



# City of Melbourne Lighting Guidelines

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## Purpose of document

### Introduction

The Lighting Guidelines brings together City of Melbourne’s various lighting policies and lighting masterplans, consolidating the principles to provide guidance for the delivery of the City’s lighting designs and installations. The Guidelines are a supporting document to the City’s Public Lighting Strategy.

The primary objective of the Lighting Guidelines to ensure that when new lighting is designed and installed in the City, it meets the requirements of the City of Melbourne and its residential and business stakeholders.

The lighting principles set out in the Lighting Guidelines aim to provide a consistent and unified approach to lighting the City with the objective of improving the quality, consistency and efficiency in the application of lighting in the City’s streets and public spaces.

The Lighting Guidelines provide technical guidance to the City and the City’s lighting designers, enabling lighting designs for the City to be undertaken in a manner that that meets the desired outcomes. The Guidelines include information such as lighting technical parameters, technologies and furniture (eg poles and luminaires) that should be considered to ensure consistency of approach for lighting across the City.

The Lighting Guidelines have an expected life span of 10 years, after which an overall review of all elements should be undertaken. During the life span of 10 years, the Lighting Guidelines should remain a living document that reflects changes in lighting technologies and considers changes to other relevant public realm policies.

### Objectives

The lighting principles set out in the Lighting Guidelines have the objectives as follows:

#### To facilitate safe movement

In its most basic form and function, lighting is provided to facilitate safe movement of vehicles, cyclists and pedestrians by allowing clear identification of objects and people.

#### To provide orientation

Good lighting will highlight important features of the City and environment and show the colours of buildings and landscapes that will enable visitors to quickly identify with locations. This will allow them to orient themselves around the City quickly.

#### To improve hazard identification

The provision of good functional lighting will enhance the perception of safety and security associated with an area, and encourages patronage.

The “Fear of Crime” is associated with the visual perception of the space. At night time, appropriate lighting reveals the space in a manner that allows recognition of any potential threat. It can also assist with

investigation of crime in that description of elements, such as colour of clothing, can be identified and reported more accurately.

The lighting should enable signage to be read and hazards to be navigated.

### **Provide a unified approach to the Urban Design**

To develop a unified approach to public lighting applied across the City as a holistic scheme.

The integrated approach should be complementary to the urban design, in both the day time and night time environment.

### **To improve environmental sustainability**

Providing energy efficient lighting systems can not only lead to reduced costs, but will in turn reduce the causes of greenhouse gas emissions effecting the environment.

City of Melbourne's objective is to reduce greenhouse emissions, which can be achieved effectively with the use of modern lighting technologies.

Sky pollution through wasted light into the sky is also recognised as an environmental concern. City of Melbourne's objective is to minimising this waste light.

### **Co-existing policy documents**

The Lighting Guidelines complements and reinforces the objectives of established policies that have been developed and adopted by the Melbourne City Council.

[City of Melbourne Public Lighting Strategy 2013](http://www.melbourne.vic.gov.au/residents/home-neighbourhood/street-lighting/pages/public-lighting-strategy.aspx)<sup>1</sup>

[Docklands Design and Construction Standards](http://www.melbourne.vic.gov.au/building-and-development/standards-specifications/pages/design-standards.aspx)<sup>2</sup>

Design Standards 601

Service Asset Management Plan Part 6 – Metered Public Lighting 2018

City of Melbourne Light Poles

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<sup>1</sup> <http://www.melbourne.vic.gov.au/residents/home-neighbourhood/street-lighting/pages/public-lighting-strategy.aspx>

<sup>2</sup> <http://www.melbourne.vic.gov.au/building-and-development/standards-specifications/pages/design-standards.aspx>

## General design principles

The lighting designer should comply with the lighting principles to ensure a lighting scheme is suitable for the space and does not cause danger or irritation to the public.

