City of Perth

# Public Lighting Framework

2019 – 2029





## ACKNOWLEDGEMENT

***We acknowledge the Whadjuk Nyoongar people, Traditional Owners of the lands and waters where the City of Perth is today and pay our respects to Elders past and present.***

*Russell Square, Northbridge*

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# CHAIR COMMISSIONER'S MESSAGE



Our city at night attracts a diversity of activity and culture which enhances Perth's sense of place. As a result, the City of Perth aims to apply a holistic approach to all public realm lighting.

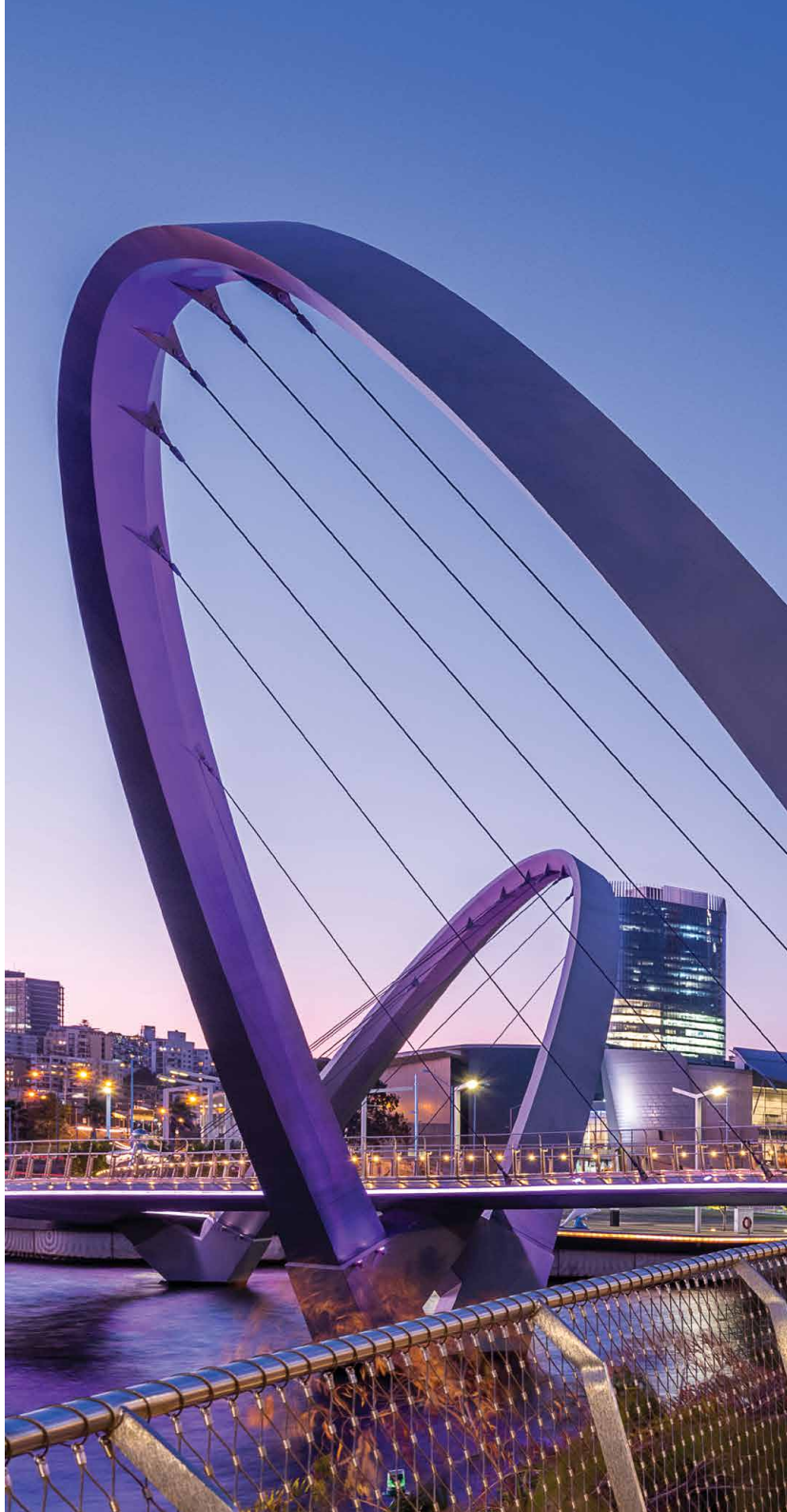
Not only does good lighting promote safety, it is integral to the look and feel of the city after dark. It provides vibrancy for the night-time economy and opens Perth to a wider range of social and physical activities out of working hours.

This vision for an inviting and well-lit city mirrors the City's Strategic Community Plan which puts forward the aspiration of Perth being vibrant, connected and progressive.

This aspiration will be supported by the modernisation of our lighting and there are measures to make all public lighting more efficient and environmentally sustainable.

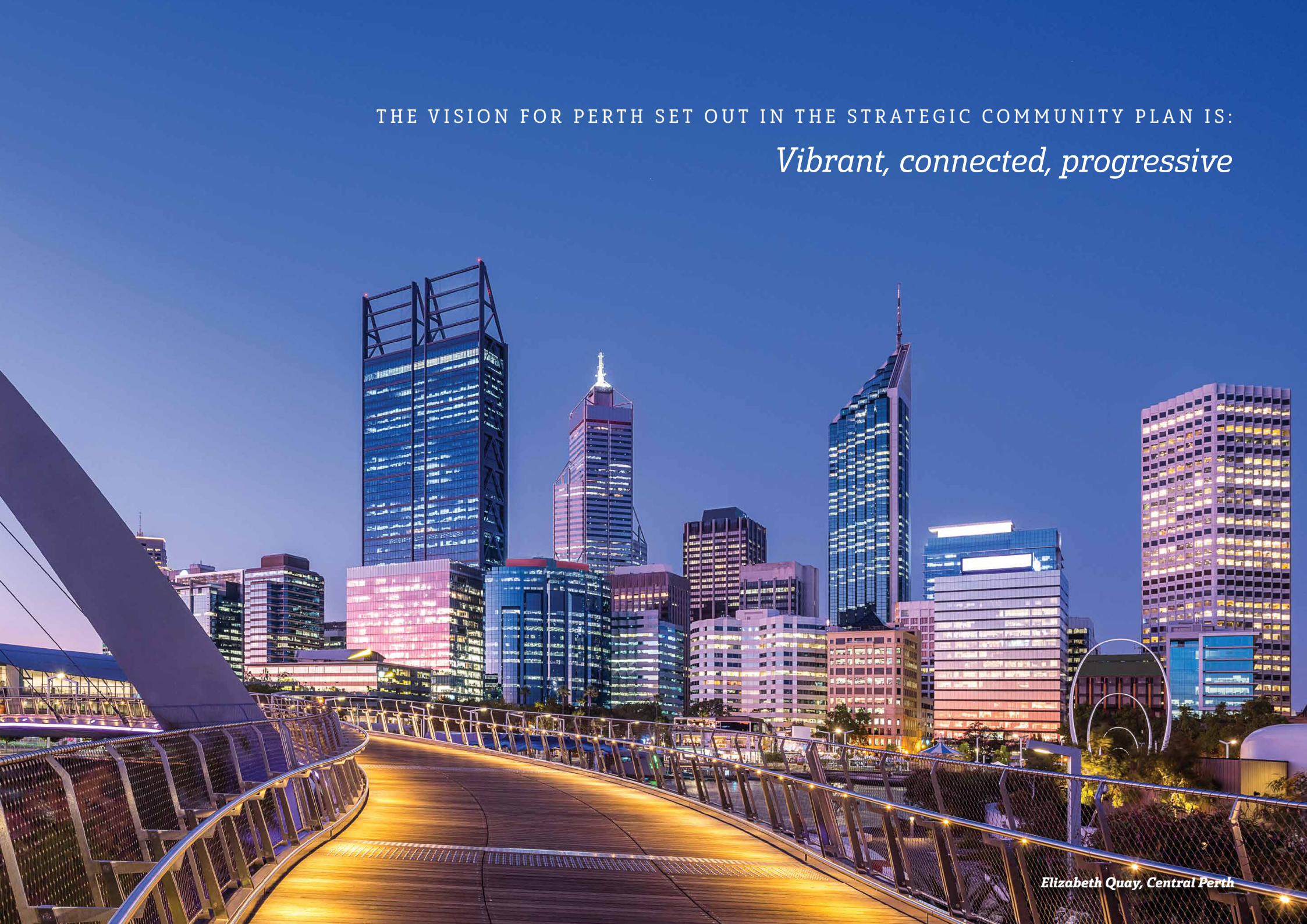
This Public Lighting Framework will contribute to Perth's growth as a friendly and beautiful place to be.

**ANDREW HAMMOND**
Chair Commissioner



THE VISION FOR PERTH SET OUT IN THE STRATEGIC COMMUNITY PLAN IS:

*Vibrant, connected, progressive*



***Elizabeth Quay, Central Perth***



*McLean Lane, Central Perth*

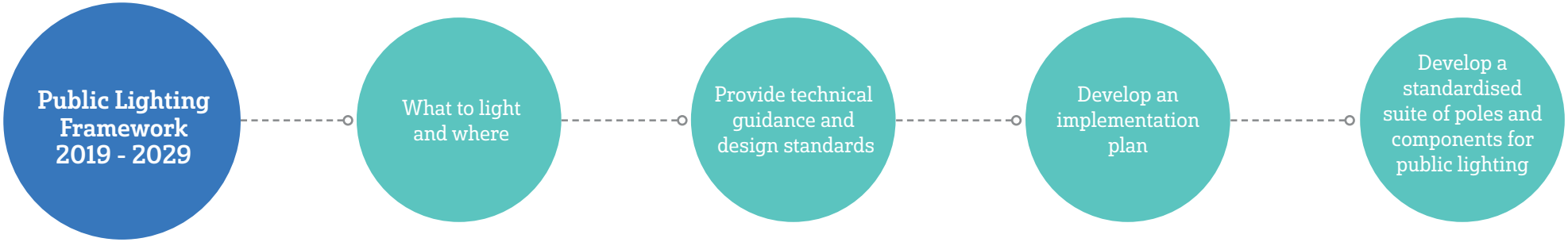
# INTRODUCTION

## WHY DO WE NEED A LIGHTING FRAMEWORK?

Much of Perth's existing street lighting meets only basic needs. Historically, a utilitarian approach to public lighting emphasised safety for motorists, not pedestrian amenity. Only a few streets and spaces have dedicated lighting for pedestrians. While existing lighting would have complied with Australian Standards for illumination levels when it was installed, in places it is doubtful that the aging infrastructure still meets those standards, let alone achieving less quantifiable ambitions for amenity and attractiveness.

We can do better. The total nightscape of Perth should be shaped to create a more legible city, reveal its character after dark, promote safety, and connect its night economy.

Yet this is no small ambition. The scale of project creates a need for an approach that can be rolled out in stages over an extended period. The importance of the cumulative effect of lighting across the city also means it involves multiple stakeholders and requires cooperation with adjacent local governments, public and private landowners, businesses, institutions, developers and other groups. We need a coordinating plan that sets out agreed aims and approaches, while allowing flexibility for individual actions and projects to be elaborated over time.




## WHAT IS THE LIGHTING FRAMEWORK?

The Lighting Framework complements a number of existing documents that provide a guiding framework for Perth's development. The most important of these in shaping the Lighting Framework's aims and content are:

- City of Perth Strategic Community Plan
- An Urban Design Framework: A Vision for Perth 2029

Within this context, the Lighting Framework sets out a holistic approach to public lighting, aiming to:

- Create a vibrant, exciting and safe environment that will encourage people to remain in the city in the evening, supporting economic growth.
- Enhance Perth's image to attract investment and tourism.
- Implement sustainable lighting standards that will reduce energy use, greenhouse gas emissions and maintenance costs, and help to deliver a consistent high quality of public lighting across the city.

The key strategies adopted to achieve these aims include:

- Provide a high standard of functional lighting, judiciously augmented with enhancement lighting to define the street hierarchy, mark gateways, and differentiate precincts and activity areas. This will support safe use of public spaces, enhance the experience of visiting Perth, and strengthen the image of the city. This is addressed in Part 1 of this document, which focuses on what to light, and where.
- Provide technical guidance and design standards for lighting projects. This will support consistent delivery by the City of Perth and encourage other organisations, property owners and businesses to do their part to support the strategy. This is addressed in Part 2 of this document, which focuses on technical criteria of how to provide public lighting.
- Develop an implementation plan for lighting projects and for lighting improvements delivered through other capital works projects. This is a separate document for use by the City of Perth's administration.
- Develop a suite of standard poles and components for public lighting. This will help to minimise clutter, contribute to Perth's visual identity, and facilitate management and maintenance.
- The City of Perth's Design and Construction Notes are a guide to the detailed design and construction of a variety of elements used in public spaces, including lighting. They are available online at ***www.perth.wa.gov.au/planning-development/planning-and-building-tools/design-standards-development-within-city***.

## KEEPING IT CURRENT

The framework will be reviewed every four years to take into account community consultation and updated annually to align with technological advances and contemporary research.



# 1 Lighting Perth

*Elizabeth Quay, Central Perth*

# 1.1 LIGHTING FOCUS AREAS AND OBJECTIVES

To support this vision, public lighting in Perth should be improved to:

FOCUS AREA 1



### MAKE PERTH A SAFER AND MORE INVITING PLACE TO WALK AND BICYCLE.

Improve safety and people's perceptions of Perth as a safe place.

Support orientation and wayfinding to help people find their way through the city.

FOCUS AREA 2

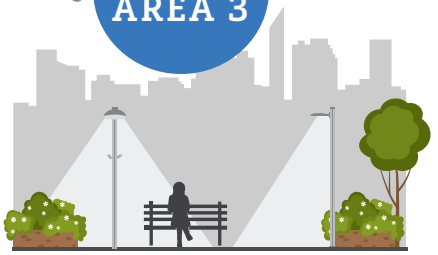


### SUPPORT MORE DIVERSE ACTIVITY IN PERTH'S PUBLIC PLACES.

Support the city's economy by encouraging evening activity and patronage of local businesses.

Stimulate a more cosmopolitan, vibrant and interesting city that encourages more people to live here and that supports increased tourism.

FOCUS AREA 3



### EXPRESS AND ENHANCE PERTH'S SENSE OF PLACE.

Enhance a sense of place by enhancing the unique aesthetic characteristics of our significant buildings, monuments and public spaces.

FOCUS AREA 4



### MAKE OUR LIGHTING MORE EFFICIENT.

Create a more environmentally sustainable city by reducing energy use and greenhouse gas emissions.

Support efficient delivery and operation of high quality lighting infrastructure, and manage it to deliver the best value for the community.

FOCUS AREA 1

## A SAFER AND MORE INVITING PLACE TO WALK AND BICYCLE

Provision for walking and cycling is fundamental to a good city:

- Walking supports all other transport modes, connecting from public transport services and even carparks to shops, offices and other destinations.
- Walking and cycling have significant sustainability benefits in comparison to other transport modes.
- There are significant public health benefits associated with walking and cycling, with resulting economic and social benefits.
- More people walking through an area – a higher footfall – benefits retail and hospitality businesses.
- Increased pedestrian busy-ness of streets and other public places improves safety by supporting increased passive surveillance.

Lighting should therefore be provided to make walking and cycling the most attractive options for getting around and to the city at night – to make it safe, easy and enjoyable.

### OBJECTIVE 1.1

### Provide a high standard of lighting to footpaths and bike paths

A high standard of lighting should be provided to footpaths and bike paths throughout the city, designed not only for safety but to improve comfort and interest.

- Provide lighting to meet relevant standards, ensuring consistent illumination along travel paths and avoiding dark spots due to shadows from awnings or trees, and strong contrasts with nearby spaces.
- Ensure that lighting for pedestrian and bike paths links to public transport facilities including bus stops and rail stations. Where relatively bright lighting is required at stations, create smooth transitions to other areas; avoid abrupt changes in light levels.
- Establish a hierarchy of routes across parks, with key links that are well lit all night and others that are downplayed after (say) midnight.
- Use lighting to define routes and to highlight potentially conflicting paths of travel, as where pedestrian and bike paths merge or cross.
- Ensure that street crossings, freeway undercrofts and other spaces that may be associated with safety hazards or crime risks are well lit.
- Ensure that street signs and directional signs, and timetables and maps at transport facilities, are illuminated.
- Illuminate areas and features adjoining travel paths, to avoid strong contrasts with lit paths that may reduce safety and perceived safety, and to add interest and amenity, including lighting of open spaces, and facade and shop window lighting.
- Consider the Swan River holistically when lighting along its foreshores. Perth Water has both local and regional significance and provides a broad range of opportunities and facilities to the community. Details of this approach are illustrated in **Figure 1: Preferred Cycling Network and Foreshore Pathways**.



