PROPOSED MIXED-USE REDEVELOPMENT

4-6 Bligh Street, Sydney CBD
Reflective Glare

Prepared for:

Holdmark
Suite 2, 2-4 Giffnock Avenue
MACQUARIE PARK NSW 2113

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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 Holdmark (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.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.31041-R02-v2.0	16 December 2022	Dr Peter Georgiou	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy
610.31041-R02-v1.0	1 November 2022	Dr Peter Georgiou	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Holdmark to assess the environmental impact of a proposed mixed-use hotel and commercial redevelopment (herein the "Project") located at 4-6 Bligh Street, Sydney, with regard to the potential reflectivity of the facades of the building.

Response to SEARs - SSD 48674209

This report has been prepared to accompany a State Significant Development Application (SSDA) for the Project, specifically to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project (SSD-48674209) with respect to reflective glare effects.

Issue and Assessment Requirements	Documentation
5. *Environmental Amenity* • *Address how good internal and external environmental amenity is achieved, including access to natural daylight and ventilation, pedestrian movement throughout the site, access to landscape and outdoor spaces.* • *Assess amenity impacts on the surrounding locality, including lighting impacts, solar access, visual privacy, view loss and view sharing, overshadowing and wind impacts. A high level of environmental amenity for any surrounding residential or other sensitive land uses must be demonstrated.*	Reflective Glare Study (this report)

Site Context

The site for the purposes of this SSDA is a single allotment identified as 4-6 Bligh Street, Sydney and known as Lot 1 in Deposited Plan 1244245. The application seeks consent for the construction of a 59-storey mixed-use hotel and commercial development. The purpose of the project is to revitalise the site and deliver new commercial floorspace and public realm improvements consistent with the City's vision to strengthen the role of Central Sydney as an international tourism and commercial destination.

The development site is located within the northern part of Sydney's Central CBD precinct surrounded by numerous high-rise buildings, including No.1 O'Connell Street, No.1 Bligh Street, Governor Phillip and Governor Macquarie Towers, Aurora Place, Chifley Tower, etc. Circular Quay and Sydney Cove are located just over 500 m north of the site. To the east are the parkland areas of the Royal Botanic Gardens and The Domain. To the south are the main central spine of the Sydney CBD precinct (south to southwest) and Hyde Park (south-southeast). To the west are more Sydney CBD buildings, Barangaroo and Darling Harbour.

EXECUTIVE SUMMARY

Background to this Report

This Project was subject to a detailed reflective glare study undertaken in 2019 (in response to the then-relevant SEARs requirements – refer SSD 9527).

The 2019 study – herein referred to as the 2019 SLR Glare Study – was documented in:

- SLR Report 610.18713-R02, *"Proposed Mixed-Use Development, 4-6 Bligh Street, Sydney CBD, Reflective Glare Study"*, September 2019.

The following is noted:

- The current design of the Project is essentially IDENTICAL in overall façade geometry to the previous design. On this basis, all other factors being constant, the potential glare impact of the Project would be identical to that assessed in the 2019 SLR Glare Study.
- Since the time of the 2019 SLR Glare Study, several new developments have been (or are being) delivered in near proximity to the Project, the nearest being the AMP site redevelopment at 50 Bridge Street, Sydney CBD, which is shielded at the Project site by the Governor Phillip and Governor Macquarie towers. Accordingly, with respect to the surrounds, and again with all other factors being constant, there are no NEW buildings which have the potential to block either incoming solar rays or outgoing reflections and the glare impact of the Project would be identical to that assessed in the 2019 SLR Glare Study.
- Finally, in relation to Façade Reflective Characteristics, in the 2019 SLR Glare Study, the proposed redevelopment was (conservatively) assumed to have façade elements, stainless steel cladding and glazing, with a reflectivity value no greater than 20%. While some elements of the glazing selection are still to be finalised, the stainless steel cladding of the 2022 Design Iteration of the Project will retain the previous matt finish of the previous design with a reflectivity value considerably less than 20%.