One of the principle aims of public lighting is to ensure that the required levels of illumination are provided so that the public realm is appropriate and safe. The lighting is provided to allow safe movement of vehicles, cyclists and pedestrians.

To achieve suitable levels of safety and amenity, performance criteria is provided in the following sections.

### Pedestrian comfort and safety

The lighting should generally aim to achieve the following:

- Illuminate edges of streets and ensure public areas are well lit;
- Ensure changes in level are visible;
- Enable a person's features to be recognised from at least 10-15 metres away;
- Enable orientation and way finding to take place;
- Illuminate the built form to enhance the overall visual perception space.

### Suitable lighting levels

Ensure all new outdoor lighting designs meet recommended codes of practice for traffic safety and pedestrian amenity.

Comply with the relevant Australian Standards and be guided by the following:

- Up to Category V1 to be used for targeted areas (e.g. high use roads where high levels of pedestrian use take place, major boulevards); category P3 or P2 if nominated on footpaths.
- Category V3 to be used for boulevards, major roads and neighbourhood retail strips; category P3 on footpaths.
- Category V5 for major streets; category P3 on footpaths.
- Category P1 in areas of high pedestrian use.
- Category P2 in streets where higher levels are required due to position and usage.
- Category P3 for lanes and minor streets within the CBD and certain other locations
- Category P4 to be used for minor residential streets, minor laneways,
- Category P5 for very minor lanes which service garages, is always visible from the main street and where light pollution may be a problem.
- Category P6 to be used for primarily pedestrian areas especially within the CBD;
- Category P7 for use primarily pedestrian where category P6 is not justifiable.
- P3/P4 for pedestrian and bike paths.

The levels provided are based on general conditions; designs should take into account other issues such as type of usage and crime within the particular area. Other factors that should be taken into consideration may include the prestige and tourism associated with the area.

The limits specified are minimum levels only and may be exceeded where suitable or to match adjacent areas.

## **Spill**

Environmental impacts due to public lighting can be minimised or mitigated by the following actions:

- Placement of LED luminaires is of critical importance. to limit spill.
- To reduce light pollution, luminaires shall be angled and/or fitted with shielding to reduce light pollution to the night sky
- Lighting shall be designed, shielded and installed louvres as necessary to prevent undue spill into properties.

## **Glare**

Glare is a visual sensation caused where a light source in the field of view is significantly brighter than the visual system is adapted to. In simple terms, glare results when bright spots are viewed against a dark background.

It can be disabling or simply uncomfortable. It is subjective, and sensitivity to glare can vary widely among the population. Older people are usually more sensitive to glare due to the aging characteristics of the eye.

Glare can be divided into two types, disability and discomfort glare.

Disability glare is the reduction in visibility caused by intense light sources in the field of view. Discomfort glare is the sensation of annoyance or even pain induced by overly bright sources.

All lighting and especially floodlighting shall take glare into account as part of the design.

## **Colour temperature**

Colour Temperature is expressed in Kelvins (K) and is the colour of the light source. It is expressed as "temperature" because, like fire, the hotter fire the more it changes from a warm yellow hue to a cool white/blue hue.

The colour temperature for general street lighting the City of Melbourne shall be 4000K.

## **Colour rendering**

The colour rendering of a light source refers to the accuracy with which colours are represented when illuminated by the light source. It is expressed in CRI where the colour rendering of "0" means that the light is monochromatic light where no colours of the spectrum are discernible; whilst colour rendering of "100" means that all colours of the spectrum can be distinguished.

In residential streets and other areas of low activity, the colour rendition is less significant as the eye will operate in the mesopic range, which means that colours will be less discernible.

For general street lighting the colour rendering of a source should be a minimum of 70.

In city squares and malls and where there is high pedestrian use, a minimum colour rendering of 80 should be considered.

## **Use of inground luminaires**

In ground luminaires are problematic to maintain and can create discomfort glare for pedestrians. It is City of Melbourne policy to not install in ground luminaires.

