Attachment B25

Light Spill Study – Waterloo Estate (South) – Land and Housing Corporation

WATERLOO PRECINCT DEVELOPMENT

Waterloo South Renewal
Light Spill Assessment

Prepared for:

NSW Landing and Housing Corporation
Level 1, 223 Liverpool Road
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with NSW Landing and Housing Corporation (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.17084-R09-v1.1	24 March 2020	Peter Hayman	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy
610.17084-R09-v1.0	19 March 2020	Peter Hayman	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR has been engaged by NSW Landing and Housing Corporation (LAHC) to provide a lighting assessment of the proposed Waterloo Precinct Development. This report covers the Waterloo South part of the proposed development, with the key deliverable being an outdoor lighting model for the proposed site and an outline of any potential recommendations.

The Waterloo South Precinct is located approximately 3.3km south-southwest of the Sydney CBD in the suburb of Waterloo. It is located entirely within the City of Sydney local government area (LGA).

It is bordered by Wellington Street to the north (with the large "Village Green" on the north side on Wellington Street), Pitt Street to the east, McEvoy Street to the south and Cope Street and Botany Road to the west. It also includes one block east of Pitt Street bordered by Wellington, Gibson and Kellick Streets. The Precinct has an approximate gross site area 12.32 hectares (ha), including private land and road reserves, as defined by the centre line of external roads.

A baseline survey was conducted to establish current night-time lighting levels.

- There is currently significant night-time activity throughout neighboring areas of the site, with it being a well-developed mixed suburban and commercial retail precinct. Lighting sources consist of street lights, floodlights, light emitted from commercial shops and from passing vehicles;
- This was confirmed in the baseline survey results with a wide range of night-time lighting levels present in the local environment;
- In general, areas close to and directly under light fixtures (especially close to road intersections) have high illuminance; and
- A number of surveyed areas exceeded the applicable night-timer lighting level requirements of Australian Standard AS 4282-1997 Control of the Obtrusive Effect of Outdoor Lighting (herein "AS 4282-1997").

A future 3D lighting simulation model of the site was developed using lighting fixtures of the type likely to be used on the site. The resulting light spill was modelled using dedicated lighting software AGi32. This model only assessed additional light produced by the Waterloo South development.

- The resulting illuminance levels on the facades of surrounding buildings from the Waterloo South Development were seen to meet the requirements of AS 4282-1997.
- Any light spill from proposed development on to the facades of surrounding buildings can be managed to avoid unacceptable impacts because (among other things) lighting can be designed, installed and operated to comply with AS4282.

SLR has provided several recommendations to manage potential light spill during the detailed design phase of the proposal. As more detailed lighting design plans are generated, the lighting model will be updated to re-confirm compliance with AS 4282-1997.

Comprehensive lighting design will be undertaken as part of future detailed design.

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Lighting Terminology

A description of the common terminology used for the lighting study, taken from *AS 4282-1997: Control of the Obtrusive Effects of Outdoor Lighting* is shown in **Table 1.**

Table 1 Lighting Terminology (Consistent with AS 4282-1997)

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.
Spill light	Light emitted by a lighting installation which falls outside the boundaries of the property on which the installation is sited.
Residential property	Land upon which a dwelling exists or may be developed, e.g.: land zoned for residential development.
Dwelling	A building in which people normally reside, especially during the hours of darkness, e.g. house, hotel, motel, hospital.
Illuminance	The luminous flux arriving at a surface divided by the area of the illuminated surface. Unit: lux(lx); 1 lx = 1 lm/m^2
Luminous intensity	The concentration of luminous flux emitted in a specific direction. The SI unit of luminous intensity is the candela (cd).
Luminous flux	The measure of the quantity of light. For a lamp or luminaire it normally refers to the total light emitted irrespective of the directions in which it is distributed. Unit: lumen (lm).
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.
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.

1 Introduction

The Greater Sydney Region Plan and Eastern City District Plan seek to align growth with infrastructure, including transport, social and green infrastructure. With the catalyst of Waterloo Metro Station, there is an opportunity to deliver urban renewal to Waterloo Estate that will create great spaces and places for people to live, work and visit.

The proposed rezoning of Waterloo Estate is to be staged over the next 20 years to enable a coordinated renewal approach that minimises disruption for existing tenants and allows for the up-front delivery of key public domain elements such as public open space. Aligned to this staged approach, Waterloo Estate comprises three separate, but adjoining and inter-related stages:

- Waterloo South;
- Waterloo Central; and
- Waterloo North.

Waterloo South has been identified as the first stage for renewal. The lower number and density social housing dwellings spread over a relatively large area, makes Waterloo South ideal as a first sub-precinct, as new housing can be provided with the least disruption for existing tenants and early delivery of key public domain elements, such as public open space.

A planning proposal for Waterloo South is being led by NSW Land and Housing Corporation (LAHC). This will set out the strategic justification for the proposal and provide an assessment of the relevant strategic plans, state environmental planning policies, ministerial directions and the environmental, social and economic impacts of the proposed amendment. The outcome of this planning proposal will be a revised planning framework that will enable future development applications for the redevelopment of Waterloo South. The proposed planning framework that is subject of this planning proposal, includes:

- **Amendments to the Sydney Local Environmental Plan 2012** – This will include amendments to the zoning and development standards (i.e. maximum building heights and floor space ratio) applied to Waterloo South. Precinct-specific local provisions may also be included.
- **A Development Control Plan (DCP)** – This will be a new part inserted into 'Section 5: Specific Areas' of the Sydney DCP 2012 and include detailed controls to inform future development of Waterloo South.
- **An infrastructure framework** – in depth needs analysis of the infrastructure required to service the needs of the future community including open space, community facilities and servicing infrastructure.

1.1 Waterloo Estate

Waterloo Estate is located approximately 3.3km south-south-west of the Sydney CBD in the suburb of Waterloo (refer to **Figure 1**). It is located entirely within the City of Sydney local government area (LGA). Waterloo Estate is situated approximately 0.6km from Redfern train station and 0.5km from Australia Technology Park. The precinct adjoins the new Waterloo Metro Station, scheduled to open in 2024. The Waterloo Metro Quarter adjoins Waterloo Estate and includes the station and over station development, and was rezoned in 2019. Waterloo Estate comprises land bounded by Cope, Phillip, Pitt and McEvoy Street, including an additional area bounded by Wellington, Gibson, Kellick and Pitt Streets. It has an approximate gross site area of 18.98 hectares (14.4 hectares excluding roads). Waterloo Estate currently comprises 2,012 social housing dwellings owned by LAHC, 125 private dwellings, a small group of shops and community uses on the corner of Wellington and George Streets, and commercial properties on the south-east corner of Cope and Wellington Streets.

A map of Waterloo Estate and relevant boundaries is illustrated in **Figure 2**.