Based on the above considerations, it has been concluded that the 2019 SLR Glare Study comprehensively covers all necessary aspects of the UPDATED (SSD-48674209) SEARs requirements for the (current) Project.

This report therefore re-confirms the key elements of the 2019 SLR Glare Study and its recommendations for the most recent (October 2022) design iteration of the Project.

EXECUTIVE SUMMARY

2019 SLR GLARE STUDY – KEY RESULTS

Preliminary Screening Analysis

In a preliminary screening analysis, several potential glare geometries were excluded, including:

- Southbound Bligh Street traffic, south of the site - motorists looking in the opposite direction to incoming reflections)
- Harbour Tunnel southbound traffic emerging from tunnel – blockage from intervening buildings

In the preliminary TI Value analysis, SLR identified areas that may be affected by potential adverse glare.

- Late afternoon solar rays reflecting off the proposed development's Bligh Street façade Office floors onto Bligh Street traffic (located north of the site); and
- Morning solar rays reflecting off the proposed development's SE façade Hotel floors onto northbound Elizabeth Street traffic.

In the final detailed TI Value analysis, potential glare occurrences were analysed further.

Bligh Street Reflections – Road Traffic Disabilit6y Glare

- Very low altitude incoming solar rays are intercepted by buildings upstream of the site.
- For solar rays able to impact the Bligh Street façade and reflect downwards onto Bligh Street, the angle between the line of sight of drivers and the reflected ray observed by the driver is relatively large (TI Values are at a maximum when viewing a reflected ray directly, tending to zero when the angle between the line of sight and reflection is perpendicular).
- It is virtually impossible for the Bligh Street Office floor façade to see an entire solar disc because of the deep ribbed geometry of the façade – 600 mm deep fins spaced approximately 1.5 m apart.

The detailed TI analysis demonstrated that there would be no glare from the Bligh Street façade.

Elizabeth Street Upper Hotel Floor Reflections – Road Traffic Disabilit6y Glare

- Reflections only become apparent for motorists close to Market Street, ie reflections do not exist for locations north of Market Street due to blockage from Chifley Tower.
- TI Values decrease with distance – the distance from the proposed development to where reflections become apparent on Elizabeth Street is over 450 m
- Finally, for the solar angles of concern, incoming solar rays are only able to impact on a relatively small width of façade (less than 500 mm) due to the blockage effect of the vertical fins present. Glare usually only can arise when a motorist is able to view a full solar disc (typically an area of glazing of at least 1 m diameter.

The detailed TI analysis demonstrated that there would be no glare from the southeast facing façade.

EXECUTIVE SUMMARY

Pedestrian Discomfort Glare

Detailed (Stage 3) calculations for all pedestrian locations examined yielded Cd/m^2 and TI Values all below the recommended 2/3 criteria levels due to a combination of the following:

- A large number of incoming solar ray and outgoing reflected ray conditions are eliminated due to blockage from the numerous tall buildings surrounding the site.
- TI Values decrease with distance – TI Values drop off significantly for pedestrian positions at distant locations such as Circular Quay;
- Due to the "ribbing" present on almost all facades, eg Bligh Street facade for Bligh Street pedestrian locations south of the site, almost all potential incoming solar angles of concern can only impact a relatively small width of façade due to the blockage effect of the vertical fins present. As noted, glare usually can only arise when a receiver is able to view a full solar disc (typically an area of glazing of at least 1 m diameter.
- Finally, pedestrians have the capacity to adjust their line of sight to reduce any potential effects of discomfort glare and are usually focussed on horizontal view lines when at pedestrian crossings, etc.

It should also be noted that the detailed Cd/m^2 and TI Value Analysis results from the 2019 SLR Glare Study yielded Cd/m^2 values well below the usual limiting 500 Cd/m^2 criterion.