## **CCTV**

Modern full HD camera's come with self-correction software that allows them to operate in a wide range of environments.

In practice, good quality pictures can be achieved at low lighting levels.

The two factors that most affect the CCTV effectiveness are flaring caused by glare to the camera lens, and contrast caused by uneven lighting. A well designed lighting system will minimise these two elements.

The suitable placement of cameras with respect to the surrounding context should be considered as part of the design process.

## **Implementation**

The aim of this section is to provide a consistent set of principles to implement a lighting design.

Refer appendix D for a map of the City of Melbourne which displays the different zones.

### **Arterial roads**

Primary and Secondary Arterial Roads are VicRoads controlled.

All lighting to be modified must be designed by a VicRoads approved lighting designer.

Generally these roads are illuminated to category V1 or category V3 depending on VicRoads designation.

### **Wall mounted lighting**

Wall mounted lighting occurs in many areas within the City of Melbourne.

CitiPower does not prefer wall mounted lighting and may not install this lighting where it did not exist previously and pole mounted lighting is possible. CitiPower will provide a point of supply at the entrance to the laneway on application to enable Council to connect new public lighting assets to operate and maintain in locations where wall mounted lighting is the only option.

Generally CitiPower connected wall mounted lighting is only installed within the CBD, North Melbourne, West Melbourne, parts of Carlton and some small sections of Kensington.

CitiPower must be able to access the lighting within a lane using their standard truck. If this is not possible then wall mounted lighting may not be permitted.

With regard to cabling for new installations, Council would be required to meet necessary wiring regulations. CitiPower will nominate a point of supply to enable council to meet statutory lighting requirements.

Even where the buildings are providing their own lighting it is necessary to have public lighting that is either grid connected or City of Melbourne metered connected within public lanes. This is to ensure that the lanes are not reliant on adjacent buildings to operate and maintain statutory lighting.

Wall mounted lighting connected to the CitiPower grid or City of Melbourne metered power must be accessible along its total length and not be installed within title boundaries.

The preferred method of mounting to walls shall be with chemsets.

All cabling shall be run on the surface of a building mounted within galvanised steel conduits, MIMS cabling or similar approved method. All underground works and pits shall be undertaken by a CitiPower approved contractor.

A design showing lighting calculations and preferred position of luminaires needs to be submitted to the City of Melbourne and CitiPower for approval. If the building surface is not suitable then pole mounted lighting will be required.

## **Catenary lighting**

Catenary lighting exists in various locations within the CBD and is maintained by the City of Melbourne, examples include the Bourke Street Mall, Little Bourke Street and Manchester lane.

This lighting is maintained by the City of Melbourne.

No works are to be undertaken to the catenary lighting included installing temporary Christmas lighting without the express permission of the City of Melbourne.

## **CBD lighting**

In CBD areas it is important to ensure that the lighting between lanes and street is not greatly contrasted in illumination levels. The lighting may readily exceed the minimum standard to achieve local aims of safety, linking with brightly illuminated areas such as malls and to encourage pedestrian use.

In general, the following minimum levels are required.

### **Category V1, P2 on footpath**

- Primary Arterial Roads e.g. Spencer Street, Primary Major Roads e.g. Flinders Street,

### **Category V3, P3 on footpath**

- CBD Major Roads e.g. Exhibition Street

### **Category P2**

- Major Lanes e.g. Little Collins Street

### **Category P3**

- Minor Lanes for example Gallaghers Place. Note: some lanes have been historically illuminated to higher levels due to safety and/or heavy usage e.g. Brien Lane, Bullens Lane

### **Category P4**

- Not acceptable within CBD.

### **Category P6, P7**

- Large open areas such as Swanston Street Walk and Bourke Street Mall.

In many lanes it is difficult to have poles and historically the lighting has been wall mounted.

Generally, wall mounted lighting schemes where they have been historically present shall be retained where possible.