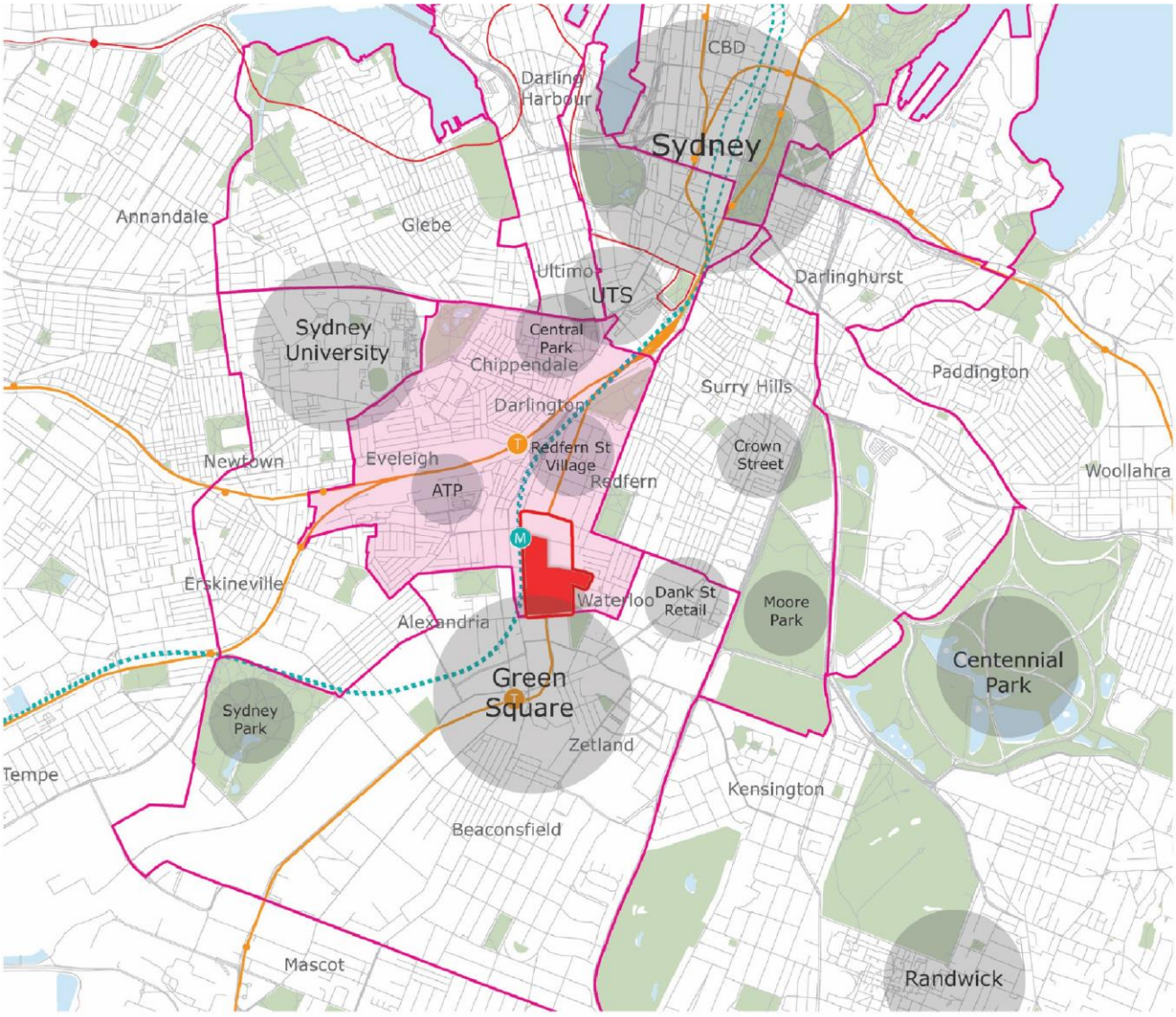

Figure 1 Location plan of Waterloo Estate and Waterloo South

Source: Turner Studio

1.1.1 Waterloo South

Waterloo South includes land bounded by Cope, Raglan, George, Wellington, Gibson, Kellick, Pitt and McEvoy Streets, and has an approximate gross site area of 12.32 hectares (approximately 65% of the total Estate).

Waterloo South currently comprises 749 social housing dwellings owned by LAHC, 125 private dwellings, and commercial properties on the south-east corner of Cope and Wellington Streets. Existing social housing within Waterloo South is predominantly walk up flat buildings constructed in the 1950s and '60s, and mid-rise residential flat buildings (Drysdale, Dobell & 76 Wellington Street) constructed in the 1980s. Listed Heritage Items within Waterloo South include the Duke of Wellington Hotel, Electricity Substation 174 on the corner of George and McEvoy Streets, the terrace houses at 229-231 Cope Street and the Former Waterloo Pre-School at 225-227 Cope Street. The State Heritage listed 'Potts Hill to Waterloo Pressure Tunnel and Shafts' passes underneath the precinct.

A map of Waterloo South and relevant boundaries is illustrated in **Figure 2**.

Figure 2 Waterloo Precinct

Source: Ethos Urban

1.2 Renewal Vision

The transition of Waterloo Estate will occur over a 20-year timeframe, replacing and providing fit for purpose social (affordable rental) housing as well as private housing to create a new integrated and inclusive mixed-tenure community.

This aligns with Future Directions for Social Housing in NSW – the NSW Government's vision for social housing. It also aligns with LAHC's Communities Plus program, which is tasked with achieving three key objectives:

1. Provide more social housing
2. Provide a better social housing experience
3. Provide more opportunities and support for social housing tenants

The following is LAHC's Redevelopment Vision for Waterloo Estate, which was derived from extensive consultation and technical studies:

Source: Let's Talk Waterloo: Waterloo Redevelopment (Elton Consulting, 2019)

Culture and Heritage

- Recognise and celebrate the significance of Waterloo's Aboriginal history and heritage across the built and natural environments.
- Make Waterloo an affordable place for more Aboriginal people to live and work.
- Foster connection to culture by supporting authentic storytelling and recognition of artistic, cultural and sporting achievements.

Communal and Open Space

- Create high quality, accessible and safe open spaces that connect people to nature and cater to different needs, purposes and age groups.
- Create open spaces that bring people together and contribute to community cohesion and wellbeing.

Movement and Connectivity

- Make public transport, walking and cycling the preferred choice with accessible, reliable and safe connections and amenities.
- Make Waterloo a desired destination with the new Waterloo Station at the heart of the Precinct's transport network – serving as the gateway to a welcoming, safe and active community.

Character of Waterloo

- Strengthen the diversity, inclusiveness and community spirit of Waterloo.
- Reflect the current character of Waterloo in the new built environment by mixing old and new.

Local Employment Opportunities

- Encourage a broad mix of businesses and social enterprise in the area that provides choice for residents and creates local job opportunities.

Community Services, Including Support for Those Who Are Vulnerable

- Ensure that social and human services support an increased population and meet the diverse needs of the community, including the most vulnerable residents.
- Provide flexible communal spaces to support cultural events, festivals and activities that strengthen community spirit.

Accessible Services

- Deliver improved and affordable services that support the everyday needs of the community, such as health and wellbeing, grocery and retail options.

Design Excellence

- Ensure architectural design excellence so that buildings and surrounds reflect community diversity, are environmentally sustainable & people friendly – contributing to lively, attractive and safe neighbourhoods.
- Recognise and celebrate Waterloo's history and culture in the built environment through artistic and creative expression.

- Create an integrated, inclusive community where existing residents and newcomers feel welcome, through a thoughtfully designed mix of private, social (affordable rental) housing.

1.3 Purpose of this Report

This report relates to the Waterloo South planning proposal. While it provides comprehensive baseline investigations for Waterloo Estate, it only assesses the proposed planning framework amendments and Indicative Concept Proposal for Waterloo South.

The key matters addressed as part of this study, include:

- Current and likely future light pollution affecting the precinct, including sources and nature and impact.

1.4 Waterloo South Planning Proposal

The planning proposal will establish new land use planning controls for Waterloo South, including zoning and development standards to be included in Sydney LEP 2012, a new section in Part 5 of DCP 2012, and an infrastructure framework. Turner Studio and Turf has prepared an Urban Design and Public Domain Study which establishes an Indicative Concept Proposal presenting an indicative renewal outcome for Waterloo South. The Urban Design and Public Domain Study provides a comprehensive urban design vision and strategy to guide future development of Waterloo South and has informed the proposed planning framework. The Indicative Concept Proposal has also been used as the basis for testing, understanding and communicating the potential development outcomes of the proposed planning framework.

The Indicative Concept Proposal comprises:

- Approximately 2.57 hectares of public open space representing 17.8% of the total Estate (Gross Estate area - existing roads) proposed to be dedicated to the City of Sydney Council, comprising:
    - Village Green – a 2.25 hectare park located next to the Waterloo Metro Station; and
    - Waterloo Common and adjacent – 0.32 hectares located in the heart of the Waterloo South precinct.
    - The 2.57 hectares all fall within the Waterloo South Planning Proposal representing 32.3% of public open space (Gross Waterloo South area – proposed roads)
- Retention of 52% of existing high and moderate value trees (including existing fig trees) and the planting of three trees to replace each high and moderate value tree removed.
- Coverage of 30% of Waterloo South by tree canopy.
- Approximately 257,000 sqm of GFA on the LAHC land, comprising:
    - Approximately 239,100 sqm GFA of residential accommodation, providing for approximately 3,048 dwellings comprising a mix of market and social (affordable rental) housing dwellings;
    - Approximately 11,200 sqm of GFA for commercial premises, including, but not limited to, supermarkets, shops, food & drink premises and health facilities; and
    - Approximately 6,700 sqm of community facilities and early education and childcare facilities.

The key features of the Indicative Concept Proposal are:

- It is a design and open space led approach.
- Creation of two large parks of high amenity by ensuring good sunlight access.
- Creation of a pedestrian priority precinct with new open spaces and a network of roads, lanes and pedestrian links.
- Conversion of George Street into a landscaped pedestrian and cycle friendly boulevard and creation of a walkable loop designed to cater to the needs of all ages.
- A new local retail hub located centrally within Waterloo South to serve the needs of the local community.
- A target of 80% of dwellings to have local retail services and open space within 200m of their building entry.
- Achievement of a 6 Star Green Star Communities rating, with minimum 5-star Green Star – Design & As-Built (Design Review certified).
- A range of Water Sensitive Urban Design (WSUD) features.

