Transport
for NSW

Central Precinct Renewal Program

Pollution Assessment

July 2022

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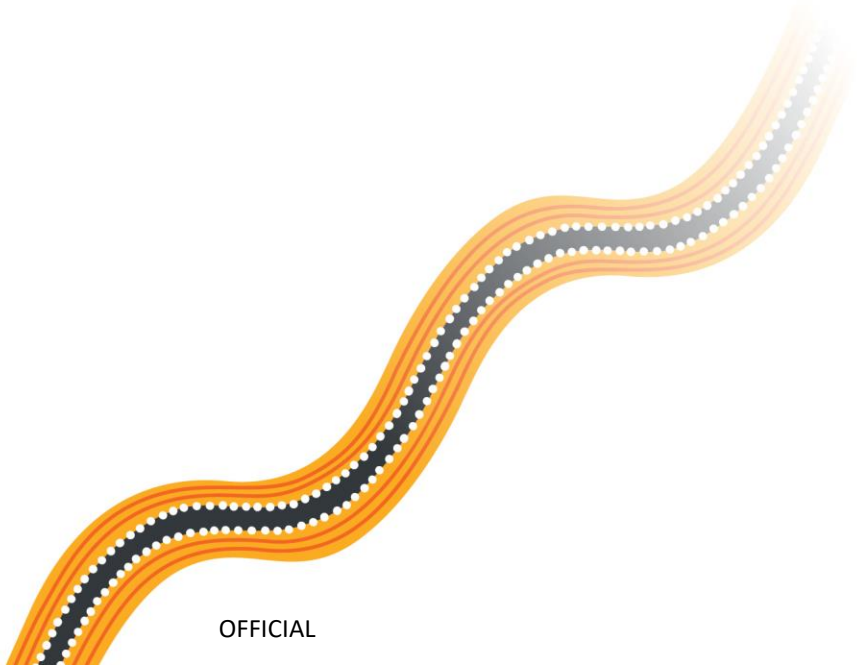
NSW GOVERNMENT

Acknowledgement of Country

We respectfully acknowledge the Traditional Custodians of the Central Precinct, the Gadigal and recognise the importance of place to Aboriginal people and their continuing connection to Country and culture. We pay our respect to Elders past, present and emerging.



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Versions

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Abbreviations

Abbreviation	Definition
ANZECC	Australian and New Zealand Environment Conservation Council
BOOS	Bondi Ocean Outfall Sewer
CBD	Central Business District
CoS	City of Sydney Council
CPRP	Central Precinct Renewal Project
DCP	Development control plan
DPE	NSW Department of Planning and Environment
GANSW	Government Architect NSW
GFA	Gross floor area
LGA	The City of Sydney local government area
NEPM	National Environment Protection (Ambient Air Quality) Measure
NSW EPA	New South Wales Environmental Protection Authority
SSP	State Significant Precinct
TfNSW	Transport for NSW
WSUD	Water Sensitive Urban Design

Definitions

Term	Definition
Amenity	The extent to which a place, experience or service is pleasant, attractive or comfortable. Improved features, facilities or services may contribute to increase amenity.
Central Precinct	Central Precinct State Significant Precinct
Central Sydney	Land identified as Central Sydney under the Sydney Local Environmental Plan 2012 and represents the Metropolitan Centre of Sydney. Central Sydney includes Sydney's Central Business District
Character	The combination of the attributes, characteristics and qualities of a place (GANSW, 2021, Draft Urban Design Guide)
Community	Particular types of stakeholder and refers to groups of people in particular places who are both affected by our work and experience the outcomes and benefits of our activities
Control	A numerical standard that is applied in a prescriptive manner
Corridor	A broad, linear geographical area between places
Council	The City of Sydney Council
District Plan	means the Eastern City District Plan
Goods Line	The official name for the partly elevated walkway from Central Station to Darling Harbour following the route of a disused railway line
Interchange	A facility to transfer from one mode of transport or one transport service to another. For example, a station with an adjoining light rail stop
Mobility	The ability to move or be moved easily and without constraints
Mortuary Station	The building formerly used as a railway station on the Rookwood Cemetery railway line, now disused
Over rail corridor development or Over Station Development	Development of air space over railway corridors
Planning instrument	Means any of the following: • strategic plan (comprising regional strategic plans and district strategic plans) and local strategic planning statements • environmental planning instrument (comprising State environmental planning policies and local environmental plans) development control plan
Precinct	Geographical area with boundaries determined by land use and other unique characteristics. For example, an area where there is an agglomeration of warehouses may be termed a freight precinct
Proponent	Transport for NSW
Proposal	Proposed amendments to the planning framework
Public spaces	means areas that are publicly accessible where people can interact with each other and make social connections
Rail network	means the rail infrastructure in NSW

Term	Definition
Railway corridor	The land within Central Precinct on which a railway is built; comprising all property between property fences, or if no fences, everywhere within 15m from the outermost rails. Under planning legislation rail corridor is defined as land: a) that is owned, leased, managed or controlled by a public authority for the purpose of a railway or rail infrastructure facilities: or b) that is zoned under an environmental planning instrument predominately or solely for development of the purpose of a railway or rail infrastructure facilities
Reference Master Plan	A non-statutory document that shows one way in which the precinct may develop in the future in accordance with the proposed amendments to the planning framework Note: Refer to the GANSW Advisory Note v2, dated 12/09/2018 for further guidance
Siding	A short stretch of rail track used to store rolling stock or enable trains on the same line to pass
State	The state of New South Wales
State Significant Precinct	The areas with state or regional planning significance because of their social, economic or environmental characteristics
Strategic Framework	The document prepared by Transport for NSW for Central Precinct in 2021 that addresses key matters including vision, priorities, public space, strategic connections, design excellence, identify sub-precincts for future detailed planning and also outlines the next steps in the State Significant Precinct process for Central Precinct
Strategic plan	The regional strategic plan, district strategic plan or a local strategic planning statement
Sub-precinct	The definable areas within Central Precinct SSP due to its unique local character, opportunities and constraints, either current or future. The Western Gateway is a sub-precinct
Sydney Metro	A fully-automated, high frequency rail network connecting Sydney
Tech Central	The State government initiative as set out in The Sydney Innovation and Technology Precinct Panel Report 2018. Previously known as the Sydney Innovation and Technology Precinct. Tech Central is located south of the Sydney central business district, surrounded by the suburbs of Redfern, Ultimo, Haymarket, Camperdown, Chippendale, Darlington, Surry Hills and Eveleigh
Transport for NSW	The statutory authority of the New South Wales Government responsible for managing transport services in New South Wales.
Transport interchange	A facility designed for transitioning between different modes, such as a major bus stop or train station
Transport modes	The five public transport modes are metro, trains, buses, ferries and light rail. The two active transport modes are walking and cycling
Vibrant streets / places	Places that have a high demand for movement as well as place with a need to balance different demands within available road space

Executive summary

Arcadis has been engaged by Transport for NSW to prepare this Pollution Assessment as part of the Central State Significant Precinct (SSP) Study. This assessment addresses the study requirements issued by the NSW Department of Planning, Infrastructure and Environment (the Department) to guide the preparation of the SSP Study, specifically the requirement to:

Prepare a pollution assessment for the proposal that identifies and assesses any potential pollution impacts resulting from the proposal including but not limited to water, air and light pollution and which includes an analysis of the potential impact on adjoining uses and recommends development standards to be applied to subsequent development stages.

This report provides a high-level assessment of the Central Precinct Renewal Project (CPRP) for potential impacts associated with water, air and light pollution on Central Precinct and adjoining areas. It identifies the policy framework relevant to each component, identifies potential impacts and provides recommendations for subsequent design and development stages.

Key outcomes of the Pollution Assessment are:

- The development of the CPRP presents an opportunity to substantially reduce pollutant loads entering the receiving waters of Blackwattle Bay and Darling Harbour from the Central Precinct when compared with the existing situation. The aspiration to be "significantly beyond best practice" for water quality is a realistic outcome with the appropriate design of water quality treatment infrastructure. This is in part, due to the establishment of a deck over the rail corridor and the resulting opportunity to capture and treat stormwater runoff from the deck. There are also opportunities to improve the quality of stormwater runoff from other areas of the precinct through the establishment of new treatment infrastructure, as well as treating upstream stormwater that passes through the precinct.
- The main potential source of air pollution associated with the development of the CPRP is diesel locomotive exhaust emitted below the proposed deck and which will need to be extracted and vented to the surface. The proposed solution of venting these exhausts through ventilation systems of the buildings above the deck is likely to be able to ensure appropriate air quality for sensitive receptors both above and below deck level. Detailed air quality investigations will however need to be undertaken in all subsequent design stages to ensure that the ventilation system has appropriate capacity and outlets are located such that air quality of sensitive receptors is maintained.
- While the development of the CPRP will inevitably result in a range of outdoor lighting sources, it is anticipated that light pollution can be effectively managed through appropriate lighting design.

Recommendations of this Pollution Assessments are:

- At the next stage of the Master Plan development, specific water quality management principles for each sub-precinct should be identified and preliminary evaluations undertaken of the likely water quality performance of any drainage solutions. The sub-precinct approach should be applied during concept design, increasing in granularity during subsequent design stages, with more detailed evaluations of performance occurring.

- Appropriate air quality modelling should be undertaken during relevant design stages to ensure that project specific criteria can be met. This will include assessing existing receptors and potential future receptor locations associated with the CPRP. It is envisaged that an iterative process will be required where outlet points and exhaust system capacity may need to be altered depending on the outcomes of modelling. During concept design this process should be focused on identifying outlet locations where there is a certainty that air quality criteria can be met. In detailed design more specific analysis is to be undertaken to optimise ventilation design to ensure that the air quality within and surrounding the precinct is as good as can be reasonably achieved.
- A Night-time Master Plan should be prepared, which defines the aesthetic and functional criteria for the proposed lighting within the precinct, and assists in achieving a holistic, welcoming, safe and well-structured lit environment. This would have appropriate reference to Australian Standards: AS 4282:2019. The Night-time Master Plan should be prepared during concept design and updated as appropriate during subsequent design stages.
- Wildlife impacts should be considered in all stages of lighting design, particularly where there is adjacent wildlife habitat (such as tree canopies in Belmore Park).

1. Introduction

Located within the heart of Eastern Harbour City, Central Precinct is Australia's busiest transport interchange. The precinct currently holds latent potential with all its inherent advantages of location and transport connections to revitalise Central Sydney. Capitalising on Central Precinct's prime location within Tech Central, a NSW Government commitment to create the biggest technology hub of its kind in Australia, Central Precinct presents the ultimate transformative opportunity to deliver a connected destination for living, creativity and jobs. The renewal of Central Precinct will provide a world-class transport interchange experience, important space for jobs of the future, improved connections with surrounding areas, new and improved public spaces and social infrastructure to support the community.

1.1 Tech Central

1.1.1 Overview

The NSW Government is committed to working with the local community to develop the biggest innovation district of its kind in Australia. Bringing together six neighbourhoods near the Sydney CBD (Haymarket, Ultimo, Surry Hills, Camperdown, Darlington North Eveleigh and South Eveleigh), Tech Central is a thriving innovation ecosystem that includes world-class universities, a world-leading research hospital, 100 + research institutions, investors and a wide range of tech and innovation companies. The vision for Tech Central is for it to be a place where universities, startups, scaleups, high-tech giants and the community collaborate to solve problems, socialise and spark ideas that change our world. It is also for it to be place where centring First Nations voices, low carbon living, green spaces, places for all people and easy transport and digital connections support resilience, amenity, inclusivity, vitality and growth.

Tech Central is an essential component of the Greater Sydney Region Plan's Eastern Harbour City Innovation Corridor. It aims to leverage the existing rich heritage, culture, activity, innovation and technology, education and health institutions within the precinct as well as the excellent transport links provided by the Central and Redfern Station transport interchanges.

The Central Precinct is located within the Haymarket neighbourhood of Tech Central. Planned to become the CBD for Sydney's 21st century, this neighbourhood is already home to The Quantum Terminal (affordable coworking space in the iconic Central Station Sydney Terminal Building) the Scaleup Hub (affordable and flexible workspace for high-growth technology scaleups) and is soon to be the home of Atlassian's headquarters. It is also in close proximity to a number of important education and research institutions.

The planned urban renewal of the Central Precinct has been identified as a key project to achieving the vision for Tech Central.

1.1.2 Background & Context to Tech Central

In August 2018, the NSW Government established the Sydney Innovation and Technology Precinct Panel (the Panel) comprising representatives from various industry, health, education, government agencies and key community members. In December 2018 'The Sydney Innovation and Technology Precinct Panel Report' was produced, setting out the Panel's recommendations for a pathway to delivering a successful innovation and technology district at Tech Central. In February 2019, the NSW Government adopted the Panel's report and committed to delivering the following:

- 25,000 additional innovation jobs
- 25,000 new STEM and life sciences students
- 200,000 m² for technology companies, and
- 50,000 m² of affordable space for startups and scaleups

In February 2019, the Greater Sydney Commission released a Place Strategy for the area that is now known as Tech Central (Camperdown-Ultimo Collaboration Area Place Strategy, GSC). The Place Strategy, developed collaboratively by a range of stakeholders involved in planning for Tech Central's future, was prepared to inform public and private policy and investment decisions by identifying and recognising the complex, place-specific issues inhibiting growth and change. The strategy identifies shared objectives for the place and sets out priorities and actions to realise the vision for the area under the key themes of Connectivity, Liveability, Productivity, Sustainability and Governance.

Both the Panel Report and Place Strategy recognise the importance of the Central Precinct to Tech Central's future.

In July 2019, Central Precinct was declared a nominated State Significant Precinct (SSP) in recognition of its potential to boost investment and deliver new jobs. The SSP planning process for Central Precinct will identify a new statutory planning framework for Central Precinct. This involves two key stages:

- **Stage 1**: Development of a draft Strategic Vision which has since evolved into the Central Precinct Strategic Framework
- **Stage 2**: Preparation of an SSP study with associated technical analysis and community and stakeholder consultation.

In March 2021, the Central Precinct Strategic Framework was adopted representing the completion of Stage 1 of the planning process to develop a new planning framework for Central Precinct. The Strategic Framework outlines the vision, planning priorities, design principles, and the proposed future character of sub-precincts within Central Precinct. This is intended to inform and guide further detailed planning and design investigations as part of this SSP Study (Stage 2 of the SSP planning process).

This SSP Study intends to amend the planning controls applicable to Central Precinct under the SSP SEPP 2005 to reflect the vision and planning priorities set for the precinct under the Strategic Framework. Study Requirements were issued in December 2020 to guide the investigations and the proposed new planning controls.

1.2 Central Precinct vision

Central Precinct will be a vibrant and exciting place that unites a world-class transport interchange with innovative and diverse businesses and high-quality public spaces. It will embrace design, sustainability and connectivity, celebrate its unique built form and social and cultural heritage and become a centre for the jobs of the future and economic growth.

1.3 Case for change

Over the coming years, Central Station will come under increasing pressure as technological innovations progress, investment in transport infrastructure increases and daily passenger movements increase.

Sydney Metro, Australia's biggest public transport project, will result in the delivery of a new generation of world-class, fast, safe, and reliable trains enabling faster services across Sydney's rail network. In 2024, Sydney Metro's Central Station will open with daily passenger movements forecast to increase from 270,000 persons to 450,000 persons over the next 30 years.

In its current state, Central Station is underperforming as Australia's major transport interchange – it's currently a hole in the heart of Sydney's CBD, lacking connectivity, activation and quality public spaces.

The renewal of Central Precinct will expand and revitalise Central Station, and transform this underutilised part of Sydney from a place that people simply move through to one where they want to visit, work, relax, connect and socialise. Its renewal also presents the potential to deliver on the strategic intent and key policies of regional, district and local strategic plans, providing for a city-shaping opportunity that can deliver economic, social and environmental benefit. Specifically, it will:

- make a substantial direct and indirect contribution to achieving the Premier's Priorities by facilitating upgrades to Sydney's largest and most significant public transport interchange, improving the level of service for users and visitors, and supporting the creation of new jobs and housing
- implement the recommendations of the NSW State Infrastructure Strategy 2018-2038, in particular the upgrading of the major transport interchange at Central to meet future customer growth
- contribute to key 'Directions' of the Greater Sydney Region Plan, to deliver 'a city supported by infrastructure', help create 'a city of great places', support 'a well connected city', deliver new 'jobs and skills for the city' and create 'an efficient city'
- implement the outcomes envisaged within the Eastern City District Plan including reinforcing the Harbour CBD's role as the national economic powerhouse of Australia and supporting its continued growth as a Global International City

- deliver on the shared objectives and priorities for Tech Central, the future focal point of Sydney's innovation and technology community, which aims to boost innovation, economic development and knowledge intensive jobs while creating an environment that foster collaboration and the exchanging of ideas
- deliver an outcome that responds to the overarching vision and objectives of the Central Sydney Planning Strategy. In particular it will assist with implementing a number of 'key moves' outlined in the strategy, including to 'ensure development responds to its context', 'ensure infrastructure keeps pace with growth', 'move people more easily', 'protect, enhance and expand Central Sydney's heritage, public places and spaces', and to 'reaffirm commitment to design excellence.'

1.4 About this report

The purpose of this report is to provide a pollution assessment of the proposed changes and consider any potential impacts that may result within and surrounding the Central Precinct. This report addresses study requirement 3.3 Pollution Assessment. The relevant study requirements, considerations and consultation requirements, and location of where these have been responded to is outlined in **Table 1** below.

The report is related and aligned to several other reports being prepared as part of the SSP Study. In particular the *Central Precinct Renewal Program Environmental Sustainability, Climate Change and Waste Management Report* which includes ambitions for stormwater quality and the *Central Precinct Renewal Program Water Quality, Flooding and Stormwater Report* which establishes principles for stormwater quality management. In addition to the above, this report draws directly on and summarises, a Light Pollution Assessment prepared by Arup (refer to **Chapter 4**).

1.4.1 SSP Study requirements

The SSP study requirements as issued by the Department relating to the Pollution Assessment are listed in **Table 1** along with where each is addressed in this document.

Table 1: Study requirements, considerations, and consultation requirements

Ref	Requirement or consideration	Summary response	Where addressed
Study requirement			
3.3	Prepare a pollution assessment for the proposal that identifies and assesses any potential pollution impacts resulting from the proposal including but not limited to water, air and light pollution and which includes an analysis of the potential impact on adjoining uses and recommends development standards to be applied to subsequent development stages.	This Pollution Assessment fulfils this study requirement. The potential pollution impacts on water, air and light have been assessed to help inform DPE's assessment and decision making process. Note that other forms of pollution, including noise and waste, are addressed in separate studies and therefore not included here.	The entire Pollution Assessment
Study consideration			
3	The studies are to demonstrate how the studies inform and support the preparation of the proposed planning framework including any recommended planning controls or DCP/Design Guideline provisions.	Based on the water, air and light pollution assessment undertaken, recommendations have been provided to inform the preparation of the proposed planning framework, planning controls/provisions.	Chapter 6: Conclusions and recommendations addresses this matter
Consultation			
3	The Studies are to be informed by consultation with: • The City of Sydney; particularly in relation to establishing and agreeing on a methodology for wind, view and solar access analysis; • DPIE (in particular the Public Spaces team, Government Architect, Green and Resilient	Consultation specifically related to the Pollution Assessment has occurred with the City of Sydney, DPE and the NSW Environment Protection Authority.	Chapter 5: Consultation addresses this matter

Ref	Requirement or consideration	Summary response	Where addressed
	Public Places team where relevant); and • NSW Environment Protection Authority (where relevant). Advice should be sought from the Central Precinct Design. Review Panel throughout the process, particularly in relation to the outcomes of amenity studies as they relate to and inform the urban design of the precinct.		
Author			
3	• The wind study is to be prepared by suitably qualified wind professional(s) with the necessary experience and expertise to undertake the required works including wind tunnel testing; • The noise and vibration assessment is to be undertaken and signed off by a suitably qualified acoustic and vibration professional(s) with the necessary experience and expertise to undertake the required works; • The view and visual assessment is to be prepared by a suitably qualified professional(s) with the necessary experience and expertise to undertake the required works; and • The daylight, sky view factor and solar access analysis is to be undertaken by a suitably qualified professional(s) with the necessary experience and expertise to undertake the required works.	No specific author requirements have been specified for the Pollution Assessment. The Pollution Assessment has been prepared by an appropriately qualified and experienced consultant. This report has been authored by Peter Rand, Technical Director – Environment	
Guidance documents			
3	The following documents provide guidance for this Study: • State Environmental Planning Policy (Infrastructure) 2007 (DPIE, 2007); • City of Sydney Open Space, Sports and Recreational Needs Study (CoS, 2016); • Assessing Vibration: A Technical Guideline (DEC, 2006); • Development Near Rail Corridors and Busy Roads – Interim Guideline; • City of Sydney Public Design Manual and Public Domain Design;	From this list, the following relevant guidance documents have been considered as part of the Pollution Assessment: • Sydney Development Control Plan 2012; Refer to the respective sections of the Pollution Assessment for a list of additional guidance and policy documents that have been reviewed and used where relevant.	The following sections address this matter: Section 2.1: Policy Framework (water pollution) Section 3.1: Policy Framework (air pollution) Section 4.1: Policy framework (light pollution)

Ref	Requirement or consideration	Summary response	Where addressed
	• Guidelines from NSW Govt Architect and City of Sydney Competitive Design Policy; • Guidelines for Landscape and Visual Impact Assessment (LI & IEMA 2013); • NSW Land and Environment Court photomontage policy; • NSW Green Cover Technical Guidelines; • NSW Greener Spaces; • District and regional Plan Strategies and actions; Study Requirements NSW Department of Planning, Industry and Environment | CM9 Record Number | 15 • Greater Sydney Green Grid Spatial Framework; • Sydney Development Control Plan 2012; • City of Sydney public domain codes including: Streets Code and Technical Specifications, Legible Sydney Wayfinding Strategy & Design Manual, Street Tree Masterplan, Urban Forest Strategy & any other relevant Sydney Code; and • Draft Central Sydney Planning Strategy and draft DCP.		