There are particular areas where particular luminaires have been designed for that area and these luminaires if removed shall be replaced with a similar luminaire. This includes areas such as the laneways off Little Bourke Street which are fitted with the “Chinatown Luminaire”,

Other areas are fitted with the City of Melbourne’s decorative suite of luminaires such as Meyers Place and these may not be changed without City of Melbourne permission.

## **Southbank**

In CBD areas it is important to ensure that the lighting is balanced. The lighting may readily exceed the minimum standard to achieve local aims of safety, linking with malls and to encourage pedestrian use.

Southbank Boulevard (except for the section where the tram runs), Southbank Promenade and Riverside Quay are metered. The remaining streets are unmetered.

As per the CBD, the lighting shall be illuminated in a similar manner. No minor street is to be illuminated to less than category P3. The boulevard shall be illuminated to category P7.

## **Docklands**

The Docklands lighting is often metered and maintained by the City of Melbourne. A significant portion of the precinct is now unmetered under the care of CitiPower.

There is a particular suite of poles and lighting fixtures that must be used when undertaking works. All works have to be approved by the City of Melbourne. It is noted that unpainted streetlights are accepted for CitiPower connected areas.

As per the CBD, the lighting shall be illuminated similarly and no minor street is to be illuminated to less than category P3. The boulevard shall be illuminated to category P7.

## **North Melbourne**

North Melbourne is essentially a residential area.

As the streets are quite busy at night, they are usually illuminated to category P5 or category P3 if solely residential.

## **West Melbourne**

West Melbourne was an industrial area though there are some residential facilities being built. The streets are well illuminated, often to category V5.

## **Flemington, Kensington**

Flemington and Kensington consist of a mixture of residential and industrial areas. Jemena and CitiPower are manage different sections of this area.

Sections of Kensington use decorative luminaires and poles. Any new works shall provide an equal of modernised version of the existing lighting.

Generally, they are illuminated to minimum Australian Standards which is normally category P4 for residential streets, P5 for lanes and P3 for distributor roads.

## **Carlton**

Carlton is a heavily pedestrian trafficked area and there are areas where students, disadvantaged and many other types of people congregate.

As a result, it is usual to illuminate the streets to category V5 in many zones and at least to category P3 for minor streets. The lighting presently provided should be assessed and matched in any future upgrades.

There are some decorative luminaires especially along major roads such as Lygon Street.

## **Parkville**

The precinct surrounds Royal Park and is generally a residential area except for the CSL factory and mental health facilities within the area.

There are pockets where decorative luminaires are used particularly at the old Commonwealth Games Village. There is also some special lighting at the Manningham Bridge.

The lighting should be treated similarly to Carlton.

## **East Melbourne, South Yarra**

South Yarra and East Melbourne are residential district with many streets heavily treed. At present, the streets are illuminated to a higher level than standard suburban residential streets, usually to category P2, if not brighter.

The lighting should be category P2 for distributor roads and P3 for the local roads.

Laneways should be illuminated to category P4.

## **Fishermans Bend, Port Melbourne**

These areas were historically industrial and the lighting at present is often sparse or non-existent. The area is to become residential. Future lighting plans have yet to be developed.

The new developments should be designed to meet similar requirements to Docklands. Large squares and promenades should be illuminated to category P6.

Minor roads should be designed to category P2 as a minimum.

## **Retail areas**

Lighting to a higher illuminance than the surrounds will help differentiate retail precincts from surrounding residential or mixed use area.

Retail lighting will vary according to position, be it a mall, retail strip or promenade.

Shopping strips should be illuminated to category P2 as a minimum.

Generally, Promenades should be illuminated to at least P7 with higher levels justified such as Docklands in front of the water.

## **Historic conservation areas**

Historic lighting elements should be retained though internal lamp upgrades to improve efficiency and performance shall be encouraged.

There are a few gas lanterns still operating and areas such as Bank Place and Chinatown where luminaires developed to suit the context have been developed.