The proposed land allocation for the Waterloo South precinct is described in **Table 2** below.

Table 2 Breakdown of allocation of land within the Waterloo South

Land allocation	Existing	Proposed
Roads	3.12ha / 25.3%	4.38ha / 35.5%
Developed area (Private sites)	0.86ha / 6.98%	0.86ha / 7%
Developed area (LAHC property)	8.28ha / 67.2%	4.26ha / 34.6%
Public open space (proposed to be dedicated to the City of Sydney)	Nil / 0%	2.57ha / 20.9% (32.3% excluding roads)
Other publicly accessible open space (Including former roads and private/LAHC land)	0.06ha / 0.5%	0.25ha / 2%
TOTAL	**12.32ha**	**12.32ha**

The Indicative Concept Proposal for the Waterloo South is illustrated in **Figure 3** below.

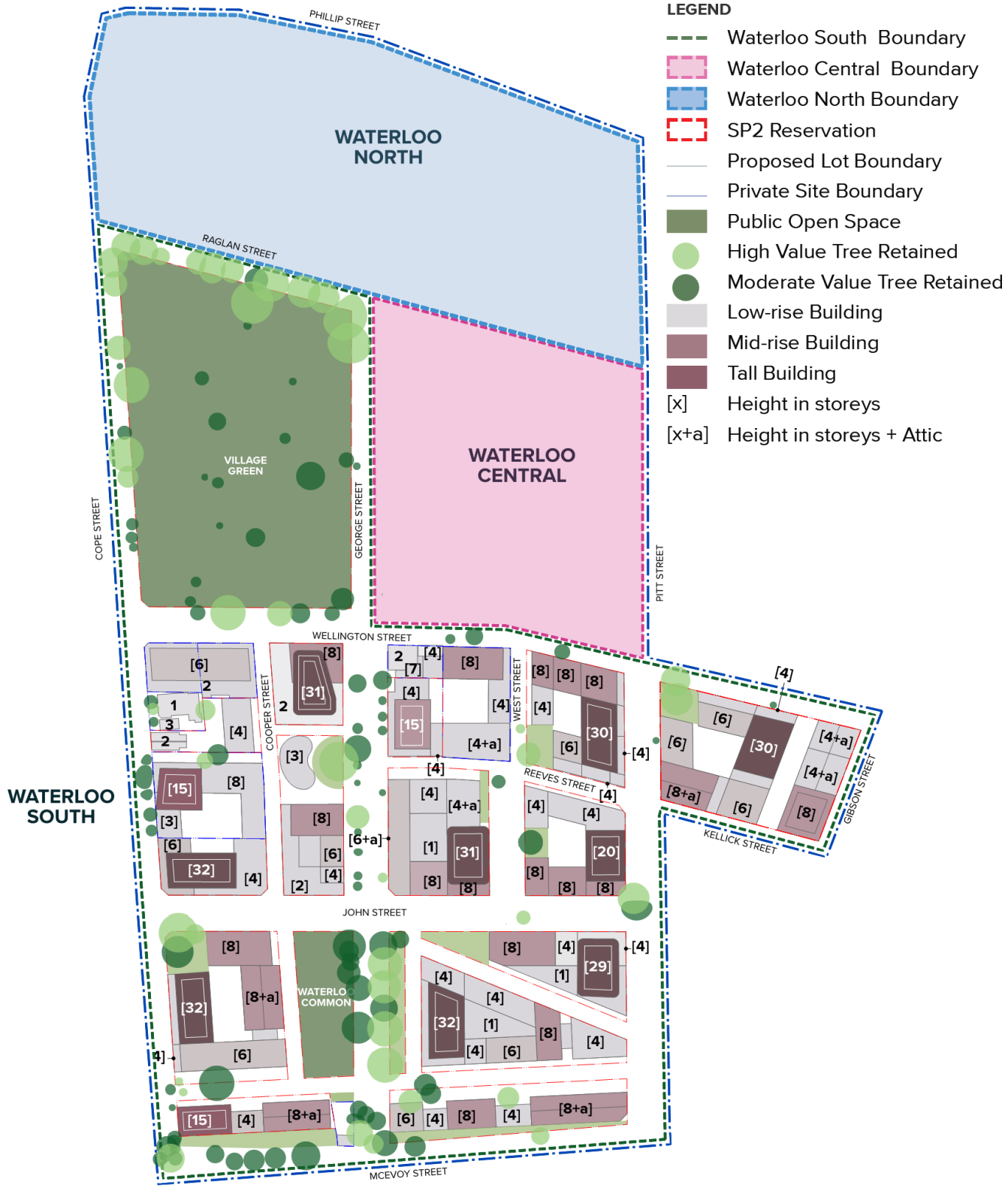

Figure 3 Indicative Concept Proposal
Source: Turner Studio

1.5 Previous Study

SLR has previously prepared a Light Spill Assessment for the Estate Development (Refer SLR Report 610.17084-R08-v0.8 dated 13th March 2019). The following changes have been proposed since preparing the above report:

- The removal of three buildings between the Village Green and the Metro Quarter.
- Increase in area of the Village Green.
- A lower built form with the maximum height reduced from 40 to 32 storeys.
- Increased retention of trees and wider streets.
- The Central and North sites will be subject to Future proposals.

2 Study Requirements

On 19 May 2017 the Minister issued Study Requirements for the Waterloo Estate. Of relevance to this study are the following requirements:

Note that the requirements cover the elements of Noise (and Vibration), Air Quality and Lighting (referred to sometimes in the requirements as *"pollution"*).

Table 3 Minister's Study Requirements and Where Addressed within this Report

Reference	Item Requirement	Refer Section:
18. Noise, Vibration and Pollution		
18.1	*Provide a noise and vibration impact assessment for the proposal. The assessment will address the relevant policies and guidelines in relation to noise including State Environmental Planning Policy (Infrastructure) 2007 and the Development Near Rail Corridors and Busy Roads – Interim Guideline.*	no
18.2	*Consider and assess potential pollution impacts from the proposed rezoning including, but not limited to, water, air, noise and **light pollution**.*	**Section 3**
18.3	*Provide an air quality assessment for the proposal. The assessment will address the relevant policies and guidelines in relation to air quality including State Environmental Planning Policy (Infrastructure) 2007 and the Development Near Rail Corridors and Busy Roads – Interim Guideline.*	nan
18.4	*These assessments should also consider other current local air and noise issues in the Waterloo area, including potential cumulative impacts from the Waterloo Estate.*	**Section 4**
18.5	*Identify and map current and proposed future sensitive receptors (e.g. residential uses, schools, child care centres).*	**Section 5**
18.6	*Identify current and likely future noise, vibration and **pollution** affecting the precinct, including sources and nature and impact. Site monitoring will be required to determine current road noise levels on Botany Road. 3D mapping to clearly communicate these impacts, including demonstrating for example how noise reduces with distance from source, is desirable.*	**Section 4** **Section 5**
18.7	*Model the likely future noise, vibration and **pollution** scenario based on 3D block envelope diagrams prepared by the urban designer. This is to include road and rail noise.*	**Section 6**
18.8	*Recommend appropriate noise and vibration mitigation measures. The consultant is expected to work with the urban designer, and suggested measures are provided for the protection of future residents of buildings through the careful siting and layout of buildings maintaining natural ventilation through open windows.*	na
18.9	*Outline the recommended measures relating to noise, vibration and **pollution** to minimise the nuisance and harm to people or property within the precinct.*	**Section 7**

3 Light Spill – Impact & Applicable Standards

As outlined in the above sections, the purpose of this report is to address the Minister for Planning Assessment Requirements issued Study pertaining to potential light spill impacts.

This Light Spill Assessment (LSA) has been prepared in general accordance with the Australian Standard AS 4282-1997 *Control of the Obtrusive Effect of Outdoor Lighting* (herein "AS 4282-1997")

3.1 Lighting Spill Impact

The adverse effects of light spill are due both to an increase in general illuminance that may cause annoyance and may disrupt sleeping patterns, and from the direct view of the light source that can cause glare issues.