2019 SLR Glare Study - Overall Summary

Despite the relatively tall height of the proposed redevelopment, no glare conditions of concern were identified due to a façade design featuring extensive vertical fins that disrupt both incoming solar rays and outgoing reflections combined with significant blockage to a large range of solar rays (both incoming and outgoing) from the numerous tall buildings surrounding the site.

EXECUTIVE SUMMARY

UPDATED SUMMARY FOR THE OCTOBER 2022 PROJECT DESIGN

The following has already been noted:

- The current design of the Project is essentially IDENTICAL in overall façade geometry to the previous design. On this basis, all other factors being constant, the potential glare impact of the Project would be identical to that assessed in the 2019 SLR Glare Study.
- Since the time of the 2019 SLR Glare Study, several new developments have been (or are being) delivered in near proximity to the Project. There are none however with the potential to block either incoming solar rays or outgoing reflections and the hence the glare impact of the Project would be identical to that assessed in the 2019 SLR Glare Study.
- Finally, in relation to Façade Reflective Characteristics, in the 2019 SLR Glare Study, the proposed redevelopment was (conservatively) assumed to have façade elements, stainless steel cladding and glazing, with a reflectivity value no greater than 20%. While some elements of the glazing selection are still to be finalised, the stainless steel cladding of the 2022 Design Iteration of the Project will retain the previous matt finish of the previous design with a reflectivity value considerably less than 20%.

Based on the above, the 2019 SLR Glare Study comprehensively covers all necessary aspects of the UPDATED (SSD-48674209) SEARs requirements for the (current) Project, including the overall conclusion that no specific mitigation treatments will be needed in relation to the potential for adverse glare from the proposed redevelopment.

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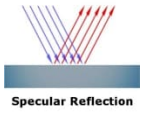
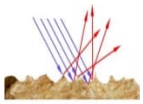
Abbreviations and Definitions

Terms relevant to Daytime Reflective Glare	
PV Panel	Photovoltaic (PV) panels are designed to absorb solar energy and retain as much of the solar spectrum as possible in order to produce electricity.
Glare	Glare refers to the reflections of the sun off any reflective surface, experienced as a source of excessive brightness relative to the surrounding diffused lighting. Glare covers reflections: . Which can be experienced by both stationary and moving observers (the latter referred to as "glint"). . Which are either specular or diffuse.
Specular	A reflection which is essentially mirror-like – there is virtually no loss of intensity or angle dispersion between the incoming solar ray and outgoing reflection.  Specular Reflection
Diffuse	A reflection in which the outgoing reflected rays are dispersed over a wide ("diffuse") range of angle compared to the incoming (parallel) solar rays, typical of "rougher" surfaces.  Diffuse Reflection
KVP	Key View Points (KVPs) are offsite locations where receivers of interest have the potential to experience adverse reflective glare.

Terms relevant to Night-Time Illumination	
Luminous intensity	The concentration of luminous flux emitted in a specific direction. Unit: candela (Cd).
Luminance AS 1158.2:2020	This is the physical quantity corresponding to the brightness of a surface (eg a lamp, luminaire or reflecting material such as façade glazing) when viewed from a specified direction. Unit: Cd/m^2
Illuminance AS 1158.2:2020	This is the physical measure of illumination. It is the luminous flux arriving at a surface divided by the area of the illuminated surface – the unit is lux (lx) … 1 lx = 1 lm/m^2 The term covers both "Horizontal Illuminance" (the value of illuminance on a designated horizontal plane at ground level) and "Vertical Illuminance" (the value of illuminance on a designated vertical plane at a height of 1.5m above ground level).
Glare AS 1158.2:2020	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. Glare can include: (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.
Threshold Increment (TI) AS 4282:2019	TI is 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. Higher TI values correspond to greater disability glare.