1.5 Study Area

Central Precinct is located at the south-east edge of Central Sydney (refer to **Figure 1**). Central Precinct is surrounded by a number of suburbs including, Haymarket to the north, Chippendale to the south and Surry Hills to the south-east. It is located within the City of Sydney local government area (LGA) with an approximate gross site area of 24 hectares of Government owned land. The precinct comprises land bounded by Pitt Street and Regent Street to the west, Cleveland Street to the south, Eddy Avenue, Hay Street and Goulburn Street to the north and Elizabeth Street and Chalmer Street to the east.

Central Precinct has been an important site for transport operations for over 150 years. Today, Central Station is Australia's busiest transport interchanges and is the anchor of New South Wales's (NSW) rail network. It provides 24 platforms for suburban and Intercity and Regional train connections as well as a direct link to Sydney Airport. The broader transport interchange also caters for light rail, bus, coach and point to point connections such as taxis. The transport interchange will also form part of the Sydney Metro network, with new underground platforms to be provided for Sydney Metro services under Platform 13, 15 and 16 at Central Station. Sydney Metro services will begin in 2024. The precinct also comprises several significant heritage items including the state-heritage listed Sydney Terminal Building and the Clock Tower.

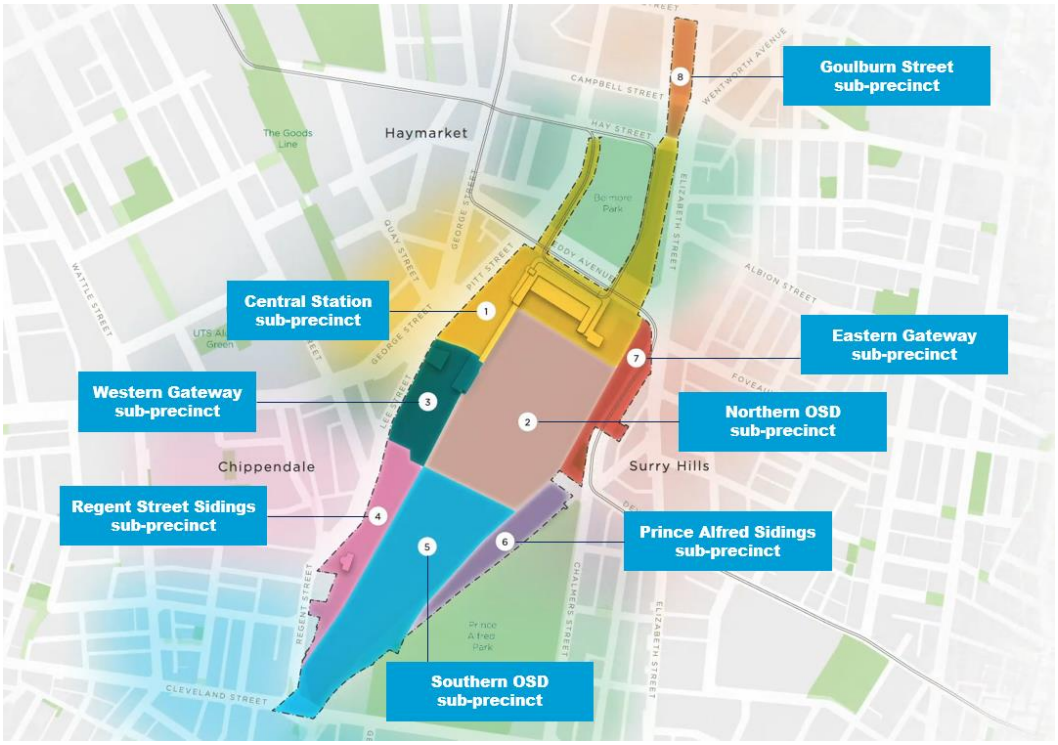
Figure 1: Location plan of Central Precinct

As part of the Strategic Framework, eight sub-precincts have been defined that reflect and positively respond to the varying character of the surrounding areas. These sub-precincts are:

- Central Station
- Northern Over Station Development
- Western Gateway
- Regent Street Sidings
- Southern Over Station Development
- Prince Alfred Sidings
- Eastern Gateway
- Goulburn Street.

The location of these sub-precincts and relevant boundaries is illustrated in **Figure 2**.

Figure 2: Central Precinct and sub-precincts



1.5.1 Planning priorities

To help realise the vision of Central Precinct and the desired local character of the sub-precincts, the following planning priorities have been developed and are grouped into five key themes as outlined in **Table 2** below.

Table 2: Central Precinct planning priorities

Theme	Planning priorities
Place and destination	• Unite the city by reconnecting with the surrounding suburbs • Shape a great place that is vibrant, diverse, active, inclusive and has a high level of amenity • Deliver a precinct which responds to its urban context and embeds design excellence Improve existing and providing additional connected public space in the precinct of high environmental amenity and comfort • Protect and celebrate the precinct's heritage values • Create a people focussed precinct through a focus on public transport, cycling and walkability • Facilitate the precinct's focus on transport and economic diversity in tourism and across commercial sectors including office, business and retail.
People and community	• Design public spaces that promote health, equality and well-being • Promote social cohesion by providing spaces for gathering, connection, exchange, opportunity and cultural expression • Honour and celebrate the cultural heritage and identity of the precinct's past and present Aboriginal community • Create a safe and intuitive precinct that promotes social access and inclusion • Support programs and initiatives that benefit communities and people

Theme	Planning priorities
	• Create a precinct that responds to the current and future needs of transport customers, workers, residents and visitors, including those of the broader local community.
Mobility and access	• Provide a world class, integrated and seamless transport interchange • Maintain the precinct's role as NSW's main transport interchange • Improve the transport customer experience, including wayfinding, pedestrian flows and interchange between different transport modes • Facilitate and enhancing connections within and towards key locations in southern Central Sydney • Deliver a people focussed precinct that is walkable, well connected, safe and puts people first • Design infrastructure that will adapt to future changes in transport and mobility.
Economy and innovation	• Advance Sydney's status as a global city • Support the creation of jobs and economic growth including new and emerging industries such as innovation and technology and explore the provision of space for cultural and creative uses and start-ups • Provide an active and diverse commercial hub with a rich network of complementary uses that nurture and support business • Support both the day and night economies of the precinct through diverse complementary uses, promoting liveability and productivity • Foster collaboration between major institutions in the precinct including transport, education, health and business • Create a smart precinct that incorporates digital infrastructure to support research and innovation.

1.5.2 Reference Master Plan

Architectus and Tyrrell Studio have prepared a Place Strategy, Urban Design Framework and a Public Domain Strategy which establishes the Reference Master Plan for Central Precinct. The Urban Design Framework and Public Domain Strategy provides a comprehensive urban design vision and strategy to guide future development of Central Precinct and has informed the proposed planning framework of the SSP Study.

The Reference Master Plan includes:

- Approximately 22,000 sqm of publicly accessible open space comprising:
    - Central Green – a 6,000 square metre publicly accessible park located in immediately south of the Sydney Terminal building
    - Central Square – 7,000 square metre publicly accessible square located at the George Street and Pitt Street junction
    - Mortuary Station Gardens – a 4,470 square metre publicly accessible park (excluding Mortuary Station building) located at Mortuary Station
    - Henry Deane Plaza – a publicly accessible plaza located in the Western Gateway sub-precinct
    - Eddy Avenue Plaza – a 1,680 square metre publicly accessible plaza located in the north-eastern portion of the Sydney Terminal building

  - Western Terminal Extension Building Rooftop - a 970sqm publicly accessible space above the Western Terminal Extension Building Rooftop.

- Approximately 269,500 square metres of office gross floor area (GFA)
- Approximately 22,850 square metres of retail GFA
- Approximately 53,600 square metres of hotel GFA
- Approximately 84,900 square metres of residential accommodation GFA, providing for approximately 850 dwellings (assuming 1 dwelling per 100sqm GFA). The Central Precinct SSP Study will include the commitment to deliver 15 per cent of any new residential floor space as affordable housing.
- Approximately 47,250 square metres of education/tech space GFA
- Approximately 22,500 square metres of student accommodation GFA
- Approximately 14,300 square metres of community/cultural space GFA.

The key features of the Indicative Reference Master Plan, include:

- A network of new and enhanced open spaces linked by green connections. This will include:
  - A Central Green (Dune Gardens) at the north of Central Precinct that will create a new civic public realm extension of the Sydney Terminal building and a new vantage point for Central Sydney
  - A new Central Square which will deliver on the vision for a new public square at Central Station, as one of three major public spaces within Central Sydney connected by a people-friendly spine along George Street
  - Mortuary Station Park at Mortuary Station that will be a key public domain interface between Chippendale and the over-station development. that will draw on the story of Rookwood Cemetery and the Victorian Garden context with the established rail heritage of the Goods Line and the rail lines
  - Henry Deane Plaza which will prioritise the pedestrian experience, improving connectivity and pedestrian legibility within the Western Gateway sub-precinct and provide clear direct links to and from the State heritage listed Central Station and its surrounds
  - Eddy Avenue Plaza – will transform into a high-amenity environment with significant greening and an enhanced interface with the Sydney Terminal building.
- A new network of circulation that will establish a clear layer of legibility and public use of the place. This will include:
  - A 15 - 24 metre wide Central Avenue that is laid out in the spirit of other street layouts within Central Sydney and which responds to the position of the Central clocktower, providing new key landmark views to the clocktower. Central Avenue will be a place for people to dwell and to move through quickly. It brings together the threads of character from the wider city and wraps them
  - Three over-rail connections to enhance access and circulation through Central Precinct, as well as provide pedestrian and bicycle cross connections through the precinct

- The extension of public access along the Goods Line from Mortuary Station Gardens, offering a new connection to Darling Harbour
- New vertical transportation locations throughout the precinct allowing for seamless vertical connections.
- An active recreation system supports health and well-being through its running and cycling loops, fitness stations, distributed play elements, informal sports provision, and additional formal recreation courts.
- a network of fine grain laneways that are open to the sky

The proposed land allocation for Central Precinct is described in **Table 3** below.

Table 3 Breakdown of allocation of land within Central Precinct (note: below figures, except for total Central SSP area, excludes WGP)

Land allocation	Proposed
Open-air rail corridor	101,755 sqm
Developable area	119,619 sqm
Public open space	19,185 sqm / 16% of Developable area
Other publicly accessible open space (Including movement zones, streets and links)	41,773 sqm / 35% of Developable area
Building area	58,661 sqm / 49% of Developable area
Central SSP total area (incl. WGP)	**23.8 ha**

The Indicative Reference Master Plan for Central Precinct is illustrated in **Figure 3** below.

Figure 3: Reference Master Plan

Sub-precinct		Total GFA per sub-precinct (sqm)*
S	Station (terminal building)	15,800
		15,800
A	OSD Block A	165,400
	A1	66,900
	A2	48,900
	A3	39,400
	A4	4,100
	A5	3,000
	A6	3,100
B	OSD Block B	88,900
	B1	42,700
	B2	37,200
	B3	4,000
	B4	5,000
C	OSD Block C	109,700
	C1	32,700
	C2	28,500
	C3	42,800
	C4	3,400
	C5	2,300
D	Regent Street Sidings Block D	65,000
	D1	33,300
	D2	31,700
E	Prince Alfred Sidings Block E	20,900
F	Goulburn St Car Park	49,200
Total GFA (excluding Western Gateway)		514,900
WG	Western Gateway	275,000

***Source**: Architectus and Tyrrell Studio*

2. Water pollution

The following chapter assesses the quality of stormwater runoff from the Central Precinct Renewal Project (CPRP) and how the impacts of this runoff on receiving waters could be minimised. As the stormwater management strategy for the CPRP (as documented in the *Central Precinct Renewal Program Water Quality, Flooding and Stormwater Report*) is high-level at this stage, the objective of this chapter is to provide guidance for future design development.

2.1 Policy Framework

New South Wales Water Quality and River Flow Objectives

Water quality objectives that provide guideline levels to help manage water quality have been developed for each catchment in NSW (Department of Environment and Conservation, 2006). These objectives include community-based values, long term goals, and their associated national criteria drawn from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000).

Specific objectives have been identified for the lower estuary of the Sydney Harbour catchment, which is the receiving environment for drainage from Central Precinct. These are however intended as a broader catchment management tool rather than targets that can be practically applied to individual developments.

Sydney Water Corporation Stormwater Quality Targets Policy

The Sydney Water Corporation Stormwater Targets Policy identifies percentage removal targets for key pollutants based on pre-development and post-development scenarios. This policy is focused on individual development approvals. The targets may provide a useful reference point when evaluating future stages in the design and development of the CPRP. At a precinct planning scale however project specific goals may be more appropriate.

City of Sydney Council Policies

The City of Sydney Development Control Plan (2012) includes the following targets for all developments greater than 1,000 square metres:

1) reduce the baseline annual pollutant load for litter and vegetation larger than 5 millimetres by 90 per cent
2) reduce the baseline annual pollutant load for total suspended solids by 85 per cent
3) reduce the baseline annual pollutant load for total phosphorous by 65 per cent
4) reduce the baseline annual pollutant load for total nitrogen by 45 per cent.

The City of Sydney's Environmental Strategy 2021-2025 includes the following objectives related to stormwater quality:

- 50 per cent reduction in the annual solid pollution load discharged to waterways via stormwater by 2030
- 15 per cent reduction in the annual nutrient load discharged to waterways via stormwater by 2030.

These goals are city-wide and the contribution of the CPRP to achieving them will be the subject of ongoing consultation with the City of Sydney Council.

2.2 Existing infrastructure, sources of pollution and receiving waters

2.2.1 Existing drainage infrastructure

Central Precinct incorporates the following formal drainage infrastructure as shown in **Figure 4**:

- Sydney Water Corporation trunk drainage lines – stormwater and sewer lines servicing the precinct and upstream catchment areas. Assets drain northwest, apart from the Bondi Ocean Outfall Sewer (BOOS) which drains northeast
- Track drainage within the rail corridor – generally draining north or south parallel to the tracks and discharging to the Sydney Water Corporation trunk lines within the rail corridor
- City of Sydney Council – road drainage network along public roadways discharging to the Sydney Water Corporation trunk lines
- Additional minor drainage networks are anticipated within the precinct
- A stormwater harvesting tank is located beneath the Pitt Street loading dock (future CPRP Western Forecourt sub-precinct) discharging to the local road drainage network.

2.2.2 Sources of pollutants

The majority of Central Precinct currently comprises the country and suburban railway corridor to the south of the main Central Station terminal building. There is the potential for a range of pollutants to enter the stormwater system from these areas, with nutrients likely to be draining from railway ballast and other contaminants (from such sources as diesel residue and brake dust) arising from train activity.

Roof structures above the country and suburban train platforms, as well as the terminal building and associated structures, also capture substantial quantities of rainfall.

2.2.3 Receiving waters

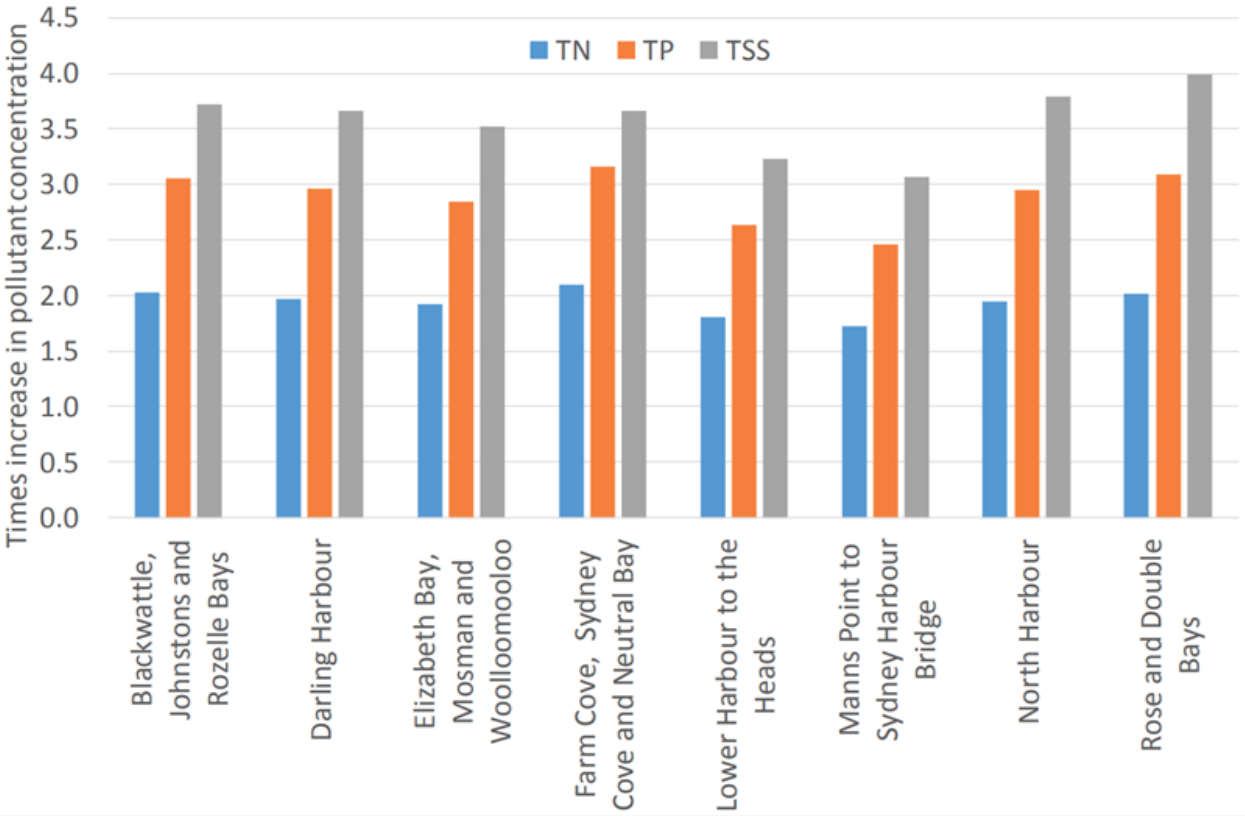
From Central Precinct, stormwater runoff drains north to Sydney Harbour through either the Darling Harbour catchment in the north or Blackwattle Bay catchment in the south. Local Land Services (2015) provides a general description of water quality in these two catchments, with nutrients and bacterial concentrations being somewhat consistent with other lower Sydney Harbour catchments, and with nutrient and sediment concentrations being considerably higher than estimated pre-European levels (**Figure 5**).

Bacteria levels in Blackwattle Bay have tended to be high, with the average enterococci count being around four times higher than the relevant ANZECC (2000) guideline value (Montoya. 2015). Comparable data is not available for Darling Harbour.

Water quality in Blackwattle Bay and Darling Harbour will contribute to the broader water quality of Sydney Harbour, which in turn influences the health of the estuarine harbour's ecosystem and can in some situations the health of recreational users of the harbour. The policy framework discussed in **Section 2.1,** particularly the New South Wales Water Quality and River Flow Objectives, recognises the range of different impacts associated with poor water quality.

Figure 4: Existing drainage infrastructure

Figure 5: Nutrient and sediment concentrations in Sydney Harbour compared to estimated pre-European levels



***Source**: Local Land Services (2015)*

2.3 Aspirations

The CPRP Environmental Sustainability, Climate Change and Waste Management Report (2022) includes the ambition: *to provide a net improvement in water quality as a result of the development*. It also has the objective: t*o reduce stormwater pollution flowing to Sydney Harbour significantly beyond best practice guidelines*. This can be taken to mean that the CPRP would set a new benchmark in Sydney for precinct-style developments in a way that can be ultimately measured in terms of pollutant load.

It should be noted that an improvement over the existing situation should not be difficult to achieve given the nature of surface conditions and the opportunities presented by covering some of the active rail corridor with an over station development deck and the associated water quality control infrastructure that can potentially be installed.

2.4 Assessment

The CPRP will create a vastly different drainage environment to the one that currently exists. There are substantial opportunities to improve stormwater quality outcomes over the current situation by ensuring that runoff is from cleaner surfaces and through efficient water quality treatment infrastructure. Stormwater runoff, once the CPRP is fully developed would occur from:

- the over station development deck, including paved and landscaped areas
- new building roofs and existing building roofs (primarily the terminal building and suburban platform roofs)
- the suburban rail corridor.

Of these, it is only the latter that has a potential for carrying higher levels of pollutants in stormwater runoff. At a high level, the stormwater management strategy for the CPRP is based on the following principles:

- Maintaining existing sub-catchment areas
- Preserving existing and creating adequate overland flow paths to the downstream
- Maximising pervious areas
- Provision for stormwater quality treatment measures
- Provision for stormwater detention
- Maintaining flood storage
- Identification and reduction of flood risk through design.

Key aspects of the proposed approach to water quality treatment measures include:

- The installation of a variety of Water Sensitive Urban Design (WSUD) measures within buildings, on the deck and in the surrounding public domain. This will generally be preferred over below ground proprietary infrastructure
- Use of multifunctional infrastructure where feasible i.e., measures that achieve water quality improvement, water conveyance and/or contribute to landscape quality.

There may also be opportunities for the treatment of upstream catchment flows. This would add to the overall water quality benefit provided by the CPRP. The ability to treat upstream flows will largely be a function of the scale of water quality treatment infrastructure that is implemented.

WSUD is a performance outcome of the green infrastructure strategy with further detail of how WSUD can be incorporated into the landscape design of the precinct being provided in the Central Precinct Renewal Program Green Infrastructure Study (TfNSW, 2022).

The effective implementation of these principles presents an opportunity to achieve a new benchmark for precinct development in Sydney. The ultimate performance of the CPRP in terms of stormwater quality will be highly dependent on the priority given to water quality treatment in subsequent design stages. This is discussed below.

2.5 Guidance for future development stages

To achieve its overarching principles, the CPRP stormwater management strategy includes the following that relate to stormwater quality:

- A sub-precinct approach will enable development controls and water quality targets to be tailored to the particular uses and built form within different areas of the precinct. This in turn will enable an evaluation against some of the broader scale water quality targets discussed in **Section 2.1**
- Maximising opportunities for water sensitive urban design. By prioritising water sensitive design, including green infrastructure, early in the planning and design of the precinct, an integrated approach may be adopted. This will help to maximise the water quality benefit that can be gained by these water sensitive urban design measures. Key aspects of the water sensitive design approach will be the use of vegetated systems where feasible and favouring distributed water quality treatment over end-of-line systems. This will be in the context of any constraints presented by the major built form elements in the CPRP, particularly the deck structure.