The adverse effects of light spill from outdoor and exterior lighting are influenced by a number of factors:

- The topology of the area. Light spill is more likely to be perceived as obtrusive if the lighting installation is located above the observer. Lighting installations are usually directed towards the ground and an observer could hence have a direct view of the luminaire.
- The surrounding topography and existing installations. Hills, trees, buildings, fences and vegetation generally have a positive effect by shielding the observer from the light source.
- Pre-existing lighting in the area. Light from a particular light source is seen as less obtrusive if it is located in, or perceived in, an area where the lighting levels are already high, e.g. along roads and near built up areas. .
- The zoning of the area. A residential area is seen as more sensitive compared to commercial areas where high lighting levels are seen as more acceptable.
- Time of use. Clearly light will be seen as being more obtrusive during night time. This is generally considered to be between 11:00 pm and 6:00 am.

Typical illuminance levels for a variety of circumstances are given in **Table 4** for comparison.

Table 4 Typical Illuminance Levels for Various Scenarios

Lighting Scenario	Horizontal Illuminance (lux)
Moonless overcast night	0.0001
Quarter Moon	0.01
Full Moon	0.1
Twilight	10
Indoor office	300
Overcast day	1,000
Indirect sunlight clear day	10,000-20,000
Direct sunlight	100,000-130,000

3.2 Sensitive Receptors

The effect of light spill is addressed in Australian Standard: *AS 4282-1997 Control of the Obtrusive Effect of Outdoor Lighting*. When designing outdoor lighting the effects on the following four areas should be taken into account:

- Impacts on residents.
- Impacts on road users (eg motorists, cyclists, pedestrians).
- Impacts on transport signalling systems (eg air, rail).
- Impacts on areas where astronomical observations are made.

Due to the proposed site's location in a mixed suburban and commercial-retail precinct, there will already be a reasonable amount of night-time lighting. It is therefore unlikely that existing lighting will affect transport signalling systems or locations where astronomical observations are made.

3.3 Requirements

The effect of light spill is addressed in Australian Standard AS 4282-1997 *Control of the Obtrusive Effect of Outdoor Lighting* (herein "AS 4282-1997"). The maximum recommended values of light technical parameters for the control of obtrusive lights are given in **Table 5**.

Table 5 Recommended Maximum Values of Light Technical Parameters (AS 4282-1997)

Light Technical Parameter	Time of Operation	Commercial Areas	Residential Areas	
			Light Surrounds	Dark Surrounds
Illuminance in vertical plane (E_v)	Pre-curfew hours	**25 lx**	**10 lx**	10 lx
	Curfew hours (11pm-6am)	**4 lx**	**2 lx**	1 lx
Luminous Intensity emitted by luminaires (I)	Pre-curfew hours	7,500 cd (for a medium to large area with Level 1 control)	100,000 cd (for a large area with Level 1 control)	100,000 cd (for a large area with Level 1 control)
	Curfew hours (11pm-6am)	2,500 cd	1,000 cd	500 cd
Threshold Increment (TI)	Limits apply at all times where users of transport systems are subjected to a reduction in the ability to see essential information	20% based on adaption luminance (L) of 10 cd/m^2		

The vertical illuminance limits for *curfew hours* apply in the plane of the windows of habitable rooms or dwellings on nearby residential properties. The vertical illuminance criteria for *pre-curfew hours* apply at the boundary of nearby residential properties in a vertical plane parallel to the boundary.

Values given are for the direct component of illuminance, ie no reflected light is taken into account.

- Limits for luminous intensity for curfew hours apply in directions where views of bright surfaces of luminaires are likely to be troublesome to residents, from positions where such views are likely to be maintained; and
- Limits for luminous intensity for pre-curfew hours apply to each luminaire in the principal plane, for all angles at and above the control direction.

As can be seen in **Table 5**, the applicable limits for adverse spill light depend on the time of operation for the lighting installation. Operation taking place during *pre-curfew hours* is less likely to give rise to complaints from adjacent residential properties, while a more restrictive limit would be applicable to *curfew hours*.

The analysis in this report has therefore been based on *curfew hour* requirements. The residential properties can be best classed as being in a residential area with "Light Surrounds" (refer **Table 5**).

Accordingly:

- Light spill from the proposed site onto the facades of the surrounding residential dwellings should be kept below 2 lux during curfew hours; and
- Light spill from the proposed site onto the facades of residential dwellings in the surrounding commercial areas should be kept below 4 lux during curfew hours.

4 Baseline Studies

SLR undertook a baseline study assessment of the existing night-time illumination environment of the streets surrounding the entire Waterloo SPP Precinct.

There is currently significant night time operation throughout the neighbouring region of the site, with it being a well-developed area. SLR has measured existing night-time lighting conditions along streets bordering the perimeter of the entire proposed site to assess the risk of adverse light spill onto nearby properties.

The goal of the baseline measurements covering streets bordering the perimeter of the precinct was to establish a baseline from which to assess the risk of adverse light spill onto nearby properties associated with the future proposal.

4.1 Methodology

SLR used two calibrated Testo 545 Light Meters to conduct the site measurements. These meters were supplied and calibrated by Air-Met Scientific Pty Ltd.

The measurements were taken approximately 1.5 m above the ground either by using a tripod in more open areas or handheld on walkways, platforms and moving around equipment. Measurements of the existing night-time lighting condition along streets bordering the precinct were recorded on the site plans and survey.

Recordings were conducted on 13 June 2017 from 6:10 pm onwards. The atmospheric conditions during testing were partly overcast. The illuminance provided by an overcast sky is 0.0001 lux and would therefore have had no impact on the survey results.

Additional measurement notes:

- The measurement spacing generally used was 5 m to 10 m.
- For larger open areas such as open lawn areas and parks, a spacing of 15 m was used.
- Existing residential buildings within the precinct typically have privacy gates or walls in front of the properties. For this reason, the measurements in front of residences were recorded on the footpath bordering the property boundary, rather than directly next to the façade or residential windows.

4.2 Measurement Locations

The measurement points are shown in **Figure 4** with the measurement locations split into street-by-street groupings. The measurement points/groupings were split as follows:

- Measurement points 1 to 9, 153 to 189: “**Metro Quarter**”
- Measurement points 10 to 152: “**The Estate**”

