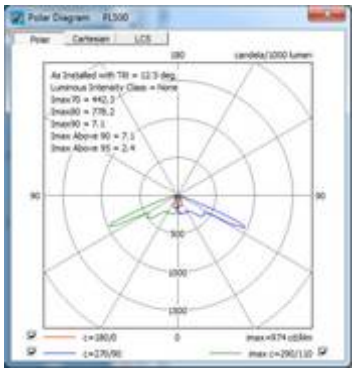
ii) Alternative demonstration of success in light pollution control, to be discussed with IDA for compliance.

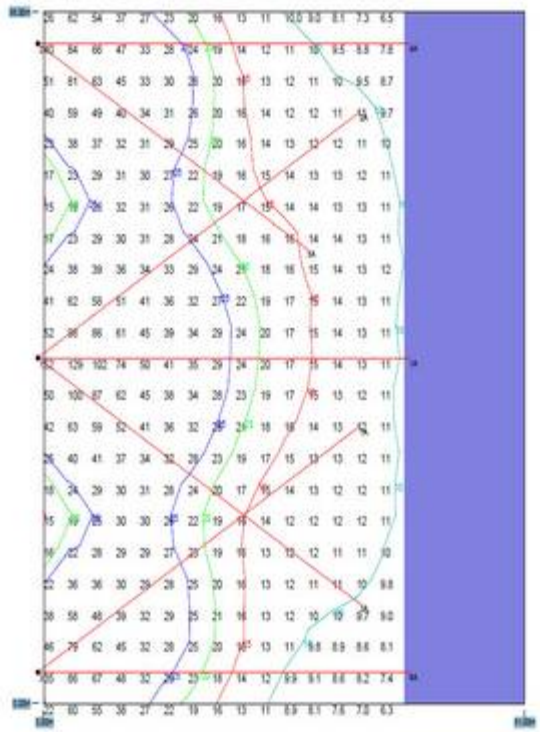
This section contains 10 projects which were all constructed prior to the production of this master plan and as such some parts contain compliant lighting but there is a great potential for near future lighting improvement work to bring the majority into compliance.

All the projects were visited in August 2018 and in most cases, where necessary, the various operators were advised of the actions needed to bring the non-compliant lighting into compliance.

6.2 Saint Helena Airport - Environmental Zone E1-1000

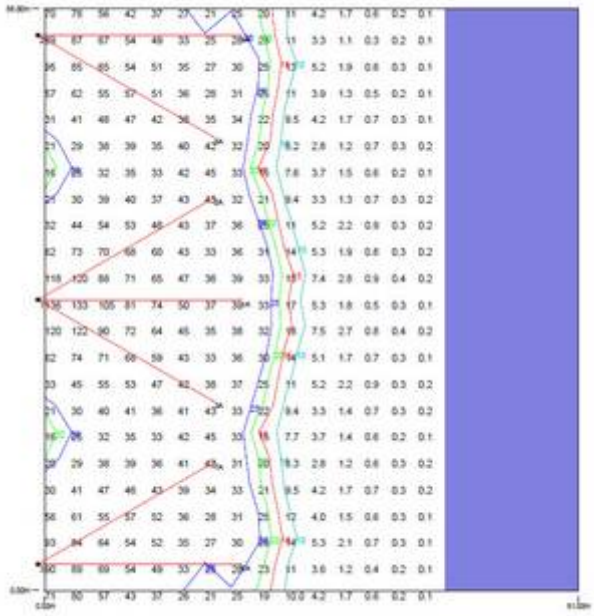
Security is a top priority on this project

Existing Luminaire	Note	Data
 	3 x High Mast Apron Lighting Luminaire Make CU PHOSCO Cat No FL500 Lamp type Philips SON-T+ PIA Watts 400W Lumens 55,000 See illuminance contour effect illustrations if tilt is reduced to zero	Number Found :- 7 Number Compliant :- 0 
 	Car Park Area Lighting Make Beka Cat No Citea Lamp type MBI Watts 150 Lumens 13,200	Number Found :- 42 Number Compliant :- 42
  some part shielded behind external wall	Wall Mounted Eyelid Bulkhead Make Thorn Cat No 96002118 - Equator Lamp type TC-TEL Watts 1 x 18 Lumens 1200	Number Found :- 56 approx Number Compliant :- 56 given the nature of security
	Ground mounted Uplighters Make Thorn Cat No 96257241 D-CO R Lamp type 6 x LED Watts 6 x 1.2 Lumens ?	Number Found :- 7 Number Compliant :- 7 Illuminating wall and looking up into large entrance canopy



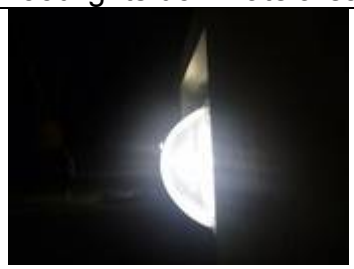
Illuminance pattern from existing luminaires tilted up 12.5 degrees

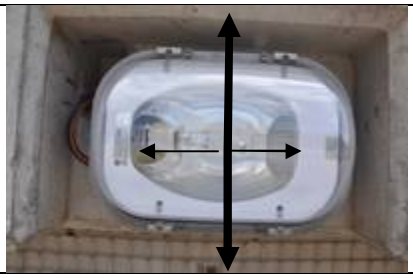
Average
Maintained Illuminance = 25 lux



Illuminance pattern if tilt in existing luminaires are reduced to zero

6.3 New Wharf, Ruperts - Environmental Zone E1-1500 (un-shielded luminaire lumen cap of 1,500)

Existing Luminaire	Note	Data
 Artist's impression of new wharf with a system of column mounted lighting units		
  Wharf was constructed with recesses for wall mounted lighting units at 10 metre spacing		
	Make BEKA Cat No Supranova Lamp type MBI Watts 70 Lumens 6,600	Number Found :- 17 Number Compliant :- 0 Only 2 or 3 left on all night with remainder only switched on when a vessel is docked. (Vessel floodlights dominate area)
		

	Major light distribution axis is up and down with the minor axis left and right 50% upward light ratio	

6.4 Rescue Boat Station, Ruperts - Environmental Zone E1-1500

Existing Luminaire	Note	Replacement Proposal
	New construction completed 2017	Only used in emergencies with last year's use on 3 nights for about 3 hours each night
 electronic intensity tables not available from Lascon	Wall Mounted Eyelid Bulkhead Make Lascon Roma ETE Cat No J41283780 Lamp type PL Watts 2x18 Lumens 2x1,200 = 2,400	Number Found :- 10 Number Compliant :- 0
	Bulkhead unit houses photocell to switch on eyelids if required	