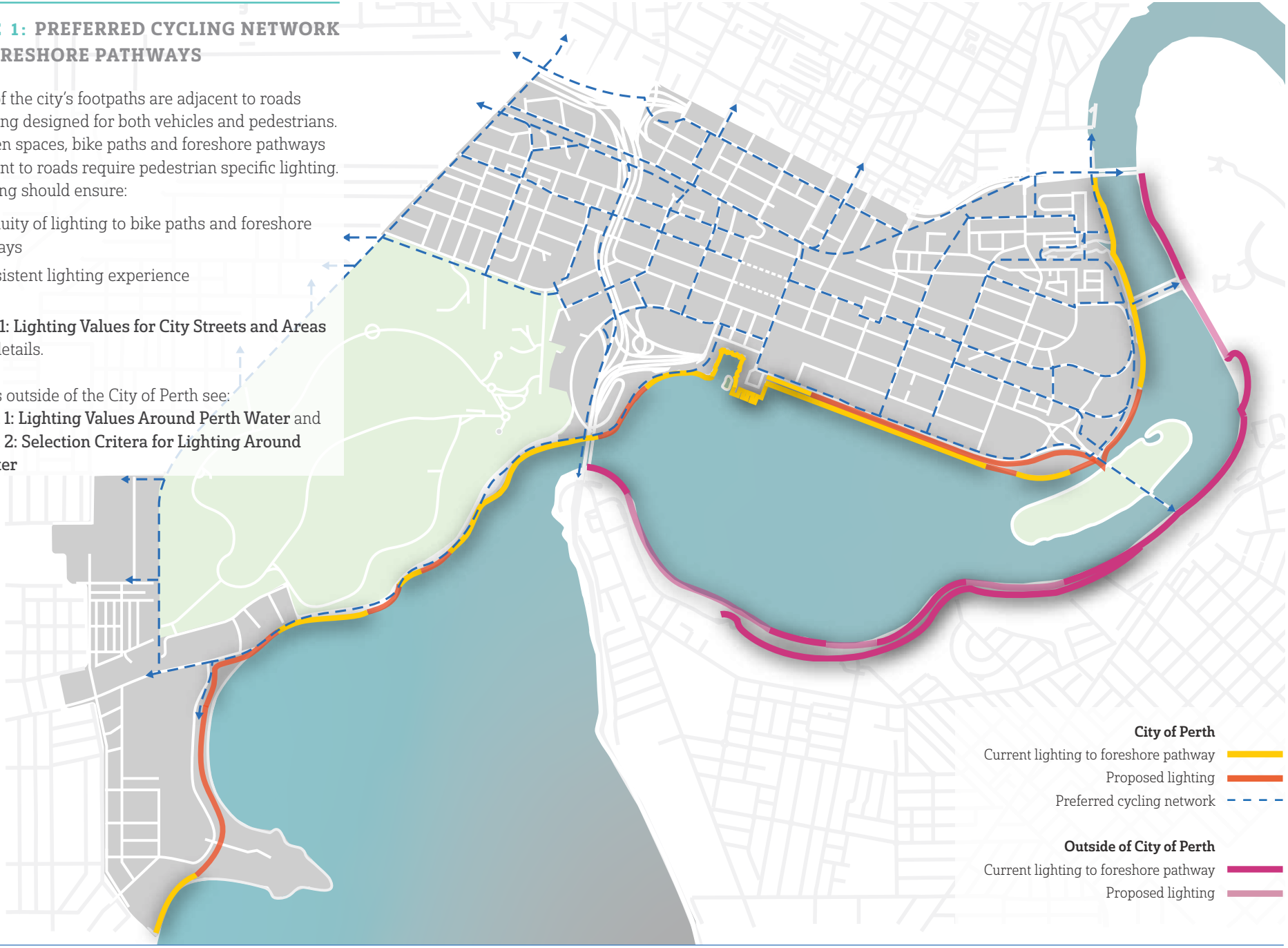
## FIGURE 1: PREFERRED CYCLING NETWORK AND FORESHORE PATHWAYS

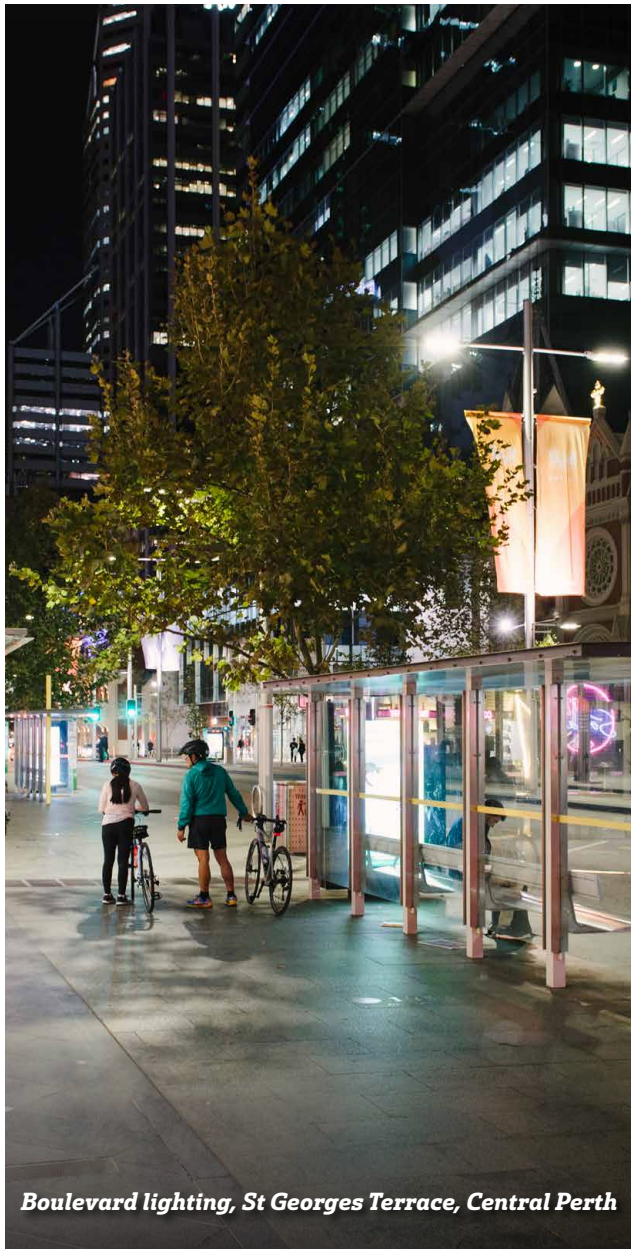
Majority of the city's footpaths are adjacent to roads with lighting designed for both vehicles and pedestrians. Public open spaces, bike paths and foreshore pathways not adjacent to roads require pedestrian specific lighting. This lighting should ensure:

- Continuity of lighting to bike paths and foreshore pathways
- A consistent lighting experience

See **Table 1: Lighting Values for City Streets and Areas** for more details.

For details outside of the City of Perth see:
**Appendix 1: Lighting Values Around Perth Water** and **Appendix 2: Selection Critera for Lighting Around Perth Water**





*Boulevard lighting, St Georges Terrace, Central Perth*

OBJECTIVE 1.2

## Create a coherent and connected nightscape

Good street lighting is not only a mechanical problem of ensuring adequate brightness to see a path of travel or hazards along it. The quality of light and character of fittings should also help people understand a street's role, for example:

– distinguishing a main route from a laneway.
– how it connects between public transport nodes, open spaces, cultural sites and key night venues, and where it is located in the city.

Central Perth features a street grid with a distinct hierarchy of major and minor streets, and this, in combination with the topography, built form and landscaping gives a sense of order and purpose to the city's various activity centres.

- Scenic drives
- City boulevards
- City avenues
- Major city streets
- Minor and residential streets
- Laneways
- Gateways

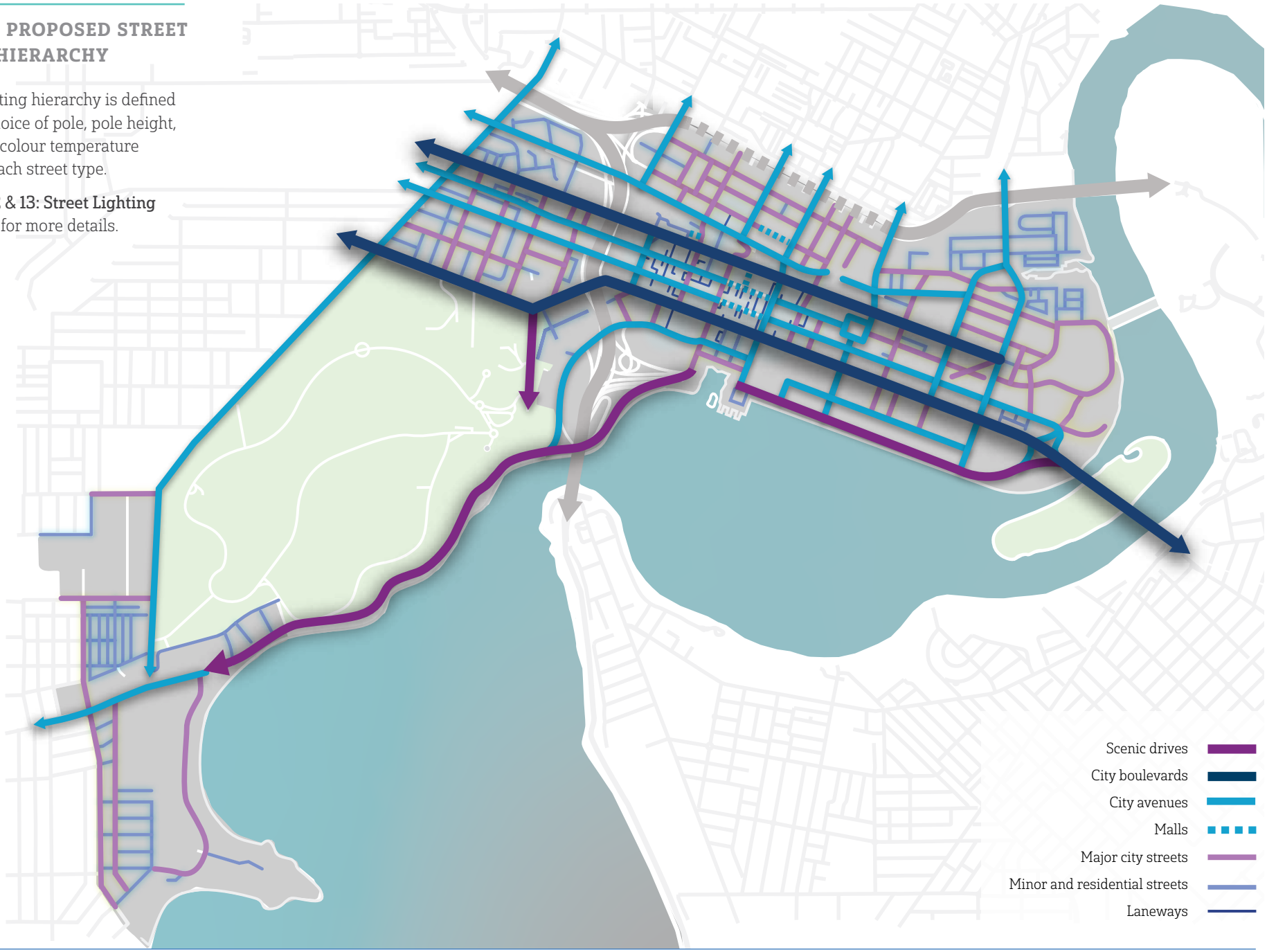
The hierarchy of Perth's streets and lanes should be expressed through consistent lighting in each type of street, encompassing variations in colour temperature and the scale and character of light poles and luminaires.

Where different streets types intersect, the treatment for the wider street should typically carry through across the intersection.

## FIGURE 2: PROPOSED STREET LIGHTING HIERARCHY

The street lighting hierarchy is defined through the choice of pole, pole height, luminaire and colour temperature specified for each street type.

See **Figures 12 & 13: Street Lighting Arrangement** for more details.



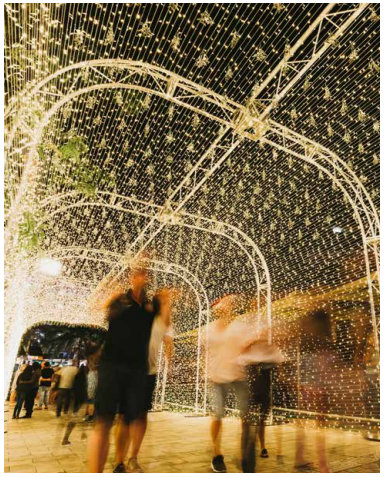
FOCUS AREA 2

## MORE DIVERSE ACTIVITIES IN PERTH'S PUBLIC SPACES

Using lighting to support the use of public spaces and to encourage people to come to the city in the evenings for other things can have wide-ranging benefits. It can:



- Contribute to the economy by encouraging people to stay on after work or to come into the city for shopping, entertainment and leisure.



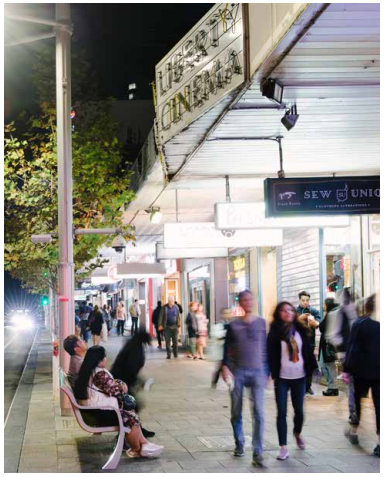
- Make the city a more compelling destination using diverse events and attractions for the local community and tourists.



- Create a sense of safety and comfort that encourages more people to use public spaces and which, in turn, increases passive surveillance, making the city even safer.



- Support the everyday lifestyle of residents by encouraging a wider range of activities and services over longer periods.



- Make a more lively and attractive city to live and work in, and to visit as a tourist, by encouraging pedestrian activity as a source of interest in itself.

OBJECTIVE 2.1

## Improve functional lighting for all uses

'Functional lighting' is often seen as the illumination required for safe movement, and it is the starting point in lighting design for public spaces. However, uses of public space in Perth extend beyond movement. Functional lighting needs to be considered in relation to many activities, including passive and active recreation, special events, and uses of facilities in public spaces, such as sports courts and toilets.

Evening activities are now concentrated in certain parts of Perth. The aim is to extend this activity to enliven the city more extensively, while, in the short term, building upon the strengths of existing activity areas.

- Provide illumination levels and qualities matched to uses of the space. For some activities like outdoor dining, good colour rendering is important so people can see nuances of colour in the environment and their food; for other activities, more basic brightness is critical.
- Consider changes in uses of spaces over time, and provide controls so lighting can respond to those changes, including variations over the course of each night, from season to season, and during special events.
- Create lighting of an appropriate character and scale for the activities in the space, with interplays of light levels and subtle effects in spaces where people linger and can appreciate the detail. Use controls to create various moods at different times.

OBJECTIVE 2.2

## Introduce new light-based attractions

While public lighting is generally used to support travel, shopping and other activities, lighting itself can be an attraction. The City of Perth has presented a number of events that make significant use of lighting, especially during the Christmas and New Year festive season. In other cities, lighting festivals with projections and dynamic lighting of structures have been important visitor attractions in their own right, as with Vivid Sydney, which draws thousands to Circular Quay over a ten-day period in winter. Melbourne's Laneway Commissions program included a number of temporary light-based artworks that each lasted for a season, complementing the development of that city's evening 'laneway culture'. Light-based attractions can vary from modest installations to brilliant extravaganzas, suiting different objectives but all helping to activate the city at night.

- Consider lighting as a component of any special event.
- Consider opportunities for light-based artworks in any commissioning programs.
- Make provision for event lighting and decorations in spaces that are potential venues, with poles capable of supporting additional luminaires, adequate power supply, and adaptable control systems.
- Locate permanent lighting infrastructure for events and Christmas decorations in the primary retail core and local retail precincts.
- Create lighting installations that are responsive to the seasons or other changes in the environment.
- Provide control systems that allow for functional lighting to be adjusted during events, for example, dimming to reduce competition with projections or other special lighting.



FOCUS AREA 3

## AN ENHANCED SENSE OF PLACE

Using lighting to enhance Perth's unique urban character can:

- Reveal and highlight the city's natural, architectural and historic features, making the most of its existing assets as well as reinforcing people's attachment to familiar landmarks.
- Create a more appealing and distinctive urban character that attracts people to live, work, visit and shop in the city and that instils a sense of civic pride.
- Help to interpret the place, heritage and culture, both Indigenous and European and their intertwined stories.
- Provide cues encouraging appropriate behaviour in different parts of the city, ranging from areas where nightlife is concentrated to quiet residential neighbourhoods.
- Improve legibility and support wayfinding.