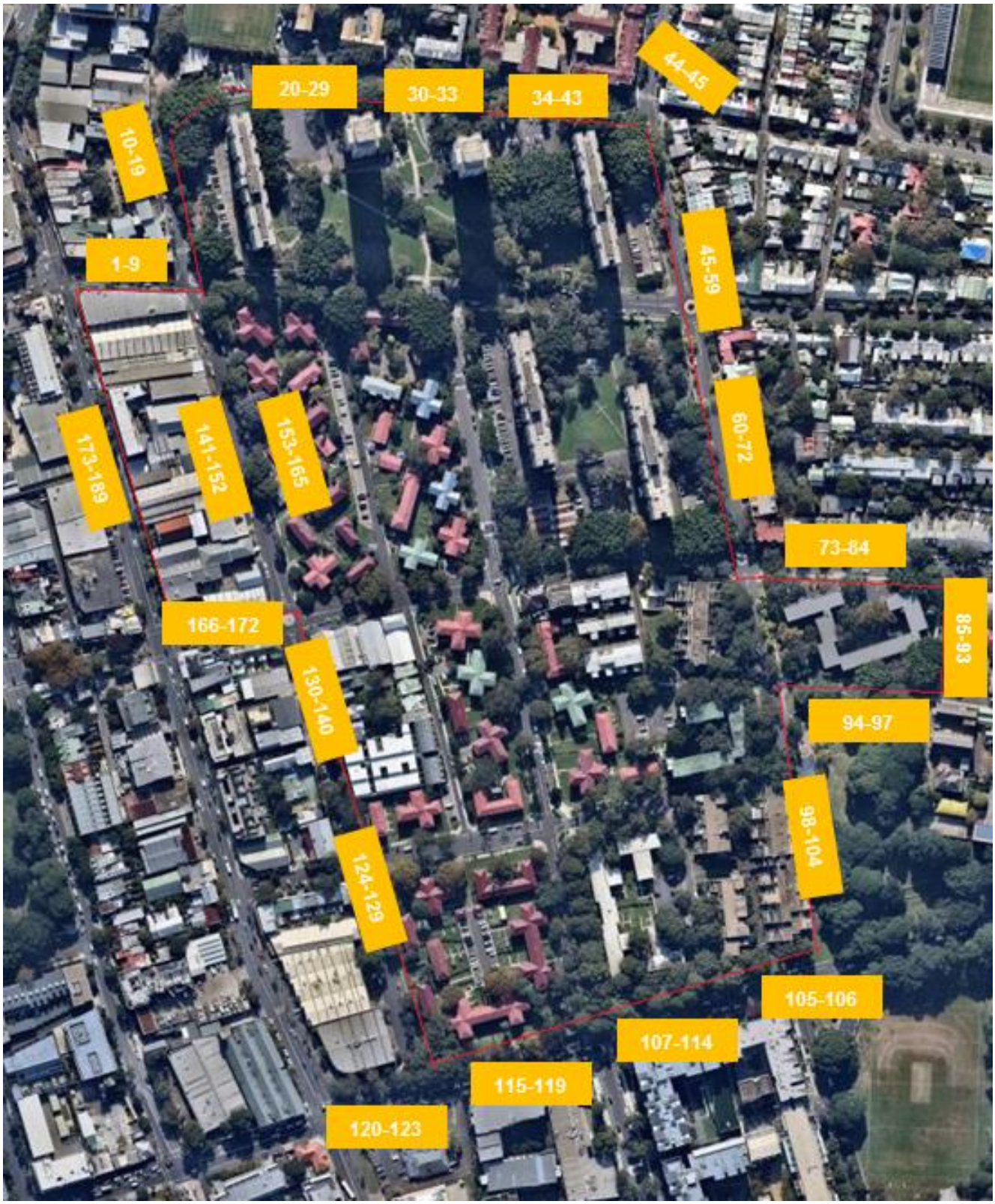

Figure 4 Light Spill Measurement Boundary and Measurement Points

4.3 Light Spill Measurements

4.3.1 Raglan Street up to Cope Street

The measurements were conducted in front of the hotel and retail shops along Raglan Street. Light sources include street lights, commercial lightboxes and passing vehicles.

The average illuminance exceeds relevant requirements in many areas. As expected, areas close to and directly under light fixtures generally have high illuminance. However, no sensitive receptors were located near the hotel and other retail shops.

Table 6 Lighting Measurements – Raglan Street up to Cope Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
1	77	50	Abbotts Hotel/under awning
2	74	25	Abbotts Hotel/under awning
3	25	15	Abbotts Hotel/under awning
4	150	50	Bottlemart/under awning
5	200	122	Tobacconist/under awning
6	17	10	Between Food Store and Tobacconist/under awning
7	39	15	Between Food Store and Tobacconist/under awning
8	92	10	Food store/under awning
9	17	13	Corner

4.3.2 Cope Street up to Phillip Street

Light sources include street lights and passing vehicles. Current lux levels at measured locations exceed the recommended value due to higher street light density for traffic.

Table 7 Lighting Measurements – Cope Street up to Phillip Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
10	30	27	Corner (away from façade frontage)
11	7	8	Near street light
12	26	35	Under street light
13	32	18	Near street light
14	17	15	Under street light
15	35	27	Under street light
16	37	30	Near street light/residential windows
17	20	20	Under street light
18	27	15	Near street light

19	18	14	Near Street light

4.3.3 Phillip Street up to George Street

Light sources include street lights and flood lights. Some locations close to street lights or flood lights exceed the recommended lux level.

Table 8 Lighting Measurements – Phillip Street up to George Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
20	42	50	Under street light, away from façade frontage
21	33	15	Near street light, away from façade frontage
22	3	4	
23	2	1	Near corner
24	10	10	Near street light
25	1	2	
26	3	4	
27	1	1	
28	4	5	
29	59	30	Near flood light

4.3.4 Phillip Street up to St Peters Lane

Light sources include street lights and flood lights. Some locations close to street lights or flood lights exceed the recommended lux level.

Table 9 Lighting Measurements – Phillip Street up to St Peters Lane

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
30	48	48	Near flood light, away from façade frontage
31	4	10	Near flood light
32	5	10	Near flood light
33	8	13	Near floodlight, away from façade frontage

4.3.5 Phillip Street up to Pitt Street

Light sources include street lights and flood lights. Some locations close to street lights exceed the recommended lux level.

Table 10 Lighting Measurements – Phillip Street up to Pitt Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
34	12	12	Near street light, past façade frontage
35	3	4	
36	12	6	Near street light
37	21	19	Under street light
38	1	2	
39	1	1	
40	6	7	Street light
41	4	5	
42	15	13	Street light
43	15	25	Corner/pedestrian crossing

4.3.6 Phillip Street / Pitt Street

Light sources include street lights and passing vehicles. Lux levels exceed recommended values due to light spill from the traffic intersection.

Table 11 Lighting Measurements – Phillip Street /Pitt Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
44	10	17	Corner
45	4	7	Corner

4.3.7 Pitt Street up to Raglan Street

Light sources include street lights. Some locations close to street lights exceed the recommended lux level.

Table 12 Lighting Measurements – Pitt Street up to Raglan Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
46	7	14	Near street light, past façade frontage

47	5	4	
48	1	2	
49	1	2	
50	7	10	Street light
51	1	3	
52	1	3	
53	1	3	
54	5	3	
55	20	23	Street light
56	1	3	
57	3	4	
58	13	14	Street light
59	32	24	Street light/corner, past façade frontage

4.3.8 Pitt Street up to Wellington Street

Light sources include street lights. Some locations close to street lights exceed the recommended lux level.

Table 13 Lighting Measurements – Pitt Street up to Wellington Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
60	2	3	Corner, past façade frontage
61	12	14	Street light
62	1	1	
63	1	2	
64	1	3	
65	1	1	
66	1	2	
67	1	1	
68	12	13	Street light
69	4	5	
70	15	21	Bus stop
71	1	3	
72	1	3	Corner, past façade frontage

4.3.9 Wellington Street up to Gibson Street – Table 13

Light sources include street lights. Some locations close to street lights exceed the recommended lux level.

Table 14 Lighting Measurements – Wellington Street up to Gibson Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
73	1	2	Past façade frontage
74	32	21	Street light
75	10	14	Near street light
76	3	7	
77	1	3	
78	2	4	
79	2	4	
80	2	4	
81	3	4	
82	11	8	
83	18	18	Near Street light
84	8	5	Past façade frontage
85	11	21	Pedestrian crossing

4.3.10 Gibson Street up to Kellick Street

Light sources include street lights. Some locations close to street lights exceed the recommended lux level.

Table 15 Lighting Measurements – Gibson Street up to Kellick Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
86	10	5	Pedestrian crossing/corner, past façade frontage
87	1	1	
88	2	2	
89	2	2	
90	1	1	
91	1	1	
92	3	4	
93	6	10	Street light, past façade frontage

4.3.11 Kellick Street up to Pitt Street

Light sources include street lights. Some locations close to street lights exceed the recommended lux level.

Table 16 Lighting Measurements – Kellick Street up to Pitt Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
94	17	7	Street light/corner, adjacent to park
95	1	2	Adjacent to park
96	6	4	Adjacent to park
97	2	2	Adjacent to park

4.3.12 Pitt Street up to McEvoy Street

Light sources include street lights and car park lights. Some locations close to street lights and car parks exceed the recommended lux level.

Table 17 Lighting Measurements – Pitt Street up to McEvoy Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
98	1	3	Adjacent to park
99	1	4	Adjacent to park
100	6	8	Street light, adjacent to park
101	2	12	Carpark
102	3	12	Carpark
103	1	4	Carpark
104	2	4	Corner, past façade frontage

4.3.13 McEvoy Street / Pitt Street

Light sources include street lights and passing vehicles. Lux levels exceed recommended values due to light spill from the traffic intersection.

Table 18 Lighting Measurements – McEvoy Street / Pitt Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
98	1	3	Adjacent to park
99	1	4	Adjacent to park

4.3.14 McEvoy Street up to George Street

Light sources include street lights and passing vehicles. Lux levels exceed recommended values due to local traffic conditions.

Table 19 Lighting Measurements – McEvoy Street up to George Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
107	14	19	Corner/street light, traffic, past façade frontage
108	29	24	Street light
109	5	4	
110	3	5	
111	5	10	Near street light
112	10	7	Near street light
113	12	12	Near street light
114	4	7	Near traffic lights, past façade frontage

4.3.15 McEvoy Street up to just before McDonalds (at Botany Road)

Light sources include street lights and passing vehicles. Lux levels exceed recommended values due to local traffic conditions.

Table 20 Lighting Measurements – McEvoy Street up to Botany Road

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
115	41	18	Street light/corner, past façade frontage
116	5	10	
117	6	9	
118	12	10	Near street light
119	10	12	Near street light
120	3	4	Corner, past façade frontage

4.3.16 McEvoy Street / Botany Road

Light sources include street lights and passing vehicles. Lux levels exceed recommended values due to local traffic conditions. The McDonalds at this intersection and its carpark are located in this area (no residential dwellings).