It is recommended that at the next stage of the Master Plan development, specific water quality management principles for each sub-precinct are identified and preliminary evaluations are undertaken of the likely water quality performance of any drainage solutions. The sub-precinct approach should be applied during concept design, increasing in granularity during subsequent design stages, with more detailed evaluations of performance occurring.

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3. Air pollution

This chapter provides details of air pollution that may be generated by the Central Precinct Renewal Project (CPRP) and potential impacts to surrounding receptors.

3.1 Policy Framework

The *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) provides the legislative authority for the NSW EPA to regulate air emissions in NSW. In undertaking this task, the NSW EPA references the National Environment Protection (Ambient Air Quality) Measure (NEPM), to which the NSW Government is a signatory. The NEPM sets standards for seven key air pollutants (**Table 4**).

Table 4: NEPM standard for air pollutants

Pollutant	Averaging Period	Maximum Concentration Standard
Carbon monoxide	8 hours	9.0 ppm
Lead	1 year	0.50 µg/m^3
Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm
PM_{10}	1 day 1 year	50 µg/m^3 25 µg/m^3
$PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3
Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm
Sulphur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm

***Note**: $PM_{2.5}$ and PM_{10} = particulate matter less than 2.5 microns and 10 microns, respectively; ppm = parts per million; µg/m^3 = micrograms per cubic metre*

3.2 Existing air pollution environment

3.2.1 Sources of air pollution

Air pollutants can have a negative impact on human health. This is recognised in the policy framework and is the primary driver of the NEPM standards listed in **Table 4**.

The main existing local sources of air pollution are vehicle emissions from the surrounding road network and diesel emissions from locomotives. Nearby construction activity would be expected to have some localised air quality impacts at times.

The air quality at Central Precinct is also influenced by the quality of the regional airshed. The most notable source of air pollution at this scale is bushfire, with major exceedances of NEPM standards having occurred during the bushfires of 2019/2020.

This is reflected in data from the nearest Environment Protection Authority air quality recording stations at Cook and Phillip Park, which is approximately one kilometre north of Central Station. The New South Wales Annual Compliance Report 2020 - National Environment Protection (Ambient Air Quality) Measure (DPIE, 2021) indicates that NEPM goals were achieved for all air pollutants except for particulate matter in 2020.

The air quality baseline is expected to improve over time both at a local and regional scale. It is intended that most regional passenger locomotives will ultimately operate under electric power when in Sydney, eliminating diesel emissions from these types of locomotives at Central Station. The timeframe for this conversion is not yet determined.

The introduction of electric locomotives and the electrification of the car and bus fleet will lower emissions locally and regionally over time. The bus fleet electrification process is underway, while the rate of uptake of electric vehicles will be subject to the market and future government policy.

3.2.2 Sensitive receivers

The Central Precinct is in a dense urban environment and surrounded by a number of receivers that are potentially sensitive to air pollutants. Of particular note are residential areas of Surry Hills to the east and south-east, and Ultimo/Chippendale to the west, including relatively recent urban development such as Central Park. Most other land uses have some level of sensitivity, particularly given the number of people that use the public domain areas of Belmore Park and Prince Alfred Park, as well as the outdoor spaces of Central Station itself and the adjacent streets. Existing receivers are shown in **Figure 6.**

The CPRP will create new sensitive receivers. These will mostly include residents, whose exposure may vary depending on the elevation of their dwelling and users of the public domain within the precinct.

Figure 6: Air quality receiver types surrounding the Central Precinct

3.3 Aspirations

It is intended that the CPRP does not contribute to any worsening of air quality either for the precinct itself or for the surrounding area.

3.4 Assessment

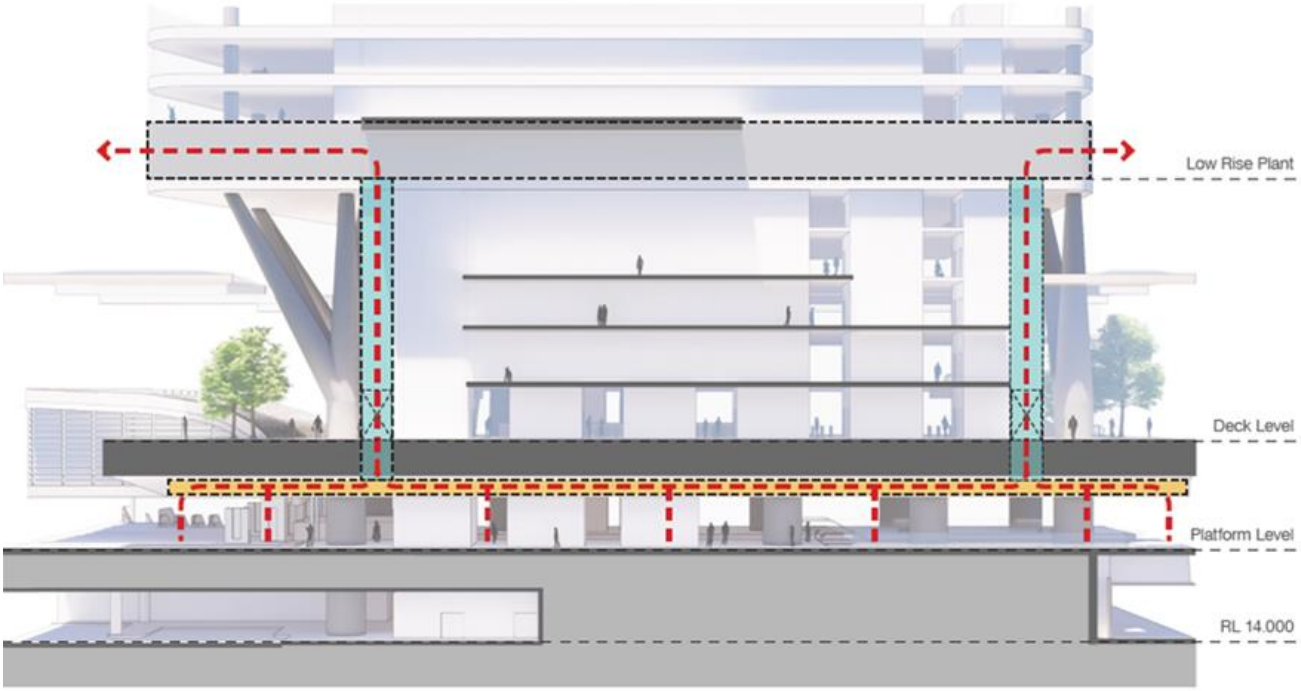
Given the limited potential for air pollution to be generated, it is not anticipated that there would be air quality impacts as a result of the development of the CPRP.

Traffic modelling undertaken for the CPRP suggests that the project would not result in major changes to traffic flows in the surrounding road network, particularly considering that limited parking is intended to be provided.

The primary potential source of air pollution within the precinct is exhaust emissions from diesel locomotives travelling below the over station development deck. This is intended to be addressed through the proposed exhaust system that will mechanically extract emissions and discharge them at an appropriate height above ground using the ventilation shafts within the buildings located on the deck (**Figure 7**). The specific location (including height) of outlet points will require detailed air quality input to ensure that there are no negative impacts to sensitive receivers within the precinct. It is not intended that outlets will be located in the public domain.

The system will also address exhaust emissions associated with delivery vehicles operating below deck level.

Figure 7: Indicative ventilation system



The exhaust system will also need to ensure that air quality is appropriate for station users at the platform level. Addressing this will require the capacity of the exhaust system to extract emissions at an appropriate rate.

The current early stage of design provides for a high degree of flexibility in station exhaust design and there can therefore be a high degree of confidence that air quality criteria within the precinct can be met, particularly if appropriate specialist air quality inputs are provided throughout subsequent design stages.

3.5 Guidance for future development stages

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2017) will provide the basis for the identification of project specific air quality criteria. This document is informed by the NEPM standards described in **Section 3.1** above and is updated periodically, so criteria may change slightly over time.

It is recommended that appropriate air quality modelling is undertaken during relevant design stages to ensure that project specific criteria can be met. This will include assessing existing receptors and potential future receptor locations associated with the CPRP. It is envisaged that an iterative process will be required where outlet points and exhaust system capacity may need to be altered depending on the outcomes of modelling. During concept design this process should be focused on identifying outlet locations where there is a certainty that air quality criteria can be met. In later detailed design more specific analysis is to be undertaken to optimise ventilation design to ensure that the air quality within and surrounding the precinct is as good as can be reasonably achieved.

4. Light pollution

A separate light pollution assessment has been prepared by Arup (Arup, 2022). The assessment is summarised in this chapter.

4.1 Policy framework

Australian Standards AS 4282:2019 Control of the obtrusive effects of outdoor lighting

Australian Standards AS 4282:2019 Control of the obtrusive effects of outdoor lighting provides the main technical guidance for the management of light pollution in Australia.

When designing outdoor lighting, AS 4282:2019 provides recommended maximum lighting values for four different lighting impacts:

- Light spill (a measurement of light in a vertical plane)
- Direct glare (luminous intensity emitted by each luminaire)
- Threshold increment (a measurement of disability glare for road users, including motorists, cyclists and pedestrians)
- Indirect light spill (upward light into the night sky).

City of Sydney Development Control Plan (2012)

The City of Sydney Development Control Plan makes reference to light pollution and obtrusive light in a number of locations. It also refers to AS 4282:2019, primarily in terms of clarifying definitions of key technical terms. The main areas of focus relate to the design of outdoor lighting on buildings, and to lighting associated with advertising.

4.2 Existing light pollution environment

The Light Pollution Assessment (Arup, 2022) established a lighting baseline for the perimeter of the precinct. Three broad categories of sensitive receptors have been identified:

- Mixed use (residential, commercial)
- Metropolitan centre (commercial)
- Public recreation (public open space areas).

The Light Pollution Assessment also identifies the specific night-time light environment at various locations. The main observations are as follows:

- There was an obtuse sense of human scale (in the extra tall walls, extra wideness of paths), that was also reinforced by the widths of the footpaths, and overwhelming use of the same materials and colours.
- Very long tall walls on both sides of the street, no transparency, gates etc.
- Ambient light/passive surveillance was not observed very much.
- There was very little lighting within a person's field of view anywhere.
- There were no focal points at eye height, such as architectural elements to guide a sense of going somewhere. No beacons of recognition in the sight line to encourage guidance.

- Unlike a lot of the CBD there are few canopies / awnings. At night these provide a sense of enclosure/safety and protection from the elements and sound. It doesn't match the character of the rest of Sydney.
- All light comes from overhead with very little at low-level.
- Varying colour temperatures occur from one area to the next, for example: old high-intensity discharge floodlights, overhead fluorescent lighting and cool white street lighting.

4.3 Aspirations

The CPRP will need to strike a balance between the provision of a safe and vibrant night-time environment for its residents and users, and excessive light spill into surrounding areas, as well as into residential properties (and other sensitive uses) within Central Precinct.

4.4 Assessment

No assessment of the light pollution impacts of the CPRP on surrounding receptors can be undertaken at this time, given the early stages of project design. However, it is anticipated that with the appropriate consideration of light pollution in all subsequent stages of project design, that light pollution can be largely avoided.

4.5 Guidance for future development stages

The Light Pollution Assessment (Arup, 2022) provides the following recommendations to ensure that light pollution is appropriately considered in the next design stages:

- Preparation of a Night-time Master Plan, which defines the aesthetic and functional criteria for the proposed lighting with the precinct, and assists in achieving a holistic, welcoming, safe and well-structured lit environment. This would have appropriate reference to AS 4282:2019. The night-time master plan should be prepared during concept design and updated as appropriate during subsequent design stages.
- Consideration of wildlife impacts in all stages of lighting design, particularly where there is adjacent wildlife habitat (such as tree canopies in Belmore Park).

5. Consultation

Consultation is a core requirement of the State Significant Precinct (SSP) study commissioned by the NSW Department of Planning and Environment (the Department). As part of the Pollution Assessment, consultation with relevant stakeholders is ongoing as outlined in the following sections. Stakeholder consultation records are provided as **Appendix B**.

5.1 Department of Planning and Environment

A meeting with the Department of Planning and Environment (the Department) occurred on 14 February 2022, which included consultation on the Pollution Assessment. The main item of concern raised by the Department was in relation to air quality impacts for users of the public domain within the precinct. The management of air quality is discussed in **Chapter 3** of this report.

5.2 City of Sydney

A meeting was held with the City of Sydney on 4 April 2022, which included consultation on the Pollution Assessment. The main area of discussion was in relation to air quality, particularly in terms of the management of locomotive diesel exhaust beneath the proposed deck. The management of air quality is discussed in **Chapter 3** of this report.

5.3 Environment Protection Authority

A meeting was held with the Environment Protection Authority (Strategic Planning Section) on 6 April 2022, which included consultation on the Pollution Assessment. The Environment Protection Authority indicated that as well as future activities that are likely to be subject to Environment Protection Licences, that the agency would also have an ongoing interest in the urban design of the precinct as it relates to human health. Guidance documents are listed in the relevant sections of this report, as are broad potential human health issues as they relate to the different pollution types.

6. Conclusions and recommendations

It is anticipated that the development of the Central Precinct Renewal Project (CPRP) would not create substantial water, air or light pollution impacts. In particular:

- The development of the CPRP presents a major opportunity to reduce pollutant loads entering the stormwater system when compared with the existing situation. The aspiration to be "significantly beyond best practice" for water quality is a realistic outcome with the appropriate design of water quality treatment infrastructure. This is primarily due to the ability to build effective water quality controls into the public domain on the deck, as well as in surrounding areas.
- It is unlikely that emissions from the CPRP would result in negative air quality impacts to receivers in surrounding areas given there are very limited potential sources of air pollution associated with the proposal. Emissions from diesel locomotive exhaust below deck level can be addressed through the proposed exhaust system provided appropriate air quality analysis is undertaken as this system is designed.
- Light spill impacts are expected to be effectively managed through appropriate lighting design.

The following recommendations are made:

- At the next stage of the Master Plan development, specific water quality management principles for each sub-precinct should be identified and preliminary evaluations undertaken of the likely water quality performance of any drainage solutions. The sub-precinct approach should be applied during concept design, increasing in granularity during subsequent design stages, with more detailed evaluations of performance occurring.
- Appropriate air quality modelling should be undertaken during relevant design stages to ensure that project specific criteria can be met. This will include assessing existing receptors and potential future receptor locations associated with the CPRP. It is envisaged that an iterative process will be required, where outlet points and exhaust system capacity, may need to be altered depending on the outcomes of modelling. During concept design this process should be focused on identifying outlet locations where there is a certainty that air quality criteria can be met. In later detailed design more specific analysis is to be undertaken to optimise ventilation design to ensure that the air quality within and surrounding the precinct is as good as can be reasonably achieved.
- A Night-time Master Plan should be prepared, which defines the aesthetic and functional criteria for the proposed lighting with the precinct, and assists in achieving a holistic, welcoming, safe and well-structured lit environment. This would have appropriate reference to AS 4282:2019. The night-time master plan should be prepared during concept design and updated as appropriate during subsequent design stages.
- Wildlife impacts should be considered in all stages of lighting design, particularly where there is adjacent wildlife habitat (such as tree canopies in Belmore Park).

To further support the preparation of the proposed planning framework a line of sight table has also been provided as **Appendix A** which outlines pollution issues, aspirations and solutions.

7. References

- Arup (2022) *Central Station State Significant Precinct – Lighting Pollution Assessment*
- Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000*) Australian and New Zealand Guidelines for Fresh and Marine Water Quality*
- City of Sydney Council (2012) *Sydney Development Control Plan*
- Department of Planning, Industry and Environment (DPIE) (2021) *New South Wales Annual Compliance Report 2020 - National Environment Protection (Ambient Air Quality) Measure*
- Local Land Services (2015) *Sydney Harbour Water Quality Improvement Plan*
- New South Wales Environment Protection Authority (2017) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
- Transport for New South Wales (2022) *Central Precinct Renewal Program – Environmental Sustainability, Climate Change and Waste Management Report*
- Transport for New South Wales (2022) *Central Precinct Renewal Program – Green Infrastructure Study*
- Transport for New South Wales (2022) *Central Precinct Renewal Program – Water Quality, Flooding and Stormwater Report*

Appendix A – Line of sight

Issue	Aspirations	Solutions
Not contributing adequately to NSW Government and City of Sydney Council strategic objectives of improving the water quality of Sydney Harbour	To reduce stormwater pollution flowing to Sydney Harbour significantly beyond best practice guidelines (as taken from the CPRP Environmental Sustainability, Climate Change and Waste Management Report)	Embedding water sensitive urban design principles into the next stage of master planning and ensuring that the water quality performance of the proposed approaches is evaluated at each design stage (and quantified where feasible)
Air quality impacts resulting from emissions of locomotive exhausts	That the CPRP does not contribute to any worsening of air quality either for the precinct itself or for the surrounding area	Ensuring that the master plan allows adequate space for locomotive emissions control and subsequent stages of design incorporate ventilation design that ensures air quality standards are met
The development of CPRP results in obtrusive light spill into surrounding areas	An appropriate balance is struck between the provision of a safe and vibrant night time environment for its residents and users, and excessive light spill into surrounding areas, as well as into residential properties (and other sensitive uses) within the precinct	The master plan and subsequent design stages appropriately consider light spill as well as the provision of appropriate outdoor lighting within the CPRP

Appendix B – Evidence of consultation

MINUTES

Issue date	Tuesday, 19 April 2022
Issue to	Attendees
Issued by	Melanie Gostelow
Subject	Central Precinct SSP – City of Sydney Consultation – Pollution, Noise & Vibration
Reference	CPRP-ADAP-CEN-CV-MIN-000008
Client	TfNSW
Meeting date	Monday, 4 April 2022
Time	01:00 PM
Location	Online
Present	James Dirickx-Jones (CoS), Paul Stokes (CoS), Andrew McMillan (CoS), Niamh Hynes (CoS), Hugh Thornton (TfNSW), Peter Rand (Arcadis) Melanie Gostelow (Arcadis), Ben Lawrence (RWDI), Matthew Di Maggio (Ethos Urban), Kimberly Bautista (Ethos Urban), Tim Carr (Arup), Rebecca Cadorin (Arup)
Copy to	Colin Sargent (TfNSW), John Merrick (Arcadis) + Attendees

ITEM	COMMENTS	ACTION
1	**Introductions** JD – James Dirickx-Jones, Strategic Planning and Urban Design Unit MG – Melanie Gostelow, Arcadis, managing the Arcadis disciplines working on the SSP, as well as leading Stormwater and Flooding. PR – Peter Rand, Arcadis, undertaking the Pollution Assessment covering air, light and water. TC – Tim Carr, Arup – specialist light study RC – Rebecca Cadorin – light study BL – Ben Lawrence, RWDI, Noise and Vibration Assessment MD – Matthew Di Maggio, Ethos Urban, planning team for the project KB – Kimberly Bautista, Ethos Urban, planning team for the project HT – Hugh Thornton, TfNSW	Note
2	**Central Precinct Overview** MG – Consultation aiming to keep Council updated on the Central Precinct status and the current focus of the SSP study, answer any questions and understand Council's aspirations and concerns regarding the project. Brief overview of the Central Precinct with masterplan images. Large extent from Goulburn to Cleveland Street surrounding Central station. Precinct also broken down into sub-precincts. Currently undertaking the State Significant Precinct study to support the design moving forward. Masterplan has been developed to illustrate what is possible to accompany the SSP studies. We are not currently seeking approval for the masterplan. Looking at over-station development with high rises above a portion of the rail corridor as well as parcels of land surrounding the rail corridor.	Note

ITEM	COMMENTS	ACTION
3	**Pollution – Water** PR – Pollution Assessment being prepared in response to the SSP study requirements. Key focus is light, air and water pollution. Assessing impacts and guiding future development standards. Other forms of pollution such as noise are covered in other SSP studies. Study requirements focus on impacts of the development on external receptors which the Pollution Assessment covers. The assessment does look at impacts which may occur within the development and future receptors. Currently at a high-level planning stage, assessment is high-level. Flagging issues and potential impacts which may need to be responded to in the design process. Water, aligns with the Central Precinct stormwater strategy. Assessment reframes and focuses on potential impacts and environment management. Policy framework considered including Council's DCP and State of Environment Report. Assessment doesn't go so far as to define water quality targets. Development will change the drainage environment presenting an opportunity to improve water quality discharging to receiving waters. Stormwater management is broad principles, no stormwater design at this stage which limits pollution assessment. Approach may vary across sub-precincts.	Note
4	**Pollution – Air** PR - Air, not expecting a residential area to generate a lot of air pollutants, the main being changes in traffic movements. This isn't expected to be the case for Central Precinct given the limited parking being provided. Traffic modelling is indicating a significant increase in traffic isn't expected, and the future electrification of vehicles is expected. Constructing a deck over the rail corridor may constrain exhaust from diesel locomotives, also expecting electrification over time. Disembarking location may change. Looking at how the building design can vent exhaust from diesel locomotives and delivery vehicles below the deck level. Building designers have conceptually developed a scheme where diesel is vented through the buildings which is also used to funnel smoke in a fire, dual purpose system. Understand what the air quality is of emissions relative to receptors within the precinct. JD – Plans for diesel locomotives timing. PR – Diesel locomotives to be catered for in the interim with air quality to be satisfactory below and above the deck. Requires sufficient capacity of the exhaust system as well as location of exhaust points above the deck. PS – Confirm if coal steam trains have been considered. PR – Has been discussed, likely that those trains would have to depart somewhere else. No firm plans currently made. HT – Approach isn't confirmed at this stage as we are currently looking at a planning instrument. AM – Air quality recording stations. Confirm where background data is being sourced from. Note Cross City Tunnel exhaust doesn't have any treatment. PR – Cook and Philip Park being the closest location. No qualitative modelling being undertaken at this point.	Note
5	**Pollution – Light** TC – Light study, large site to consider without a design to assess. Light study has created a current baseline looking at building lighting and wildlife lighting. Looked at the technical design parameters for light pollution and how these should be applied for the following stages.	Note