## **Residential/village streets**

In residential areas reduce sideways spill or glare onto adjacent residential buildings. Gentle subtle lighting should be encouraged. The amount of light should be enough to see a person's face and enough to ensure a good ambience. The lighting must have the ability to ensure a good balance of lighting in residential areas.

The main purpose of residential lighting is to assist pedestrians to orientate themselves and detect potential hazards and to discourage fear of crime while protecting the integrity of the night time environment through control of light spill and glare.

The purpose of residential lighting is not to provide drivers with adequate visibility, cars have headlights that serve this purpose, though the lighting will aid in orientation and visibility at corners.

The lighting in residential zones consists of local roads and collector roads.

Collector roads, as the name suggests, are roads which collect and distribute traffic in residential areas as well as serve abutting properties.

Generally local roads are illuminated to category P4 to AS/NZS 1158.3.1:2005 while collector roads are illuminated to a higher level, from category P3 to P2 depending on local characteristics.

A secondary aim may be to enhance the prestige and amenity of the location but the lighting should be designed to minimise any obtrusive effects.

Where a street has a large tree canopy then to aid in orientation and to improve the aesthetics of the street, a small amount of up lighting from the luminaire may be justified.

## **Parks and gardens**

### **General**

Melbourne's parks and gardens remain open at night. Sporting events and organised entertainment can attract large evening crowds to parks and gardens. Open spaces also contain important pedestrian routes that link the central city with surrounding neighbourhoods.

Parkland borders many of Melbourne's main thoroughfares. In daylight, these streets benefit from the adjacent landscape. At night, an unlit park can create the effect of an unnerving void.

Parks and Gardens vary in size, position and usage.

Parks require individual consideration as to how they are to be illuminated.

### **Paths**

Parks provide important pedestrian connections between the central city and the surrounding neighbourhoods.

Selective lighting can help direct pedestrians to the safest, most frequently used thoroughfares.

Generally, the paths should be illuminated to at least category P3 of AS/NZS 1158.3.1:2005. Major routes should be illuminated to category P2 or higher to suit the surrounding areas.

Not all paths should be illuminated. Some paths may not be illuminated under police advice to discourage their use due to conditions along the path such as heavy foliage. Police have requested paths are not lit in the past.

Paths that lead to cul-de-sacs should not be illuminated.

## **General Lighting**

The public lighting strategy states that it is neither practical nor desirable to illuminate large landscapes in their entirety. Limited lighting in parks keeps costs down, reduces energy consumption and helps protect biodiversity in the city. For example, bats are sensitive to lighting and other nocturnal species rely on darkness to forage and locate homes

Picnic areas, areas frequented by users playing sport recreationally, dog walkers may be illuminated however consideration should be considered with regard to switching off the lighting by 10pm.

Some general open lighting does exist in certain parks due to the nature and usage of the park.

Lighting in open areas shall be designed to limit upward spill and avoid tree canopies.

## **Feature Lighting**

Feature lighting of a park may be undertaken to increase the attractiveness of the park and provide wayfinding locations.

Typical elements that may be illuminated include manicured garden beds (e.g. the floral clock garden), statues, memorials, building elements such as frescoes, under bridges and other single elements.

Up-lighting is to be avoided where possible. If necessary, the lighting should be designed to maximise the illumination to the element while minimising the amount of upward spill produced. This requires careful design.

## **Small Parks**

Very small parks that may contain a children's playground or similar may not be illuminated however from a public safety point of view it will be necessary to ensure that anyone within the park is visible. This is usually achieved through the existing street lighting. Some additional lighting may be installed however it should normally be switched off at 10pm.

Parks with sections hidden from the street shall be illuminated. Preferably the hidden sections are removed through pruning/improved landscape design.

## **Large Parks and Gardens**

Individual lighting plans have been developed for many of the larger parks which should be used for determining illumination levels. This is contained in the Melbourne's Parks and Gardens strategy 1995.