Table 21 Lighting Measurements – McEvoy St up to Botany Rd

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
121	34	4	McDonalds carpark light
122	6	1	
123	17	13	Near traffic lights

4.3.17 Cope Street up to John Street

Light sources include street lights and flood lights. Lux levels located close to street lights and flood lights exceed recommended lux values.

Table 22 Lighting Measurements – Cope Street up to John Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
124	2	2	Past façade frontage
125	2	2	
126	1	1	
127	1	1	
128	54	6	Street light/flood lights off building
129	1	1	Corner, past façade frontage

4.3.18 Cope Street up to Wellington Street

Light sources include street lights and flood lights. Lux levels located close to street lights and flood lights exceed recommended lux values.

Table 23 Lighting Measurements – Cope Street up to Wellington Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
130	9	10	Corner/street light, past façade frontage
131	1	1	
132	2	2	
133	3	5	
134	1	1	
135	3	5	
136	2	2	
137	2	2	
138	1	1	

139	1	1	
140	7	4	Corner/street light, past façade frontage

4.3.19 Cope Street up to Raglan Street

Light sources include street lights. Lux levels located close to street lights exceed recommended lux values. Industrial warehouses are located in this area only.

Table 24 Lighting Measurements – Cope Street up to Raglan Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
141	2	4	Past façade frontage
142	18	21	Street light
143	15	21	Street light
144	3	4	
145	35	7	Street light
146	4	4	
147	1	1	
148	1	4	
149	1	2	
150	15	10	Street light
151	4	8	
152	16	15	Corner/street light, past façade frontage

4.3.20 Cope Street up to Wellington Street

Light sources include street lights and the bus stop lighting. Areas close to bus stop have high illuminance for safety reasons.

Lux levels located close to street lights and exceed recommended lux values.

Table 25 Lighting Measurements – Cope Street up to Wellington Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
153	2	6	Past façade frontage
154	29	27	Street light/bus stop
155	17	24	Street light/bus stop
156	1	1	
157	3	1	

158	2	5	
159	1	3	
160	20	18	Street light
161	1	1	
162	1	1	
163	3	2	
164	7	1	
165	10	18	Corner/bus stop, past façade frontage

4.3.21 Wellington Street up to Botany Road

Light sources include street lights and passing vehicles. Lux levels exceed recommended lux values at some locations to due to local traffic conditions. Hotel and commercial shops are located in this area.

Table 26 Lighting Measurements – Wellington Street up to Botany Road

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
166	16	18	Corner/street light, past façade frontage
167	7	2	
168	1	2	Trees
169	2	2	Trees
170	3	2	Trees
171	27	4	Cauliflower Hotel frontage
172	57	68	Cauliflower Hotel/ corner

4.3.22 Botany Road up to Raglan Street

Light sources include street lights and passing vehicles. Lux levels exceed recommended lux values at some locations due to local traffic conditions. Commercial tenancies and industrial warehouses are located in this area.

Table 27 Lighting Measurements – Botany Road up to Raglan Street

Ref No	Horizontal Illuminance (lx)	Property Façade Illuminance (vertical) (lx)	Location
173	3	7	Corner/under awning
174	5	6	
175	4	6	
176	7	8	
177	24	20	Street light

178	30	17	Street light
179	8	10	
180	2	2	
181	4	5	
182	18	19	Street light
183	23	24	Street light
184	6	7	
185	2	6	
186	2	1	
187	1	4	
188	19	9	Street light
189	4	10	Corner/traffic light, past façade frontage

4.4 Baseline Conclusions

Based on results outlined in **Section 5.3**, the following conclusions were reached as a result of site lighting measurements:

- A number of surveyed areas failed to satisfy the AS 4282-1997 requirement.
- In general, areas close to and directly under light fixtures (especially close to road intersections) have high illuminance.

Recommendations to mitigate and minimise light spill along with exact illuminance requirements and levels for the site and on the nearby dwelling facades will be confirmed through quantitative light spill modelling and calculation, as further information becomes available.

5 Lighting Design for the Proposal

The lighting design for the Waterloo South site has not yet been completed but it is possible to make reasonable assumptions about the location and intensity of the site lighting.

Surrounding receptors fall into the following categories:

- North clockwise around to the east: residential + active recreation
- East clockwise around to the south: residential + commercial
- South clockwise around to the north: residential + commercial + retail

Comprehensive lighting design will be undertaken as part of future detailed design.

5.1 Lighting Requirements

Lighting for the site will take into account the following considerations:

- Safety of the resident;
- Regulations and design standards;
- Minimise the impact of new lighting on the surrounding environment; and
- Maximise the efficiency of the lighting system.

Based off standards outlined in AS/NZS 1158-Lighting for Roads and Public Spaces the required minimum illuminance values for relevant outdoor spaces identified within the Estate are outlined in below Table.

Table 28 Minimum Lighting Values for Different Outdoor Areas (AS/NZS 1158)

Location	Assessed Category	Average Horizontal Illuminance for Site (lux)
Pedestrian pathway	P6-P7	14-21
Outdoor shopping precinct	P6-P7	14-21
Open arcades	P6-P7	14-21
Transport terminals and interchanges	P6-P7	14-21
Steps, stairways and ramps	P9	14-21
Subways including associated ramps or stairways	P10	35

5.2 Lighting Model for the Proposal

A 3D digital geometry was generated for the site from the received AutoCAD file. The building envelop plan is shown in **Figure 3**. This was then imported into the light modelling program AGi32.

- Luminaires and a ground plane were added;
- Surrounding buildings were added to the model;
- Trees were not included in the model to give a worst-case scenario. For the same reason all lights were assumed to be switched "on" for the analysis;
- A grey surface was used for buildings and an asphalt texture was used for ground surfaces;
- A horizontal 2 m by 2 m calculation grid was used, 0.5 m above local ground level, for all pedestrian areas such as the parks and boulevards to provide an indication of the area illuminance; and
- A vertical 1 m by 1 m grid was added to the facades of all nearby surrounding buildings to calculate the light spill at those facades.

5.2.1 Areas to be Illuminated

This section aims to identify areas of the site where new lighting will be needed as well as the minimum illumination required for those areas.

SLR added lighting to the following areas of the model:

- Village Green and Waterloo Common areas;
- Around Community Hubs;
- Along the Pedestrian Boulevards;
- Along street fronts with Commercial, Retail and Community space;
- Other smaller open park spaces; and
- Pedestrian Links.

Fluorescent lighting was used around commercial and retail areas under awnings and undercrofts.

LED area lighting was used for the major open area and smaller parks.

The area lighting was positioned to inwards towards the middle of the parks to reduce the potential for light spill on to surrounding buildings.

Bollard style lighting was used along pathways through the larger open spaces and for the pedestrian links.

All lights used in the model were full cut-off luminaires with an upward waste light ratio of zero.

6 Lighting Model Results

6.1 Area Lighting

The initial goal of the modelling was to produce a lighting case that provided at least the minimum required illuminance to the main pedestrian areas. The lighting model produced the results shown in **Table 29**.

Table 29 Ground Illuminance from Lighting Model within Estate Site

Area	Calculated Average Lux 0.5 metres above ground
Village Green	19.8
Waterloo Common	22.3
Pedestrian Boulevard (Central)	20.3
Pedestrian Boulevard (South)	43.8
Community Hub – Near corner of Cooper & Wellington Streets	32.8
Community Hub – Corner of John St & South Park	51.5
Open Space – Corner of Pitt & Wellington Streets (SE)	29.5
Open Space – Corner of Cope & John Streets	28.4
Open Space – Corner of 9m Laneways off Pitt & Wellington Streets	27.1

Comparing the model output with the recommended lux levels in **Table 28** suggests that the lighting model is over-illuminated in terms of minimum requirements, but should provide a conservative case for assessing the light spill in the surrounding environment.

6.2 Light Spill Assessment

As previously stated, calculation points were added to the facades of all surrounding buildings immediately facing the site. Some buildings on the opposite side of Waterloo Park have not been included due to their distance from the site. Facades with illuminance greater than one have been investigated in detail.