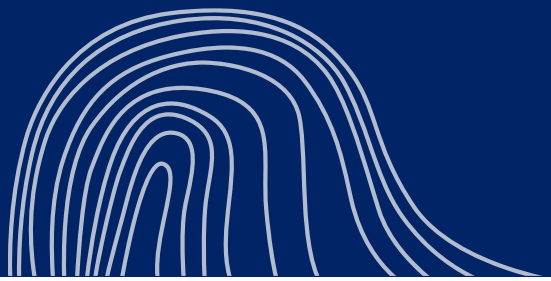
ITEM	COMMENTS	ACTION
	Baseline buildings, Australian Standards for light pollution. Impractically to model at this stage. Used HDR photography to quantify current brightness around the site which can be used as a 2020 baseline for future reference. Also looked at both parks and taken measurements as flora and fauna react differently. Identified sensitive receivers, and explained how Australian standards would be applied to each site moving forward. Provided recommendations including a night time masterplan for the site, to avoid changes in character. Specific recommendations provided about how existing conditions could be further analysed through a light vulnerability assessment considering CPTED. Simplistic but thorough approach for the large scale of the precinct. AM – Current lighting in the area appears to be over designed. How in-depth will the study be? Overarching guideline or specifics? TC – Not detailed at this stage. Next stages will look at more specific locations and how design standards are applied.	
6	**Noise & Vibration** BL – Assessment of noise emitted from the site on surrounding receivers, as well noise from the surrounding environment and how it effects development. SSP requirements include modelling and mapping. Typically, these noise assessments would happen at the end of the project when further design details are available. Core purpose is to identify key impacts early to ensure they are considered in the design process. More detailed studies to come as the design progresses. Noise assessment based on historical information, expansion plans for Sydney Yard and other transport nodes. Developed a noise model to predict noise exposure and impact on receivers. Stability of existing structures, likely the construction will have more of an influence than the proposed operational site. Rail noise, looks at the intercity lines, suburban lines and the light rail. Assessed existing and estimated future growth. Guidelines considered including City of Sydney DCP, AS2107, use to inform how noise levels are assessed and what criteria should be set. Road noise also a critical factor. Structure-borne noise impacts, vibration generated by trains and how it is transmitted and reradiated as noise. A detailed study of the track form has been undertaken, significant input into the design to ensure noise levels are within appropriate limits. External noise emissions, critical receivers mix of residential, commercial, industrial and outdoor recreation. Assessment conclusion, noise levels can be achieved using traditional building techniques. Structure-borne noise and vibration from Sydney Yard, internal noise criteria and human comfort vibration levels can be met. PS – Suggest meeting further down the line to discuss technical detail. Construction noise and vibration criteria not included in reporting. Heritage buildings vibration sensitive. Future entertainment noise. BL – Valid points which have been flagged. Current noise report is being updated to comment on construction noise at a high-level, given the early nature of the project and lack of design detail. Future stage of the project both points would be looked at in further detail.	Note

MINUTES

Issue date	Tuesday, 19 April 2022
Issue to	Attendees
Issued by	Melanie Gostelow
Subject	Central Precinct SSP - EPA Initial Consultation
Reference	CPRP-ADAP-CEN-CV-MIN-000010
Client	TfNSW
Meeting date	Wednesday, 6 April 2022
Time	11:30 AM
Location	Online
Present	Anthony Knox (NSW EPA), Lauren Musgrave (NSW EPA), Jacqueline Pulkkinen (NSW EPA), Hugh Thornton (TfNSW), Melanie Gostelow (Arcadis), Peter Rand (Arcadis), Rebecca Cadorin (Arup), Tim Carr (Arup), Paul Stoller (AtelierTen), Ben Lawrence (RWDI).
Copy to	Colin Sargent (TfNSW), John Merrick (Arcadis) + Attendees

ITEM	COMMENTS	ACTION
1	**Initial Comments** LM – Discussion in relation to the study requirements for the Central State Significant Precinct. Confirm seeking input from EPA on Pollution, Sustainability and Noise. PR – EPA can review and provide input on other items of interest. Aim of the consultation is to give EPA an understanding of the scope of the current studies. Key is that Central Precinct is still at a high-level masterplanning phase without a design to assess. Technically providing input to shape the next phases of the project, rather than doing more detailed technical assessments. BL – Similar for the noise assessment, this has been done as an overall assessment acknowledging the design will change as it is detailed. The current assessment is to be used as a guide prior to further development of the design and final assessment. TC – For the lighting report no modelling has been undertaken at this stage. It is a baseline looking at existing conditions only.	Note
2	**High Level Central Precinct Overview** MG – Brief overview of the Central Precinct with masterplan images. Large extent from Goulburn to Cleveland Street. Looking at over-station development with high rises above a portion of the rail corridor as well as parcels of land surrounding the rail corridor. Masterplan has been developed to illustrate what is possible to accompany the SSP studies. Precinct also broken down into sub-precincts. PS – Sustainability perspective, outlining big picture outcomes. Returning cleaner water to the harbour, net zero, commitment to increase habitat and biodiversity outcomes across the precinct. Healthy built environment. Climate risk and resilience. LM – Seeking confirmation of masterplan status.	Note

ITEM	COMMENTS	ACTION
	PS – Lodging a planning application which will respond to the SSP requirements. Current masterplan is evidence that the SSP requirements can be addressed, but the masterplan will be further developed before it is finalised.	
3	**Introductions** JP – Unit head of strategic planning unit for EPA working with Lauren and Anthony. MG – Melanie Gostelow leading the Arcadis disciplines (7) working on the SSP requirements. Also Stormwater and Flooding lead. PR – Peter Rand coordinating the Pollution Assessment looking at water, air and light. Other aspects of pollution such as noise have their own studies. TC – Tim Carr and Rebecca Cadorin from Arup working on the light study for the pollution assessment. BL – Ben Lawrence for the Noise Assessment	Note
4	**EPA Involvement** MG – Confirmation that studies are being developed for the whole of precinct. The planning framework is being developed to allow for a varied approach for different sub-precinct given the varying nature of the land uses. Noting the Western Gateway development are further along in the planning process. Currently seeking feedback from EPA at the precinct level. JP – Study requirements have been reviewed by EPA. Key issues for EPA in the regulatory space are air, noise, odour, waste, contamination and water quality. Previously EPA has given comments on the Central Precinct, not all appear to have been captured. Key issues at the early stage, seeking ongoing consultation and key EPA guidance documents being reflected. Apparent gaps in the SSP requirements. Suggest follow-up conversations at a more detailed level to discuss specific issues further. JP – EPA also has a role for precinct level planning around broader environment and human health outcomes such as avoiding conflicts in land use, best practice outcomes for precinct. Interested in involvement in the masterplanning. AK – Note licenced activities in the area (EPLs), mindful of the Sydney Metro works EPL. Apartments on Chalmers Street also had some interested community members. Keeping community informed. LM – Potentially more residential sensitive receivers. PR – Study requirements focus on external receivers. We will be creating receivers.	Note
5	**Next Steps** JP – Suggest further information is provided so EPA can better understand the intention of the site. EPA involvement may be more regulator or advocacy. EPA can then identify key issues and where they can value add. Want to avoid having broad conversations which may not be relevant. MG – Will take the feedback back to TfNSW to discuss how further information can be provided. AK – Confirm the aim is land use changes with design objectives and performance standards. HT – Making an application to change the planning instrument. A new state significant precinct planning law as well as a design guide.	ACTION



NSW GOVERNMENT

Central Precinct Renewal Program

Lighting Pollution Assessment

LP RPT 001

Central, Sydney 2000

Final | April 2022

ARUP

Document Verification

Central Station State Significant Precinct			286289 00		
Pollution Assessment					
Central Station, Sydney, 2000					
Revision	Date				
Draft for comment	18 February 2022	Description	Initial report for comment		
			Prepared by	Checked by	Approved by
		Name	Rhiannon West	Rebecca Cadorin	Tim Carr
Revised draft for comment	25 February 2022	Description	Updated report for comment		
			Prepared by	Checked by	Approved by
		Name	Rhiannon West	Rebecca Cadorin	Tim Carr
Final	07 March 2022	Description	Final report		
			Prepared by	Checked by	Approved by
		Name	Rhiannon West	Rebecca Cadorin	Tim Carr
Final Revised	04 April 2022	Description	Final report revised with comments		
			Prepared by	Checked by	Approved by
		Name	Rhiannon West	Rebecca Cadorin	Tim Carr
		Description			
			Prepared by	Checked by	Approved by
		Name			

Contents Page

Image: City of Sydney Planning Map

Building Contributions

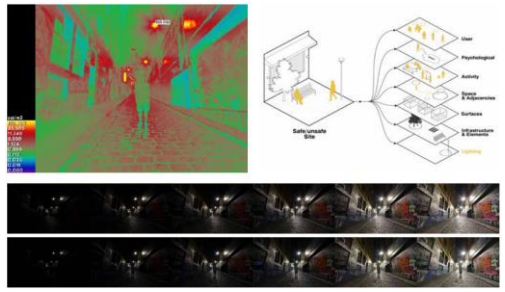


Image: Nighttime Vulnerability Assessment (NVA)

Multiple Cities, Australia

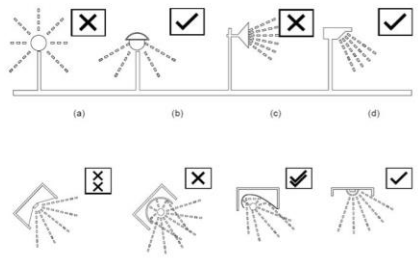


Image: Obtrusive Light Types

AS/NZS 4282:2019

Part 1

Context and Introduction

- Acknowledgment to Country
- Study Requirements
- Executive Summary
- Land use and existing contributions
- Lighting Standards & Requirements

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We respectfully acknowledge the Traditional Custodians of the Central Precinct, the Gadigal and recognise the importance of this place to Aboriginal people and their continuing connection to Country and culture.

We pay our respect to Elders past, present and emerging.

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Central Precinct Renewal

Study Requirement

Prepare a pollution assessment for the proposal that identifies and assesses any potential pollution impacts resulting from the proposal including but not limited to water, air and light pollution and which includes an analysis of the potential impact on adjoining uses and recommends development standards to be applied to subsequent development stages.

Study Requirement Checklist

Ref	Requirement or consideration	Summary response	Where addressed
3.4	Prepare a pollution assessment for the proposal that identifies light pollution and which includes an analysis of the potential impact on adjoining uses and recommends development standards to be applied to subsequent development stages.	As part of the public domain strategy (PDS) the future detailed design of development within the precinct must be in accordance with, Obtrusive lighting AS/NZS 4282:2019 Australian/New Zealand Standard and the CoS DCP should be integrated into the design guide as part of the planning framework. In additional to the base line standards Arup recommends that a night time masterplan is developed that addresses safety and accessibility at night-time aligned with CPTED principles and improved conditions for nocturnal wildlife.	Identify existing + Potential future Impacts - Part 2 Site Specific Requirements + Recommendations - Part 3

Glossary

Key Lighting Terms Used

The terminology listed below is taken from Australian Standards: AS 4282-2019: Control of the obtrusive effects of outdoor lighting 1.4 Definitions:

Terminology	Definition
Control Direction	The direction that lies in the vertical plane and contains the luminaire's maximum intensity, and its declination is at a given vertical angle below the horizon
Dwelling	A building in which people normally reside, especially during the hours of darkness, e.g. house, hotel, motel, hospital.
Glare	Condition of vision in which there is a discomfort or a reduction in the ability to see, or both, caused by an unsuitable distribution or range of luminance, or to extreme contrast in the field of vision (a) Disability Glare – Glare that impairs the visibility of objects without necessarily causing discomfort. (b) Discomfort Glare – Glare that causes discomfort without necessarily impairing the visibility of objects.
Luminaire	Apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except for the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary circuit auxiliaries together with the means for connecting them to the electrical supply.
Obtrusive light	Spill light which, because of quantitative, directional or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction or a reduction in the ability to see essential information, eg traffic lights.

Terminology	Definition
Sky Glow	The brightening of the night sky as the result of excessive radiation both (Direct/Indirect) & (Artificial/Natural)
Spill Light	Light emitted by a lighting installation which falls outside the boundaries of the property on which the installation is sited
Threshold Increment	The measure of disability glare expressed as the percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present. Note: Higher values of TI correspond to greater disability glare.
Upward Light Ratio	The ratio between the luminuous flux emitted above the horizontal plane to the total flux emitted by a light source. The ULR is used as a measure to limit direct spill light to the sky
Luminance	The physical quantity corresponding to the brightness of a surface (e.g. a lamp, luminaire or reflecting material such as the road surface) when viewed from a specified direction. SI Unit: candela per square metre (cd/m2).
Luminous Intensity	The luminous intensity (in candelas or cd) is a measure of how bright the beam in a particular direction is.

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Executive Summary

Overview

Arup has prepared this Lighting Pollution Assessment on behalf of Ethos Urban, in support of a masterplan for the Central Precinct Renewal Program by Transport for NSW (TfNSW).

This lighting pollution report assess:

- Assessment of the existing pollution impacts to surrounding areas and recommendations to inform the planning framework.
- Light advisory and Site Specific Recommendations for the Central Precinct Renewal Program (SSP).

This report provides a number of recommendations to ensure any potential light pollution created during the development of the precinct is minimised.

The following recommendations are proposed for the planning framework.

During design development stages, lighting modelling is recommended to simulate proposed precinct lighting in compliance with minimum requirements:

- AS/NZS 4282:2019 Australian/New Zealand Standard, Control of the obtrusive effects of outdoor lighting
- Sydney Development Control Plan 2012
- CoS Public Domain Design Codes – Sydney Lights

In additional to the base line standards we recommend developing a night time masterplan that address CPTED principles, safety and accessibility during night-time and improved conditions for nocturnal wildlife.

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Existing Baseline Assessment

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Central Precinct Renewal

Relevant boundaries and zone types

Based on the City of Sydney Planning information available, the site area consists of 3 categories (identified in the table below).

In accordance with *AS/NZS 4282:2019 Australian/New Zealand Standard Control of the obtrusive effects of outdoor lighting*, requirements are provided for vertical illuminance during curfew hours apply in the plane of the windows of habitable rooms or dwellings on nearby residential properties. Category B4 'Mixed Use' offer a variety of purposes, including commercial, residential, retail and office and therefore will need to comply with these requirements.

Furthermore, it is recommended that considerations for Safety, Ecology and Dark Skies should be assessed to allow for a more holistic overall design approach.

'Sensitive Receptors'

'Sensitive receptor is any living organism that has increased sensitivity or exposure to environmental contaminants that may have adverse effects.'
National Light Pollution Guidelines for Wildlife V1 January 2020

	Category	Requirements	Recommendations
	B4 – Mixed Use (residential, commercial)	AS/NZS 4282:2019 Sydney Development Control Plan 2012	Improve Safety
	B8 – Metropolitan Centre (commercial)	Sydney Development Control Plan 2012	Improve Safety
	RE1 – Public Recreation (public open space areas)	Sydney Development Control Plan 2012	Improve Safety Ecology Dark Skies

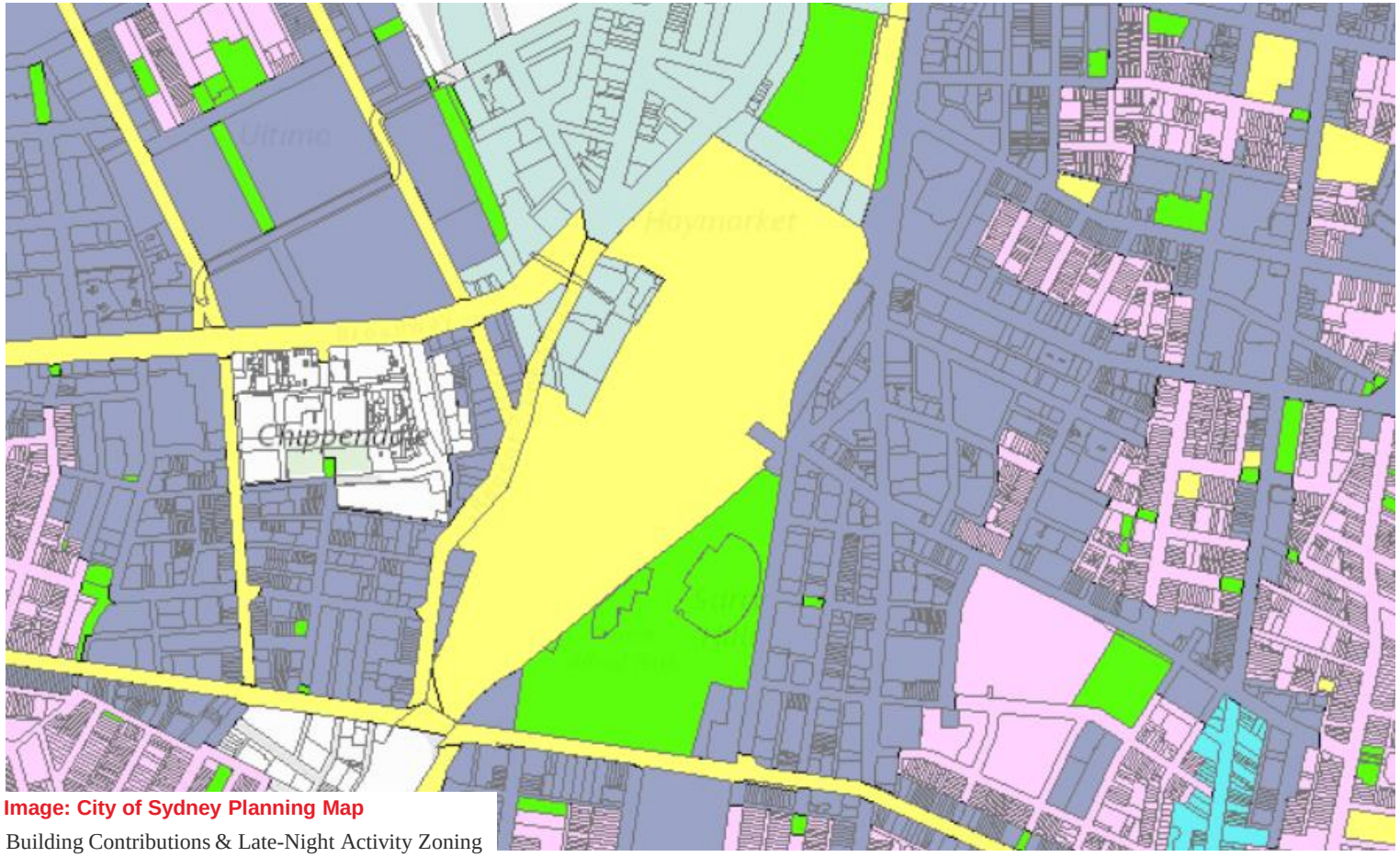

Image: City of Sydney Planning Map

Building Contributions & Late-Night Activity Zoning

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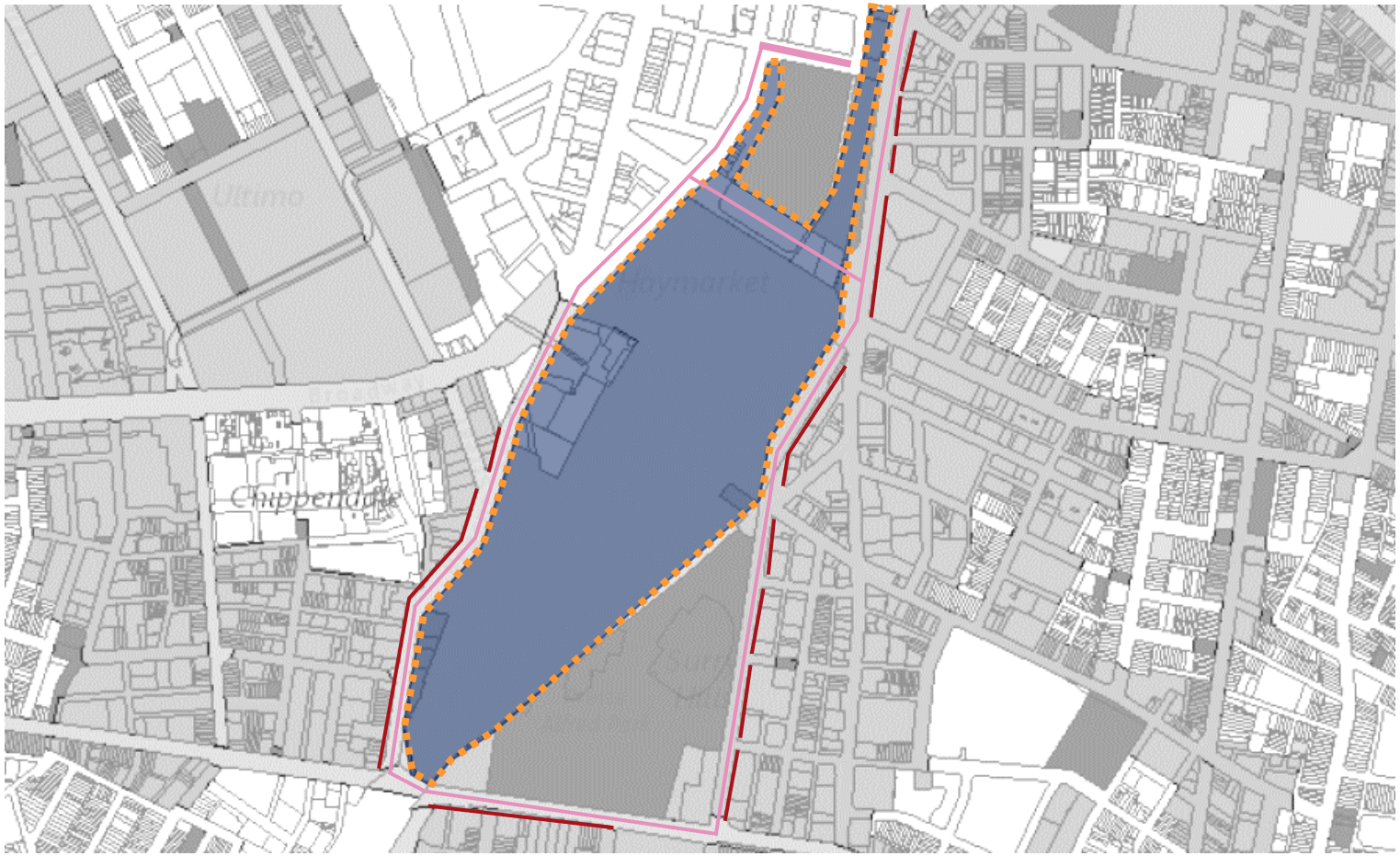
Light Technical Parameters

When designing outdoor lighting, the effects of four potential impacts are set out in AS/NZS 4282-2019 should be taken into account:

	Light Technical Parameter	Time	Recommended Maximum Value	Reference
Light Spill; A measurement of light in a vertical plane only required for Residential Buildings (Zones B4) around the site boundary				
	Illuminance in vertical plane (Ev)	Pre-Curfew (6am – 11pm)	25lx	AS/NZS 4282-2019, Table 3.2
		Curfew (11pm – 6am)	5lx	AS/NZS 4282-2019, Table 3.2
Direct glare; Maximum Luminous Intensity emitted by each luminaire located within the site boundary				
	Luminous Intensity emitted by luminaires (I)	Pre-Curfew (6am – 11pm)	25,000cd	AS/NZS 4282-2019, Table 3.3
		Curfew (11pm – 6am)	2,500 cd	
Threshold Increment (TI); A measurement of disability glare for road users e.g. motorists, cyclists, pedestrians around the site boundary				
	Threshold Increment (TI)	20% (adaption level 5 cd)		AS/NZS 4282-2019, Table 3.2
Indirect Light Spill; Upward Light ratio in to the night sky from the site				
	Upward Light Ratio (ULR)	50%		AS/NZS 4282-2019 Clause 3.3.5.7 (c)



Part 2

Lighting Assessment

- Recommendations for precinct development
- Control of the obtrusive effects of outdoor lighting
- Site Specific Recommendations
- Nighttime Vulnerability Assessment (NVA)
- Lighting for Australian Wildlife

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Lighting Pollution: Baseline Site Condition Overview

Around the precinct

A night-time assessment of the existing lighting conditions was undertaken across several nights (from 9 – 16 February 2022). This assessment identifies and assesses any potential pollution impacts currently around the site and creates a baseline survey of the site boundary.