6.5 Solomon's Fuel, Ruperts - Environmental Zone E1-1500 (1,500 lm cap)

This site may have a limited life

Existing Luminaire	Note	Data
 Fuel Area	Bi-symmetric Floodlight - DSC0065,66 Make Hadar Cat No ? Lamp type SON/T Watts 150w Lumens 16,500	Number Found :- 4 Number Compliant :- 0
 Second Fuel Area	Double Asymmetric Floodlight - DSC0068 Make ? Cat No ? Lamp type ? Watts ? Lumens ?	Number Found :- 2 Number Compliant :- 0
	Bowl type street light in fuel area - DSC0067 Bowl with UV deterioration	Number Found :- 1 Number Compliant :- 0
	 Second Fuel Store now assumed to be Solomon's	

6.6 Power Station, Ruperts - Environmental Zone E1-1500 (1,500 lumen cap)

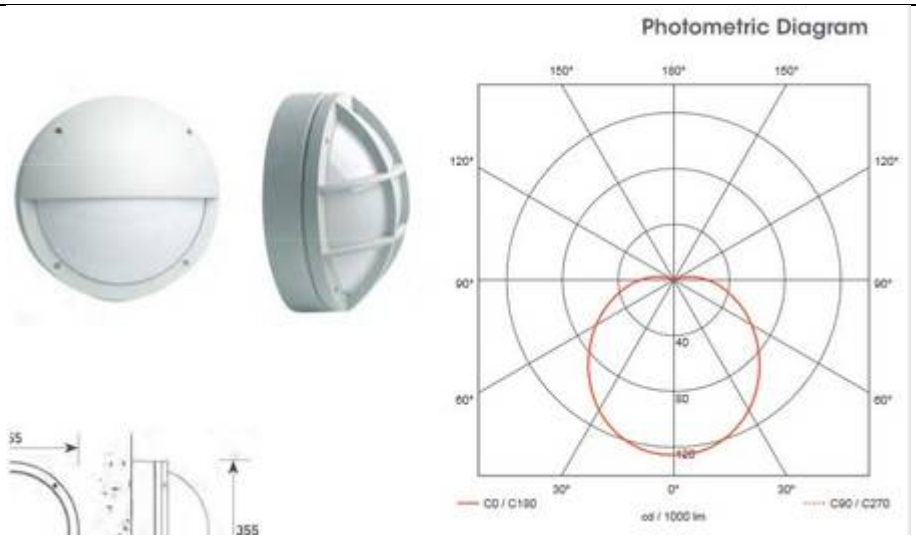
Existing Luminaire	Note	Data
 Red star on map	LED Street light Make Beka Schreder Cat No LEDlume optic 1035 Lamp type 48xLED Watts 61 Lumens 5376 CCT ?	Number Found :- 14 Number Compliant :- 13 Non-compliant :- 1 -
 DSC0060,62,63&74	Circular Symmetric Floodlight Redundant unit to be removed	Number Found :- 4 Scheduled to be replaced with Beka LEDlume
	Wall Mounted Bulkhead DSC0064 Lumens less than 1,500lm	Number Found :- 1 Number Compliant :- 1
		

6.7 Upper Ruperts Fuel Storage - Environmental Zone E1-1500 (1,500 lmcap)

Existing Luminaire	Note	Data
 2 way cluster on 4 columns 1 under construction	Area floodlights illuminate the tanks to one side and transmission pipelines to the other side	
	Double Asymmetric Wide Angle Floodlights Make Beka? Cat No Projectolux Lamp type Sodium Watts 250w Lumens 33,200	Number Found :- 20 Number Compliant :- 0
 	Column mounted deep bowl bulkhead - behind tank area Make ? Cat No ? Lamp type CFL Watts 2x26w Lumens 1,800 /lamp 3,600lm total output	Number Found :- 5 per 2 tanks + 10? more behind other tanks + about 27 in bund area About 50 in total Number Compliant :- 0

  *These are currently illuminated in addition to the floodlights.*	 Tank stair and link bridge vertical fluorescent bulkhead Make Beka Cat No Protectaline Lamp type FL Watts 2x36w Lumens 2,800 per lamp 5,600 total output	Number found :- 7 per 2 tank system (twice) + 9 for 4 tank system Total :- 23 Compliant :- 0
	Pipeline walkway below floodlit area vertical fluorescent bulkhead Make Beka Cat No Protectaline Lamp type FL Watts 2x36w Lumens 2,800/ lamp 5,600 total output	Number Found :- at least 14 Compliant :- 0
		Possible installation of more Protectaline Fluorescent units - details not yet known

	Possible installation of lighting on steps as yet details unknown	
		Possible installation of lighting in loading area as yet details unknown
	Wall Mounted Eyelid Bulkhead Make Voltex - Lascon Cat No J283780 Lamp type PL Watts 2x18w Lumens 2x1,200 = 2,400	Number Found :- 3 Number Compliant :- 0 26% distribution efficiency
 electronic intensity tables not available from Lascon	Wall Mounted Bulkhead Make Voltex - Lascon Cat No J0023345 Lamp type PL Watts 2x18w Lumens 2x1,200 = 2,400	Number Found :- 6 Number Compliant :- 0 26% distribution efficiency



6.8 Jacob's Ladder, Jamestown - Environmental Zone E1-1000

Existing Luminaire	Note	Replacement Proposal
	Bulkhead Unit on short ground mounted bracket Number found :- 70 Number Compliant :- 0	
	Re-lighting project scheduled to be started mm/yy Must be installed in horizontal full cut-off mode for dark sky status compliance	 **Escafeld LED floodlight** Source Lumens = 1,000 Power = 10 watts Colour Temperature adjustable to 2,700K

6.9 Market Hall, Jamestown - Environmental Zone E1-1500

Existing Luminaire	Note	Data
		
	Bowl type street light on wall bracket Make ? Cat No ? Lamp type ? Watts ? Lumens ?	Number found :- 2 + wellglass in side street

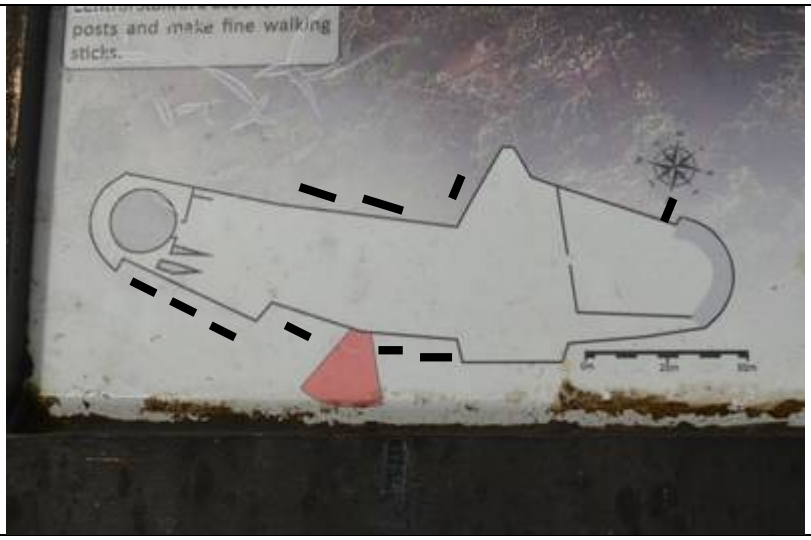
6.10 High Knoll Fort - Environmental Zone E1-1000