In the modelled images below the light spill values on the facades have been broken into the following bands corresponding to the requirements of AS4282:

- Green values = 0 - 1 Lux (meets the criteria for residential areas in dark surrounds during curfew hours)
- Yellow values = 1 - 2 Lux (meets the criteria for residential areas in light surrounds during curfew hours)
- Brown values = 2 - 4 Lux (meets the criteria for commercial areas or the boundary of commercial and residential during curfew hours)

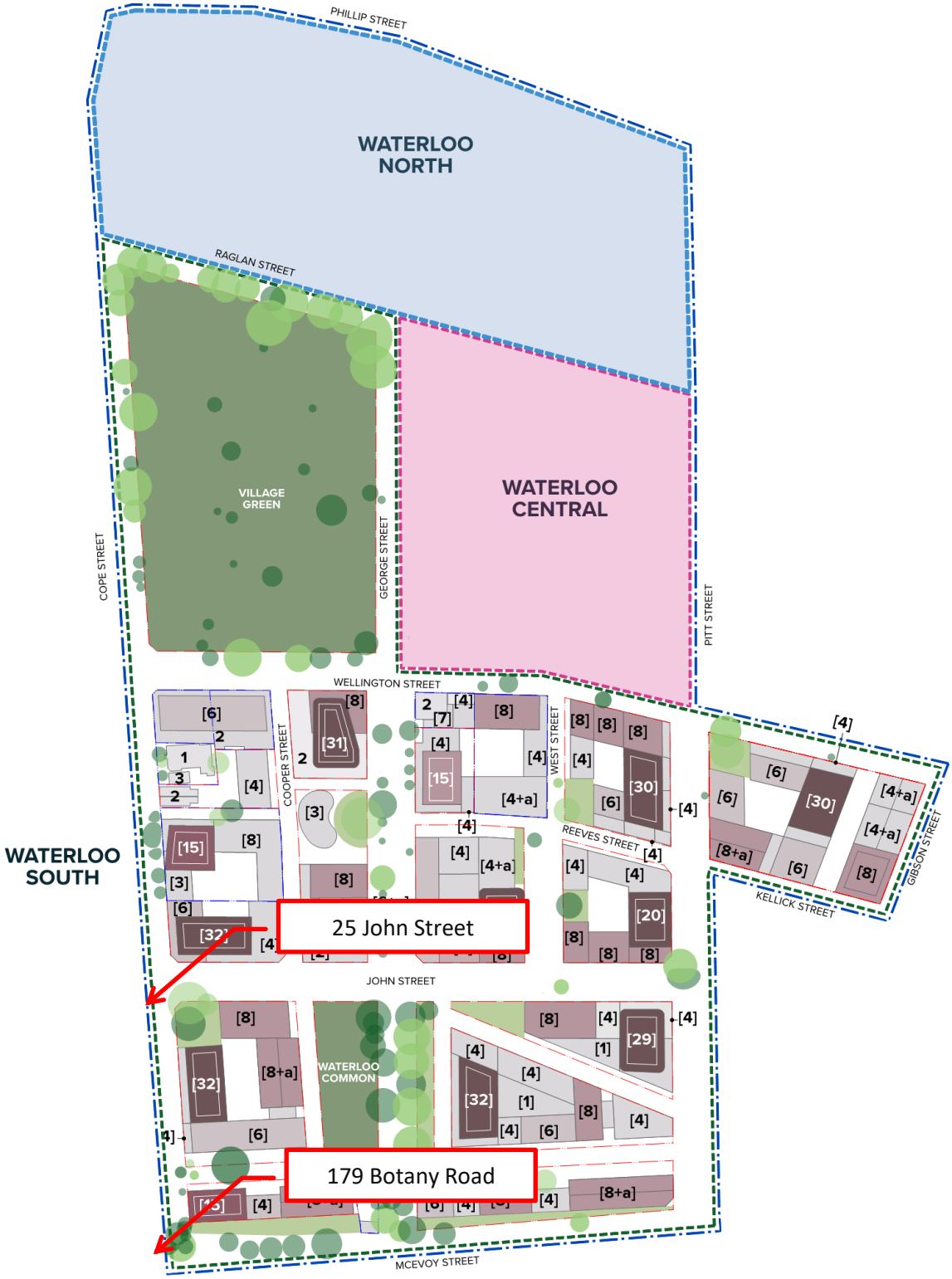

Figure 5 Areas for Further Investigation

6.2.1 25 John Street

Image: Google Street View

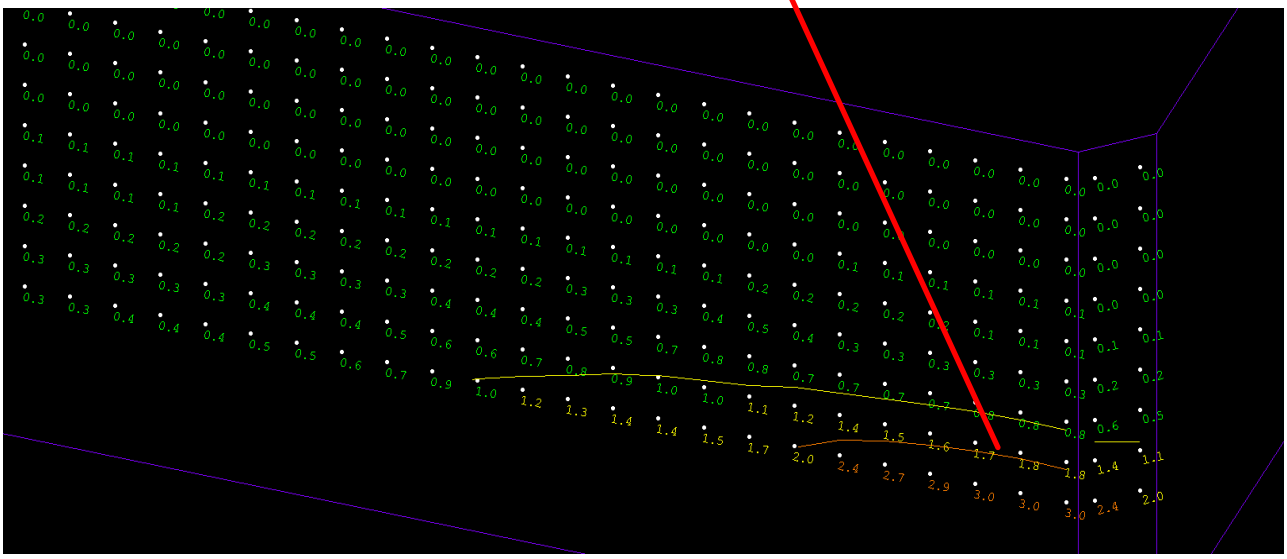

Figure 6 Modelled Façade – 25 John Street

This area faces the small park on the corner of Cope and John Streets. 25 John Street has a retail space on the ground and a residential dwelling on the upper levels with an entry on Cope Street. There is a small area near the corner where the illuminance is more than two lux with a maximum of 3 lux. This will meet the requirements of AS4282 as it is a commercial façade and the required limit is 4 lux. The first floor could contain bedroom windows and will experience between 0.1 and 0.3 lux this will also meet the requirements of AS 4282 regardless of the classification of the surrounding area. When compared to the Baseline assessment the largest contribution to illuminance on the facades will be from the nearby streetlight which was found to have an illuminance of 6 lux on the ground floor.