OBJECTIVE 3.1

### Enhance the character of neighbourhoods

While there should be consistency in the lighting of the street network, more varied lighting can be appropriate to enhance a sense of place in the city's neighbourhoods. However, enhancement lighting should still be planned as part of a consistent approach to each neighbourhood; random, site-by-site variations create the kind of chaotic visual effect that makes so many cities look the same. Site boundaries tend to disappear at night; lighting in one space is often seen in combination with lighting in others, so the cumulative impact is particularly important.

Key ways to enhance neighbourhood lighting should include:

- Concentrate enhancement lighting in neighbourhoods with evening uses including entertainment venues, evening retail frontages, and outdoor dining areas.
- Minimise and limit the scale and brightness of enhancement lighting in residential neighbourhoods.
- Respond to the character of the space. Highlight beautiful and important natural features, trees, facades and artworks to visually enrich the space and to express the city's culture and history.
- Make appropriate use of standard poles and luminaires to suit particular neighbourhoods.

The following neighbourhood maps identify current and future enhancement lighting and consider the following key drivers:

- Key pedestrian routes
- Public transport nodes and routes
- Night activity areas
- Parks

Also included are temporary lighting attractions such as Christmas decorations and festival lighting and existing permanent lighting enhancement areas such as the Hay and Murray Street Malls.

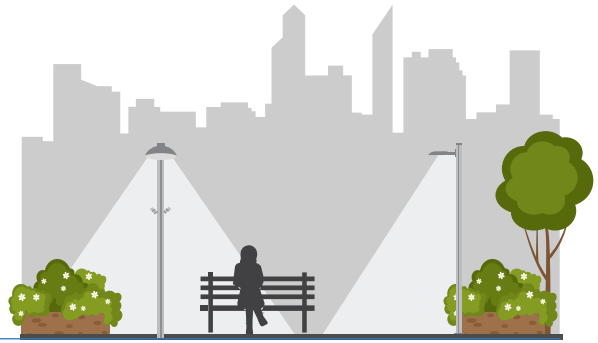


**FIGURE 3: CITY NEIGHBOURHOOD PLAN**

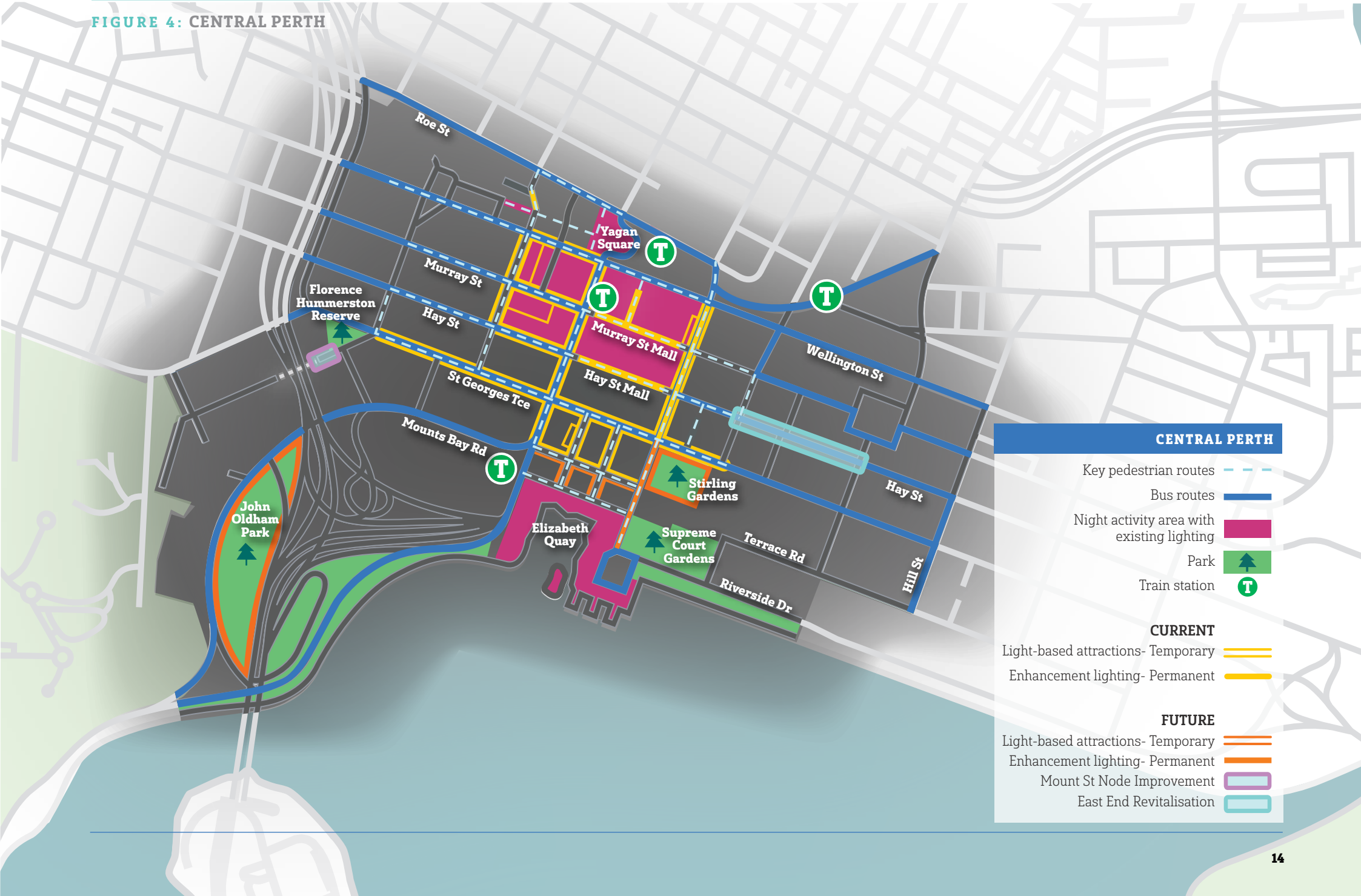
The City of Perth has six neighbourhood areas, each with its own enhancement lighting that celebrates its character.






*Custom lighting Murray Street Mall, Central Perth*

**FIGURE 4: CENTRAL PERTH**





***Enhancement lighting Hay St, West Perth***

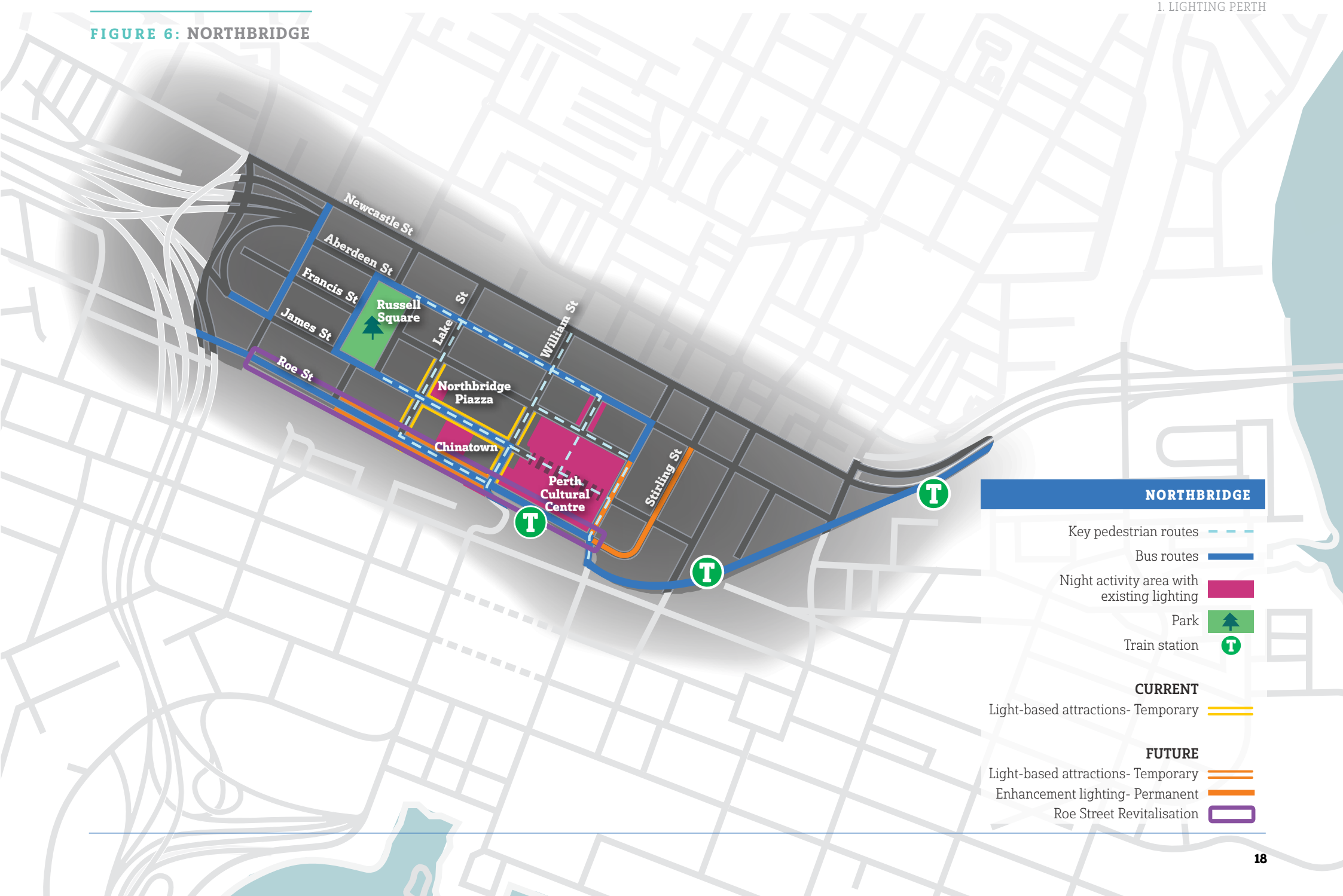
**FIGURE 5: WEST PERTH**





***Enhancement lighting Chinatown, Northbridge***

**FIGURE 6: NORTHBRIDGE**



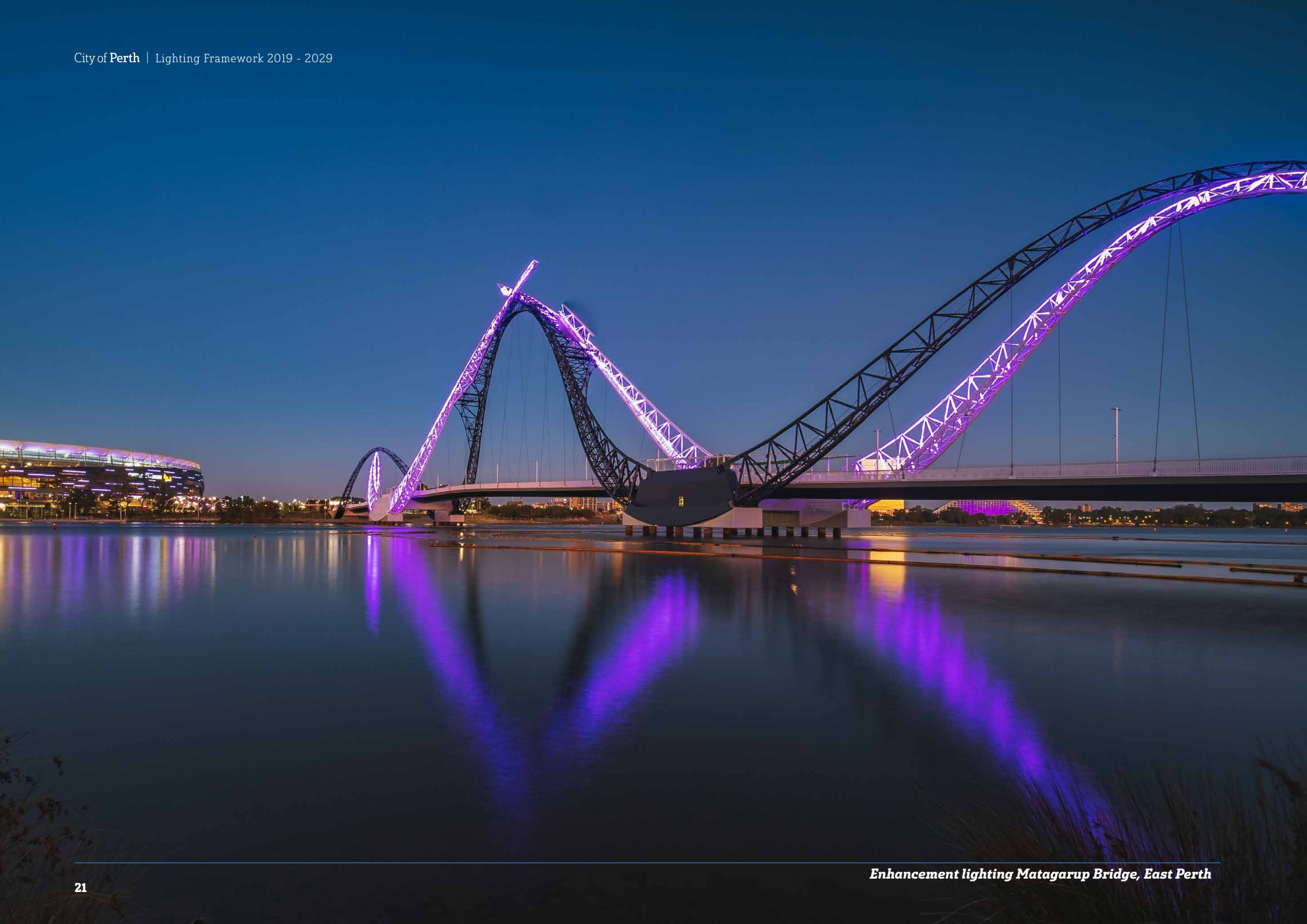





***Enhancement lighting Trafalgar Bridge, Claisebrook***

## FIGURE 7: CLAISEBROOK





***Enhancement lighting Matagarup Bridge, East Perth***

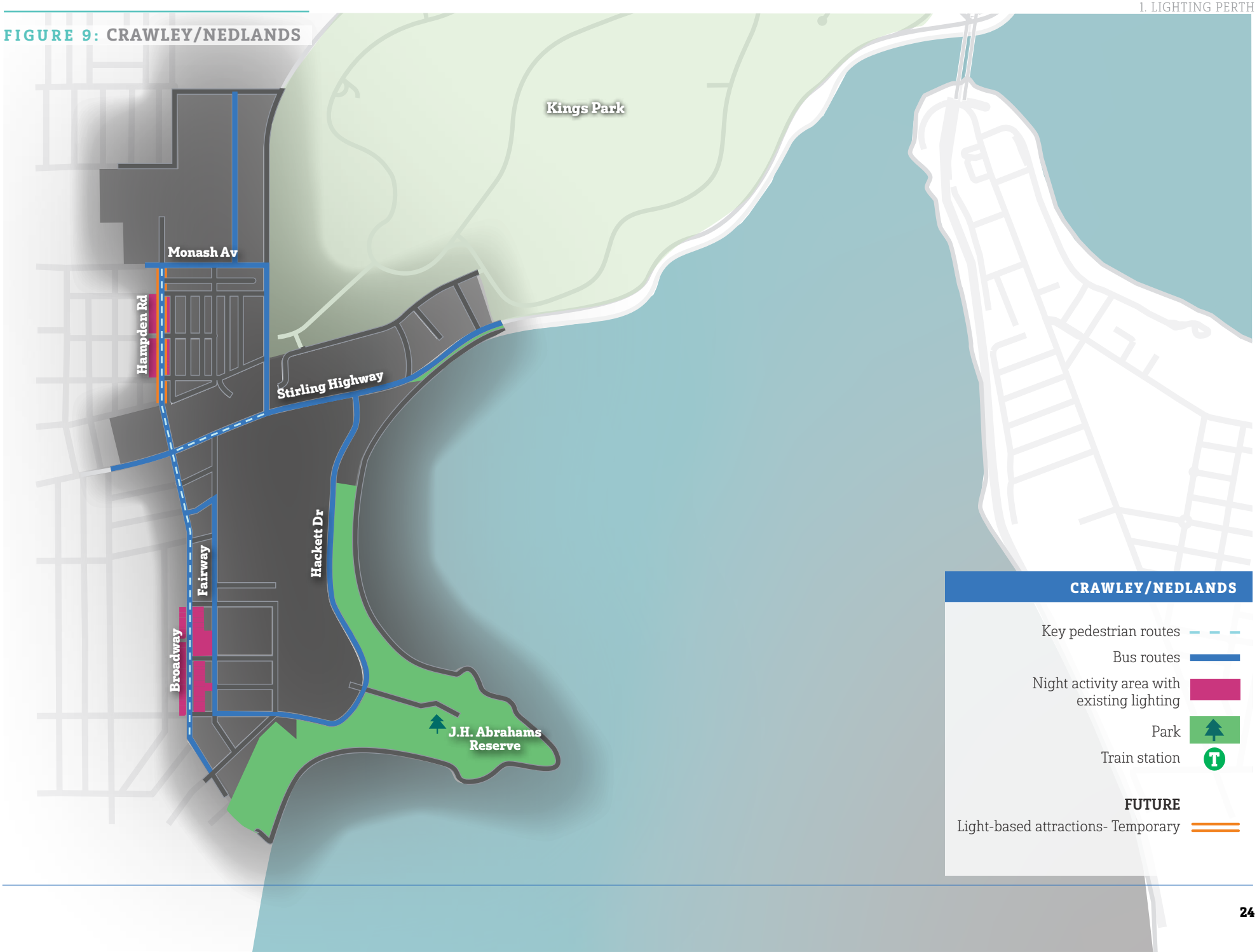
**FIGURE 8: EAST PERTH**





*Enhancement lighting UWA Winthrop Hall, Crawley*

**FIGURE 9: CRAWLEY/NEDLANDS**





*Council House, Central Perth*

OBJECTIVE 3.2

## Emphasise gateways, public art, historic sites and landmarks

Lighting should be used to accentuate historical and cultural features and connect them into people's experience of Perth at night.