This study included a series of luminance imagery taken along a 'pollution assessment path' which in turn creates a visual nighttime report observing more subjective lighting conditions such as;

- over lit areas,
- glare from light sources,
- glare to road users,
- places feeling unsafe, and,
- adverse effects on local wildlife

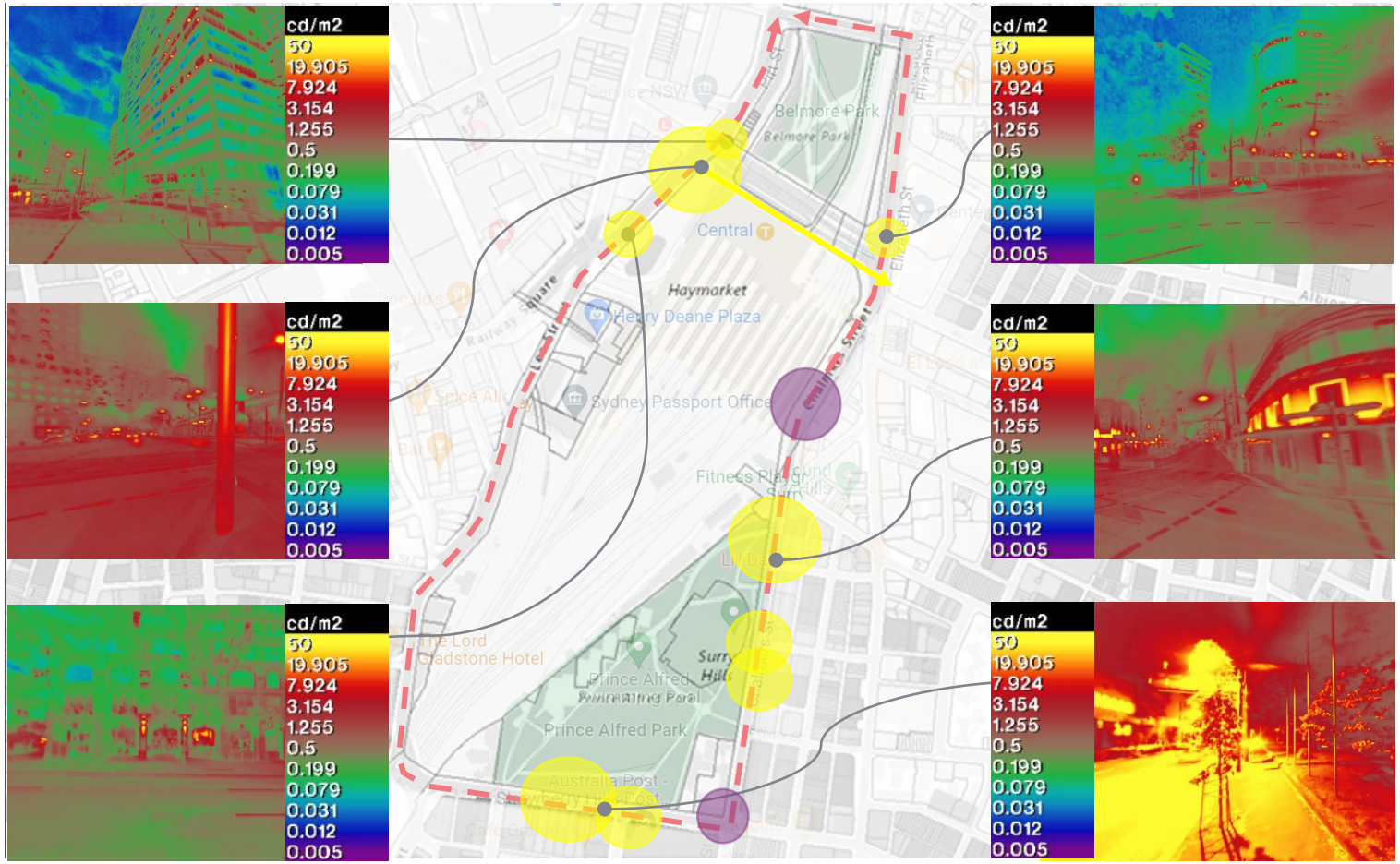
The information provided within this section is intended to act as a baseline of the luminance (brightness) of potential sensitive receptors us the SI unit of cdm2. While the Australian standard does not provide limits to luminance using this method, the imagery and measurements provided are a baseline to compare against future development, i.e. to maintain the baseline and not increase light pollution, it is recommended that the luminance readings taken here should not increase significantly.

This should be confirmed during future design work of the precinct.

Light pollution assessment path

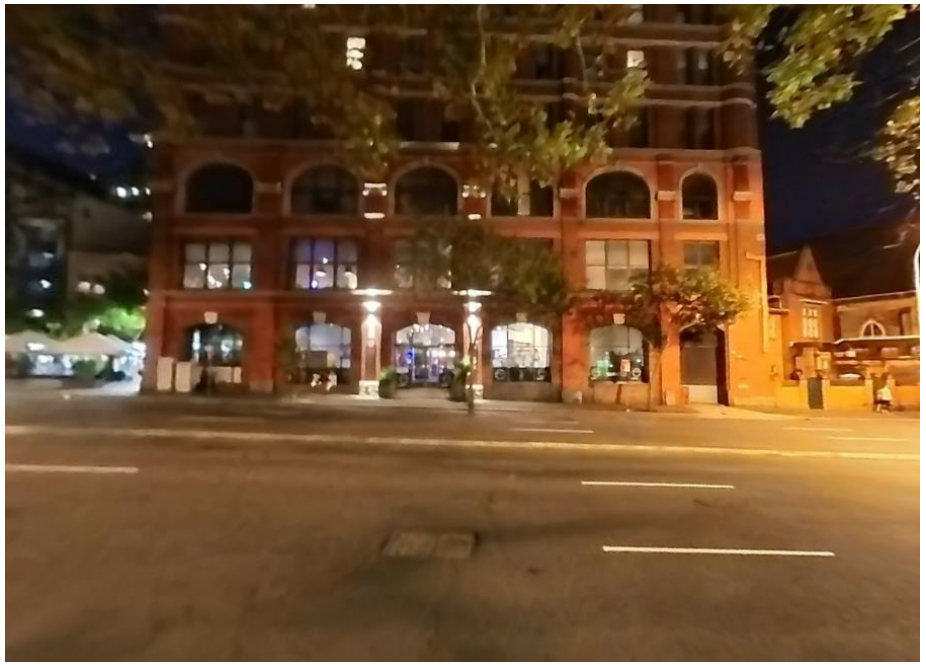
Areas demonstrate very high illuminance levels

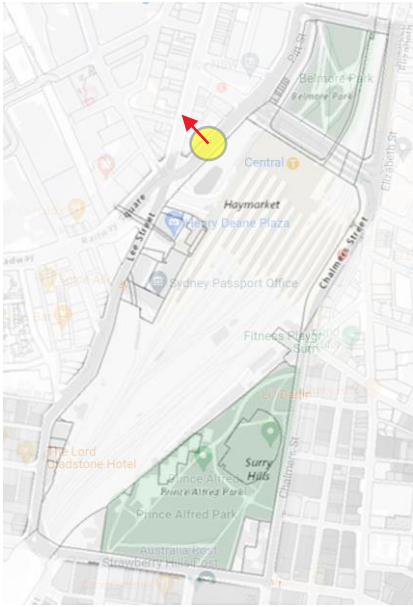
High levels of light pollutions



Lighting Pollution: HDR Imagery

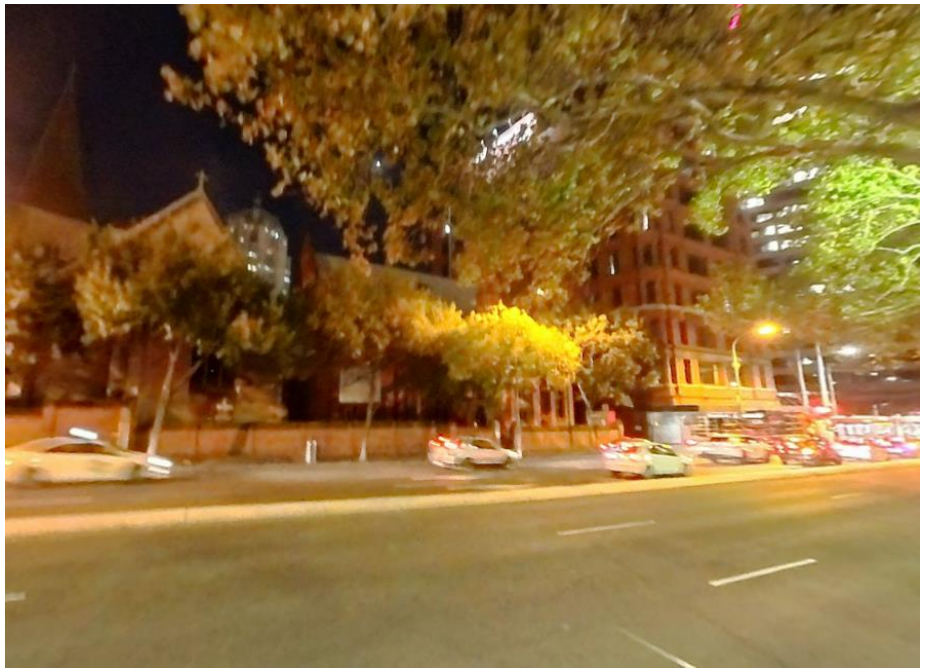
Location: Pitt Street

Site Photograph	Luminance Imagery
	



Lighting Pollution: HDR Imagery

Location: Pitt Street

Site Photograph	Luminance Imagery
	

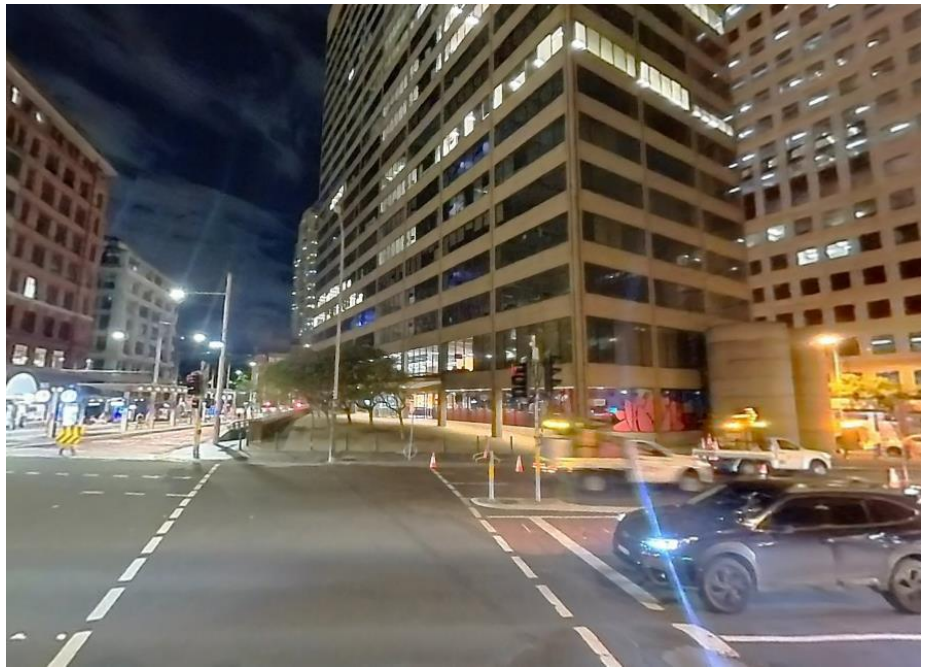
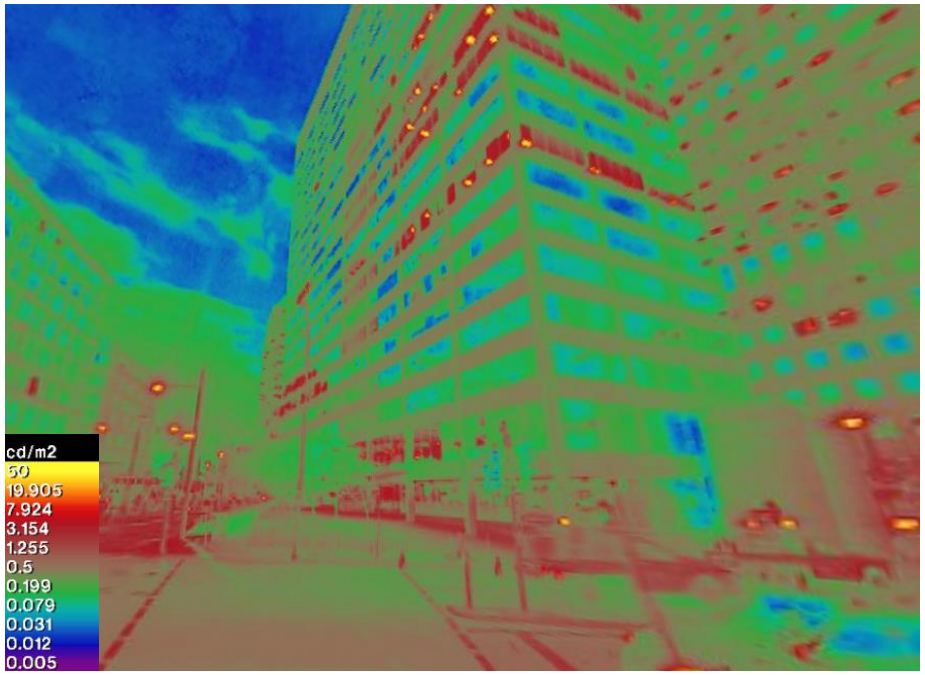
Lighting Pollution: HDR Imagery