6.2.2 179 Botany Road

Image: Google Street View

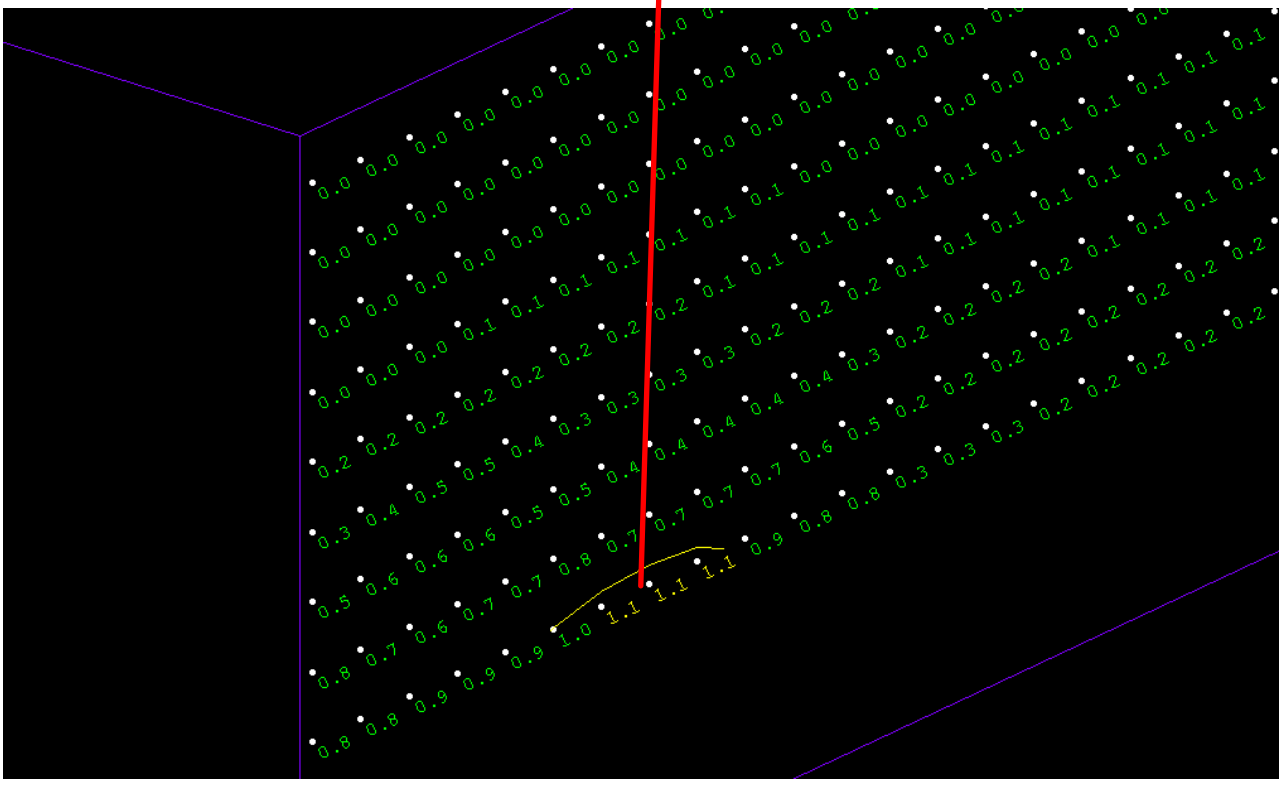

Figure 7 Modelled Façade – Rear of 179 Botany Road

This area is near the most south easterly point of the site, just to the north of the corner of Cope and McEvoy Streets. There is an area close to the ground with a maximum of 1.1 lux. This will meet the requirements of AS4282 as it is a commercial façade and the required limit is 4 lux.

6.2.3 Other Facades

Most other facades surrounding the proposed development receive some light spill between 0-1 lux. These however have not been investigated in detail as they fall well below the minimum requirements of AS 4282.

7 Recommendations

To ensure that any potential light spill from the proposal complies with the relevant requirements, the following recommendations are given.

7.1 General Mitigation

When designing outdoor light to minimise any adverse effect of the light installation, use the following general principles during the detailed lighting design phase as set out in *AS4282-1997 Control of the Obtrusive Effect of Outdoor Lighting*:

- Direct lights downward as much as possible;
- Use luminaires that are aimed to minimise light spill, e.g. full cut off luminaires where no light is emitted above the horizontal plane;
  - Note that reducing spill light means that more of the light output is used to illuminate the area and a lower power output can be used. The energy consumption for the fitting can thus be reduced without decreasing the illuminance of the area. Refer
  - Figure 8.
- Do not waste energy and increase light pollution by over-lighting;
- Keep glare to a minimum by keeping the main beam angle less than 70°. Refer
- Figure 8**;**
- Wherever possible use floodlights with asymmetric beams that permit the front glazing to be kept at or near parallel to the surface being lit;
- Be aware of the location of any surrounding sensitive receptors and direct the site lighting away from these locations where feasible; and
- Where possible position site lighting as far away from site boundaries as practicable.

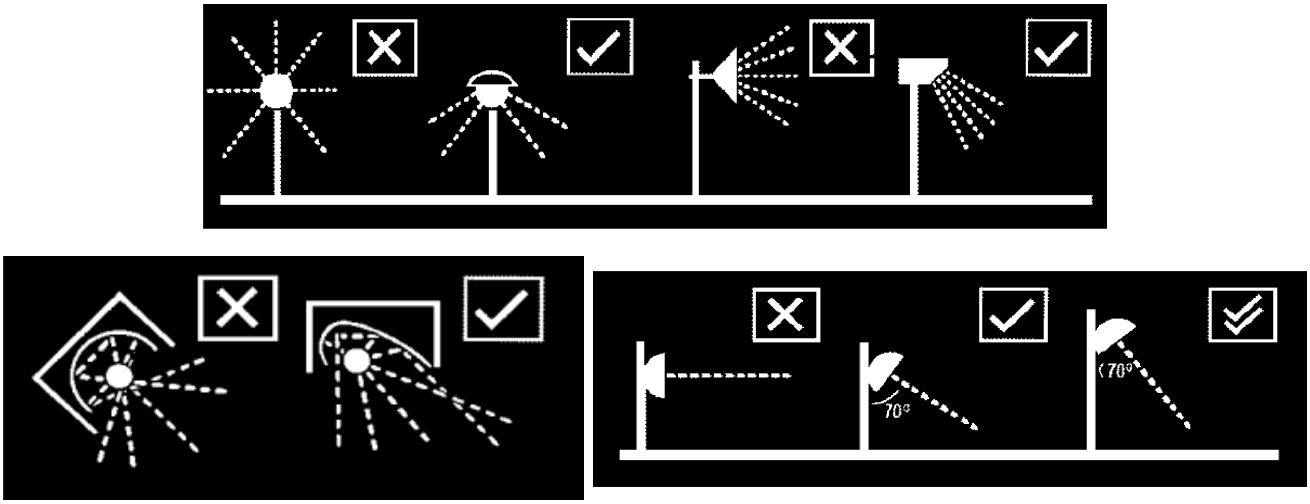

Figure 8 Luminaire Design Features that Minimise Light Spill

7.2 Site Specific Recommendations

New and/or re-furbished or re-located street lights should be aimed downward as much as possible and be shielded to prevent light escaping above the horizontal plane. This is especially important as street lights are typically much higher than the nearby surrounding houses. Refer also the recommendations made in **Section 7.1**.

Lights placed on the outside of the proposed development should be kept as low as practicable and correctly aimed to prevent light spilling on to areas where it is not needed.

Lights should be recessed into the awning where feasible.

Use full cut-off luminaires (all luminaires used in the model were full cut-off)

Take advantage of smart placement and choice of lights to minimise light spill.

Vegetation, fences and other obstacles were not included in the model, primarily due to the uncertainties involved in modelling landscaping which may be prone to seasonal changes in foliage density and varying growth height with the passage of time. They will however provide additional shielding in the real world case and further reduce light spill. This may be relevant for properties located close to street lights or flood lighting.

The proposed development will be designed to comply with AS 4282-1997.

8 Conclusion

SLR has been engaged by NSW Landing and Housing Corporation (LAHC) to provide a lighting assessment of the proposed Waterloo Precinct Development. This report covers the Waterloo South part of the proposed development, with the key deliverable being a lighting model for the proposed site and an outline of any potential recommendations.

A baseline survey was conducted to establish current night-time lighting levels.

- There is currently significant night-time activity throughout neighboring areas of the site, with it being a well-developed mixed suburban and commercial retail precinct. Lighting sources consist of street lights, floodlights, light emitted from commercial shops and from passing vehicles;
- This was confirmed in the baseline survey results with a wide range of night-time lighting levels present in the local environment;
- In general, areas close to and directly under light fixtures (especially close to road intersections) have high illuminance; and
- A number of surveyed areas exceeded the applicable night-timer lighting level requirements of Australian Standard AS 4282-1997 Control of the Obtrusive Effect of Outdoor Lighting (herein “AS 4282-1997”).

A future 3D lighting simulation model of the site was developed using lighting fixtures of the type likely to be used on the site. The resulting light spill was modelled using dedicated lighting software AGi32. This model only assessed additional light produced by the Waterloo South development.

- The resulting illuminance levels on the facades of surrounding buildings from the Waterloo South Development were seen to meet the requirements of AS 4282-1997.
- Any light spill from proposed development on to the facades of surrounding buildings can be managed to avoid unacceptable impacts because (among other things) lighting can be designed, installed and operated to comply with AS4282.

SLR has provided a number of recommendations to manage potential light spill during the detailed design phase of the proposal. As more detailed lighting design plans are generated, the lighting model will be updated to reconfirm compliance with AS 4282-1997.

Comprehensive lighting design will be undertaken as part of future detailed design.

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