- Use facade lighting to accentuate buildings of historical, architectural or community importance.
- Use lighting to transform buildings that are undistinguished architecturally but occupy prominent sites as seen at night – using these, in effect, as a canvas for imaginative lighting designs.
- Light significant trees, monuments and artworks to help interpret the history of the city as well as to highlight gateways and landmarks.
- Use lighting to emphasise major arrival points and gateways, including those for road-based travel and railway stations, creating landmarks that help with wayfinding as well as contributing to a more dramatic sense of arrival into the city .

## FIGURE 10: GATEWAYS AND LANDMARKS

Gateways and landmarks help with wayfinding as well as contributing to a more dramatic sense of arrival into the city.

Artworks and historic sites should be considered for lighting on a case by case basis.





***Perth city's skyline at night***

OBJECTIVE 3.3

## Define the postcard image of the city

Perth's location on the Swan River allows striking views across the water to the city skyline. The dark reflective water and the relative darkness of Kings Park accentuate the lit-up city at night and create an enchanting scene. Although already attractive, there is potential to enhance the city's skyline at night through carefully designed lighting schemes for key city buildings. These designs should focus on maximising the aesthetic impact of external lighting to enhance the visual appeal of the city's night time skyline. Care should also be taken to avoid excessive internal lighting which can lessen the impact of external lighting schemes and contribute to skyglow.

Imagine what it could be with a little flair in the lighting design that takes advantage of modern lamp and control technologies!

Incorporate night lighting schemes in all new tall buildings in Central Perth, using modern energy-efficient fittings and controls, to enhance the architecture of these buildings and the attractiveness of the city when viewed from a distance and especially from South Perth and Kings Park. Lighting schemes should be undertaken by a suitably qualified consultant to ensure the scheme relates to the building or place.

- Encourage building owners to provide new energy-efficient illumination schemes for existing tall buildings.
- Incorporate control systems in building lighting to minimise spill light when internal lighting is left on when building spaces are not in use.
- Minimise lighting and avoid glare along scenic drives and in Kings Park where views to lighting in the central city are an important part of the experience.




***His Majesty's Theatre, Central Perth***

FOCUS AREA 4

## MORE EFFICIENT LIGHTING

The City's lighting infrastructure should be made more efficient – to reduce operating costs, power use and light pollution – by addressing a number of considerations in combination, including:

- Use lighting sources that are efficient in their use of power to generate light.
- Apply lighting judiciously, where it is needed and when it is needed.
- Provide more easily controlled and maintainable lighting infrastructure.
- Take a total lifecycle approach, considering capital and operating costs, embodied energy as well as energy used in operations, and the potential for renewal, recycling and disposal.

OBJECTIVE 4.1

### Select and place lights to minimise use of energy and resources

An obvious aim of the Lighting Framework is to reduce power consumption. Lighting is a major consumer of energy in cities, with street lighting commonly accounting for about 14% of greenhouse gas emissions. A significant proportion of street lighting output is also lost upward into the night sky.

Lighting designs must balance a number of issues in the interests of energy efficiency, economy, and waste management. Considerations should include replacing aging infrastructure with energy efficient fixtures.

Choose appropriate luminaires and lamps to minimise energy use, maximise efficiency, and minimise maintenance expenses. Avoid over-lighting and use light only when required. Use luminaires with as many recyclable materials and components as possible, and with potential for responsible disposal of the balance.





***The Narrows Bridge is a key gateway and has great potential for the adoption of new technologies in lighting***

OBJECTIVE 4.2

## Improve maintenance and control

The selection and placement of light fittings represents only one side of the problem of addressing energy use and efficiency in public lighting design; the ability to manage the infrastructure so that it operates efficiently, over the long term, is of equal importance.

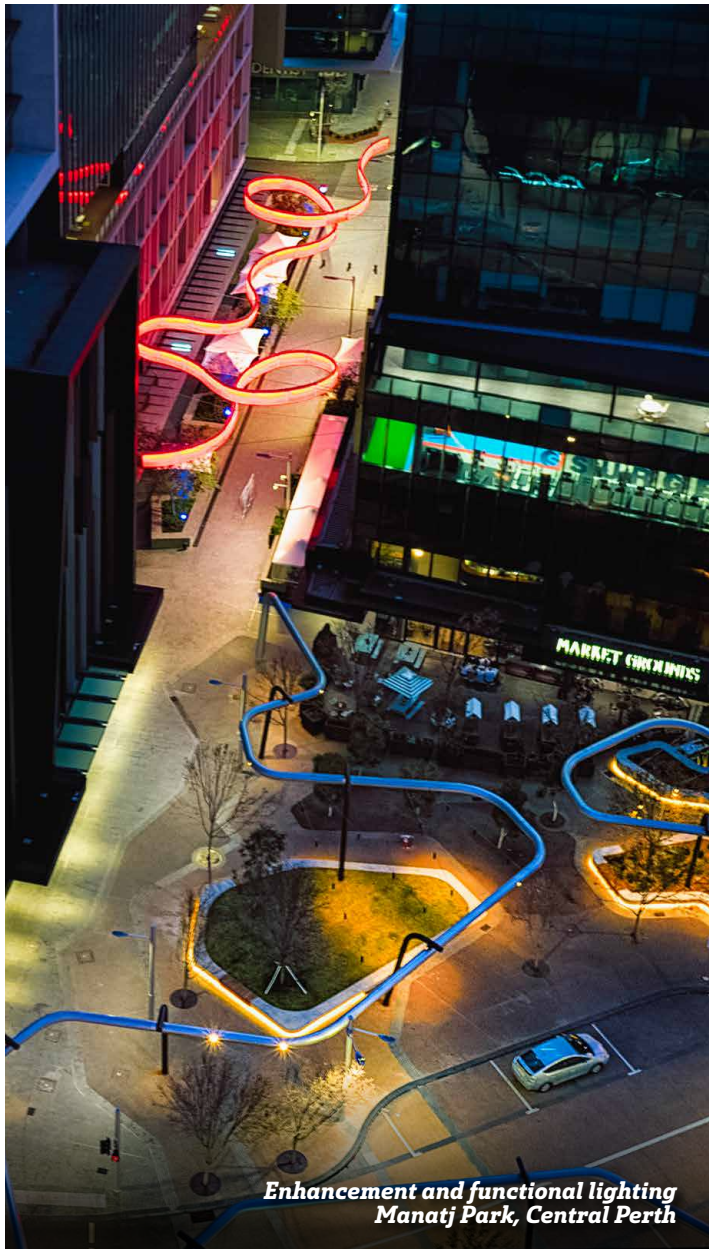
Lighting design should contribute to more easily controlled and maintainable public lighting infrastructure:

- Install appropriate control systems to enable operation of lights to minimise energy use, for example, with timed dimming or on-off systems, motion-and-photo-sensors to switch lights off when unneeded, provision for temporary special event modes, etc.
- Monitor energy consumption where possible.
- Organise controls for a given space under one agency and preferably at a single point, where possible, to facilitate coordination.
- Make maintenance easy; use standard fixtures and fittings that are familiar to maintenance staff, and enable ease of replacements; locate equipment so it is accessible for inspections, cleaning, checking electrical contacts, replacing lamps, and other repairs.
- Undertake systematic maintenance with bulk replacement of lamps at end of design life, rather than at actual failure, to help manage lamp waste and ensure luminaire performance standards.

Appropriate management and maintenance also depends on the personnel involved. It is important that full information on lighting designs is provided, in a clear and useful structure, addressing the design intent, specifications of fixtures and fittings, the control system, and maintenance requirements. This is especially important when customised lighting systems that are not in general use by the City of Perth are used.



# 2 Public Lighting Practice Guide



*Enhancement and functional lighting*
*Manatj Park, Central Perth*

# 2.1 LIGHTING GUIDELINES

## 2.1.1 GENERAL APPROACH

Good public lighting requires an integrated response to many design criteria. Various codes and standards set out expected levels for the brightness and quality of light, but other factors need to be addressed including spatial characteristics and uses of each site. As a general approach, lighting design should firstly address illumination needed to support uses and safety – 'functional lighting' – and then add layers of additional lighting to enhance spaces' experiential qualities as appropriate to the particular situation. However, functional lighting is often the most important factor contributing to spaces' experiential qualities, and enhancement lighting can also contribute to functional illumination requirements.

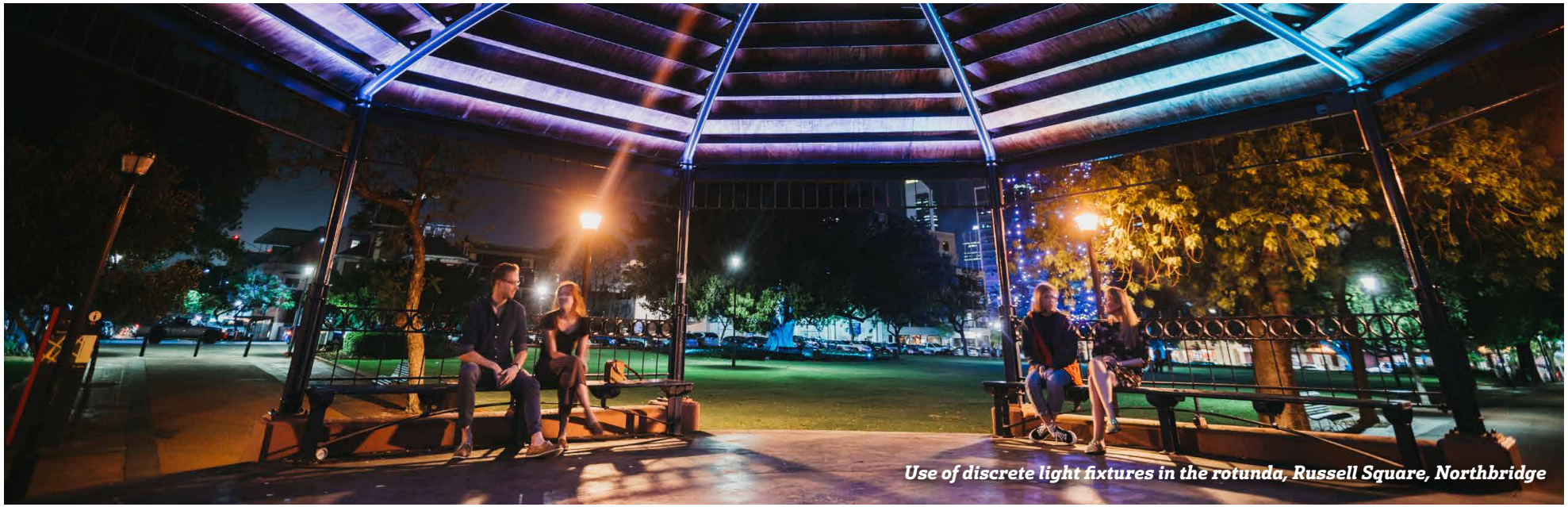
Consideration should therefore be given to:

- The properties of materials being illuminated such as colour, finish, glossiness and reflectance.
- The light colour in relation to the surface to be illuminated.
- The light intensity in relation to the viewing distance to the surface to be illuminated.
- Luminaire distribution and lighting angles, and resulting potential glare and shadows.
- Dark surroundings that create contrasts with the lit area or feature and may therefore affect the perceived brightness of spaces.
- Site uses, which influence perceptions of brightness and may generate particular requirements for lighting.
- The overall lighting atmosphere or ambience, which affects perceptions of safety and comfort.

**FIGURE 11: LIGHTING LAYERS**

Functional and enhancement lighting layers can be integrated to create a holistic lighting design.





*Use of discrete light fixtures in the rotunda, Russell Square, Northbridge*

Illumination – light falling onto the ground, other surfaces and objects – is the key concern of public lighting. However, the poles, luminaires and other fittings used to provide illumination need to be coordinated with the overall design of public spaces, and can be important parts of a space's daytime image. It is also vital that this infrastructure is safe, and can be kept in good working order.

These concerns relate not only to the selection of light fittings, but also to how and where they are placed. The design of cabling and control systems is also important to minimise energy consumption, to enable management of lighting to support varying uses at different times of night or across different times of the year, and to build in long term flexibility so the system can be adapted to suit potential future changes in use.

Lighting of vegetation, buildings, monuments and artworks can be used to express spaces' form and enrich them with visual detail and texture. Such enhancement lighting can contribute to functional lighting requirements, and can increase amenity and people's perception of safety by eliminating shadowy areas. It can also contribute in less tangible ways by enhancing places' appearance and atmosphere and encouraging their use. The most appropriate kind of enhancement lighting to use (if any) depends upon the effect wanted for the particular space, and opportunities presented by buildings and vegetation in and around it.

Public art can also be light-based – for example, illuminating features to alter perceptions of the city, using projected images, or with lights which are themselves sculptural forms. This document is not a guide for new artworks, but existing artworks must be considered in lighting schemes, and consideration of opportunities for new light-based artworks may also be appropriate in some places. Much signage is also illuminated, but this document does not address signage per se. Illuminated signs must comply with the City's relevant planning scheme provisions and policies.




***Combination of wall mounted functional lighting and coloured spot lights to enhance unique building features, Grand Lane, Central Perth***

# 2.2 ILLUMINATION REQUIREMENTS



## 2.2.1 LIGHT LEVELS AND QUALITY

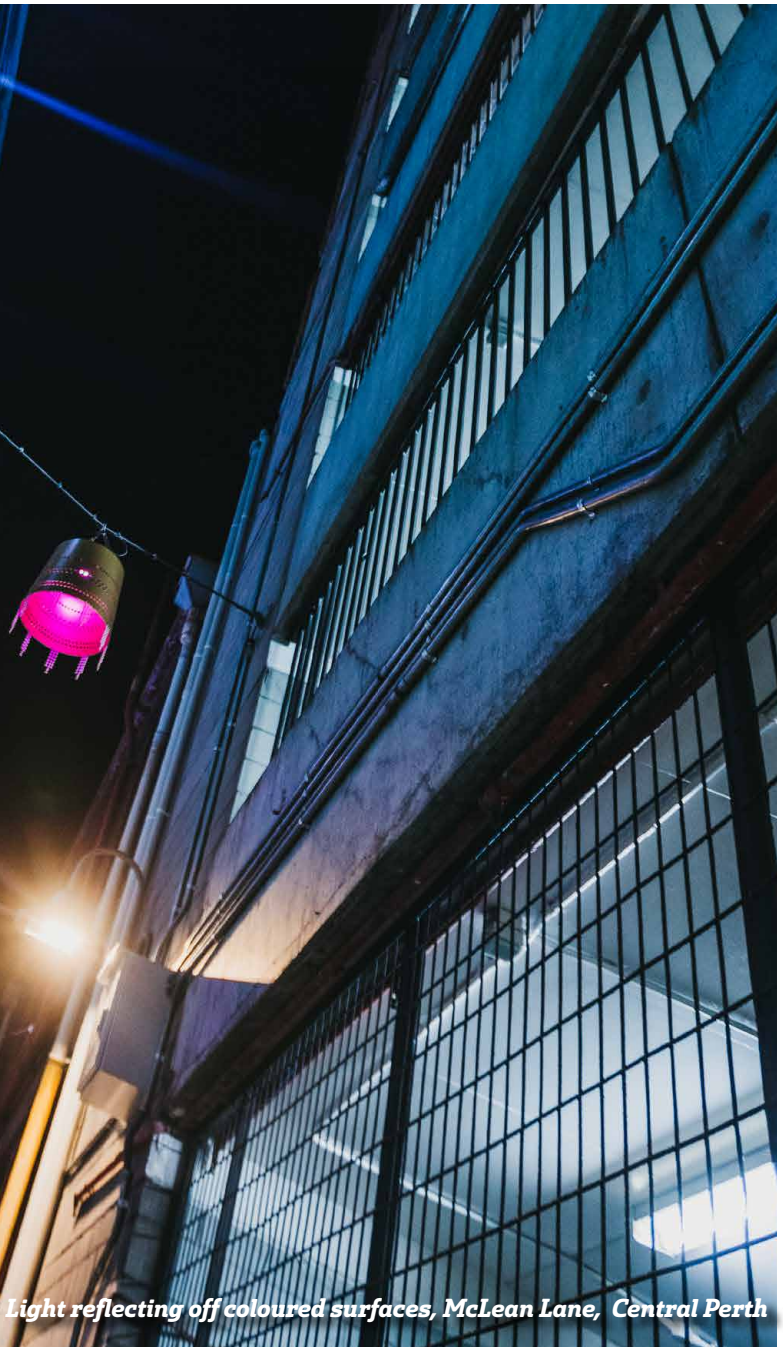
### Illuminance levels

Quantitative levels for functional lighting are generally linked to the roles that streets and other spaces play in supporting public transport, walking, bicycling and vehicular traffic. With street lighting, illumination is usually measured on the ground ('horizontal illuminance'). However, it is also important to know how much light reaches vertical surfaces ('vertical illuminance'), especially in pedestrian areas where the interface between buildings and adjoining spaces is important to people's perception of the safety, amenity and interest of the public realm.