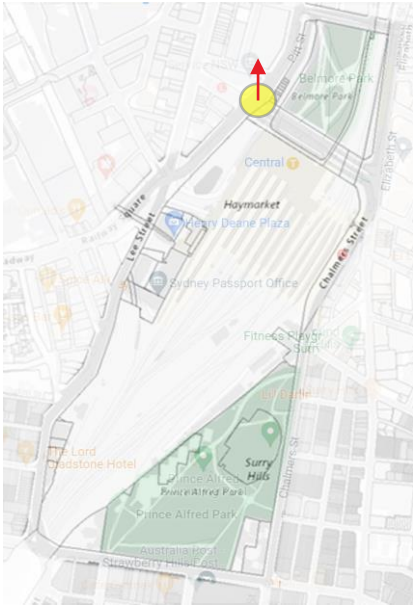
Location: Pitt Street

Site Photograph	Luminance Imagery
	

Lighting Pollution: HDR Imagery

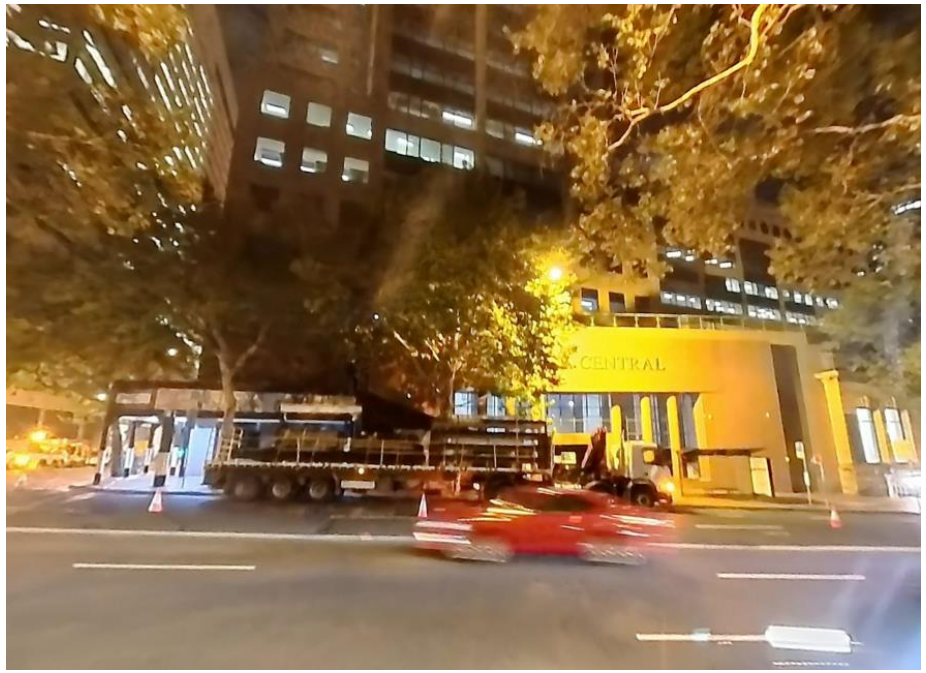
Location: Pitt Street

Site Photograph	Luminance Imagery
	



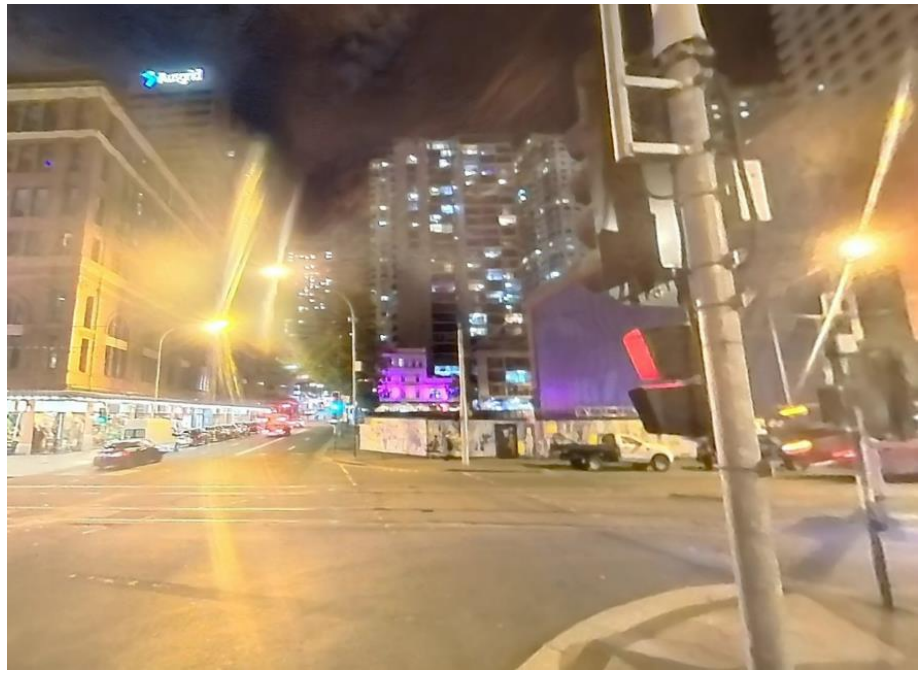
Lighting Pollution: HDR Imagery

Location: Pitt Street

Site Photograph	Luminance Imagery
	

Lighting Pollution: HDR Imagery

Location: Pitt Street, corner of Hay Street

Site Photograph	Luminance Imagery
	

Lighting Pollution: HDR Imagery

Location: Elizabeth Street

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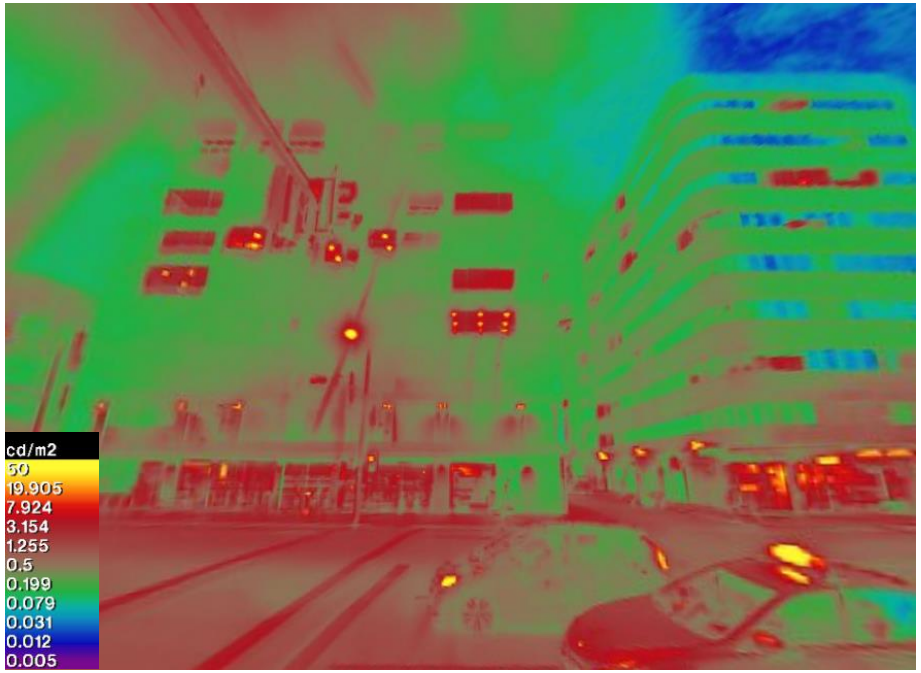
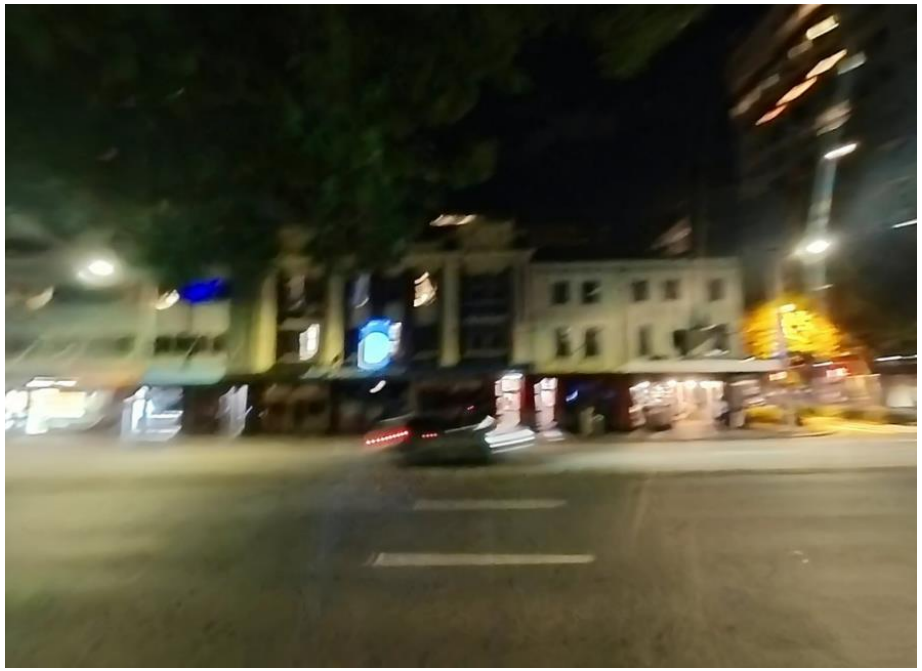
	

Lighting Pollution: HDR Imagery

Location: Elizabeth Street

Site Photograph	Luminance Imagery
	

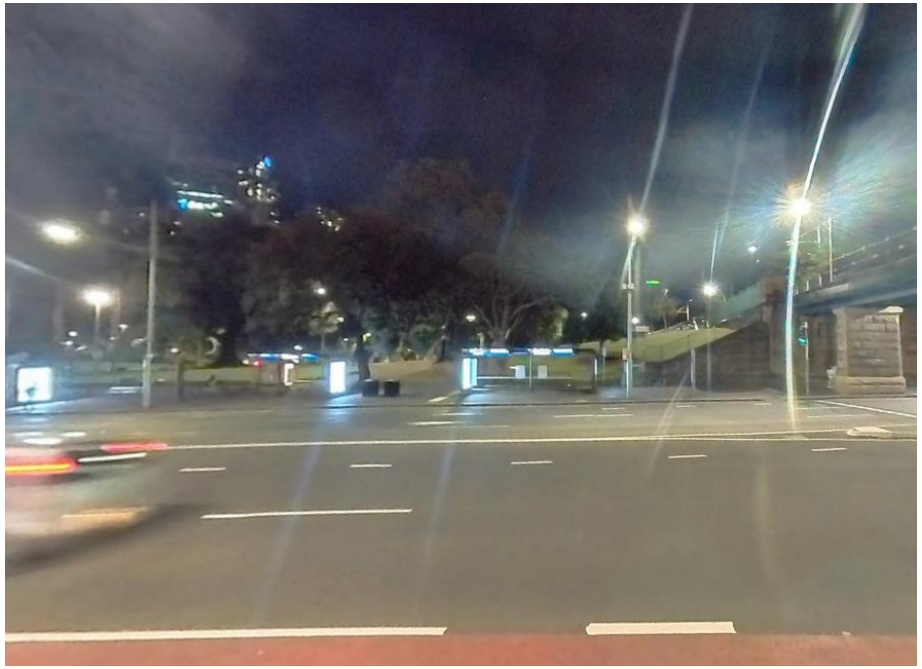
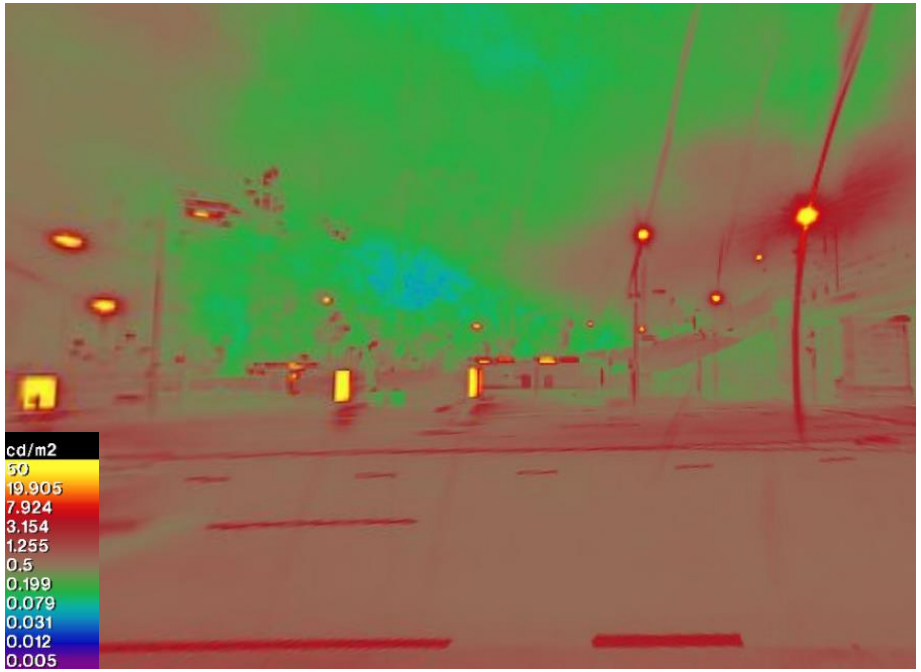
Lighting Pollution: HDR Imagery

Location: Elizabeth Street

Site Photograph	Luminance Imagery
	

Lighting Pollution: HDR Imagery

Location: Eddy Avenue

Site Photograph	Luminance Imagery
	

Lighting Pollution: HDR Imagery

Location: Elizabeth Street

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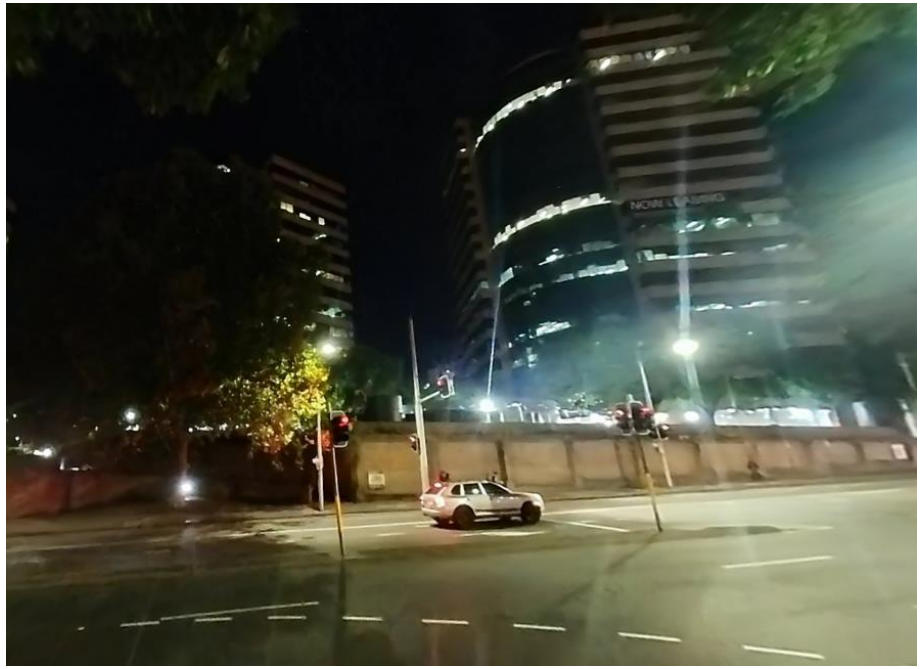	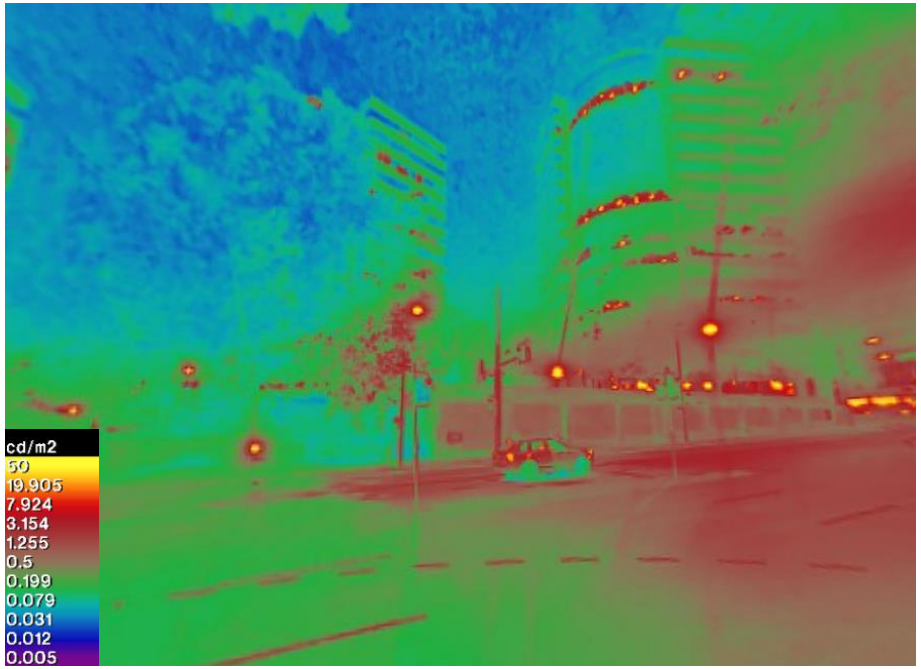

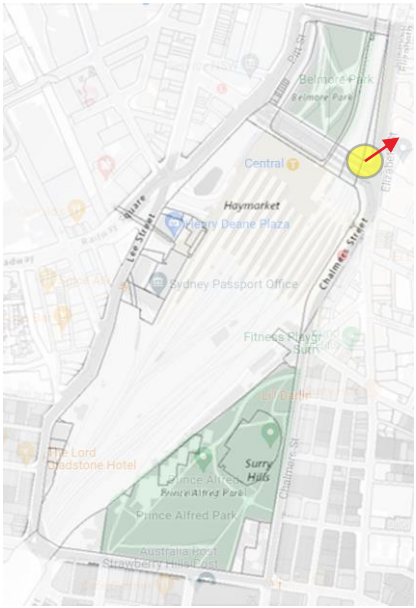

Lighting Pollution: HDR Imagery

Location: Chalmers Street

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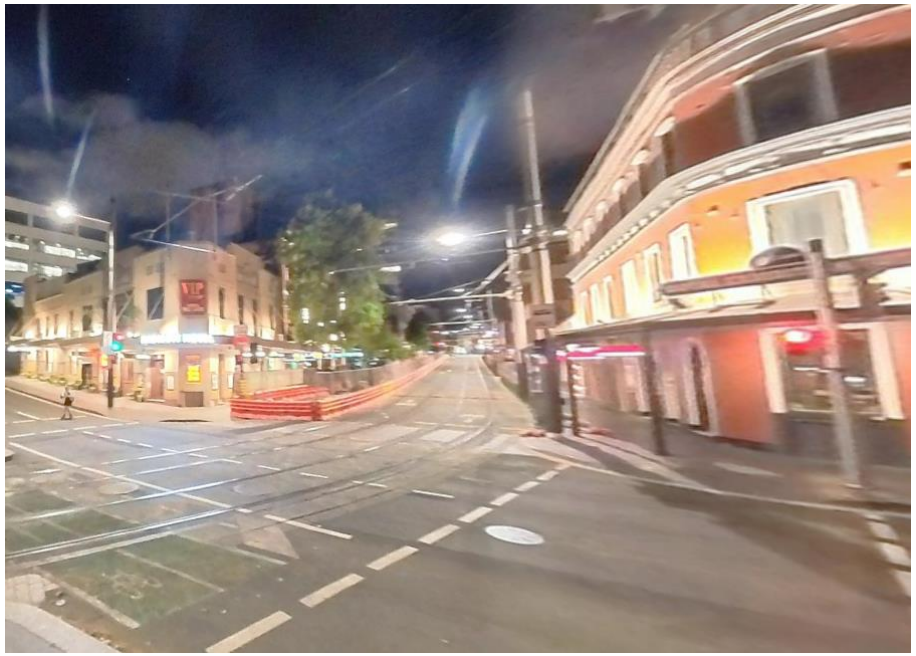	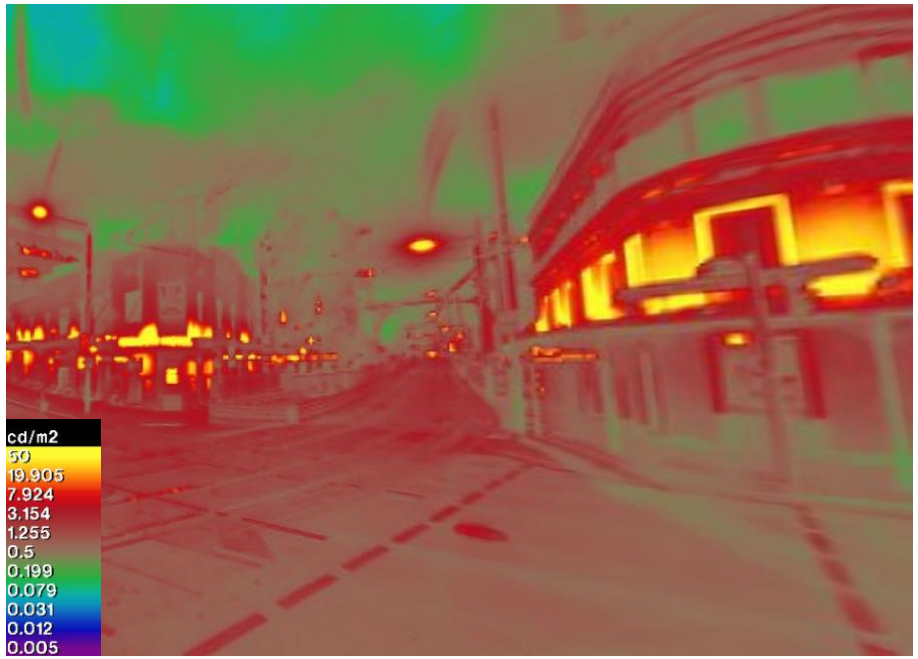

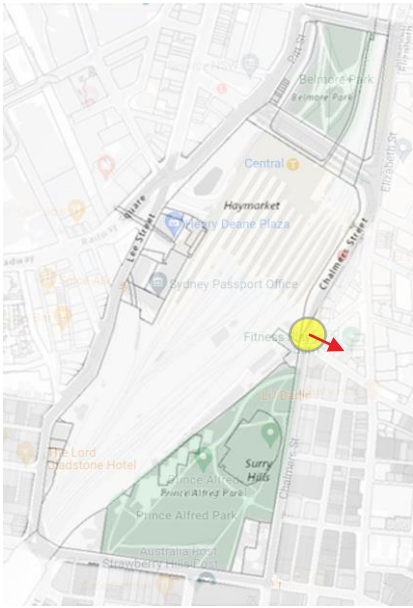

Lighting Pollution: HDR Imagery

Location: Chalmers Street

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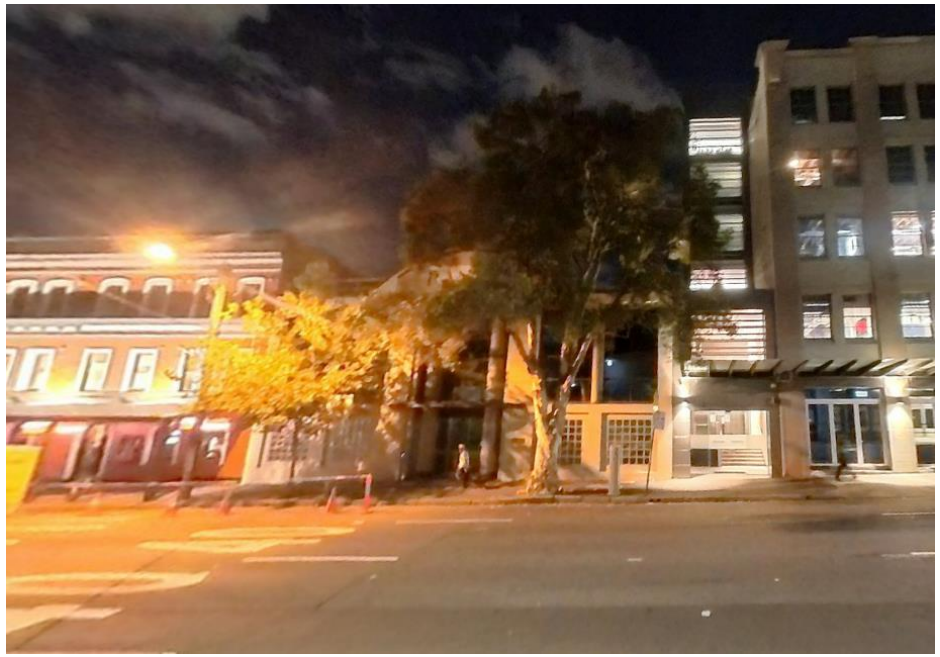	

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Location: Chalmers Street

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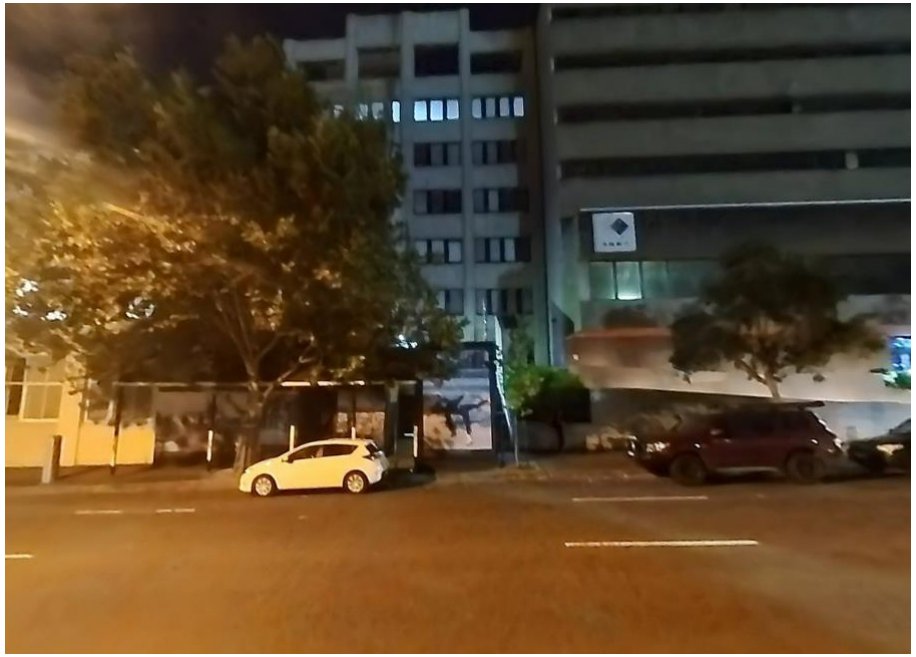	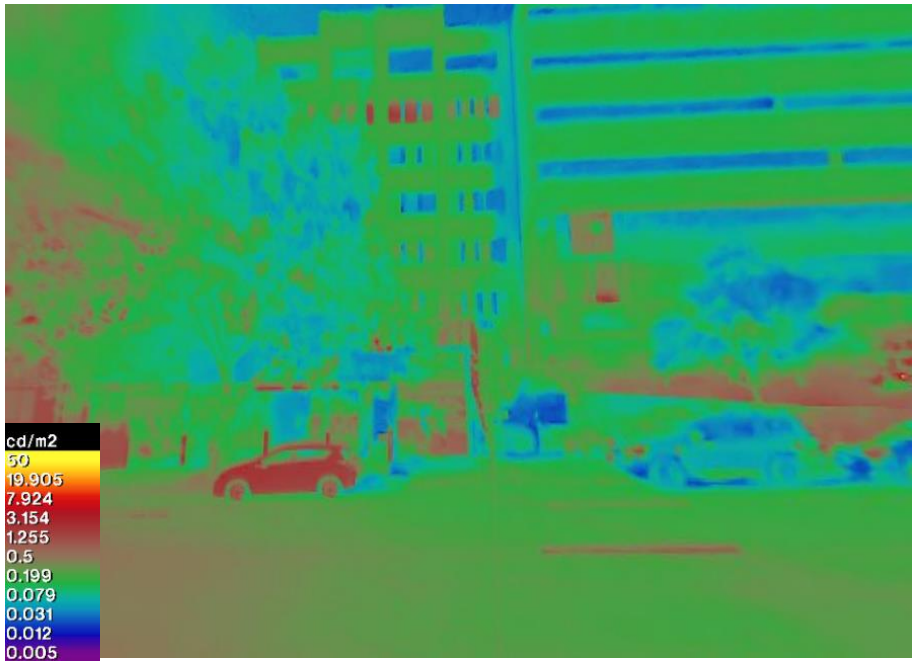