1 INTRODUCTION

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1.1 Site Context

The site for the purposes of this SSDA is a single allotment identified as 4-6 Bligh Street, Sydney and known as Lot 1 in Deposited Plan 1244245 – refer Figure 1.

The application seeks consent for the construction of a 59-storey mixed-use hotel and commercial development. The purpose of the project is to revitalise the site and deliver new commercial floorspace and public realm improvements consistent with the City's vision to strengthen the role of Central Sydney as an international tourism and commercial destination.

The development site is located within the northern part of Sydney's Central CBD precinct surrounded by numerous high-rise buildings, including No.1 O'Connell Street, No.1 Bligh Street, Governor Phillip and Governor Macquarie Towers, Aurora Place, Chifley Tower, etc. Circular Quay and Sydney Cove are located just over 500 m north of the site. To the east are the parkland areas of the Royal Botanic Gardens and The Domain. To the south are the main central spine of the Sydney CBD precinct (south to southwest) and Hyde Park (south-southeast). To the west are more Sydney CBD buildings, Barangaroo and Darling Harbour.

Figure 1 Site Context

The proposed mixed-use redevelopment will involve the construction of a 59-storey hotel and commercial office tower. The tower will have a maximum building height of RL225.88 (205m) and a total gross floor area (GFA) provision of 26,796 sqm, and will include the following elements:

- Five basement levels accommodating a substation, rainwater tank, hotel back of house, plant and services. A Porte Cochere and four service bays will be provided on basement level 1, in addition to 137 bicycle spaces and end of trip facilities on basement level 2, as well as 28 car parking spaces.
- A 12-storey podium accommodating hotel concierge and arrival at ground level, conference facilities, eight levels of commercial floor space and co-working facilities, and hotel amenities including a pool and gymnasium at level 12.
- 42 tower levels of hotel facilities including 417 hotel keys comprising standard rooms, suites and a penthouse.
- Two tower levels accommodating restaurant, bar, back of house and a landscaped terrace at level 57.
- Plant, servicing and BMU at level 59 and rooftop.

1.2 Background to this Report

This Project was subject to a detailed reflective glare study undertaken in 2019 (in response to the then-relevant SEARs requirements – refer SSD 9527).

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On the basis of the above considerations, the following has been concluded:

> The 2019 SLR Glare Study comprehensively covers all necessary aspects of the UPDATED (SSD-48674209) SEARs requirements for the (current) Project.

This report therefore reviews all key elements of the 2019 SLR Glare Study and confirms its conclusions for the most recent (October 2022) design iteration of the Project.

2 FAÇADE FEATURES RELEVANT TO GLARE IMPACT

2.1 Façade Forms

A prominent feature (relevant to glare impact) present on virtually all facades of the proposed redevelopment is the presence of significant "ribbing" created by a variety of fins at various elevation area of the building:

- The Bligh Street façade lower floors feature deep ribbing as shown in Figure 2, with fins protrude approximately 600 mm out from the façade glazing with a spacing of approximately 1.5 m.
- The Hotel component features various façade forms which consist either of expanses of a stainless steel cladding or glazing interrupted by ribbing consisting of 200 mm fins spaced between 900 mm and 1 m apart – refer Figure 3.