Required standards for illuminance levels are:

- Australian Standards AS/NZS 1158 Lighting for Roads and Public Spaces provides guidelines for exterior applications.
- Category V Lighting applies to roads where motorists' requirements are dominant, for example, traffic routes. Subcategories range from V1 to V5.
- Category P Lighting applies to roads and other types of outdoor spaces where pedestrians' requirements dominate, for example, local roads and plazas. Subcategories range from P1 to P12.
- Locations with CCTV generally require higher-than-normal vertical illuminance, in line with AS 4806. The camera performance needs to be checked for each project; the light cameras require to capture legible images has significantly reduced with technological advances.

See **Table 1: Lighting Values for City Streets and Areas** for additional details on illuminance requirements.



*Light reflecting off coloured surfaces, McLean Lane, Central Perth*

## Colour rendering and colour temperature

Colour rendering – measured on a Colour Rendering Index (CRI) – is an indication of how colours appear under different light sources and is a key consideration for legibility, comfort and safety. The higher the CRI, the better people's ability to perceive details of their environment – flesh tones, how well the steak is cooked, etc. A relatively high CRI is preferred for pedestrian areas; a lower one is acceptable on roads where vehicular traffic is the main concern.

The colour of light – or Correlated Colour Temperate (CCT) – also affects how we perceive our surroundings. 'White light' in the range of 3000 to 4000K looks much like daylight. The yellowish tones of old-fashioned high-pressure sodium lamps (1900-2500K) and bluish mercury vapour lamps (3900-5800K) distort the colours we see. LEDs and other modern lamp types have more subtle variations in colour temperature, with hues of warm or cool white, yet these still affect how we see a city at night, for example, making some paving materials look clean or dirty, park vegetation seem lush or dried up, and buildings inviting or forbidding.

A consistent use of colour temperature should be considered across most precincts, although variations can be used to differentiate areas with different functions and to subtly emphasise special features. Vehicle-focused areas generally use 4000K, while 3000K can create a welcoming environment in pedestrian spaces. Variations between 2700K and 4500K can be applied where appropriate.

Strongly coloured lighting is only suitable for use as a rare exception and on a temporary basis for short-term art installations and festivals.

See **Table 1: Lighting Values for City Streets and Areas** for colour rendering and correlated colour temperate standards.

## Light distribution, glare and shadows

Distribution of light is important with respect to even illumination of travel routes and activity areas, as well as avoiding glare or strong contrasts with adjoining darker spaces. The effect of lighting as seen by people is the ultimate concern, not the simple measurement of lux on a given surface.

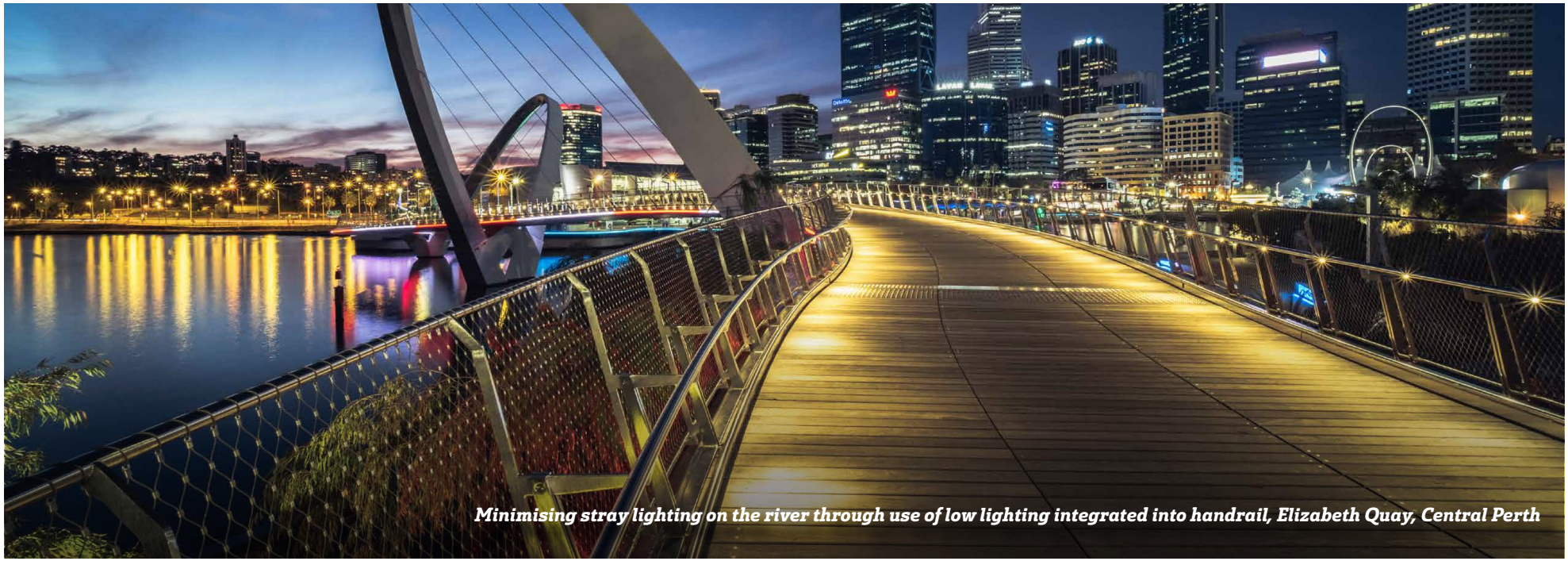
The placement and spacing of light sources therefore requires consideration of perceived effects, efficiency, and physical constraints on mounting locations. Street lights typically require luminaires with a wide light distribution to reach from the road edge to the centre. However, a wide spread of light can cause glare. If not controlled, glare reduces visibility and distracts pedestrians and drivers. Various luminaire designs feature asymmetrical beam distribution to deal with such conflicts.

People's visual environment as a whole also needs to be considered, not just the space they occupy. Even if a space is well lit, adjoining darker areas can make it seem unsafe or threatening. Increasing the lighting in the space itself may worsen this contrast; it may be better to minimise illumination in the space and add lighting around it.

Building awnings over footpaths are important parts of retail streets but can cast shadows that interfere with street lighting. In such cases, under-awning lighting may be required – as an integral part of the awning – to supplement the public lighting. Trees too are valued in urban landscapes but can conflict with lighting. In addition to existing trees, the City's Urban Forest Plan aims to increase the extent of tree canopy cover in the public realm from 19% to 30%, so new plantings and the growth of trees that may affect the performance of public lighting should also be considered when developing lighting designs.

Required standards in relation to light distribution and glare include:

- Avoid glare through the careful selection and placement of lighting equipment, selection of optics, direction of lighting, and the use of full cut-off fittings, baffles and shields as appropriate.
- Generally, do not exceed recommended illuminance levels.
- Ensure that illuminance of footpaths under awnings is as specified for that type of street or space as a whole, or to a minimum P3 category, whichever is greater, without reliance on spill lighting from shopfronts and other ground floor uses.
- Design under-awning lighting to be recessed or integrated into the awning structure and form, with all wiring and conduits concealed and protected from vandalism while allowing for easy maintenance access. The City of Perth may also encourage awning lighting to be switched on or off at certain times.
- Select and place light fittings carefully in relation to existing and proposed trees. Potential design options include short poles that place the luminaire below the tree canopy, and longer bracket arms.
- Tree trimming and pruning may be required as part of a maintenance strategy to prevent shadowing. Improvements to existing lighting levels may be possible through selective tree pruning.
- Consider views from a path into its surroundings; extend lighting off pathways to provide greater visual depth and sense of safety.



*Minimising stray lighting on the river through use of low lighting integrated into handrail, Elizabeth Quay, Central Perth*

## Stray illumination and environmental impacts

'Stray' illumination beyond areas that need to be lit is an indication of wasted energy and a form of pollution that can be a serious annoyance, as when light spill into dwellings keeps people awake, and sky glow interferes with astronomers' work. Lighting has adverse impacts on fauna and wildlife, in particular bat colonies; although insects attracted by lights can help some animals in their foraging, bats can see better in dim light than in bright light, and several species avoid street lights.

Required standards in relation to stray illumination and adverse environmental impacts include:

- Control of obtrusive lighting to nearby business and residential units must comply with AS4282 Table 2.1.
- Use luminaires with precise beam distribution suited to the situation. Direct light onto surfaces, away from dwellings and other sensitive sites, and not into the sky.
- Hide light sources from sensitive viewing angles. Use full cut-off fittings and shielding to minimise glare and stray light.
- Minimise upward light; avoid or carefully position up-lights to reduce impacts on birds' and bats' flight paths.
- Minimise luminance levels.
- Use timers or sensors so lights can be turned off when not needed.
- Use warm white lighting in parkland rather than lighting at the blue end of the spectrum and UV light, which risks disturbance of vision and damage to animals' retinas. Warm light also reduces the attraction of insects.
- Avoid flashing or animated lights or changing colours.

# 2.3 INTEGRATING LIGHTING AND SITE DESIGN

## 2.3.1 TYPICAL STREET LIGHTING

### Pole-mounted lights

In most situations, pole-mounted lights are the most important type of public lighting, and in most streets will be the only public lighting.

Design criteria for the layout of lights in streets include:

- Locate light poles so they do not interfere with circulation and other activities, and do not obstruct paths of travel or passengers' access to on-street parked vehicles.
- Place light poles so the risk of damage to the poles by vehicles is minimised, with adequate setbacks from kerbs and offsets from driveways as per City of Perth standards (Design and Construction Notes). Take particular care in areas where service trucks need to back into loading docks etc.
- Locate poles where they serve more than one purpose and thereby minimise clutter, for example illuminating footpaths and the roadway; or a footpath and bike path; or supporting street lights, signage, CCTV and traffic signals.
- Locate poles to minimise conflicts with trees and coordinate with all other streetscape features.
- Adopt a holistic approach to major and minor spaces so that lighting is coordinated with intersecting streets.

### Wall-mounted and catenary lights

Wall-mounted or catenary lights may be appropriate in narrow streets, lanes and other situations where it is undesirable to use poles because:

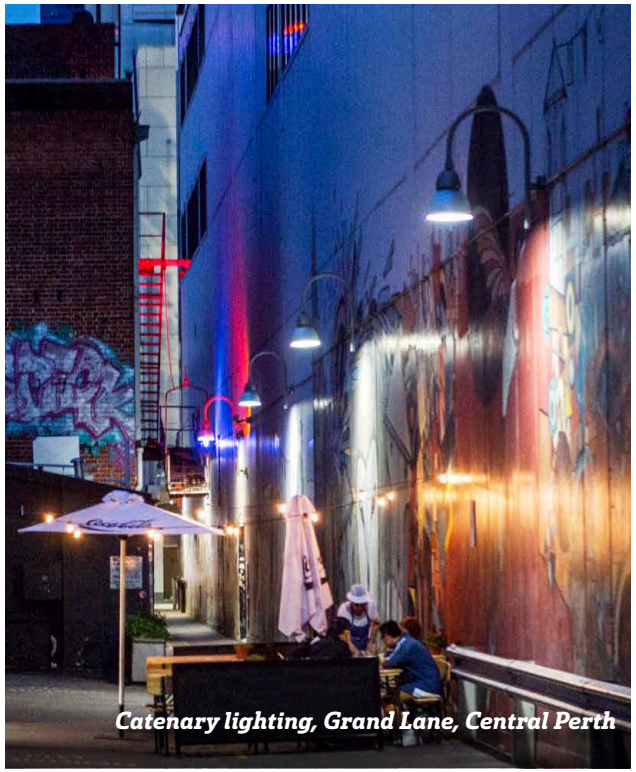
- Poles would encumber limited footpath space.
- Poles would be vulnerable to damage by maneuvering trucks.
- A clear ground area is important for other reasons.
- A wall bracket on a building may have less visual impact than a pole in front of it.

Wall-mounted lights are appropriate in laneways and narrow streets where the entire width of the space can be illuminated from one side. Catenary lighting (suspended from overhead wires) allows luminaires to be centred over a roadway or spread out above a wider space without using poles.

Installation of both wall-mounted and catenary systems should consider:

- The suitability of the building or wall, including height and structural capacity, to support the lighting including any wind loadings.
- The potential to integrate or coordinate the wall mounting detail with the design of the facade.
- The visual impacts of power supply conduits.

Some poles may be used in combination with building mounts to support a catenary system. However, if catenary lighting for a space relies extensively on poles, a floodlighting system using tall poles may be more appropriate for that space.



*Catenary lighting, Grand Lane, Central Perth*

## 2.3.2 OFF-STREET SPACES

### Squares, forecourts and parks

In contrast to the street grid, Perth's parks, plazas, and forecourt spaces vary widely in size, use and character, requiring individually tailored lighting designs. However, the integration of high-quality lighting into the design of these spaces typically requires consideration of the following:

- Lighting of small spaces can often be provided by the street lights at the edges, or with a few poles that match those in the street; with small areas and limited numbers of lights, this may be the best way to create a coordinated design. Conversely, in spaces where adjoining streets are pedestrianised or designed as shared zones, it may be appropriate to extend pedestrian-scale lighting of the space into the pedestrianised street.
- In larger spaces lighting can be varied to distinguish the open space from the streetscape, to create focal points, and to support different uses in different locations.
- Consider lighting features in and around the space, including facades, sculptures, monuments, other structures, and trees.
- Consider lighting of park entrances and perimeter.
- If a large space needs to be lit while remaining clear of poles, catenary systems or tall pole-mounted floodlights may be appropriate.
- Minimise the daytime visibility of fittings or coordinate them with other aspects of the design.
- Provide light for walking and cycling routes across the space.
- Consider views into the space from areas around it, and light features such as trees, architectural elements and artworks as appropriate.

### Large spaces and sports fields

In some city spaces, a high standard of illumination is required but the area needs to be kept clear of poles to allow for its intended use. Perhaps the most common examples of this are sports grounds, but other civic events also require spaces that are not encumbered by poles and other clutter. In these instances – for example at Northbridge Piazza– a lighting system using tall poles that allow broad distribution of light without glare is often appropriate; pedestrian use does not always require short poles.

In addition, the following should be considered:

- Provide lighting for training grounds and other sports activities in line with requirements of AS 2560 Sports Lighting, which should also be used to determine the appropriate training standard and sporting code.
- Provide lighting that generally meets but does not exceed the training standard requirements.
- Consider provision for a variety of illumination levels and qualities at different times with multiple fittings and separable controls – casual use of a sports field may not require the same level of illumination as a formal match, and significant variations may be appropriate for different uses of large civic spaces.
- Minimise light spill to neighbouring areas.
- Use switching, automatic timers and light level adjustment timers as appropriate to limit power use to times when the areas are in use.
- Use multiple switching in the control system to allow only areas in use to be turned on.