Yarra park is the responsibility of the Melbourne Cricket Club though the City of Melbourne has a responsibility also.

Provide a higher illumination level around main entrances. Conspicuous park entrances help identify safe walking routes.

Create a sense of depth among landscape elements viewed from surrounding streets. Illuminate elements at the terminations of view shafts.

Open spaces should provide positive street edges after dark.

The park lighting should be based on patterns of use and circulation.

## **Major thoroughfares**

Major thoroughfares include Southbank along the river edge, Southbank Boulevard, Kensington Banks, Docklands and various sections along the Yarra.

These sections should be illuminated throughout the night to a level suiting the nearby surrounds and to at least category P3 in accordance with AS1158.3.1:2005 and often to higher levels.

## **Royal Park**

Royal Park is the city's only wild park. The park in the "wild zones" shall be treated as a dark park to provide relatively unobstructed views of the night sky. The lighting within the park where it is required shall be minimised and switched off where possible in certain hours in consultation with the council e.g. zoo carpark 10pm.

## **Park Night Venues**

Some parks may be used for as temporary venues and it may be necessary to provide local power for the temporary lighting and stages. Examples include Argyle Square, Fitzroy Gardens and King's Domain.

The lighting should not be designed for the venue use. Additional lighting should be provided as part of the event which will be removed upon completion.

## **Sports Ground Lighting**

Sports grounds shall be illuminated in accordance with the range of standards within AS2560, council requirements and the relevant sporting body.

All designs shall comply in full with the most recent requirements of the AS4282 Control of the obtrusive effects of outdoor lighting.

## **Lighting Controls:**

Park lighting should always be designed with timer controls so the lighting can be switched off in the small hours to save energy and aid the wild life.

Lighting should be designed so as to minimise its effect on the wildlife. This may be achieved through limiting spill through careful selection of luminaires.

Where the lighting is maintained by CitiPower it is not possible to fit lighting controls. Long term it is planned to have all lighting within most parks to be metered locally and maintained by the City of Melbourne.

## **Taxi ranks, trams and bus stops**

Taxi ranks, tram and bus stops should be illuminated to a level where the driver can assess the passenger before allowing entry into the vehicle and so that people waiting at the stop can be seen clearly and can be viewed by externally.

These are basic safety issues to reduce the possibility of crime and to allow the vehicle operators to see that the potential passenger is in a suitable state to be picked up.

Taxi ranks and bus stops in central areas such as adjacent to train stations or on the main street should be illuminated to category P8 of AS/NZS 1158.3.1:2005. This is the level that is suitable for people interchange environments where there are no particular security issue concerns.

In areas that are lit less intensely such as residential streets then the lower level of category P being category P2 which will be half the level of the main terminals but at least twice the levels of the general surrounds.

If an area has crime problems then a higher level may be considered.

The lighting levels can be achieved by lighting integral to the bus or tram stop or in the case of taxi ranks, by street lighting.

## **Luminaire selection**

The choice of luminaires is limited to the City of Melbourne approved luminaires and pole range. Refer appendices for more information. Not all City of Melbourne luminaires have been accepted by Jemena or Citipower and so cannot be installed on unmetered networks.

### **Legacy existing luminaire range**

The City of Melbourne has legacy ranges. All new lighting shall match the lighting within the legacy range adjacent.

### **Lighting networks**

Major streetlights are to be fitted with the City of Melbourne approved Silver Springs Control System which allows communication of luminaire operation into a radio network that can be accessed by the City of Melbourne, Citipower and Jemena.

### **Uplighting**

Inground luminaires are not permitted due to maintenance issues. In general, no elements shall be up-lit however in certain circumstances where the lighting is carefully controlled a modest amount of up-lighting may be permitted.

# Appendix A

## Glossary of lighting terms

### **Illuminance**

Illuminance is the measure of the quantity of light incident on a point or a surface. It is measured in units of lux.