Planning Application Appraisal	Note	Data
  		There was insufficient technical information to give a positive answer at planning application stage. The visualisation provided with the planning data looks like the output from a spot type floodlight rather than a linear distribution expected from a linear wall wash unit. It will be on projects this size and sensitivity on which the lighting master plan will be advocating the use of a stand alone lighting impact assessment to help planners in the future. ie. No data - No permission

30 LED Barr / 1watt/LED
45degree beam angle

Number found:- 10

Number installed:- 21



Units shown here indicate those which are easily seen from the castle approach path or from the viewing platforms in the castle

6.11 The Briars Telecommunication Station - Environmental Zone E1-1000

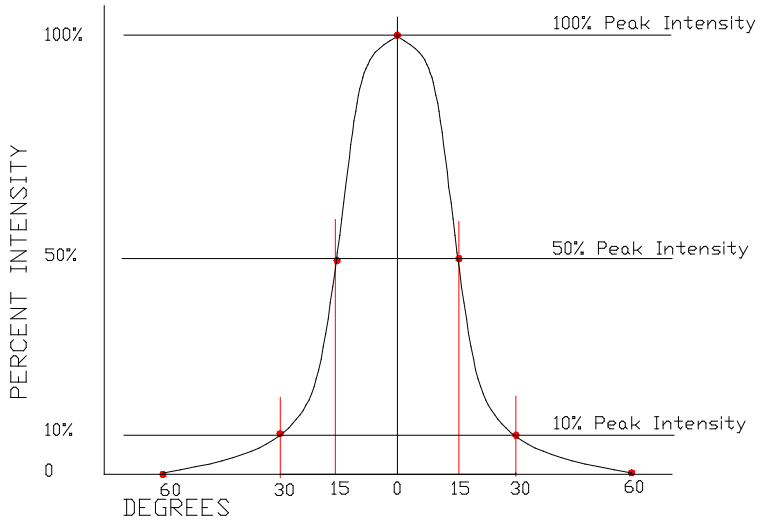
Existing Luminaire	Note	Replacement Recommendation
 Distant view from High Knoll Fort		
Bi-symmetric LED floodlights elevated 45 degrees	Residential concern about light intrusion into bedroom	

Appendix A – Definitions

Unit/Term	
lumen	A unit of light (luminous flux) emitted from a point source of one candela intensity, sometimes expressed in kilolumens - **(klm**)
candela	A unit of luminous intensity
illuminance	The quantity of luminous flux incident upon a unit area, expressed as lumens per square metre or **lux**
luminance	The luminous intensity (or brightness) of a surface or source expressed in terms of surface area i.e. **candelas per square metre (cd/m^2)** To convert dark sky 'brightness' to luminance Use the formula: [value in cd/m^2] = $10.8 \times 10^4 \times 10^{(-0.4 * [\text{value in visual magnitudes/arcsec squared}])}$
reflectance	The reflection factor (or index) of a surface or material
inter-reflection	The result of various reflections
efficacy	In lighting terms - the value of light obtained per unit of electrical energy input i.e. **lumens per watt**
wattage	The nominal load rating of a lamp (excludes any allowances for associated operating gear losses usually taken as averaging10% of the nominal wattage value(lower for electronic control gear))
luminaire	The total package of lantern, lamp and all associated integral items of operating control and switch gear
projector	A special luminaire designed to provide a concentrated pattern of light
skylight	The variable brightness value of daytime sky caused by sunlight scattered by particles of dust and vapour in the earth's atmosphere (skylight can reach values in excess of 2,000 candelas per square metre)
moonlight	The luminous flux emitted by the moon received at the earth's surface at an average value of between 0.3 and 0.5 lux (a rural surface under moonlight conditions will have an average brightness of about 0.002 candelas per square metre i.e. 1/500 cd/m^2)
sky glow	The variable brightness value of night-time sky caused by upward components of light from direct and inter-reflected light off the earth's surface (the brightness of sky glow is dependent on the amount of upward light and the presence and density of atmospheric particles and their distance above ground level)
aura	The hemisphere of light rising up from ground level encircling a light source or lighting array caused by low level mist and fog particles

Disability glare This is glare from a lamp or luminaire which prevents a visual task from being carried out by obscuring ones vision. It is sometimes associated with visual pain.

Cartesian diagram



IES, TM14, & Elumdat

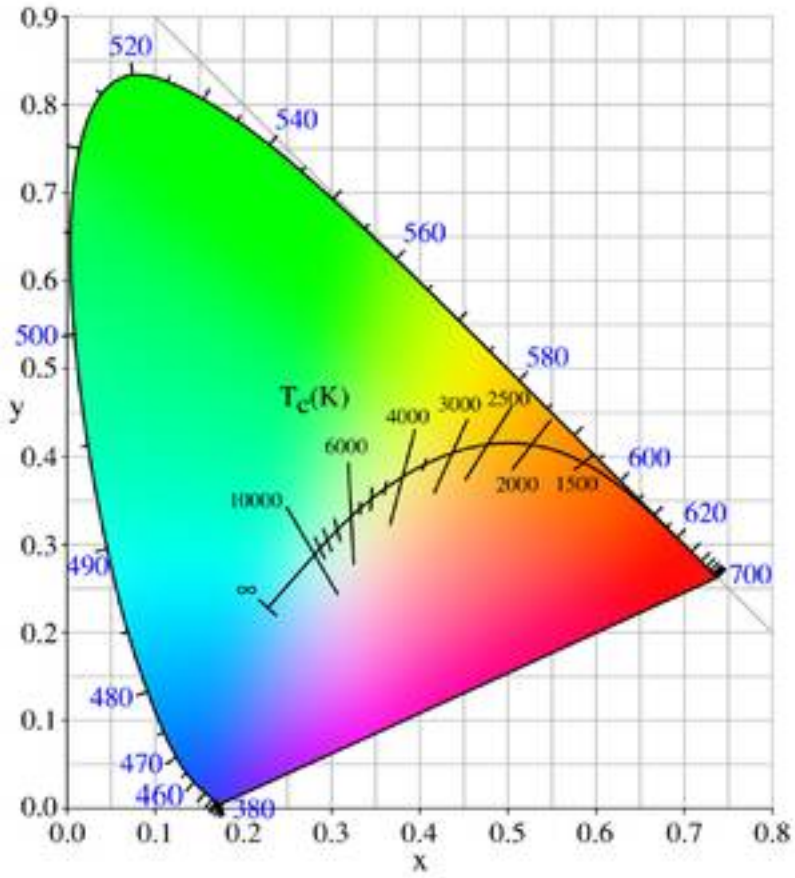
Are different electronic formats of luminaire intensity distribution. They are not a meaningful representation in hard copy printed format, like a Cartesian or polar diagram, however, as numeric data input for a computer algorithm they represent a 3-dimentional array. Some computer algorithms recognise all three different formats whilst other algorithms only recognise one format.