Lighting Pollution: HDR Imagery

Location: Chalmers Street

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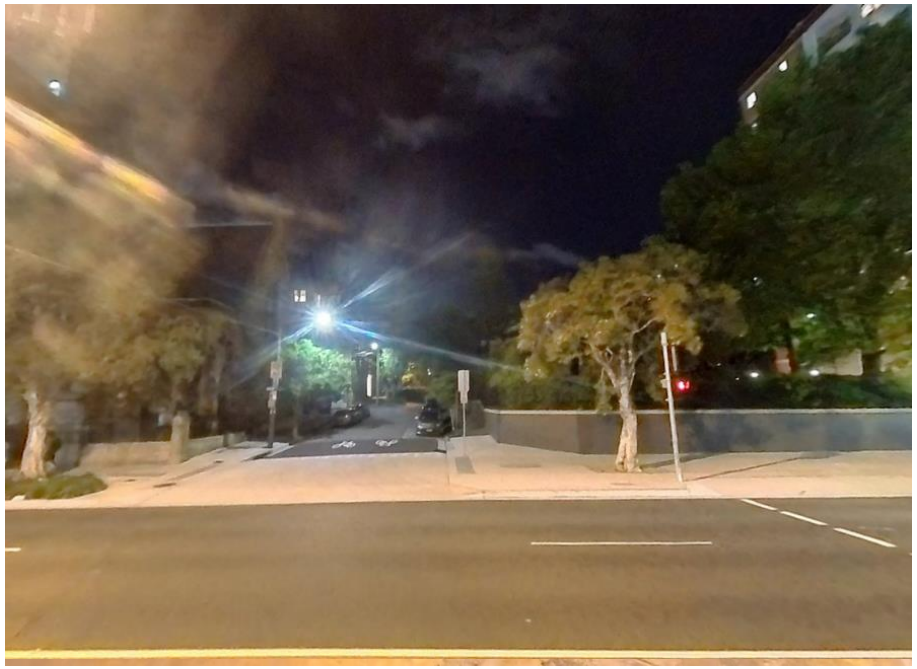	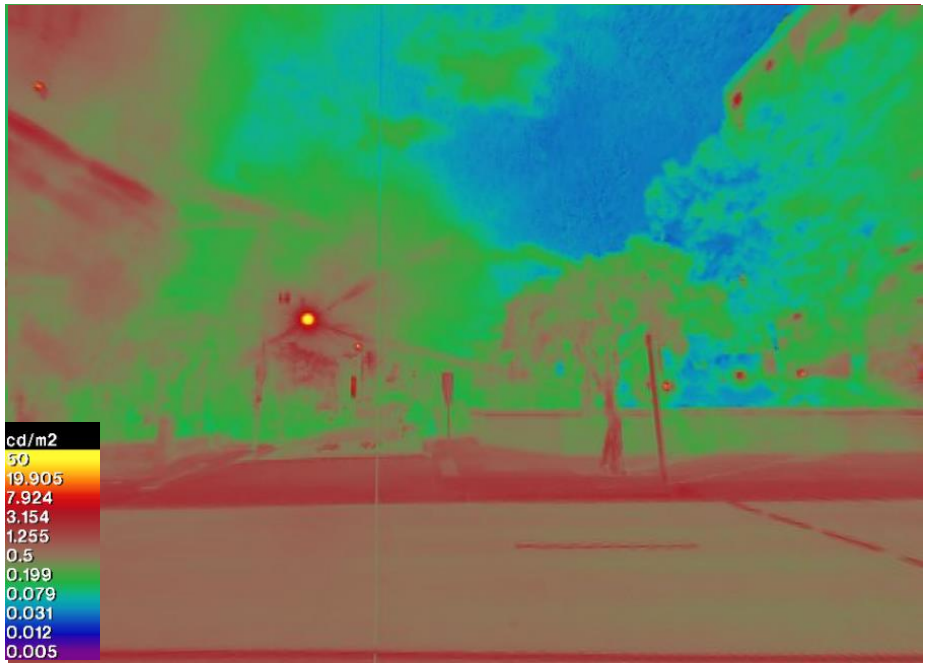

Lighting Pollution: HDR Imagery

Location: Chalmers Street

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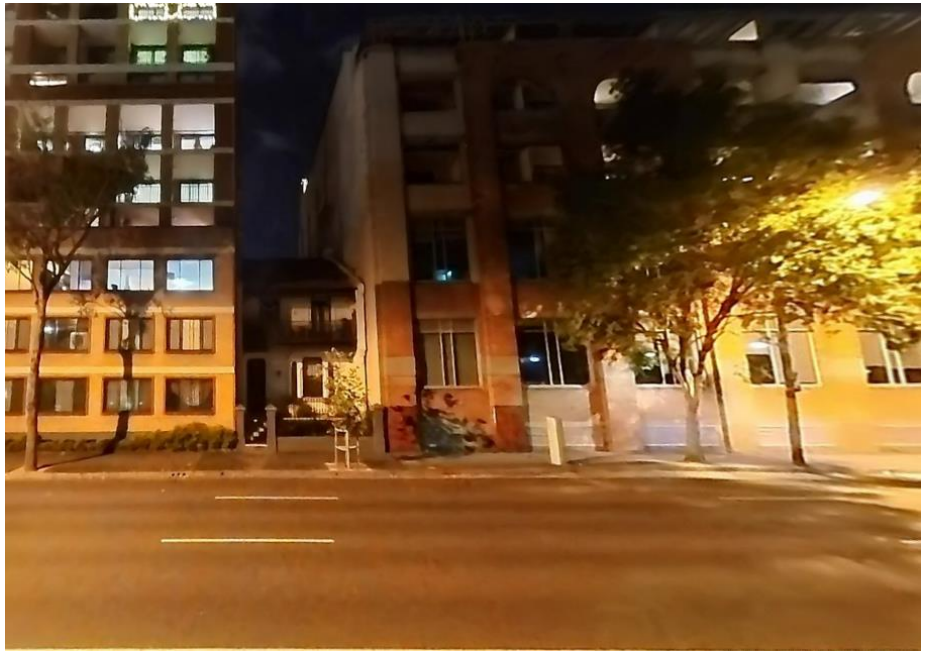
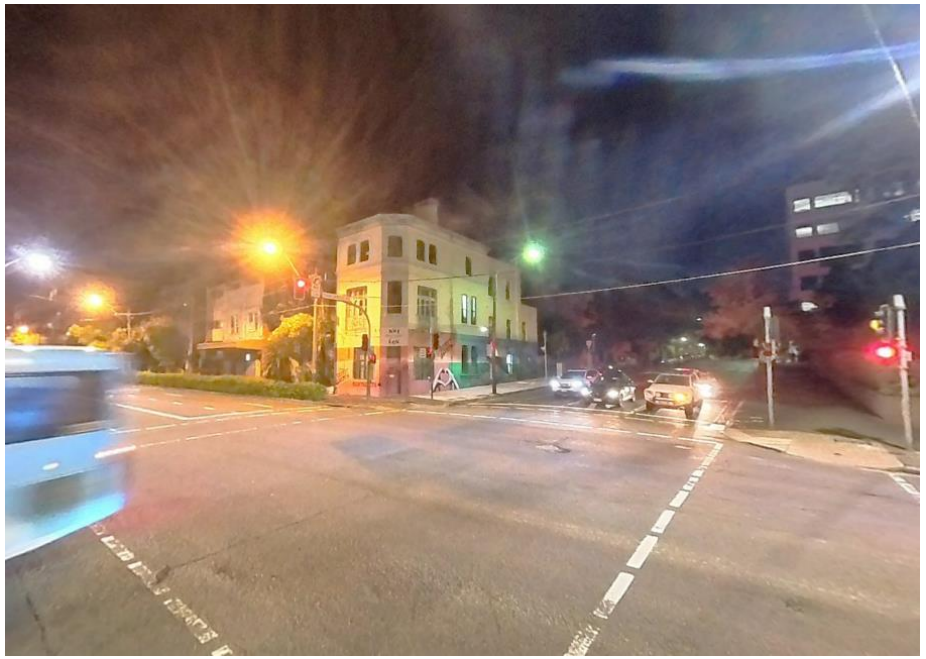
	

Lighting Pollution: HDR Imagery

Location: Chalmers Street, corner of Cleveland Street

Site Photograph	Luminance Imagery
	

Lighting Pollution: HDR Imagery

Location: Cleveland Street

Site Photograph	Luminance Imagery
	

Visual Appraisal of Light Pollution from the Precinct

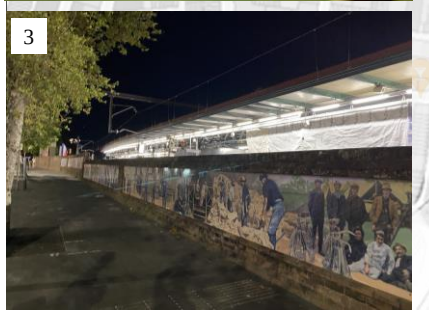
Baseline Studies

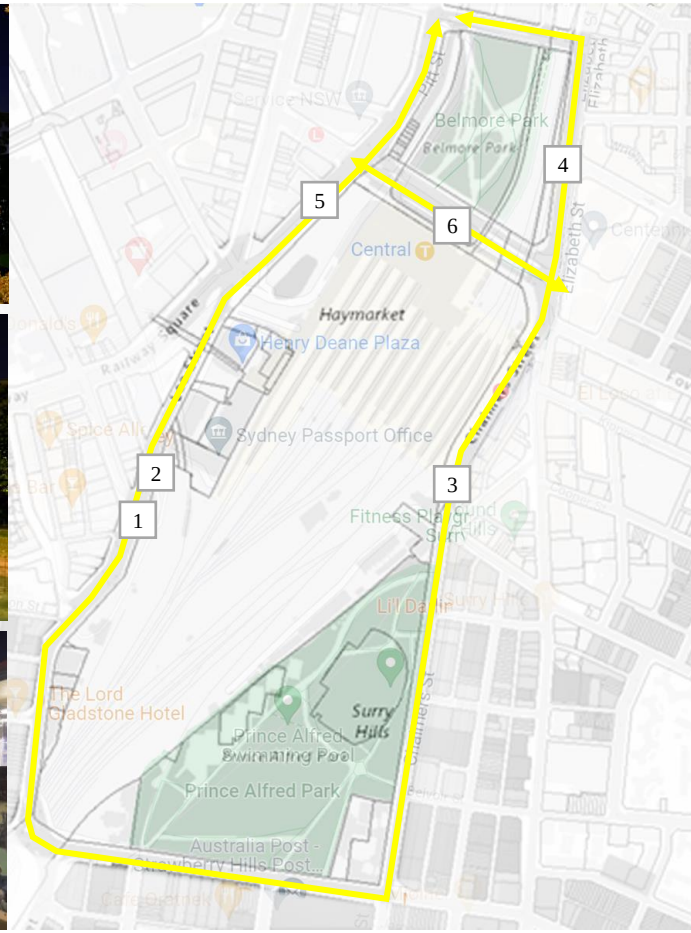
There is currently significant low levels of pedestrian activity and high levels of vehicle activity around the precinct during evening hours.

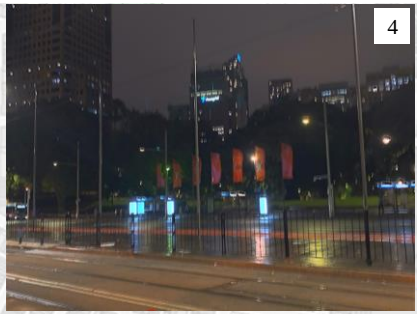
The surrounding areas are well-developed with light sources consisting of street lights, floodlights and spill light from commercial shops and passing vehicles.

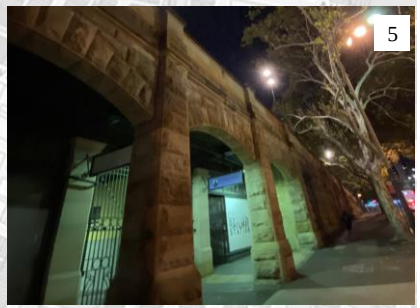
Primarily, it was observed that:

- High and low lighting levels, such as Light Rail areas, provide high spill light.
- All lighting is coming from above, with no ambient light or passive surveillance.
- The majority of light sources have no glare control and provide spill light upward in to the night sky.
- Further recommendation to mitigate lighting pollution for future development can be found in in Part 3.









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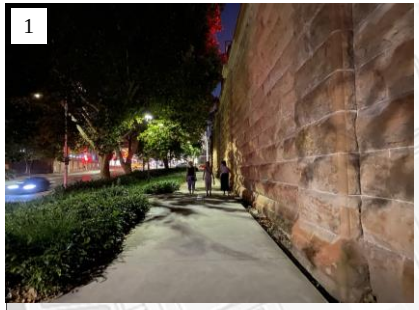
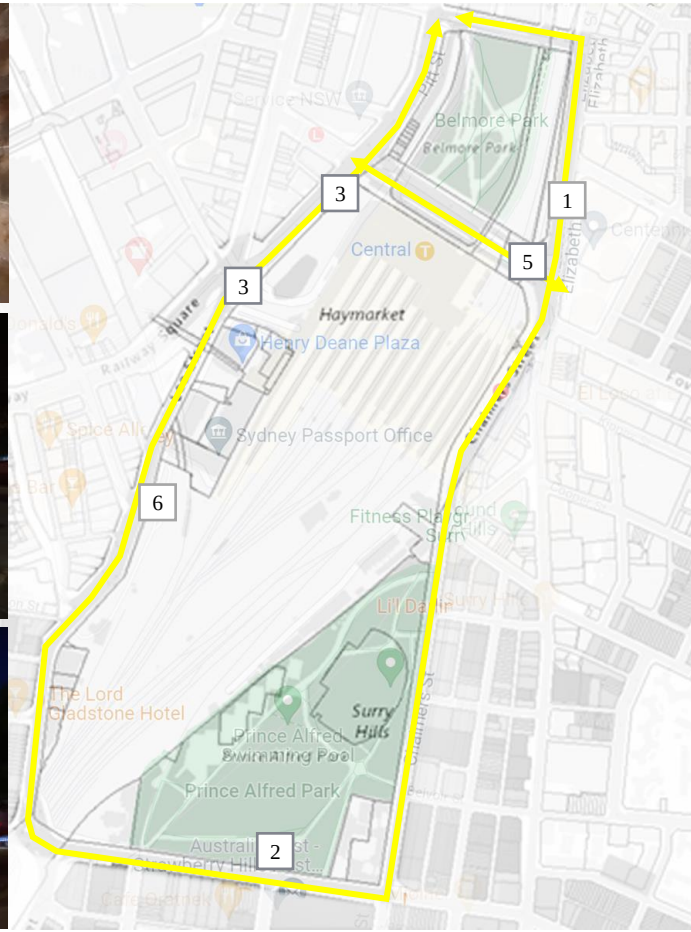
Visual Appraisal of Existing Lighting Conditions

Baseline Studies

In addition to the pollution appraisal, an assessment of the atmospheric lighting conditions was undertaken:

- There was an obtuse sense of human scale (in the extra tall walls, extra wideness of paths), that was also reinforced by widths of the footpaths, and overwhelming use of the same materials and colours.
- Very long tall walls on both sides of the street, no transparency, gates etc.
- Ambient light/passive surveillance was not observed very much.
- Very little lighting within a person's field of view anywhere.
- No focal points at eye height, such as architectural elements to guide a sense of going somewhere. No beacons of recognition in sight line to encourage guidance.
- Unlike a lot of the CBD the there are few canopy's / awnings. At night these provide a sense of enclosure/safety and protection from the elements and sound. It doesn't match the character of the rest of Sydney.
- All lights comes from overhead with very little at low-level.
- Varying colour temperatures from one area to the next, for example; old High-intensity discharge floodlights, overhead fluorescent lighting and cool white street lighting.
- Further recommendations in Part 3.





Visual appraisal of Existing Public Recreation Areas

Baseline Studies

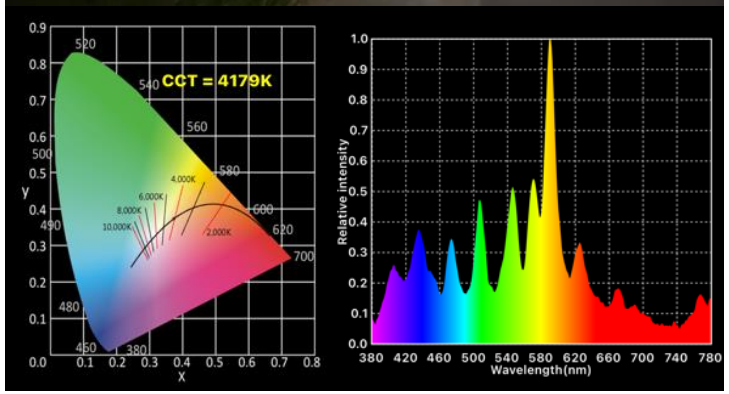
An assessment of Belmore Park and Alfred Park was undertaken to understand the current atmospheric and lighting conditions at nighttime. Some key observations are:

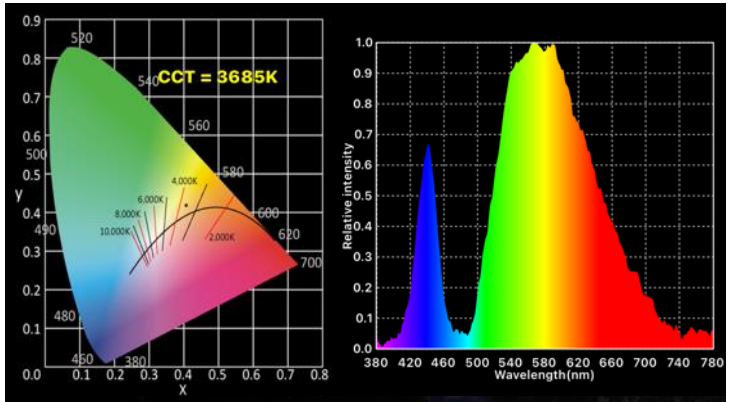
- Lighting is supplied via pole mounted floodlights only.
- Nocturnal animals in the area are micro bats and insects.
- Current lighting within the park has high a colour temperature range of around 35000k – 4500K with spikes in yellow and blue spectrums.

Any future lighting design work in these parks should consider the micro bat population. Typical examples of minimising impacts can be:

- Directing the lighting to where it is needed to avoid light spillage.
- Minimizing upward lighting to avoid light pollution.
- Lighting towards the red end of the spectrum (current lighting is toward the blue end)
- Limiting the times during which the lighting can be used to provide some dark periods.
- Maintaining the brightness as low as possible for compliance.
- Low level lighting, warm white light with low levels of blue spectrums.

Further details in on lighting for Ecology can be found in Part 3.