### **Average Illuminance**

Average illuminance is the illuminance averaged across a number measurement points within a defined area. For determination of average illuminance a grid of measurement points should be recorded.

### **Luminaire**

Complete lighting fixture including lamp, reflector system, housing and control gear.

### **Lantern**

As above, generally a term used by Supply Authorities to describe street lights (luminaires)

### **Luminance**

Luminance is the measure of the quantity of light reflected, or emanating from, a surface. It is measured in units of candela per square metre. An internally-illuminated surface, or a transparent surface such as a window, has inherent luminance. The luminance of a reflective surface is a function of the incident light on the surface (illumination) and the reflectivity of the surface. Luminance is the measure of what is commonly referred to as brightness.

### **Direct light**

Light that is incident on a point or area that has taken a path direct from a source of light, such as a luminaire.

### **Lumens**

Measure of flux emanating from a lamp source.

### **Efficacy**

The efficacy of the lamp is a measure of how efficient a lamp source is. It is measured by the light output (lumens) produced for each unit of power (Watts) input. Efficacy is expressed in lumens/Watt.

### **Reflected/ Indirect light**

Light that is incident on a point or area that has been reflected by at least one surface since emanating from a light source.

### **Lux**

A unit of measurement that provides a value for the amount of illumination that is present at a location.

### **Candela Distribution Curve**

A candela distribution curve is a pictorial representation of the intensities of light of various angles. Curves for luminaires with symmetrical light distributions show one line.

### **Lamp Distribution Curve**

A candela distribution curve is a pictorial representation of the intensities of light of various angles. Curves for luminaires with symmetrical light distributions show one line.

### **Colour Temperature**

The colour temperature of a light source refers to the apparent whiteness of the light produced. Measured in Kelvin (K), and technically related to the comparison of the temperature against that of a black body radiator, generally the more blue the light, the higher the colour temperature. Conversely, a lower colour temperature refers to a more yellow light.

### **Colour Rendering**

The colour rendering of a light source refers to the accuracy with which colours are represented when illuminated by the source. The Colour Rendering Index C.R.I. may be considered as a percentage, where most accurate representation is obtained at a C.R.I. of 100. Colour rendering of typical light sources:

- Incandescent: 100
- LED: 60- 98
- Metal Halide: 50 - 95
- High Pressure Sodium: 30
- Daylight (midday): 100

### **Spill**

Spill refers to light that misses its target. It represents waste light. Light spill contributes to sky glow and may be a nuisance to observers.”

### **Mesopic**

Mesopic vision is a combination of photopic vision and scotopic vision in low but not quite dark situations. Mesopic light levels range from luminances of approximately 0.001 to 3 cd m<sup>2</sup>. Most night time outdoor and road lighting is in the mesopic range.

Human see using rods and cones, but in the mesopic range the cones which see coloured light start to shut down. Under these conditions, blue/green light can be seen better than red/orange light.

### **Photopic**

Photopic vision is the vision of the eye under well lit conditions. Adaptation is much faster under photopic vision. Adaptation can occur in 5 minutes for photopic vision but it can take 30 minutes to transition from photopic to scotopic.

### **Scotopic**

Scotopic vision is the vision of the eye under low light conditions. In the human eye cone cells are non-functional in low light and so colours cannot be seen. Scotopic vision is produced exclusively through rod cells which are most sensitive to wavelengths of light around 498 nm (green-blue) and are insensitive to wavelengths longer than about 640 nm (red).

### **Veiling**

Veiling luminance is the effect produced by bright sources or objects in

### **Luminance**

the visual field that causes decreased visibility and visual performance.



# Appendix B

## Lighting palette standard luminaires



**Image 1: Standard Major Road lighting**

Sylvania RoadLED



**Image 2: Standard Minor Road lighting**

Sylvania StreetLED



**Image 3: City of Melbourne Catenary light for Malls and certain laneways**



**Image 4: Handrail Luminaire Planet “Puck” or Klicktube LEDPod**