Light intrusion Is light entering or illuminating windows beyond the intended area requiring illumination. Sometimes referred to incorrectly as 'light trespass' since the word 'trespass' has different legal implications in the UK.

Average luminance
Or average illuminance
Are all based on a maintained average which means the lowest average value to which the installation will fall before lamp replacing and luminaire cleaning takes place as part of a maintenance regime cycle.

Light Source Temperature, Colour, and Appearance

Colour Temperature
The **colour temperature** of a light source is the temperature of an ideal black-body radiator that radiates light of comparable hue to that of the light source. Colour temperature is a characteristic of visible light that has important applications in lighting, astrophysics, horticulture, and other fields. In practice, colour temperature is only meaningful for light sources that do in fact correspond somewhat closely to the radiation of some black body, i.e., those on a line from reddish/orange via yellow and more or less white to blueish white; it does not make sense to speak of the colour temperature of, e.g., a green or a purple light. Colour temperature is conventionally stated in the unit of absolute temperature, the Kelvin, having the unit symbol K.



The CIE (1931) x,y chromaticity space

also showing the chromaticities of black-body light sources of various temperatures (Planckian locus), and lines of constant correlated colour temperature.

Source Wikipedia

The "Correlated Colour Temperature" (CCT / Tcp) provides guidance of the colour appearance of lamps whether or not their chromaticity point (from the x & y values) is on the black body locus line.**

BS 5489-1:2013 and BSEN 12665:2002 use the abbreviation of Tcp to replace CCT. The abbreviation CCT is still used in American documents

Colour Appearance

The colour appearance of a light source can be defined objectively in terms of the temperature, in degrees Kelvin, to which a thermal radiator (e.g. a black body) would have to be heated to have the same colour appearance as that of the light source being assessed. A GLS tungsten filament lamp (traditional domestic light bulb) has a colour temperature of c.2700° Kelvin (usually written as 2700K).

The CIE categories of "Warm", "Intermediate" and "Cool" relate to CCTs as follows:

Below 3300K	**-**	**WARM**
300K to 5300K	**-**	**INTERMEDIATE or NEUTRAL**
Above 5300K	**-**	**COOL**

Dark Sky Light Source Colour Issues

In 2010 the International Dark-Sky Association (IDA) produced a paper "**Visibility, Environmental and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting**" which is a compilation of various research abstracts available at that time. All the research abstracts chosen relate to the possible 'harmful' effects of the blue content in most 'white' light sources. The IDA terminology of 'blue-rich white' includes metal halide, fluorescent, induction and **all CCT versions of LED** light sources. The following pages show the various spectral power radiation of these and other light sources which have no or very little blue content in their spectrum (ie below 500 nanometers).

Four years later when exterior lighting, especially highway lighting in the UK, was undergoing a substantial light source change from yellow sodium to various forms of white light the IDA reviewed their dark sky friendly fixtures approval process. In addition to their 'fully shielded' requirements they will now limit approval to luminaires which use a light source CCT of 3,000K or less.

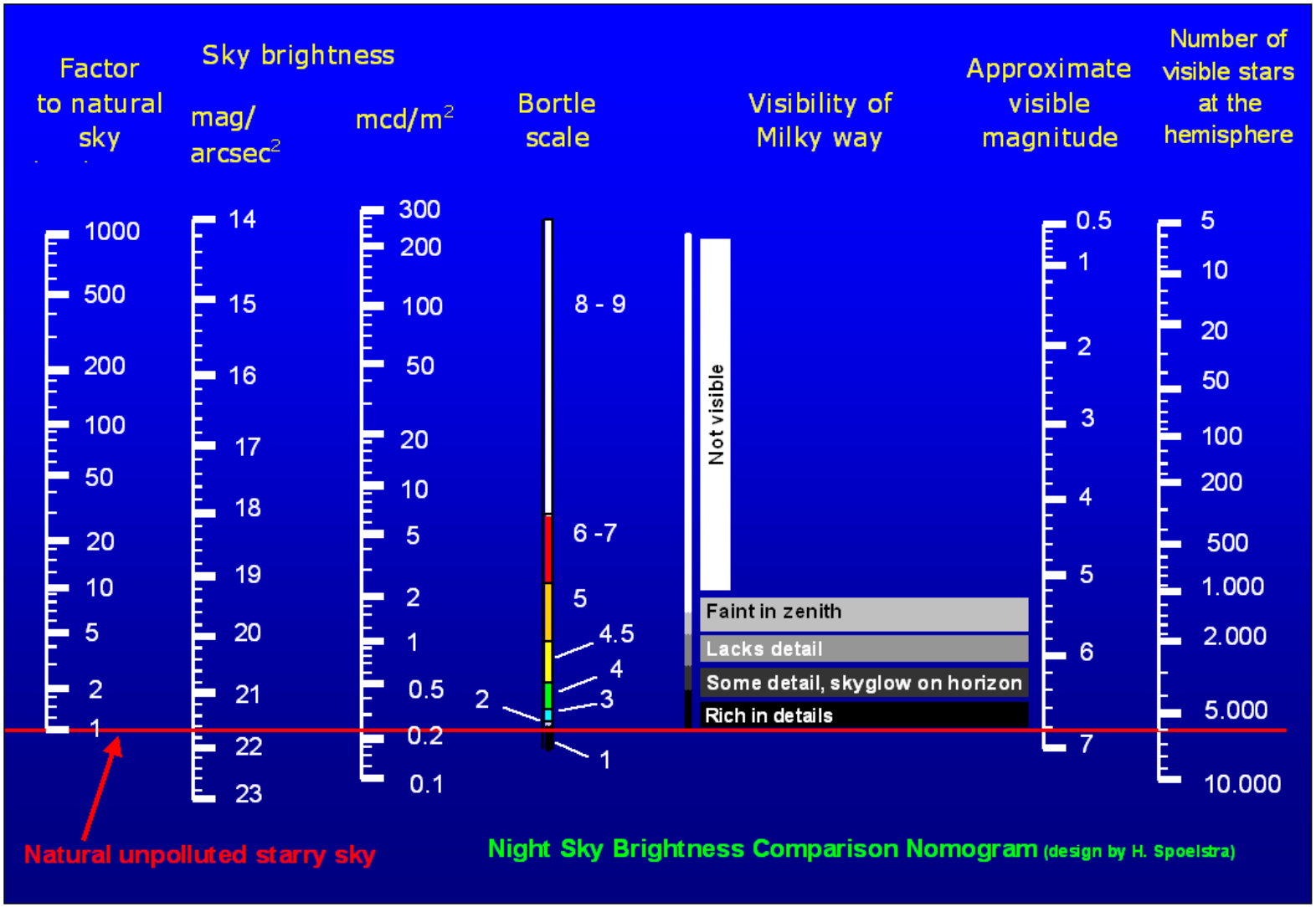
There are two issues in the 2010 paper which point towards limiting astronomy and also general vision 'glare'. Both of the main issues and also secondary ecology issues are linked to the blue content of white light. The paper supports continued use of yellow light which as shown in the following spectral analysis are deficient in blue spectral content. The paper cites the Rayleigh Scatter Index effect of the blue radiation appearing to be greater than yellow radiation.