Figure 2 Bligh Street Façade – Lower Floors

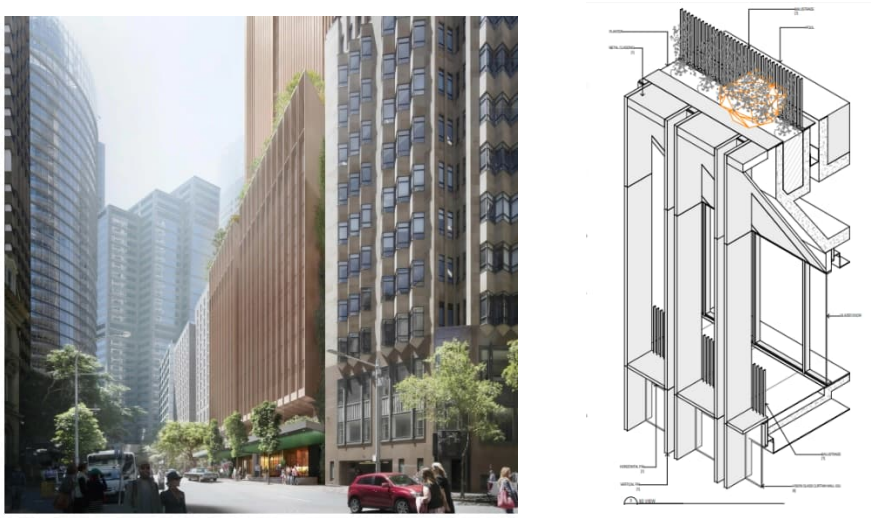


Figure 3 Upper Level Façades – Hotel Component

2.2 Cladding Reflectivity

Glazing

It has been conservatively assumed that all glazing elements would have a (zero incidence angle) reflectivity value no greater than 20%.

Metal Cladding

The metal cladding to be used on the Project will be a stainless steel product. Care needs to be taken when referring to the "reflectivity" of such products. Generally speaking, materials are either specular or diffuse in terms of their reflectance – refer Abbreviations and Definitions.

Some materials however are described as having both a specular component and diffuse component, which can be confusing in terms of their potential to create reflective glare - this applies in particular to stainless steel (SS) which is a naturally reflective type of surface.

- Oxidation does not develop rapidly with SS so the surface remains smooth for much longer than normal cladding materials. This is normally seen as a "plus", being good for corrosion resistance;
- SS however can have a very large range of surface finishes depending upon the "rolling" technique used in production, ranging from a quite "reflective" sheen to a very "dull" sheen. As a result, in terms of their reflectance, SS finishes can be separated into different groups of surface types;
- Reflective SS Finishes are similar to a mirror, with very little scattering of light. They are sometimes called "Bright Annealed" because the mirror-like surface is created by an annealing process;
- Diffused Reflective SS Finishes are ones where minute surface fractures or indentations help to scatter reflected light but not overwhelmingly so – a "sheen" still remains; and
- Low Reflective SS Finishes possess a dull reflection with light scattered just like a rough surface.

Applying surface coatings to SS generally leads to a more diffuse finish, ie a more scattered, subdued appearance which leads to an excellent outcome in terms of solar radiation and energy performance. Such coated finishes:

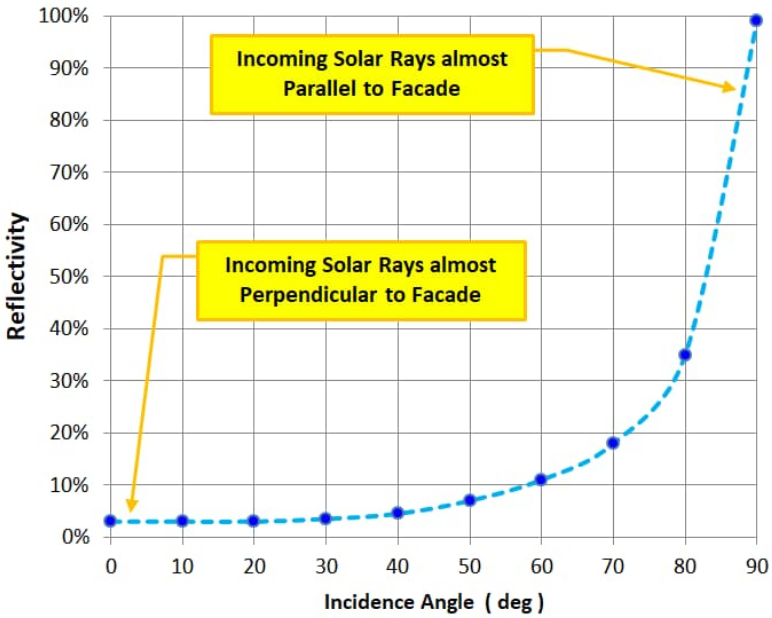
- deliver a low glare finish that avoids unwanted glare, but still
- deliver significant overall reflectance at most solar wavelengths, resulting in building energy savings (less energy required to heat and cool the building)