# 2.4 ENHANCEMENT LIGHTING

## 2.4.1 TREE AND PLANT LIGHTING

General guidelines for lighting vegetation include:

- Design tree lighting for existing vegetation, not in anticipation of a new tree's size in the distant future.
- Locate luminaires on adjacent poles or in the ground. If planting is located close to another structure, lights may be integrated in this structure pending approval by the City of Perth.
- Do not attach light fittings to trees.
- Locate in-ground lighting where it will not cause glare for pedestrians.
- Design up-lighting of trees to minimise upward spill light:
  - Generally, direct up-lights towards the trunk.
  - Up-lighting directed into the canopy may be appropriate with dense evergreen trees.
  - Up-lighting into deciduous tree canopies must be controlled with a seasonal timer to turn off the lights when the tree is bare.
- Consult an arborist if tree roots or branches are affected.
- Use coloured lighting only for temporary events and if agreed by the City of Perth.
- Avoid the use of machinery for excavation within tree root protection zones; hand digging and water jet trenching are preferred where work must occur that may have an impact on tree roots.

## 2.4.2 FACADE AND BUILDING LIGHTING

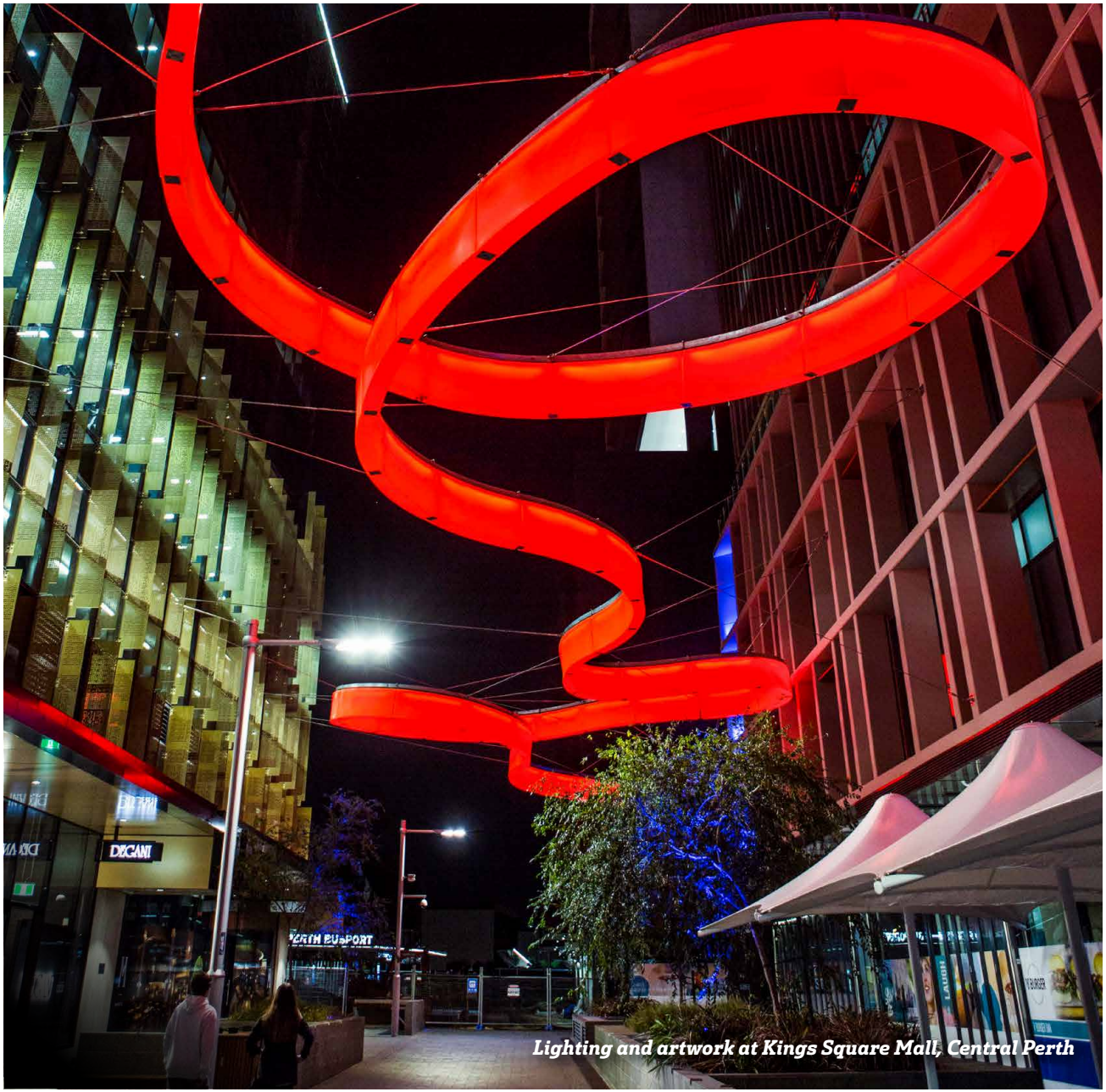
The following should be considered for building lighting:

- At a minimum, design lighting to express the architectural layering that is present during the day.
- Avoid floodlighting entire facades; highlight selected features, for example:
  - Entrances and shop fronts.
  - Architectural elements that form landmarks on key routes.
  - Colonnades and other ground floor recesses.
- Respond to the context, architectural character, materials, textures and colours, and uses of adjoining spaces:
  - Generally use light that contrasts with nearby street lighting.
  - Avoid over-illumination for promotional purposes.
  - Complement, rather than compete with, nearby building lighting.
  - Avoid using primary and saturated colours, except during festivals.
- Consider internal lighting's contribution to the public realm, supporting a sense of the street space expanding into the building, or giving the appearance of a more lively, inhabited place.
- Design shop window lighting to highlight merchandise or internal surfaces, and to avoid glare and reflections.
- Locate and design lighting equipment and wiring to minimise visual impacts, especially during the day. It should be small enough to be concealed from public view or integrated with the architecture where possible.
- Lighting equipment and wiring must not damage facades. Use care to avoid corrosion, electrolytic reactions, staining, cracking and failure of stone, terracotta, stucco or brick, and damage to fragile structures.

## 2.4.3 MONUMENTS, ARTWORKS AND SCULPTURES

General guidelines for lighting monuments, artworks and sculptures include:

- Accentuate specific features of interest, enhancing meaning and adding to the interpretation of the monument or artwork rather than evenly floodlighting it.
- Design the lighting, including colour temperature, luminaires and distribution, to enhance the colour, materiality and texture of the monument or artwork. Collaborate with the artist if possible to ensure the lighting design is consistent with the artist's intent.
- Minimise visual impacts of lighting equipment and wiring, especially during the day. Where possible, it should be:
  - Small enough to be concealed from public view or integrated with the architecture.
  - Located in a hidden position in-ground, on a nearby pole or structure, or behind a nearby fence, etc.
  - Lighting to heritage buildings should respond to the identified cultural significance of the place and will require approvals from the State Heritage Office and the City of Perth.




*Lighting and artwork at Kings Square Mall, Central Perth*

# 2.5 FUNCTIONAL LIGHTING

## 2.5.1 LIGHTING STANDARDS FOR PUBLIC SPACES AND USE OF STANDARD DETAILS

Design standards, and the consistent use of the same details in similar situations, are desirable for many reasons:

- Large-scale designs can be implemented in stages.
- A cohesive urban character and sense of place can be created.
- Long-term strategic perspectives dominate over passing fashions.
- Efficient maintenance and economies of scale are supported.
- If replacements are needed, a fit with the design is more certain.

Standard details should therefore be used in all standard situations. However, existing conditions may not match current standards, and need to be considered when selecting design details. Which detail to use depends upon the scale and nature of the work:

- Conservation of significant features: Maintain intact historic features unless they cause an unsafe or dysfunctional situation.
- Minor works and repairs: Match existing details at and adjoining the site. If two or more details exist, use the one most typical of the area.
- Reconstruction and new work: Always use the approved current standard.

Departure from standards may be supported if:

- Functional requirements are not met by existing standards.
- Conserving significant heritage features requires special treatments.
- Elements are used so rarely that no efficiencies are gained by standardisation.
- Unusually durable materials and protection from potential damage ensure that maintenance requirements will be minimal.
- It is an unusually high priority – from a broad public perspective – that a space's design has a distinct identity, and this requires using non-standard elements.

Even if they seem obviously appropriate, non-standard details must be approved for use in spaces managed by the City. Any non-standard use of approved details also requires approval – for example, for functions other than those intended or in locations other than those specified.



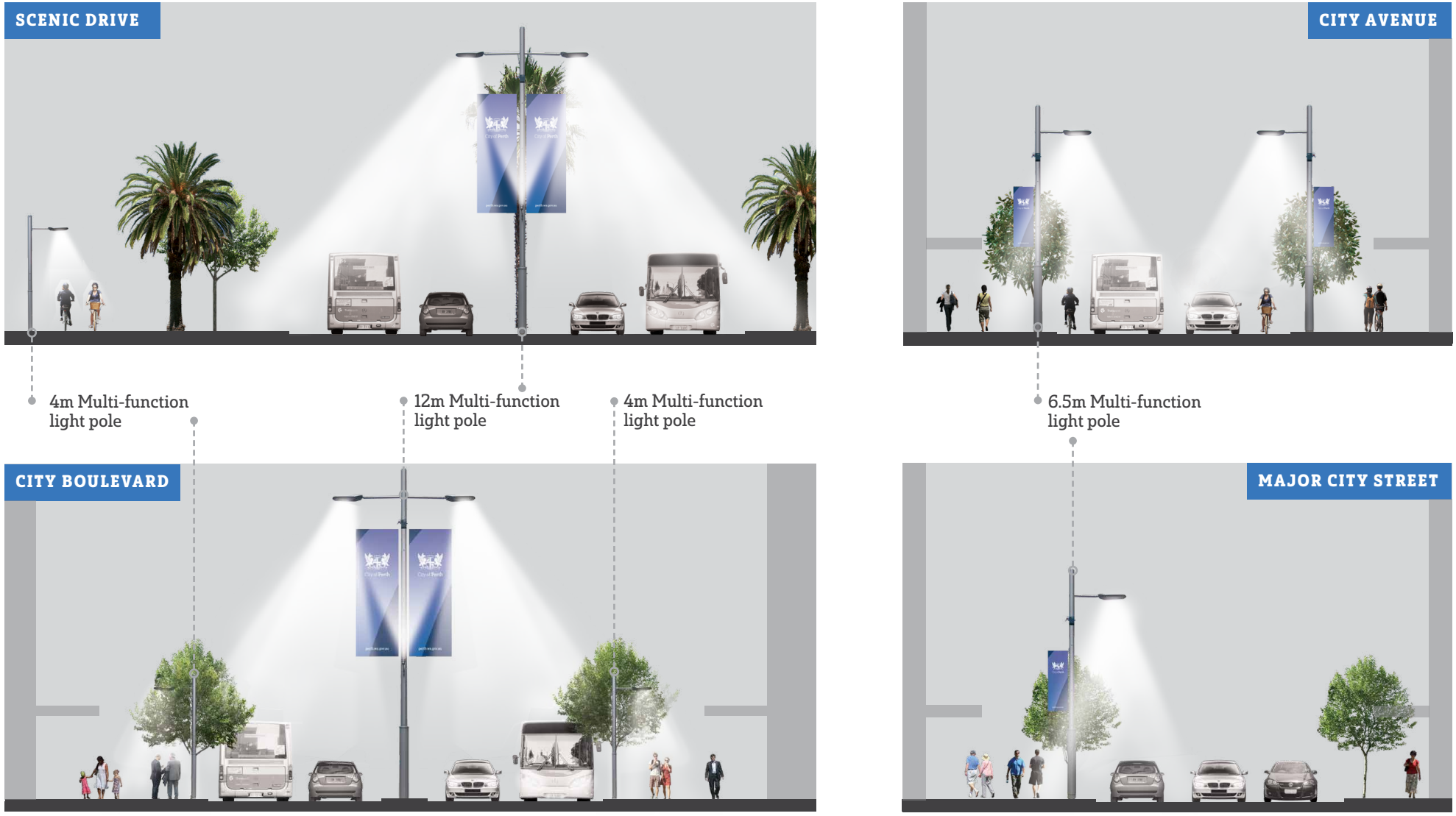


*Public lighting, Cathedral Square , Central Perth*

## TABLE 1: LIGHTING VALUES FOR CITY STREETS AND AREAS

| | ASNZS 1158.3.1:2005 | | | | | |
|---|---|---|---|---|---|---|
| **Area-wide treatments** | **Road/pathway Category** | **Operating characteristics Category V** | **Vehicle/ pedestrian lighting subcategory** | **Operating characteristics Category P** | **Correlated Colour Temperature** | **Colour Rendering Index (min.)** |
| **Scenic drives**<br>• Mounts Bay Road<br>• Riverside Drive | Arterial or principal roads<br>Principal avenues of communication for traffic movement | Moderate to high traffic volume<br>Moderate to low pedestrian volume | P2-P4 | Arterial or principal roads<br>Boulevard type category | | |
| **City boulevards**<br>• St Georges Terrace<br>• Wellington Street | Arterial or main roads in central activity areas of capital city. | Mixed vehicle and pedestrian traffic<br>Moderate to high vehicle volume<br>High pedestrian volume<br>Moderate to low vehicle speeds<br>Stationary vehicles alongside carriageway<br>Through and local traffic<br>Moderate traffic generation from abutting properties | P1-P4 | Pedestrian or cycle orientated pathway along roadway | 4000K | RA70<br>RA75 for pedestrian areas |
| **City avenues**<br>See Figure 2: Proposed Street Lighting Hierarchy | Arterial or principal roads<br>Principal avenues of communication for traffic movement | Mixed vehicle and pedestrian traffic<br>Moderate traffic volume<br>Low pedestrian volume<br>Moderate to low vehicle speeds<br>Low traffic generation from abutting properties | P1-P4 | Pedestrian or cycle orientated pathway along roadway | 4000K | RA70<br>RA75 for pedestrian areas |
| **Major city streets**<br>See Figure 2: Proposed Street Lighting Hierarchy | Collector or non-arterial roads which collect and distribute traffic in an area as well as serve abutting properties | Mixed vehicle and pedestrian traffic<br>Moderate traffic volume<br>Moderate pedestrian volume | P1-P4 | Pedestrian or cycle orientated pathway along roadway | 3500K | RA70<br>RA75 for pedestrian areas |

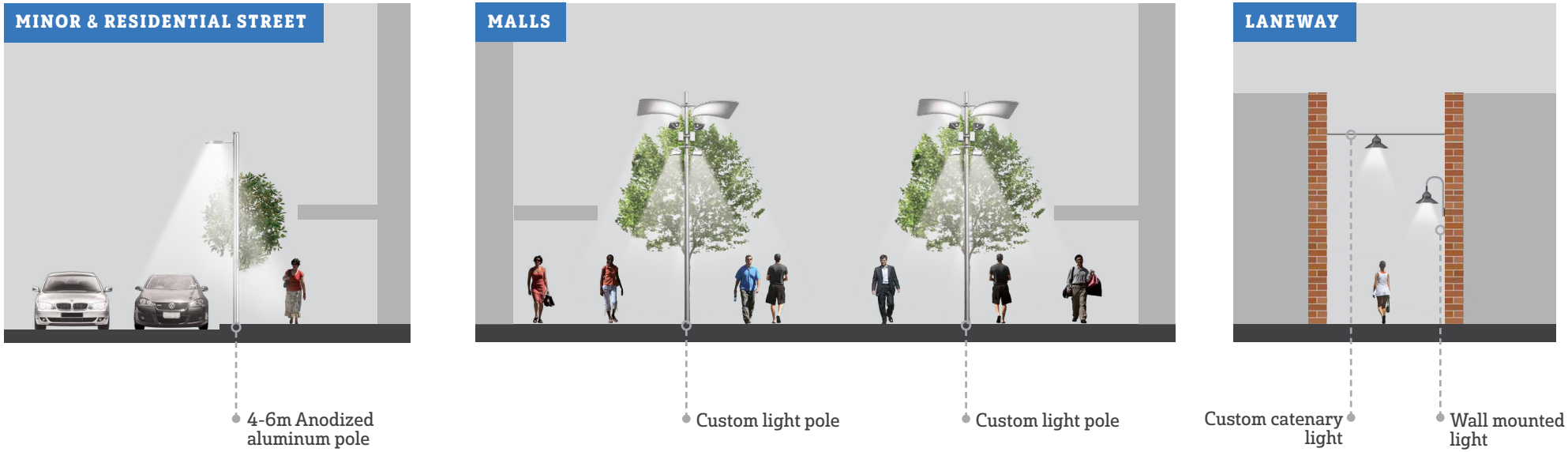
## FIGURE 12: STREET LIGHTING ARRANGEMENT