In the UK yellow low pressure sodium lamps are regarded as "grand-fathered" old technology and the overwhelming majority of UK local authorities have a policy of not installing any more new low pressure sodium street lighting installations. While this lamp has been the mainstay of many street lighting installations for more than 50 years it is now scheduled to be phased out shortly in the UK and there is also growing evidence that the high pressure sodium lamp may also follow. Maintaining these two yellow sources is becoming increasingly more expensive and this will only add to their eventual extinction. It is therefore difficult to promote their continued use and a sustainable white light compromise is required for dark sky preservation.

'Glare' results from the quantity and quality of light distribution from a luminaire and not solely from the colour of the light source. BSEN13201-2 use technical metrics to define limits of 'glare' in street lighting and the **full distribution of G6 for any source should be applied** in preference to limiting the colour temperature of the light source in dark sky places.

The use of light sources with a CCT / Tcp greater than 3,000K or a Scotopic / Photopic ratio greater than 1.3 is therefore not permitted in a UK Dark Sky Place.

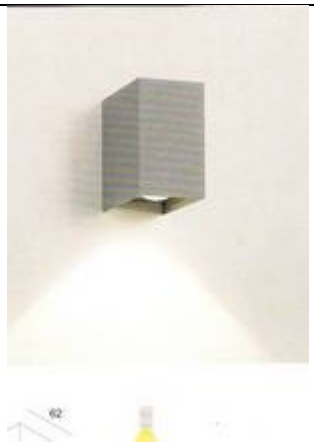
Appendix B – Sky Brightness Nomogram (by kind permission of Heck Spoelstra)



Appendix C

Domestic External Lighting Units
Suitable for exacting needs of Environmental Zone / E0-50 / E0-25 Retro-fits

Deltalight Dox



Deltalight Mono

Deltalight Visionair

Deltalight Nox

Deltalight Lookout

contact

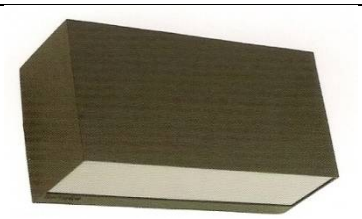
Deltalight
94 Webber Street
London
SE1 0ON

www.deltalight.co.uk

Norlys Halden
Also in - Konst Smide

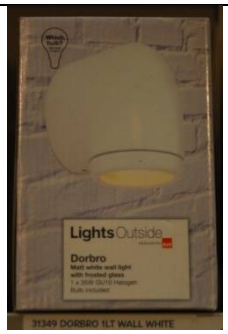
Norlys Koster A

Norlys Narvic

 Norlys Asker		Norlys & Lutec see Elstead Lighting Elstead House Mill Lane Alton Hampshire GU34 2QJ www.elstead-lighting.co.uk
 Kont Smide + others	 Kont Smide - Torino	 Kont Smide - Modena
 liteCraft Stainless Steel Down-light	 liteCraft Dacu 40 watt & LED	 liteCraft Savona (shielded version)
	Unknown Maker	liteCraft Showroom Seaward Street Kinning Park Glasgow G41 1HJ www.liteCraft.co.uk
	Zumtobel - Bega 2489 Triangular Bulkhead 18w PLC 3000^{0}K	

B&Q Solar Power
330 lumens

B&Q Solar Power Sirah



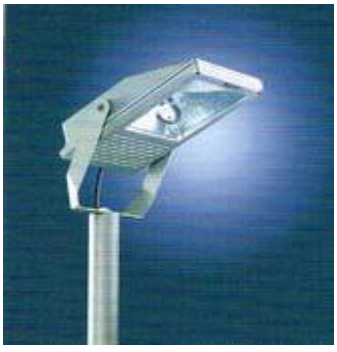
B&Q Midas LED

B&Q Merak

B&Q Canopus

B&Q Bohm LED 1,100 lumens
3,000K warm white

B&Q led Telamon
2800, 1,800 or 800 lumens but must be horizontal
DANGER
Currently only available in 5,000K cool white and not suitable in dark sky area



Sitco + Others - Double Asymmetric Mini Flood

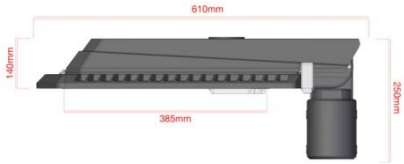
All floodlights like this are designed to be mounted horizontally (not as shown in manufacturer's illustration)

Additional shielding as illustrated right can limit light at task area boundary

Appendix D

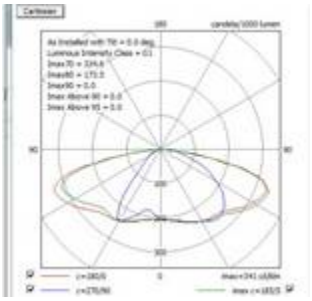
Luminaire Profile Examples for Environmental Zone E1 / E2-0%
with typical intensity distribution of light emerging near the horizontal axis

2700K CCT - 1920 lumens
LKD 18L-350M-27K-8C



4200K CCT - 2504 lumens
LKD 18L-350M-42K-8C

File 183527MEC.IES



File 1835428MEC.IES

luminaire elevated 0^0

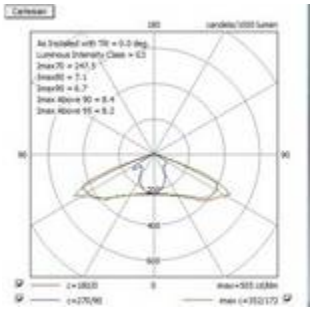
I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	173.5
70^0	334.6

√

Gives G3 overall -but G6 at 90 and above so OK at 2700K CCT with IDA

Escafeld ISL- 25w LED Allinone
3000K CCT

Photometric File AL1235K-M1.ldt



6000K version not suitable in Dark Sky Place

luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	43.1
70^0	328.8

√

G6 compliant @ 3,000K

Escafeld LED 10 watt Floodlight - 1,000 lumens
Colour set to 2,700K

Application to replace existing bulkhead units on Jacob's Ladder

Units must be installed with glass horizontal, not as illustration or tilted upwards

ASD Lighting
Highway Diamond LED

Also double asymmetric floodlight optic

Optic HWD-B40LED0850-S5
(8 LED's + others)

Warning
No LEDs with CCT > 3,000K in dark sky places

luminaire elevated 0^0

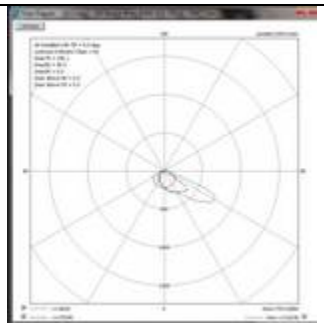
I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	17.2
70^0	71.1

√

Optic S2 and S5 are G6 compliant

I-tables only show NW-(neutral white) 4000K CCT but 3000K option is available on request