In relation to the proposed redevelopment, the following was understood at the time of the 2019 SLR Glare Study:

- The metal cladding likely to be used is a ROSY GOLD GRANEX or equivalent.
- For reference purposes, a close match to this product is a RIMEX stainless steel product term termed: "Granex M1A".

Based on the data sourced from the RIMEX brochure covering all of their stainless steel products, the reflectivity for this product has been reproduced in Figure 4.

Figure 4 RIMEX Granex M1A Reflectivity



ROSY GOLD GRANEX has a definite "matt" finish – as compared to other highly annealed stainless steel surfaces.

It has been very conservatively assumed that the SS cladding elements have the same nominal reflectivity as the glazing elements of the facade, ie 20% (at zero incidence angle).

2.3 Influence of Surrounding Buildings

In terms of its reflectivity potential, the Project site benefits from the shielding (blockage) of both incoming solar rays and outgoing reflections generated by the numerous similar height towers surrounding the site, including:

- Aurora Place and Chifley Tower to the east;
- Deutsche Bank Tower, 12 Chifley Tower and 52 Martin Place to the southeast;
- No.1 Bligh, Governor Macquarie and Governor Phillip towers to the north;
- No.1 O'Connell, Norwich House and Mulpha House to the west; and
- 55 Hunter Street and Capita Centre to the south.

3 REFLECTIVITY IMPACT METHODOLOGY AND CRITERIA

3.1 Glare Characteristics

- At large angles of incidence (typically greater than 70°), the reflectivity of all cladding types *increases significantly*. Thus, the potential for glare increases regardless of the cladding type, when incoming solar rays can impact on a building close to parallel to the plane of the glazing/cladding;
- On a practical level, incoming solar rays with an altitude angle greater than 20° are intersected and obstructed by a typical windscreen roof-line. In this Report, it is assumed that the sun altitude angle must be less than 25° to have the potential to produce a traffic disability glare event;
- Pedestrian discomfort glare can occur when the sun altitude is greater than 25°. However, in most such instances, a pedestrian is able to adjust their line of sight to a more horizontal view away from the glare source; and
- It is assumed that glare events can only occur when the solar altitude is greater than about 3°, enabling the entire solar disc to be visible.

3.2 Glare Acceptability Criteria

The criteria used within this report to assess the acceptability or otherwise of glare events are the limiting values of the so-called *"Threshold Increment Value"*, or *TI Value,* of the reflection condition, as shown in Table 1.