## TABLE 1: LIGHTING VALUES FOR CITY STREETS AND AREAS

| | ASNZS 1158.3.1:2005 | | | | | |
|---|---|---|---|---|---|---|
| **Area-wide treatments** | **Road/pathway Category** | **Operating characteristics Category** | **Vehicle/ pedestrian lighting subcategory** | **Operating characteristics Category P** | **Correlated Colour Temperature** | **Colour Rendering Index (min.)** |
| **Minor and residential streets** | Local roads used primarily for access to abutting properties | Low traffic volume<br>Low to moderate pedestrian volume | P1-P4 | Mixed vehicle and pedestrian / cycle traffic dependent on specific street | 3000K-3500K | RA70<br>RA75 for pedestrian areas |
| **Laneways** | Access road to abutting properties | Low traffic volume<br>Low to moderate pedestrian volume | P1-P4 | Mixed vehicle and pedestrian / cycle traffic dependent on specific street | 2700-3500K | |
| **Gateways**<br>• Major transit nodes | Arterial or main roads in central activity areas of capital city | High traffic volume<br>Moderate to low pedestrian volume | P1-P3 | Intensely urban<br>High traffic volume<br>Pedestrian and cyclist shared path<br>Moderate to high pedestrian volume | | |
| **Malls, plazas, forecourts**<br>• Forrest Place<br>• Hay Street Mall<br>• King Square Mall<br>• Murray Street Mall<br>• Northbridge Piazza<br>• Yagan Square | Pedestrian zone with loading access to some properties | High pedestrian volume<br>Low traffic volume | P6-P8 | Primarily pedestrian activity zone<br>Primarily pedestrian destination<br>Service, emergency vehicle road only | 3000K | RA75 |

**FIGURE 13: STREET LIGHTING ARRANGEMENT**



## TABLE 1: LIGHTING VALUES FOR CITY STREETS AND AREAS

| | ASNZS 1158.3.1:2005 | | | | |
|---|---|---|---|---|---|
| **Area-wide treatments** | **Road/pathway Category** | **Operating characteristics Category V** | **Vehicle/ pedestrian lighting subcategory** | **Operating characteristics Category P** | **Light Solution** |
| **Pathways** | **Vista feature pathway adjacent to river foreshore**<br>• Riverside Drive | | P2 | High pedestrian/cycle traffic only<br>Medium risk of crime<br>High need to enhance prestige<br>Need to mitigate spill light into river applicable<br>Impact on sightlines & amenity from adjoining properties | Bollard Luminaire |
| | **Pathway adjacent to river foreshore**<br>• A.J. Abraham Reserve<br>• Swan Brewery | | P3 | High pedestrian/cycle traffic only<br>Low risk of crime<br>High need to enhance prestige<br>Need to mitigate spill light into river applicable<br>Impact on sightlines & amenity from adjoining properties | Bollard Luminaire<br>Pole Top Luminaire |
| | **Pathway adjacent to road**<br>• Mounts Bay Road to Swan Brewery<br>• Mounts Bay Road Swan Brewery to Riverside Drive (Narrows Bridge)<br>• Riverside Drive (Narrows Bridge) to Elizabeth Quay | | P2 | High pedestrian/cycle traffic only<br>Medium risk of crime<br>High need to enhance prestige<br>Need to mitigate spill light into river applicable<br>Impact on sightlines & amenity from adjoining properties | Pole Top Luminaire |
| | **Pathway through parkland**<br>• A.J. Abraham Reserve to Mounts Bay Road<br>• Riverside Drive<br>• East Perth Causeway Bridge to Victoria Gardens<br>• East Perth Claisebrook Cove to Windan Bridge | | P2 | High pedestrian/cycle traffic only<br>Medium risk of crime<br>High need to enhance prestige<br>Impact on sightlines & amenity from adjoining properties | Bollard Luminaire |



***Efficient use of lighting, J H Abrahams Reserve, Crawley/Nedlands***

## TABLE 1: LIGHTING VALUES FOR CITY STREETS AND AREAS

| | ASNZS 1158.3.1:2005 | | | | | |
|---|---|---|---|---|---|---|
| **Localised treatments** | **Road/pathway Category** | **Operating characteristics Category** | **Vehicle/ pedestrian lighting subcategory** | **Operating characteristics Category P** | **Correlated Colour Temperature** | **Colour Rendering Index (min.)** |
| **Pedestrian cross overs** | | Pedestrian | P1-P2 | Pedestrian road crossings | 3000-4000K | RA75 |
| **Facade and monument lighting** | | | | | 2700-4000K | RA75 |
| **Parks – walking and bike paths** | | Mixed or separate pedestrian and bicycle traffic | P1-P4 | Pedestrian or cycle orientated pathway | 3000-4000K | RA75 |
| **Parks – planted areas** | | | | | 3000-4000K | RA75 |
| **Parks – recreational areas** | | Refer to AS 2560 Sports Lighting | | | 3000-4000K | RA85 |




***Planted areas enhancement lighting, Hibernian Place, Central Perth***

# 2.6 LIGHT FITTINGS AND INFRASTRUCTURE

## 2.6.1 STANDARD POLES AND FITTINGS

A key principle of the Lighting Framework is to use a limited range of poles, luminaires, lamp types and light colours – each matched to a specific situation and used consistently wherever that situation occurs. This will add cohesion to the urban landscape, and articulate hierarchies of major and minor routes. It also ensures that the infrastructure can be managed efficiently and maintained to a high standard. Most public lighting in the City of Perth should be provided using existing approved standards.

This section provides an overview of approved standards. Further details for each fitting are provided in the City of Perth's Design and Construction Notes, which are available online at ***https://www.perth.wa.gov.au/develop/building-and-works/building-and-construction-notes***.

Much of the existing street lighting in Perth uses conventional steel poles supplied by Western Power. These do not enhance the city's image and their removal is a priority in high activity areas. As a replacement, the City of Perth's multi-function pole (MFP) has been developed to provide a consistent lighting aesthetic and to reduce clutter by integrating services including a range of luminaires, traffic signals, mobile phone transceivers, banners, street name signs, etc. They also allow high-level vehicular road lights and low-level pedestrian lights to be mounted on the same pole.

Except in particular exceptions where 'non-standard' fittings are specified, the multi-function pole is the standard for all new or replacement light poles in city avenues, boulevards and major streets, with three different height options to suit different street widths.






*Multi-function light poles Barrack St, Central Perth*

## FIGURE 14: STANDARD CITY POLES

Luminaires and fixtures are to be colour matched to pole.
Pole footings should be lowered to accommodate paving up to pole or concealed by turf or mulch in landscaped areas.
All 'Smart Infrastructure' or telecommunications infrastructure must conform with guidelines in the City's future Smart City Framework.




### 4M MULTI-FUNCTION LIGHT POLE

**Where:**
- Boulevard pedestrian lighting

### CCTV MULTI-FUNCTION POLE*

**Where:**
- City wide
  *Only to be installed when CCTV cannot be included on an existing or proposed light pole.

### 5M MULTI- FUNCTION TRAFFIC POLE

**Where:**
- Signalised traffic signals

### 6.5M MULTI-FUNCTION LIGHT POLE

**Where:**
- Avenues
- Major streets

### 12M MULTI-FUNCTION LIGHT POLE

**Where:**
- Boulevards
- Scenic drives

Retrofitted steel poles to be painted 'Dulux Ferrodor 810 : St Enoch Grey'



### 4M CIRCULAR ANODISED ALUMINIUM POLE

**Where:**
- Parks
- Foreshores
- Pedestrian share path
- Minor and residential streets

### 6M CIRCULAR ANODISED ALUMINIUM POLE

**Where:**
- Minor and residential streets

### 3.5M ANODISED ALUMINIUM POLE

**Where:**
- Parks
- Minor and residential streets

### 3.5M STAINLESS STEEL LIGHT POLE

**Where:**
- Pedestrian amenity areas within streetscapes

### BOLLARD LIGHT

**Where:**
- Parks
- Foreshores
- Public open space

### WALL MOUNTED LIGHT ON CUSTOM BRACKET

**Where:**
- Laneways

## TABLE 2: POLE ATTACHMENTS, LUMINAIRES AND ACCESSORIES

| POLE / ATTACHMENTS | 4m MFP | CCTV MFP | 5m Traffic MFP | 6.5m Light MFP | 12m Light MFP | 4m Aluminium Light Pole | 6m Aluminium Light Pole | 3.5m Aluminium Light Pole | 3.5m Stainless Steel Light Pole |
|---|---|---|---|---|---|---|---|---|---|
| Pole Base Internal diameter (mm) | 150 | 150 | 150 | 200 | 250 | 120 | 150 | 120 | 102 |
| 5G Small Cell | | | | ● | ● | ● | ● | | |
| City Public Wifi Gateway | ● | ● | | ● | ● | ● | ● | | |
| City LoRa Gateway | | | | ● | ● | ● | ● | | |
| City CCTV | ● | ● | | ● | ● | ● | ● | | |
| Signage & Wayfinding | ● | | | ● | ● | ● | ● | | |
| City General Power Outlet | ● | ● | | ● | ● | ● | | | |
| Bike Rack | ● | | | ● | ● | | | | |
| Banners | | | | ● | ● | | | | |
| MRWA CCTV, Traffic Lights, Pedestrian Sensors, MRWA Signage | | | ● | ● | ● | | | | |

*Note: All attachments made to Multi-function Poles (MFP) will require MFP brackets. The attachments listed here are commonly used across the city.*

| LUMINAIRES \ POLE | 4m MFP | CCTV MFP | 5m Traffic MFP | 6.5m Light MFP | 12m Light MFP | 4m Aluminium Light Pole | 6m Aluminium Light Pole | 3.5m Aluminium Light Pole | 3.5m Stainless Steel Light Pole |
|---|---|---|---|---|---|---|---|---|---|
| **Philips Roadstar small**<br>GEN 2 CAT NO GPLS-32L700NW-G2-R2M-UNV-DALI-RCD7-PH9-GY3 | | | | ● | | | | | |
| **Philips Roadstar medium**<br>GEN 2 CAT NO GPLM-96L700NW-G2-R2M-UNV-DALI-RCD7-PH9-GY3 | | | | | ● | | ● | | |
| **iGuzzini Archilede HP**<br>HP CAT No. ED36 ST1.2 RAL7047<br>RAL 7047 TELEGRAU (MATT FINISH) | ● | | | ● | | ● | ● | | |
| **Kim Ouro LED**<br>UR20 SERIES WITH 7 PIN CAP AND DALI DRIVER<br>RAL 7047 TELEGRAU (MATT FINISH) | | | | | | ● | | ● | |
| **iGuzzini Twilight Bilbao**<br>CAT NO. BY93 - GREY 15 | | | | | | | | | ● |
| **iGuzzini Woody Spotlight**<br>CAT NO. BU82 WITH REMOTE DRIVER FIXED VIA 2 x 875MM OUTREACH ARM CAT NO. B592 | | | | ● | ● | ● | ● | | ● |

| | |
|---|---|
| **ERCO Midipoll**<br>ERCO 33310.099<br>RAL 9006 (METALLIC FINISH) | **Bollard** |
| **WE EF ASP530 LED** | **Wall Mounted Light** |

*Note: Luminaires are to be City's standard (listed above) or approved equivalent. Spotlight to be used for banner lighting or to provide additional lighting.*

## 2.6.2 SUPPLY AND CONTROL SYSTEMS

### Basic cabling and control systems

The following items should be considered:

- Consider cabling requirements for each area holistically and develop a master cabling and control strategy that addresses:
  - Current and future control requirements
  - Possible reuse of existing electrical infrastructure
- Do not use overhead wiring except where part of an approved catenary-supported lighting system, or during short-term events.
- Group fixtures by type and locations under similar conditions, for example:
  - Separate circuits for functional and decorative lighting
  - Separate control of roadway and pedestrian lights
  - Separate control for special use areas that are used only sporadically, such as sports courts
  - Separate circuits for fittings in sunlit and consistently shaded areas
- Use on-off and dimming controls to optimise lighting levels to suit uses and reduce running costs, including:
  - Astronomical time clock controller (sunset switching)
  - 'Set and forget' controls to fine-tune lighting levels for the site
  - Dynamic controls allowing adjustments to suit special occasions
- Use open access control technology where practical to automate control and establish maintenance requirements.
- Provide for temporary event lighting in appropriate locations, for example:
  - Lighting colour change(s)
  - Flexibility to isolate and stage-switch certain elements

### Smart control systems

As technology improves, the City of Perth may choose to implement 'smart controls' to enable greater flexibility in lighting level adjustments. The following should be considered to support options for smart controls:

- Smooth 0%-100% dimming
- Dynamic control for special lighting elements and events
- Compatibility with varied lighting types including colour tuning
- Asset metering and condition monitoring
- Maintenance notification and scheduling
- Automated alerts and communication with smartphones
- Public data broadcasting capability, for example, about parking availability, traffic conditions, weather, and emergency service route assistance
- Compliance with communications standards
- Wireless capability for transference of data and dimming control
- Level of automated functionality
- Sensor connectivity and compatibility
- Scalability and expandability
- Network infrastructure requirements
- Use of central management software
- Easily understood and operated central management user interface
- Direct customer-owned server hosting
- Cloud backup facility



*Integrating enhancement lighting onto standard poles, Hay St, Central Perth*

## 2.6.3 DURABILITY, MAINTENANCE AND ASSET LIFE

### Durability and maintenance provisions

- Ensure that materials and designs of luminaires, brackets and control gear will withstand environmental conditions of the site.
  - IP Ratings must be at least IP54 for elements in sheltered locations, and IP65 for any electrical components exposed to weather.
  - Elements exposed to weather must be of corrosion resistant materials including stainless steel or anodised aluminium, or treated with durable corrosion-resistant finishes.
- Select and locate fittings to minimise vandalism and ensure resistance to malicious damage.
  - Mount luminaires at heights that limit potential public access.
  - Use concealed and tamper-proof fixings.
- Support ease of maintenance.
  - Locate units, control gear and switches in public space where they are accessible for maintenance personnel.
  - Ensure that fittings at height are accessible with conventional cherry pickers or scissor-lifts. On steep slopes and where features such as sensitive plantings or heavy traffic limit access, locations should be carefully considered to ensure they can be maintained.
  - Use electrical industry standard locking devices.
- Locate cabinets to be accessible for maintenance but where they do not limit other uses of a space.
- Practice proactive asset maintenance.

### Asset life and renewal

Lighting infrastructure does not last forever.

In addition to wear, weathering and aging of parts, technological advances are likely to make light fittings obsolete. This has certainly been the case in recent years and there have been significant developments improving efficiency and performance. Mercury-vapour and high-pressure sodium lamps that were once standard for most public lighting are now antiquated, and even relatively recent developments such as halogen lamps have been superseded. LEDs and other technologies such as plasma lamps have been developed into viable options with notable economic and environmental benefits.
A variety of lighting effects are now possible or more affordable than they were in the past, and new options are available in the shapes and sizes of fittings.

Despite these advances, lighting technologies are expected to continue evolving.

- Use up-to-date technologies.
- Where possible, design power supply and control systems that can be upgraded easily to take advantage of technological improvements.
- Design lighting systems to allow for their potential future decommissioning and removal without requiring reconstruction of other assets.

Consider whole of life waste management when selecting lamps and luminaires.



***Uplighting trees using pole mounted luminaires, Murray St, Central Perth***

# 2.7 DESIGN AND APPROVAL PROCESSES

## 2.7.1 PREPARING A LIGHTING PLAN

All projects that involve lighting of the public realm, and private lighting-related designs that interface with the public realm, are to be submitted to the City of Perth for review and approval.

In preparing lighting plans, it is important to engage a qualified and impartial professional. Advice should be sought from designers who are not manufacturers' or distributors' representatives. The latter will have useful information and advice about their products, but their products may not be the best fit for the project.

Good public lighting design also requires professional expertise in public space design, not just illumination standards and techniques. Lighting designs should be developed collaboratively with lighting engineers, urban designers, landscape architects, architects, and artists as appropriate to the space and project.

To support approvals, it helps to use illustrations that communicate the design concept to all parties. Accurate representations of proposed lighting effects including colour, beam angle, light wash and shadows can be made using illuminated models, sketches and computer modelling.

On-site testing or demonstration of lighting may also be appropriate. Very slight variations in lighting angles, colour temperature and intensity can sometimes have significant impacts, especially on textured or modelled surfaces of buildings, artworks or other features.

Public lighting that is attached to adjacent privately owned walls and structures must adhere to current fire regulations and seek all relevant approvals and certifications.

### Approval of lighting plans

Lighting plans submitted for approval must clearly demonstrate:

- Support for focus areas, objectives, and performance criteria in this framework.
- Compliance with all relevant statutory requirements.
- Coordination of the lighting design with the general site design, architectural design, etc.
- Support for traffic and access requirements including clearances from swept paths for turning vehicles, offsets from kerb lines to protect infrastructure from damage, and maintenance of safe view lines.
- Coordination with other elements of the public realm including trees, furniture, signage, stormwater pits, and other service pits and covers.
- Coordination with nearby sites and consideration of the total lighting effect in the area, including consistency with planned changes that may affect the performance or perception of lighting on the site.