Thorn R2L2 LED
Neutral White
Large, Medium and Small versions have G6 options



108 luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	40.5
70^0	336.1

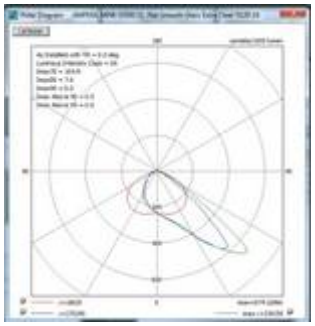
√

G6 compliant

Urbis Ampera

Mini 335672 8-24 LED = G6

Midi 336052 32-64 LED = G6 + Midi Zebra
Maxi 341042 80-128 LED= G6 + Maxi Zebra



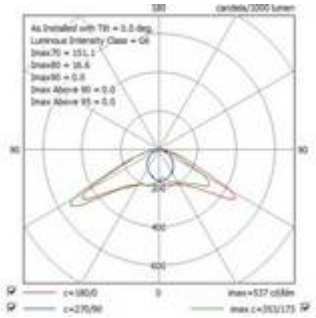
24 luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	7.6
70^0	104.8

√

G6 compliant

WE-EF
RFL530 TW/E
(on IDA approved list + VFL + PFL and RFS)
45w Cosmo



luminaire elevated 0^0

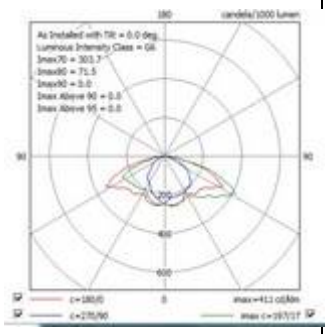
I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	16.6
70^0	151

√

45w = G6 compliant

I-tables no longer in Lighting Reality update

Phosco
P850 200 mA LED



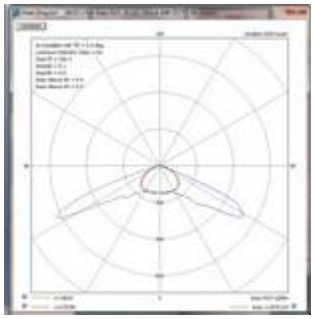
237w luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	35.4
70^0	349.6

√

87w-237w G6 compliant
Neutral white LED

Urbis
Neos Flat Glass 5121 16-24 LED Neutral White



24 luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	9.1
70^0	330.3

√

G6 compliant

Light Emitting Diodes
Flat Glass

Ruud / CU Phosco Ledway Road
30 x LED's @ 3000^{0}K
or
50 x LED's @ 4000^{0}K
Caution
6000^{0}K also available

luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	71
70^0	287

G6 compliant

√

453 CityLiter

26w PII and 35w CDM

luminaire elevated 0^0

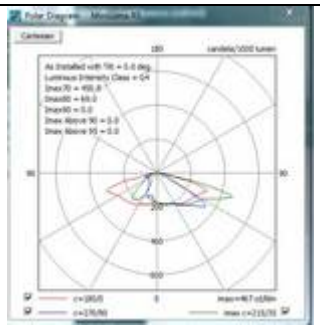
I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	8
70^0	84

√

Philips/WRTL - Mini Luma

R6 Optic

Note
I_{70} maximum
for G6 = 350 cd/1000 lm



luminaire elevated 0^0

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	71
70^0	384

Typically G4
but G6 at 80 and above

√

Thorn Lighting

Plazora Wall Light

26w TC-D fluorescent

I max	Cd/ klm
Above 95^0	0
Above 90^0	0
90^0	0
80^0	8
70^0	50

√

And others

(white paint on louvers reflects upward light)

Up to 8% ULR and not suitable in Dark Sky Places

I max	Cd/ klm
Above 95^0	1
Above 90^0	7
90^0	7
80^0	22
70^0	35

0% ULR

Thorlux Probe

57w TC-T
Compact fluorescent

4,300 lumens

7-10 days delivery
Glare control = G3

I max	Cd/ klm
Above 95^0	0.2
Above 90^0	0.4
90^0	0.4
80^0	8.1
70^0	11.5

Almost G6
0% ULR

The following examples do not fully comply with zero intensity at and above the horizontal but have been selected from many others as being the closest to “Fully Shielded” conditions and need to be located near other natural shields like buildings or trees.

DW Windsor

Garda
LED Hand Rail

I max	Cd/ klm
Above 95^0	4
Above 90^0	10
90^0	10
80^0	66
70^0	165

Emergency Exit Lighting Unit (mounted horizontally not as illustration)

Raylux 25

8 x LED’s and complete with wall mounting bracket

Unit to be mounted pointing down for G6 compliance

Currently undergoing photometric tests to prove zero intensity at and above horizontal

		luminaire elevated 0^0 I max / Cd/ klm Above 95^0 Above 90^0 90^0 80^0 70^0 G6 compliant

rayLUX 25

DIRECTIONAL WHITE-LIGHT

High Performance White-Light LED illuminators provide class leading performance, long life, energy efficiency and zero maintenance. They incorporate the very latest surface mount LED's to deliver excellent optical output and outstanding reliability, providing even illumination and excellent night time images for surveillance cameras and general area lighting.

The RAYLUX 25 provides a world class 'White-Light' output of 110lm/W at the LED source, and an independently tested luminaire output of 800 lm at 15lm/w.

Each unit is fitted with Active LED Life Control to carefully control LED output, delivering consistent illumination power and a projected working life of 10 years.

RAYLUX illuminators are supplied with bracket and power supply. Control features on the power supply include adjustable power output, photocell and telemetry control. RAYLUX 25 is designed for low light installations up to 20m (66ft).

RAYLUX 25 is also available with low voltage PSU.

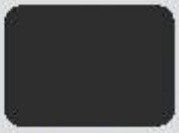
POWERFUL
- Quick Start
- PLANILIGHT® LED technology
- High Power - Low Running Costs

FLEXIBLE
- Various Angles (30, 50 or 120°)
- Fully Controllable Power Supply
- Optional Low Voltage PSU

RELIABLE
- 10 year life
- Active LED Life Control
- Vandal resistant

CONTROLLED
- Excellent Colour Rendition
- Even Output Illumination
- Low Running Costs

WHITE-LIGHT IN USE:



White-Light off

White-Light on

Version 3.2

APPLICATIONS

rayTEC

General Domestic Lighting Equipment Profiles

Through this leaflet we hope to provide you with examples of well designed equipment which you may wish to consider when purchasing new lighting units. The leaflet also contains examples of poor design relative to the exacting demands of light control within Dark Sky Places.

Unless otherwise noted the equipment illustrated is available from local DIY Stores.

Good – Reflector shaped to direct light down. Boxed as dark sky friendly and has PIR sensor separate from the lamp unit aiming. For rural setting look for unit with a 120 watt lamp or less. Also provides reduced illumination dusk to dawn for courtesy and full power on presence detection.

Poor – Lamp reflector and PIR detector point in same elevation and rotational direction. 300 / 500 watts Tungsten Halogen lamps provide too much light for use in rural settings.