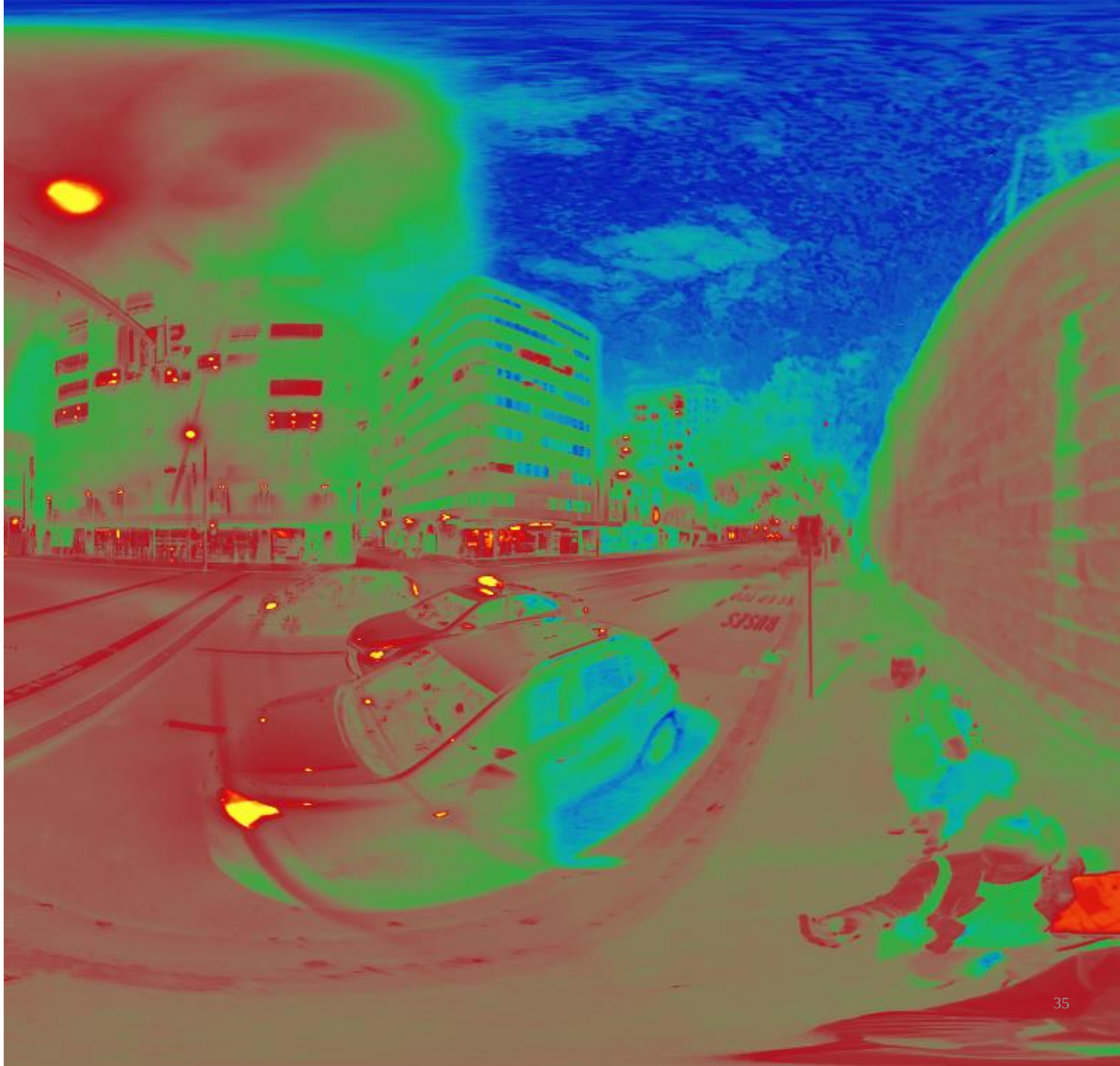




Part 3

Recommendations

- Site Specific Requirements
- Recommendations
- Control of the obtrusive effects of outdoor lighting
- Nighttime Vulnerability Assessment (NVA)
- Lighting for Australian Wildlife



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Site Specific Requirements

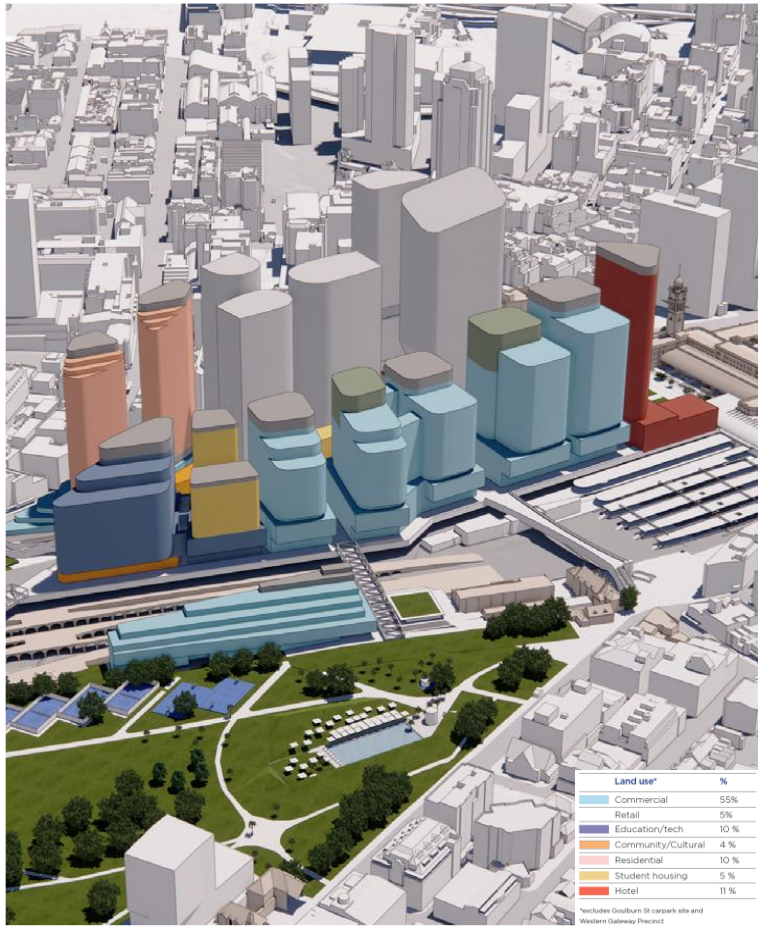
Precinct Development Pollution Requirements

This figure shows potential light pollution impacts within the site and surrounding boundary.

As part of the Public Domain Strategy (PDS) the future detailed design of development within the precinct must be in accordance with;

- Obtrusive lighting AS/NZS 4282:2019
- Standard CoS DCP
- CoS Public Domain Design Codes – Sydney Lights

	Light Technical Parameter	Time	Recommended Maximum Value	Reference
	Illuminance in vertical plane (Ev)	Pre-Curfew (6am – 11pm)	25lx	AS/NZS 4282-2019, Table 3.2
		Curfew (11pm – 6am)	5lx	AS/NZS 4282-2019, Table 3.2
	Luminous Intensity emitted by luminaires (I)	Pre-Curfew (6am – 11pm)	25,000cd	AS/NZS 4282-2019, Table 3.3
		Curfew (11pm – 6am)	2,500 cd	
	Threshold Increment (TI)	20% (adaption level 5 cd)		AS/NZS 4282-2019, Table 3.2
	Upward Light Ratio (ULR)	50%		AS/NZS 4282-2019 Clause 3.3.5.7 (c)



Recommendations

The following recommendations are proposed for the planning framework and to be carried out in the Public Domain Strategy (PDS) stage.

Night Time Masterplan

Designing urban spaces for people to share and enjoy goes beyond practical considerations. It's about creating memorable night time experiences and attracting people, energising wider city precincts and ultimately cities themselves.

A Night Time Masterplan (NTM) describes the main aspects of urban lighting within a precinct. The primary purpose of the of the NTM is to define the aesthetic and functional lighting criteria, to increase the efficiency, and quality of lighting and finally to achieve a holistic welcoming, safe, and well structured lit environment.

Lighting should have early involvement to ensure a cohesive and considered approach to the overall masterplan.

The NTM will set the strategy and principles for the precinct that include:

- AS 1158 + AS 4282 compliance targets
- CoS Public Domain Design Codes – Sydney Lights
- Lighting levels, lighting typologies and colour temperature
- Consider current and future usage at night time
- Approach to illuminating facades, awnings and landscapes
- Lighting controls and energy efficiency
- Address CPTED and perceptions of safety
- Consider lighting for wildlife
- Approach to temporary hoarding and movement/changes, to help area look accessible and appealing during construction phases.

Nighttime Vulnerability Assessment (NVA)

Current codes and standards that address night time design practices do not adequately consider the way the human eye perceives brightness and how this can affect people's experiences of safety and comfort after dark. As such there can be a dramatic difference in the way we experience our cities between day and at night.

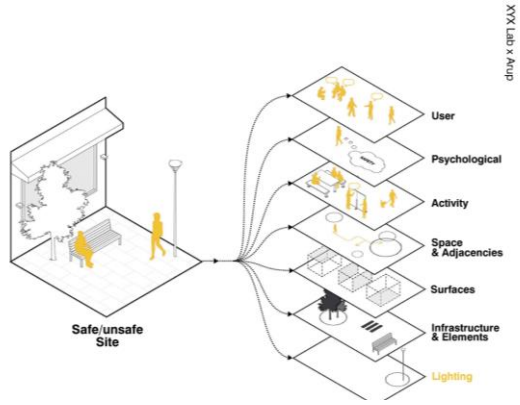
We recommend carrying out a Nighttime Vulnerability Assessment to understand the existing points of vulnerability and provide evidence based solutions to improve safety at night-time and accessibility. This work will contribute to the Night Time Masterplan.

The NVA methodology has been developed in accordance with the following:

• Research conducted by Arup University and the XYX Lab, Monash University; and

• C. Ray Jeffery's Crime Prevention Through Environmental Design (CPTED) concepts.

Further details on NVA is provided on page 38



Lighting for Wildlife

Electric light can disrupt certain behaviours in wildlife and cause physiological changes in nature. It must be understood that the ideal condition of no light for animals cannot be attained due to human beings' reliance on light. We must achieve a balance and harmony between lighting for people and animals. We have defined the critical lighting principles that impact wildlife and by controlling these we can ultimately minimise harm.

The main parameters that affect wildlife are correlated colour temperature, cut off angle contributing to spill light and the lack of scene setting for external lighting meaning that light is being left on all night.

Further details on NVA is provided on page 39

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Control of the obtrusive effects of outdoor lighting

General Mitigation

Outdoor lighting is provided for a variety of purposes, for work or recreation, for safety or security, for advertising or display or for the beautification of the night time environment.

Typical recommendations:

- Identify the sensitive receivers around the precinct on a project by project basis
- Compliance with holistic obtrusive lighting requirements including Australian Standards, State Legislation and good practice
- Complete detailed modelling of future lighting installations including all relevant light sources and sensitive buildings
- Avoid direct uplighting
- Control glare for road users
- Develop a coordinated lighting controls strategy

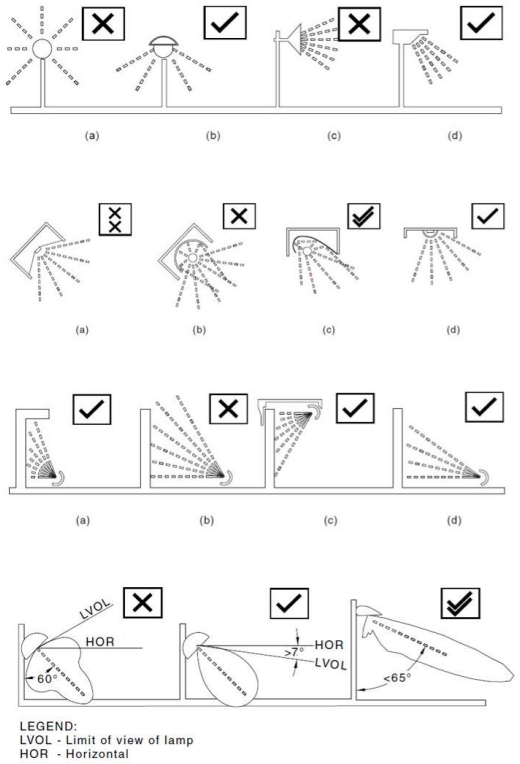

Image: AS/NZS 4282:2019 Australian/New Zealand Standard
Control of the obtrusive effects of outdoor lighting

3.2.8 External lighting

The external lighting of buildings can enhance the character of buildings at night and enliven an area. However, external lighting can create light pollution, increase energy use and greenhouse gas emissions and affect residential amenity. Often, it is more appropriate to highlight certain architectural features of a building rather than floodlighting entire facades.

Objectives

(a) Encourage appropriate external lighting of buildings that adds to the architectural character of the building.

(b) Minimise light spill to the sky.

Provisions

(1) Generally, external lighting of buildings is discouraged to avoid light pollution and the unnecessary consumption of energy and generation of greenhouse gas emissions, unless there is particular and justifiable merit in illuminating a building.

(2) Applications for decorative lighting or for the illumination of building facades, billboards or roof tops (accessible or inaccessible) are required to include a photomontage or computer modelling to illustrate the visual effect of the proposal, including the visual effect of any associated structure during the day.

(3) External light fixtures are to be integrated with the architecture of the building.

(4) The visual effects of external lighting must contribute to the character of the building, surrounds and skyline.

(5) The external lighting system must be energy efficient and subject to appropriate times of operation.

(6) External lighting must not reduce the amenity of residents in the locality.

(7) Eternal lighting must not negatively impact areas of habitat for local fauna.

(8) External lighting must minimise the light spill into the night sky.

(9) LED down lighting is preferred over up lighting to minimise light pollution.

(10) The following decorative lighting techniques are inappropriate:

(a) bud-lights and similar festoon lighting on buildings which detract from the architectural qualities of the building;

(b) broad floodlighting of facades from large light sources located separate to the building; and

(c) up lighting of flag poles and banner poles.

Image: The City of Sydney
Development Control Plans (DCP)

Nighttime Vulnerability Assessment (NVA)

Existing Site Considerations

Nighttime Vulnerability Assessment* (NVA) is ideally carried out as part of the Public Domain Strategy (PDS) to inform the Night Time Masterplan.

A NVA is an metric based assessment of the experience of vulnerability based on visual perceptions of the interaction of light with urban design elements.

The primary objective of these assessments are to identify lighting and contextual environmental characteristics that have the potential to influence the likelihood and consequences associated with a negative experience of place. An NVA consists of two assessment components:

- Part A: Physical Site Characteristic Assessment
- Part B: Technical Lighting Assessment

The final outcome of this process is intended to provide a consistent, evidence-based decision-making rationale on priority areas for discussion to be addressed in stakeholder workshops and guide design considerations when strategizing the Night Time Masterplan.

*This assessment has been developed with XYX Lab at Monash University and aligned with CPTED principles.

https://www.arup.com/projects/perceptions-of-night-time-safety-women-and-girls

https://www.arup.com.au/lighting/Out_of_sight-Out_of_mind.pdf

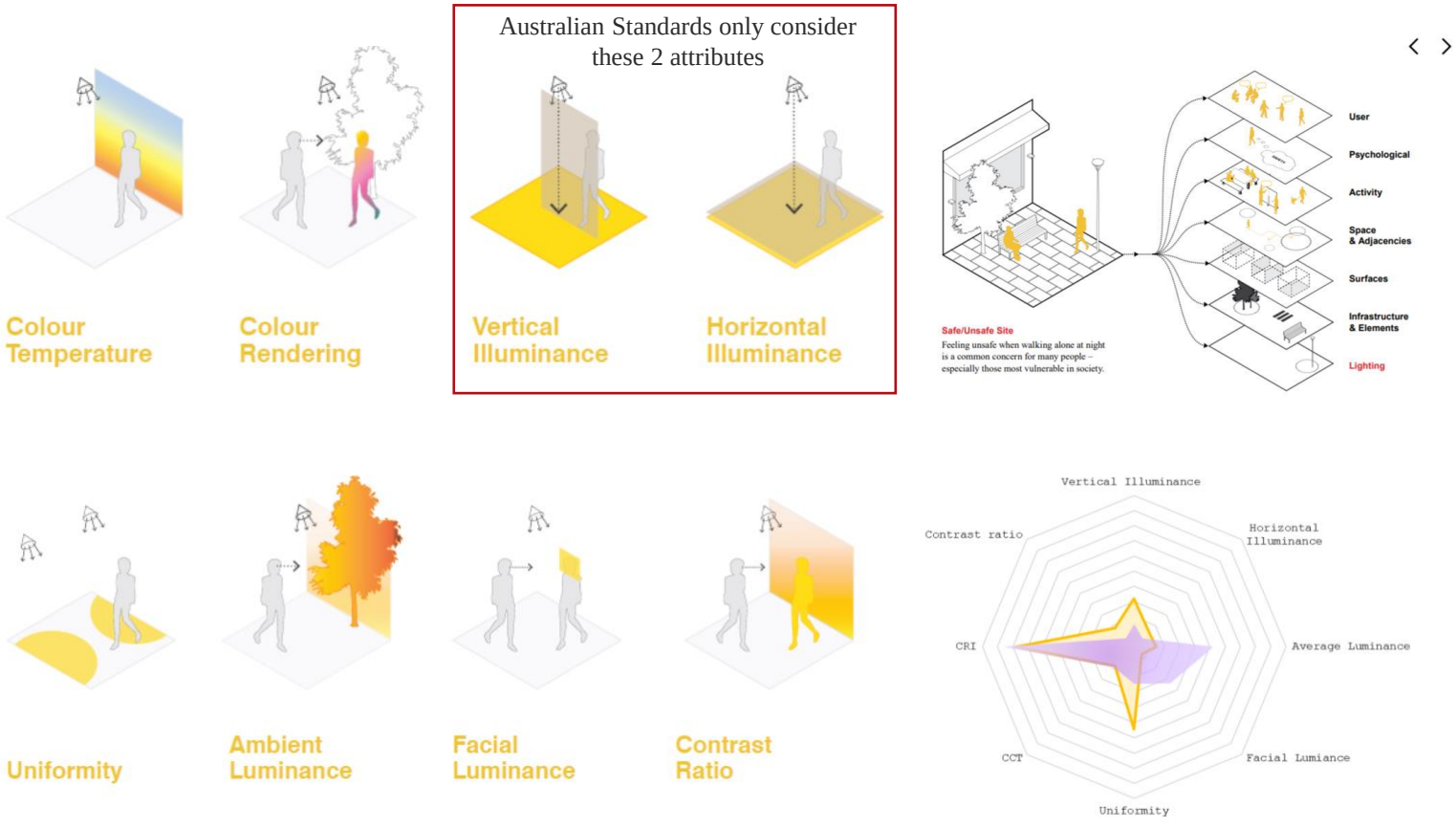

Image: Key Lighting Assessment Elements
Nighttime Vulnerability Assessment

Image: Scoring Results
Nighttime Vulnerability Assessment

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Lighting for Australian Wildlife

Considering Animals and Humans

Considerations for lighting in Public Recreational spaces which are shared by humans and ecology would be beneficial for the site precinct surrounding parks. Whilst there is no specific pollution standards for ecology, it is recommended that light spill on to the following parks around Central Precinct Renewal are considered from a ecology perspective :

- Belmore Park
- Alfred Park
- Future Parks

Key lighting considerations for the parks lighting should consider:

- Lighting at a human scale level
- Lighting to highlight key elements such as trees, pathways etc
- Lighting with warmer colour temperature and colour rendition
- Vertical and Horizontal Illuminance for facial recognition
- Lighting control with astronomical timeclock and sensors for curfew hours

No one solution to lighting at night will benefit all animal species; however, the goal is to minimise harm where possible with planet-centred design.

Current Practice

A lighting design that follows Australian standards best practice for urban park lighting. Typical Pole top lighting at 20mtr spacing, 4000K with PE cell to turn on/ off sunrise and sunset.

Advantages: Australian standards compliant approach.

Disadvantages: Not considering ecology or safety with approach.

Ideal Practice

A ‘considered’ lighting strategy that implements some best practice design elements to address wildlife.

This design will still comply with Australian standards 1158 PP3 Category. 1500mm high Bollards with smart PE cells, allow for dimming and sensors and colour temperature of 2200K. This reduces the blue spectrum of lighting which is harmful to animals.

Advantages: Considers both humans and ecology. Has potential to still comply with AS standards and considers an NVA assessment.

Disadvantages: Potentially cost increase against current practice.

Desired Practice

An ecological approach. This lighting design may not comply with Australian Standards however it will fully consider lighting for wildlife and perceptions of safety for people. 300mm high Bollards with smart PE cells, allow dimming and sensors. 2200K 5mtr spacing.

Advantages: Minimises harm towards ecology.

Disadvantages: May not comply with AS standards or NVA assessments.

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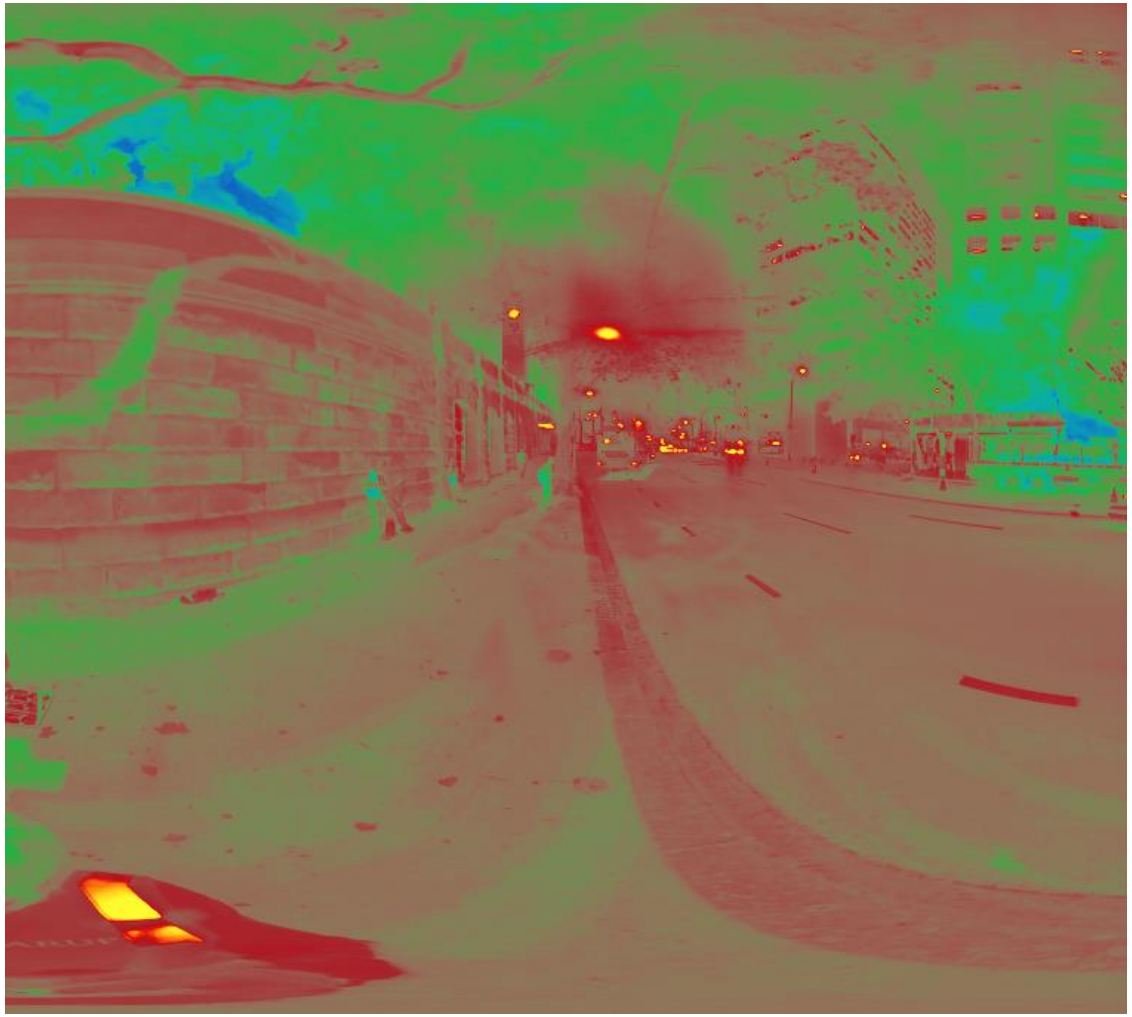

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