### Approval of non-standard fittings

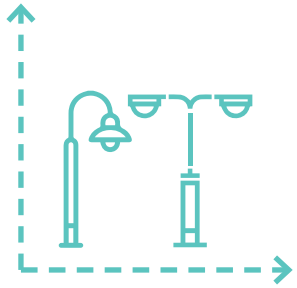
Where the City of Perth will be responsible for management and maintenance of lighting infrastructure, and where poles, luminaires or other elements are proposed that are not approved City of Perth standards, the documentation must include (in addition to the above):

- Details of all components, including:
  - Energy efficiency and source efficacy
  - Form, size, appearance and integration with its setting
  - Lighting control possibilities
  - Material durability and corrosion resistance of all parts
  - Colour, finish and consistency with City of Perth standards
  - Asset life, maintenance requirements, and lifecycle costs; lamps and fittings must have a verifiable minimum life of three years
- Photometric performance details are to be provided for all luminaire types; if a newly designed luminaire is proposed, photometric testing is required and a report documenting the results is to be submitted.
- Structural engineering design documentation and calculations may be required for poles and their footings.
- If an existing commercial product, provide:
  - Report on the quality of material and company track record
  - Warranty details
  - Contact details of the manufacturer and local suppliers
  - Report on the availability of supplies for replacement parts

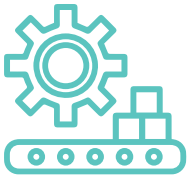
## As-built documentation and operation manuals

Documentation supporting the long-term management and maintenance of lighting infrastructure is required as a part of the handover of projects. This must include as-built drawings showing the lighting design, supply and control system.

An operation and maintenance manual must also be provided for each project. This should address:



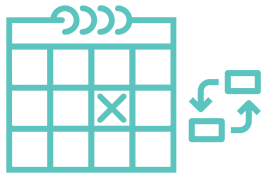
Lighting unit specifications



Manufacturer and/or supplier contact information for supply of replacements or replacement parts



Access and installation details



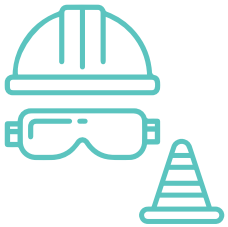
A luminaire maintenance and lamp replacement schedule



Procedures for possible future decommissioning, removal and disposal



Works required for making good



Any appropriate safety warnings for handling

# 2.8 END MATTER

## 2.8.1 GLOSSARY

**Blue-white light:** See Colour temperature or CCT

**Catenary lighting:** A lighting system where the luminaires are suspended from overhead wires (catenaries), which are fixed via brackets to adjoining buildings.

**Colour temperature or Correlated Colour Temperature (CCT):** The colour of a light source measured in degrees Kelvin (K). Blue-white or cool white indicates a high CCT, for example, 4000K. White light indicates a CCT of at least 3700K. Yellow or warm-white indicates a CCT of 2000K or less.

**Colour rendering or Colour Rendering Index (CRI):** The degree to which natural colours can be perceived under artificial light. CRI 100 means colours appear as they would in daylight. With a CRI less than 30, colours will be distorted and difficult to recognise. A CRI of 80 or above is generally acceptable for outdoor lighting. CRI relies on the total spectrum of light emitted by a source, and does not indicate its apparent colour. The impact of CCT can be related to CRI (an obviously coloured light will have a lower CRI than a 'white' light) but they are different measures. Different lamps with the same CCT rating can have significant differences in CRI ratings.

**Cool-white light:** See Colour temperature or CCT

**Down-lighting:** Lighting that is directed down onto spaces or features from elevated sources.

**Enhancement lighting:** Decorative or promotional lighting beyond functional needs. Enhancement lighting includes 'accent' lighting of small details as well as extensive installations that illuminate entire structures.

**Floodlighting:** Lighting using indiscriminate illumination of whole spaces, buildings or other objects.

**Functional lighting:** The basic level of illumination required to provide a safe environment that supports its intended use.

**Full cut-off lanterns:** A lantern designed to conceal its light source from most viewing angles, by housing lamps completely inside the fitting.

**Glare:** The discomfort or impairment of vision experienced because of an acute contrast between light and dark. When bright spots are viewed against darker areas, the latter appears darker yet because of the contrast.

**Illumination:** The amount of light falling on a given surface. The correct technical term for illumination is 'illuminance'. It is measured in units called 'lux'.

**Impact protection rating (IK Rating):** A rating of how well electrical enclosures are protected against mechanical impacts, ranging from IK00 (no protection) to IK10, which protects against impacts of up to 20 joules.

**Ingress protection rating (IP Rating):** A rating of how well electrical enclosures are sealed against moisture and intrusion of foreign bodies such as fingers, tools, insects and dirt. IP ratings are in two digits: the first indicates protection from intrusion, and the second moisture protection. IP11 offers no protection; IP79 means a dust-tight seal with protection from prolonged immersion in water under pressure.

**Lamp:** A light source. Commonly referred to as a 'light bulb' or 'light globe'.

**Lantern:** A light fitting that houses a lamp. Also referred to as a 'luminaire'.

**LED:** Light-emitting diode; a type of lamp.

**Legibility:** The degree to which people can 'read' their environment, interpret what they see, and get useful information. It is particularly used to mean how well the urban environment helps people to find their way around.

**Luminaire:** See Lantern

**Lux:** A unit of measurement for the amount of light that reaches a given location (distinct from the total light emitted from a given lamp, or the power it uses).

**Obtrusive light:** Light with negative environmental impacts, including nuisance to pedestrians and the occupants of nearby properties. This may result from the intensity or direction of illumination.

**Public lighting:** The provision of lighting in public spaces to provide a safe and comfortable night environment.

**Semi cut-off fitting:** A lantern from which a lamp partially protrudes, so the light source is visible. Semi cut-off fittings allow light to fall over a relatively broad area, so they can be spaced widely. However they allow less control over the distribution light than full cut-off fittings, can be a source of glare, and can result in much of the light generated being wasted and emitted in a skyward direction.

**Sky glow or light pollution:** The unnaturally bright night sky caused by artificial light that shines or is reflected upwards and scatters in the atmosphere. Sky glow hinders astronomers' work and diminishes everyone's awareness of the stars and other celestial phenomena. It can also disturb birds and other wildlife.

**Spill:** Light that misses its target. It represents wasted energy, contributes to sky glow, and may cause a nuisance to observers. Also referred to as 'stray' light.

**Up-lighting:** Lighting that is directed upwards onto buildings, trees or other features from low-level sources.

**Warm-white light:** See Colour temperature or CCT

**Watt:** A unit of electrical power

**White light:** See Colour temperature or CCT

**Yellow light:** See Colour temperature or CCT

## 2.8.2 ABBREVIATIONS

**CCT:** Correlated Colour Temperature (see glossary)

**CRI:** Colour Rendering Index (see glossary)

**IK:** IK Rating (see glossary)

**IP:** IP Rating (see glossary)

**K:** Degrees Kelvin

**LED:** Light-emitting diode (see glossary)



*Northbridge Piazza, Northbridge*

## 2.8.3 REFERENCES

### City of Perth references

An Urban Design Framework:  A vision for Perth 2029

Economic Development Directions Paper (Previously known as Economic Development Strategy 2010)

Environment Strategy 2015-2031

Heritage Plan (2004)

Infrastructure – Light Assets (2015/16)

Lighting Strategy (draft for public consultation, 2014)

Our Walkable City initiative

Public Art Strategy (2015)

Safe City Strategy 2016-2020

City of Perth Strategic Community Plan 2019-2029

Towards an Energy Resilient City – Strategic Directions Paper

Urban Forest Plan 2016-2036

### External stakeholder references and related documents

New Northbridge Masterplan – Metropolitan Redevelopment Authority

Perth City Link – Metropolitan Redevelopment Authority

Yagan Square – Metropolitan Redevelopment Authority

Riverbank – Metropolitan Redevelopment Authority

East Perth Powerstation Project – Metropolitan Redevelopment Authority

Claisebrook Village redevelopment – Metropolitan Redevelopment Authority

Swan River Pedestrian Bridge – State Government of Western Australia

Australia National Trust Vision Study 2015

East End Precinct document 2016

*City of Perth Act 2016*

### Key stakeholders

Stakeholders consulted or considered in preparation of the Lighting Strategy, Lighting Masterplan and Lighting Design Guide on which this document is based include:

- Metropolitan Redevelopment Authority
- Western Power
- Western Australian Planning Commission
- State Heritage Offices and other heritage agencies
- Main Roads Western Australia
- Department of Biodiversity, Conservation and Attractions
- Disability and access groups
- City residents and business owners
- Property owners and representatives
- Botanic Gardens and Parks Authority
- Community Liaison Unit, Western Australian Police
- Crime prevention and monitoring agencies
- Tourism WA
- City of South Perth
- City of Nedlands
- City of Subiaco
- City of Vincent
- Town of Victoria Park

# APPENDICES

## APPENDIX 1: LIGHTING VALUES AROUND PERTH WATER

| | ASNZS 1158.3.1:2005 | | | | |
|---|---|---|---|---|---|
| **Area-wide treatments** | **Road/pathway Category** | **Operating characteristics Category V** | **Vehicle/ pedestrian lighting subcategory** | **Operating characteristics Category P** | **Light Solution** |
| **Pathways** | **Vista feature pathway adjacent to river foreshore**<br>• Causeway Bridge to Department of Water and Environment<br>• Ellam Street to Mends Street Jetty<br>• Mends Street Jetty to Millers Pool | | P2 | High pedestrian/cycle traffic only<br>Medium risk of crime<br>High need to enhance prestige<br>Need to mitigate spill light into river applicable<br>Impact on sightlines & amenity from adjoining properties | Bollard Luminaire<br>Pole Top Luminaire |
| | **Pathway adjacent to river foreshore**<br>• Windan Bridge to Marathon Club<br>• Causeway Bridge to Department of Water and Environment<br>• Department of Water and Environment | | P3 | High pedestrian/cycle traffic only<br>Low risk of crime<br>High need to enhance prestige<br>Need to mitigate spill light into river applicable<br>Impact on sightlines & amenity from adjoining properties | Bollard Luminaire<br>Pole Top Luminaire |
| | **Pathway adjacent to road**<br>• Marathon Club | | P2 | High pedestrian/cycle traffic only<br>Medium risk of crime<br>High need to enhance prestige<br>Need to mitigate spill light into river applicable<br>Impact on sightlines & amenity from adjoining properties | Pole Top Luminaire |
| | **Pathway through parkland**<br>• Marathon Club to Causeway Bridge<br>• Department of Water and Environment to Ellam Street | | P2 | High pedestiran/cycle traffic only<br>Medium risk of crime<br>High need to enhance prestige<br>Impact on sightlines & amenity from adjoining properties | Bollard Luminaire |



*Pedestrian shared path along Mounts Bay Road, Crawley/Nedlands*

## APPENDIX 2: SELECTION CRITERIA FOR LIGHTING AROUND PERTH WATER

This check list is to assist in the specification of light fixtures that address design principles and considerations adjacent to Perth Water.

### Bollard Luminaire



| | | |
|---|---|---|
| Lamp | ☐ | LED |
| Colour temperature | ☐ | 3000K |
| Lamp life | ☐ | Min 50,000 Hours |
| Optical distribution | ☐ | Assymetrical |
| | ☐ | Symmetrical |
| Glare control | ☐ | Full cutoff |
| IP Rating | ☐ | IP66 |
| IK Rating | ☐ | IK10 |
| Lighting control | ☐ | Astro rex timer |
| | ☐ | Dali |
| Material | ☐ | Aluminium |
| Installation type | ☐ | Concrete foundation |
| Shape | ☐ | Round |
| | ☐ | Square |
| Typical mounting height | ☐ | 1-2m |
| Finish | ☐ | Powder coated |
| | ☐ | Silver colour |
| Warranty | ☐ | Min 5 years |
| Product supply/ availability | ☐ | Perth representation |
| | ☐ | Max 12 weeks lead time |
| | ☐ | 10 year product line |

### Pole & Post Top Luminaire



| | | |
|---|---|---|
| Lamp | ☐ | LED |
| Colour temperature | ☐ | 3000K |
| Lamp life | ☐ | Min 100,000 Hours |
| Optical distribution | ☐ | Assymetrical |
| | ☐ | Symmetrical |
| | ☐ | Road/Pathway |
| Glare control | ☐ | Full cutoff |
| IP Rating | ☐ | IP66 |
| IK Rating | ☐ | IK10 |
| Lighting control | ☐ | Astro rex timer |
| | ☐ | Stepped dimmed |
| | ☐ | Dali |
| | ☐ | Nema Socket |
| Pole material | ☐ | Anodised aluminium |
| | ☐ | Stainless steel |
| | ☐ | Hot dip galvanised steel |
| Typical mounting type | ☐ | 3-4m |
| Installation type | ☐ | Concrete foundation |
| | ☐ | Nail footing |
| Finish | ☐ | Powder coated |
| | ☐ | Silver colour |
| Warranty | ☐ | Min 5 years |
| Product supply/ availability | ☐ | Perth representation |
| | ☐ | Max 12 weeks lead time |
| | ☐ | 10 year product line |

### Pole & Pole Mounted Luminaire



| | | |
|---|---|---|
| Lamp | ☐ | LED |
| Colour temperature | ☐ | 3000K |
| Lamp life | ☐ | Min 100,000 Hours |
| Optical distribution | ☐ | Assymetrical |
| | ☐ | Symmetrical |
| | ☐ | Road/Pathway |
| Glare control | ☐ | Full cutoff |
| IP Rating | ☐ | IP66 |
| IK Rating | ☐ | IK10 |
| Lighting control | ☐ | Astro rex timer |
| | ☐ | Stepped dimmed |
| | ☐ | Dali |
| | ☐ | Nema Socket |
| Pole material | ☐ | Anodised aluminium |
| | ☐ | Stainless steel |
| | ☐ | Hot dip galvanised steel |
| Typical mounting type | ☐ | 4-6m |
| Installation type | ☐ | Concrete foundation |
| | ☐ | Nail footing |
| Finish | ☐ | Powder coated |
| | ☐ | Silver colour |
| Warranty | ☐ | Min 5 years |
| Product supply/ availability | ☐ | Perth representation |
| | ☐ | Max 12 weeks lead time |
| | ☐ | 10 year product line |

## Area Luminaire



| | | |
|---|---|---|
| Lamp | ☐ | LED |
| Colour temperature | ☐ | 3000K |
| Lamp life | ☐ | Min 50,000 Hours |
| Optical distribution | ☐ | Symmetrical narrow |
| | ☐ | Symmetrical wide |
| | ☐ | Symmetrical flat |
| IP Rating | ☐ | IP66 |
| IK Rating | ☐ | IK10 |
| Lighting control | ☐ | Astro rex timer |
| | ☐ | Dali |
| Pole material | ☐ | Anodised aluminium |
| | ☐ | Stainless steel |
| | ☐ | Hot dip galvanised steel |
| Installation type | ☐ | Concrete foundation |
| | ☐ | Nail footing |
| Finish | ☐ | Powder coated |
| | ☐ | Silver colour |
| Warranty | ☐ | Min 5 years |
| Product supply/ availability | ☐ | Perth representation |
| | ☐ | Max 12 weeks lead time |
| | ☐ | 10 year product line |

## Spot Light Luminaire



| | | |
|---|---|---|
| Lamp | ☐ | LED |
| Colour temperature | ☐ | 3000K |
| Lamp life | ☐ | Min 50,000 Hours |
| Optical distribution | ☐ | Symmetrical narrow |
| | ☐ | Symmetrical wide |
| | ☐ | Symmetrical flat |
| IP Rating | ☐ | IP66 |
| IK Rating | ☐ | IK10 |
| Lighting control | ☐ | Astro rex timer |
| | ☐ | Dali |
| Pole material | ☐ | Anodised aluminium |
| | ☐ | Stainless steel |
| | ☐ | Hot dip galvanised steel |
| Installation type | ☐ | Concrete foundation |
| | ☐ | Nail footing |
| Finish | ☐ | Powder coated |
| | ☐ | Silver colour |
| Warranty | ☐ | Min 5 years |
| Product supply/ availability | ☐ | Perth representation |
| | ☐ | Max 12 weeks lead time |
| | ☐ | 10 year product line |

## Pole



| | | |
|---|---|---|
| Pole height | ☐ | 3m |
| | ☐ | 4m |
| | ☐ | 6m |
| Pole shape | ☐ | Round |
| | ☐ | Tapered circular |
| Pole material | ☐ | Anodised aluminium |
| | ☐ | Stainless steel |
| | ☐ | Hot dip galvanised steel |
| Installation type | ☐ | Concrete foundation |
| | ☐ | Nail footing |

City of Perth

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