Good – Can direct light in 2 directions and lamps are less than 100 watts. Limit elevation angle to less than 45 degrees. Various other similar styles with integral PIR detector on mounting. 60w capsule with dimming for courtesy or LED lamps

Good – (above and below) 70w or 150w metal halide lamp. Must be installed with glass window **horizontal** – **and not as illustrated**. When the lamp is located at one end of the reflector the main beam will emerge from the glass window at about 45 degrees. Known technically as a double asymmetric light distribution.

APPENDIX E

Very Good – (SILL 453 CityLiter) Designed to be mounted horizontally and available in a range of low wattage lamps. Luminaire has IDA Dark Sky Friendly Fixture Award.
Fluorescent range + 35/70w metal halide

Poor – Low wattage light source but projects light upwards when mounted as shown and needs to be near horizontal to limit sky glow. (**Bracket does not allow horizontal fixing**)
18 watt PL-C = 1,200 lm

Poor – No light control

Fair – Upward light limited but lamp must be less than 500 lm.

Poor – No light control

Good – Porch light with downward light

Poor – Bollard with no light control and produces glare

Fair – External louvers limit some upward light and reduces glare. Lamp must be less than 500 lm

The output of lamps are now valued in lumens in preference to watts as in the past. The table below provides basic user guidance when comparing lamp watts and lumens for lamps in luminaires with no light control.

Lamp type & Watts		Lamp Lumens (lm)
Clear Bulb GLS	40w	420
Candle Lamp clear	40w	400
Candle Lamp halogen	28w	370
Superlux Krypton	40w	455
Halogen energy saver	28w	370
Halogen linear		
12v Tungsten Halogen	30w	415
T2 linear fluorescent	8w	540
T8 linear fluorescent	8w	385
Compact Fluorescent	9w	480
Elegance globe	9w	405
Elegance candle	9w	405
Elegance spiral	9w	450
2D compact fluorescent		
3 loop compact fluor't		
1 loop compact fluor't	7w	425
LED Opal globe		

In order to protect the dark night sky it is proposed to limit the lamp output on existing poor or no light-controlled luminaires to **500** lumens in dark sky parks and reserves with **1,500** lumens in dark sky communities.
Red cells in the table above indicate that there are no lamps less than 500 lumens and therefore must be in luminaires that have horizontal fully cut-off visors.

Illustration	*Lamp Name*	*Lamp Type*	*Nominal Watts*	*Output Lumens*
	Standard, clear bulb (old traditional)	Incandescent GLS	15 w 25 w 40 w 60 w 100 w	90 220 420 710 1,330
	Halogen Classic replacement	Halogen capsule	28 w 42 w 70 w 105 w	370 630 1,180 1,900
	Clear LED replacement	Light Emitting Diodes 2,700 K Colour temperature	10 w 12 w 15 w	810 1,055 1,521
	Standard, pearl frosted bulb (old traditional)	Incandescent GLS	15 w 25 w 40 w 60 w 100 w	90 220 415 700 935
	LED equivalent in Edison Screw or Bayonet Cap	Light Emitting Diodes 2,700 K Colour temperature	6 w 7 w 10 w 12 w 16 w	450 470 810 1,055 1,300
	Candle, clear bulb	Incandescent Tungsten	25 w 40 w 60 w	220 400 660
	Candle, opal bulb	Incandescent Tungsten	25 w 40 w 60 w	190 390 640
	Twisted Candle, clear bulb	Incandescent Tungsten	15 w 25 w 40 w 60 w	90 200 400 660

Illustration	*Lamp Name*	*Lamp Type*	*Nominal Watts*	*Output Lumens*
	Twisted Candle, opal bulb	Incandescent Tungsten	15 w 25 w 40 w 60 w	90 200 400 660
		LED equivalent	3 w	245
	GE Candle Lamp (B&Q)	Incandescent Tungsten	18 w 30 w 45 w	170 415 710
		Incandescent Tungsten Halogen	18 w 28 w 42 w	210 370 630
	Round, clear bulb	Incandescent Tungsten	25 w 40 w 60 w	200 400 660
	Round, opal bulb	Incandescent Tungsten	25 w 40 w 60 w	200 400 660
	Superlux Krypton mushroom, opal Standard	Incandescent Tungsten	25 w 40 w 60 w 75 w	240 455 760 1,000
	Superlux Krypton mushroom, opal And burning position		25 w 40 w 60 w	160 300 530
	Haloline linear	Incandescent Tungsten Halogen	60 w 80 w 100 w 120 w 130 w 240 w 400 w	840 1,400 1,900 2,250 2,440 4,900 8,700

Illustration	*Lamp Name*	*Lamp Type*	*Nominal Watts*	*Output Lumens*
	Halostar 12V	Incandescent Tungsten Halogen	G4 5 w G4 10w G4 14w G4 20w G4 25w G9 25w G9 18w G9 28w G9 30w G9 42w G9 50w	40 120 215 300 470 255 204 370 415 670 855
	LED Parathom clear globe	Solid State Light Emitting Diode	1.6 w 2 w 3 w 4 w 5 w 6 w	70 100 165 250 550 470
	Master LED opal globe	Solid State Light Emitting Diode	6 w 7.5 w 12 w	337 470 650
	Master LED reflector	Solid State Light Emitting Diode	4 w 7 w GU10 4w	110 230 200
	Lumilux T2 tubular	Discharge Linear Fluorescent T5 Tubular T8 Tubular	6 w 8 w 11 w 13 w 4 w 6 w 8 w 13 w 10 w 15 w	330 540 750 940 130 270 385 830 650 950

Illustration	*Lamp Name*	*Lamp Type*	*Nominal Watts*	*Output Lumens*
	Biax Extra Mini	Discharge Compact Fluorescent	9 w 11 w 15 w 23 w	450 620 900 1,240
	Elegance Globe	Discharge Compact Fluorescent	7 w 9 w 11 w 15 w 20 w	286 405 610 830 1,152
	DIALL Globe (B&Q)	Discharge Compact Fluorescent	13 w 15 w 23 w 30 w	664 820 1,400
	Elegance Candle	LED Discharge Compact Fluorescent	3 w 5 w 6 w 5 w 7 w 9 w	245 330 470 200 286 405
	Spiral	Discharge Compact Fluorescent	8 w 11 w 15 w 23 w 35 w	540 770 970 1,450 2,285
	2D Square	Discharge Compact Fluorescent	16/14 w 21/19 w 28 w 38/34 w	1,100 1,375 2,150 3,020
	Circular	Discharge Compact Fluorescent	22 w 32 w 40 w	1,000 2,250 3,100

Illustration	*Lamp Name*	*Lamp Type*	*Nominal Watts*	*Output Lumens*
	Biax S/E	Discharge Compact Fluorescent	5W 7W 9W 11W	265 425 600 900
	Biax D	Discharge Compact Fluorescent	10W 11W 13w	600 610 900
	Biax T	Discharge Compact Fluorescent	13W 15W 18/20W 42W	900 845 1,200 3,200

Appendix G
Property Self-Audit Guidelines – The Next Step for Improvement

Of particular interest in the lighting audit was the high percentage of security style floodlights, many of them with the glass almost vertical. The application for a dark sky status would benefit greatly if more "security" style floodlights were tilted down, preferably horizontal.

Are you ready to help improve the dark night time sky conditions ????
If so survey your property externally (all buildings and any free-standing lighting eg. on poles in exercise yards or ménage areas)

Tungsten Halogen Floodlights

Preferred Step

Replace with new fitting having good light control & meeting the Lighting Management Plan requirements

or ***Option 1***

Tilt down until glass is horizontal and thereby meeting the requirements of a "fully shielded" luminaire.

Reduce lamp size if possible (500watts to 300watts or 150watts to 100watts).

or ***Option 2***

Tilt down as far as fitting allows (integral sensor units sometimes limits the downward angle).

Fabricate shielding from aluminium or similar material and fix securely in place.

Ensure that shielding as fixed, allows no light at or above the horizontal axis.

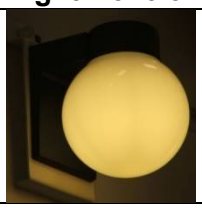
Reduce lamp size if possible.

Remember:-

SWITCH OFF - AFTER YOUR WORK IS FINISHED
NO TASK – NO LIGHTING

For all other fittings consider implementing changes or upgrades see following page:-

1) No or very minimal Light Control


Preferred step
Measure the building footprint and consider replacing these types of light unit with new fitting(s) having good light control, preferably “fully cut-off” like the examples on the following page (Table G2) and thereby meeting the Lighting Master Plan (LMP) requirements.
Try not to exceed the total lumen limit in the table below for your size of property.

	Night Time Environmental Zone					
	E0-0	E0-25 E0-50	E1-500	E1-1000	E1-1500	E2-0%
Total Site Lumens for exterior lighting	No new light units	500 lm plus 4.5 lm / m^2 of site structures*	600 lm plus 4.5 lm / m^2 of site structures*	750 lm plus 4.5 lm / m^2 of site structures*	1,500 lm plus 4.5 lm / m^2 of site structures*	2,500 lm plus 4.5 lm / m^2 of site structures*
Baseline calculation Result =		Calculate	Calculate	Calculate	Calculate	Calculate
Single or twin unit on property and **no light control** luminaire's lumen maximum	No light units	Replace or modify to FCO and 500 lm	500 lm in existing unit	1,000 lm in existing unit	1,500 lm in existing unit	1,500 lm in existing unit
3 or more on property and **no light control** luminaire's fixed lumen up to optimised maximum	No light units	Replace or modify to FCO and Up to 420 lm	Up to 420 lm Total lm not to exceed baseline	Up to 500 lm Total lm not to exceed baseline	Up to 500 lm Total lm not to exceed baseline	Up to 630 lm Total lm not to exceed baseline
Single or twin unit on property and **Fully Cut-Off** luminaire's lumen maximum	No light units	630 lm	750 lm	1000 lm	1,500 lm	1,500 lm
3 or more units on property and **Fully Cut-Off** luminaire's fixed lumen up to optimized maximum	No light units	Up to 500 lm Total lm not to exceed baseline	Up to 500 lm Total lm not to exceed baseline	Up to 630 lm Total lm not to exceed baseline	Up to 630 lm Total lm not to exceed baseline	Up to 750 lm Total lm not to exceed baseline

Table G1 - Total lumen limit and individual lamp lumen limit per property
* Site structures is the sum of the land area of residential buildings, habitable structures, garages, recreational buildings and storage structures on each property plot.

 Fully cut-off example	 Fully cut-off example	 Fully cut-off example
 Only part shielded so limit lamp size as per table.	 Only part shielded so limit lamp size as per table.	 Only part shielded so limit lamp size as per table.

Table G2(above) Typical shielded and part shielded lighting units.

A full list of domestic lamp types, their wattage and their lumen outputs are shown in the previous appendix as reference data. However, lamp manufacturers are continually improving lamp efficiency and some lamp lumen outputs may change through time. An abridged version is shown in Table G3 below

or ***Option 1***

Shield to fully comply with LMP requirements.

Fabricate shielding from aluminium or similar material and fix securely in place.

Ensure shielding as fixed, allows no light at or above the horizontal axis.

or ***Option 2***

If high power lamp, replace lamp with one having less than 1000 lumen output (see tables in Appendix).

Consider shielding as well.

Table G3 Abridged lamp watts and lumens

Lamp type & Watts		**Lamp Lumens (lm)**
Clear Bulb GLS	40w	420
Candle Lamp clear	40w	400
Candle Lamp halogen	28w	370
Superlux Krypton	40w	455
Halogen energy saver	28w	370
Halogen linear		
12v Tungsten Halogen	30w	415
T2 linear fluorescent	8w	540
T8 linear fluorescent	8w	385
Compact Fluorescent Elegance globe	9w 9w	480 405
Elegance candle	9w	405
Elegance spiral	9w	450
2D compact fluorescent		
3 loop compact fluor't		
1 loop compact fluor't	7w	425
LED Opal globe		

2) Partly Cut-off Fittings



Keep luminaire tilted down to lowest limit

Preferred step

Adjust tilt angle down to meet LMP requirements.

or ***Option 1***

Tilt down if adjustable and

Provide additional shielding to comply with LMP requirements.

Fabricate shielding or cowl from aluminium or similar material and fix securely in place.

Ensure that shielding / cowl as fixed, allows no light at or above the horizontal axis.

or ***Option 2***

Consider replacing with new fitting having improved light control & meeting LMP requirements

or ***Option 3***

If high power lamp, replace lamp with one having less than 1000 lumen output (see tables in Appendix)

Consider tilt reduction as well, if possible.

Consider shielding as well.

For all external lighting:-

- Check switching times are sensible / consider time limitation as appropriate.
- PIR detectors are properly aimed to avoid nuisance switching.
- Consider installing a push button switch with short time delay facility.

Summary & Plan of Saint Helena Night Environmental Zones

Zone Index	Typical Environment	Light Control Description
E0-0	**National Parks, Nature Reserves & Wirebird Protection**	**No new lighting**
E0-25	**Coastal Village Area or existing property in E0-0 area**	**Fully Cut-off regardless of wattage and no light presence beyond 25 metres of unit or property boundary if closer than 25 metres.**
E0-50	**Property in E1 area but just beyond boundary of E0-0 area**	**Fully Cut-off regardless of wattage and no light presence beyond 50 metres of unit or property boundary if closer than 50 metres.**
E1-500	**Residential area close to E0-0 area**	**All luminaires with a light source greater than 500 lumens to be horizontal and fully cut-off.**
E1-1000	**Generality of residential area like Half Tree Hollow**	**All luminaires with a light source greater than 1,000 lumens to be horizontal and fully cut-off.**
E2-0%	**Jamestown and Ruperts only**	**All luminaires with a light source greater than 1,500 lumens to be horizontal and fully cut-off.**