Table 1 Threshold Increment (TI) Criteria

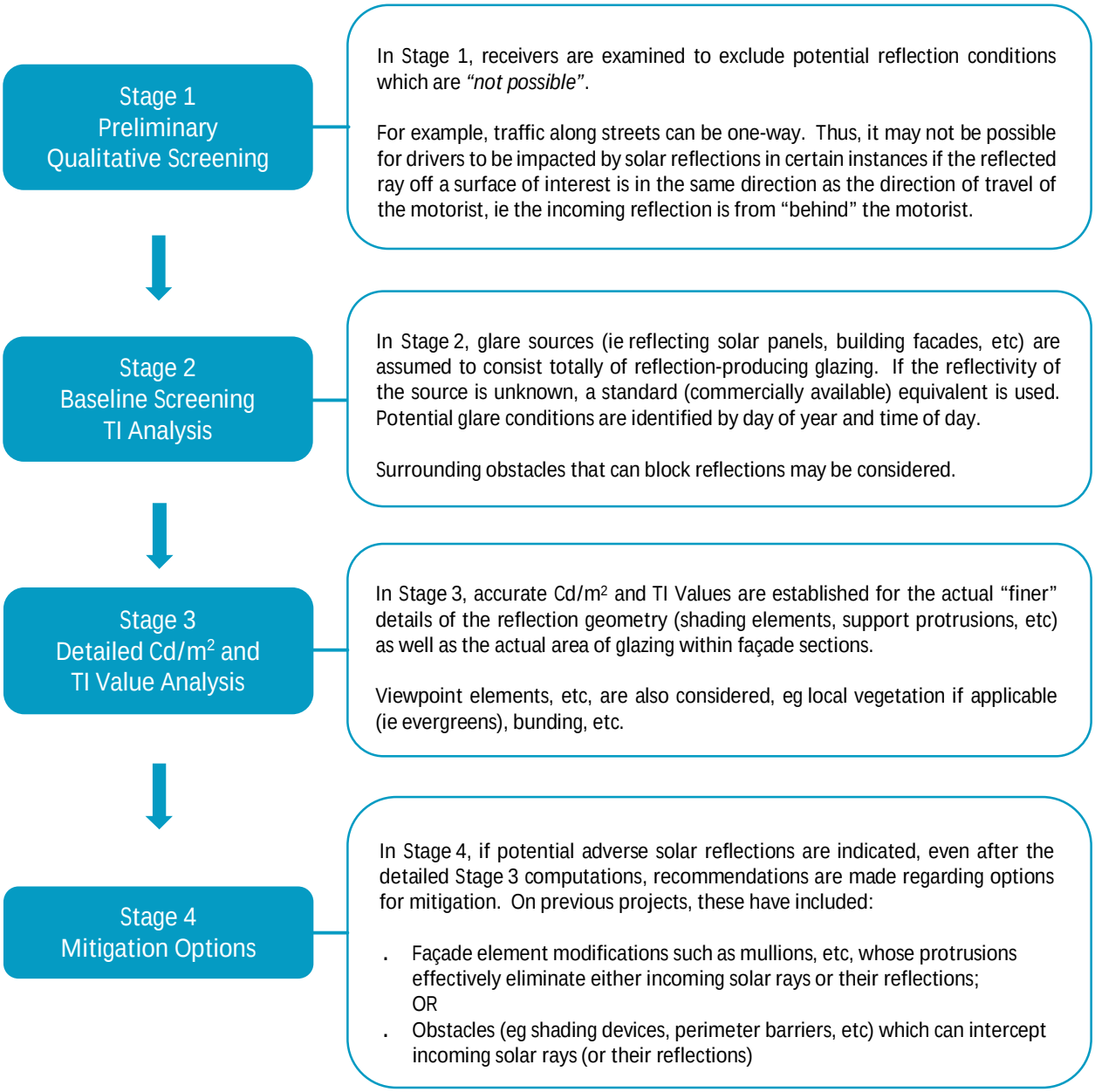
Glare Category	Classification	TI Acceptable Limit
Disability Glare (for motorists)	Major Roads	10
	Minor Roads	20
Discomfort Glare (for pedestrians)	Pedestrian Crossings	2
	Other Footpath Locations	3

An additional criterion normally applied to glare analyses is to not exceed a luminance value of 500 Cd/m^2.

3.3 Reflectivity Analysis Methodology

SLR carries out reflectivity TI-Cd/m^2 calculations using a four-stage process, shown in Figure 5.

Figure 5 SLR's TI-Cd/m^2 Analysis Methodology



4 GLARE IMPACT ANALYSIS

4.1 Solar Angle Variations

The range of solar angles at the project site is shown in Figure 6. Key solar angle limits for the solstice and equinox days are listed in Table 2.

Figure 6 Variation of Annual Solar Angle Azimuth and Altitude for Project Site Location

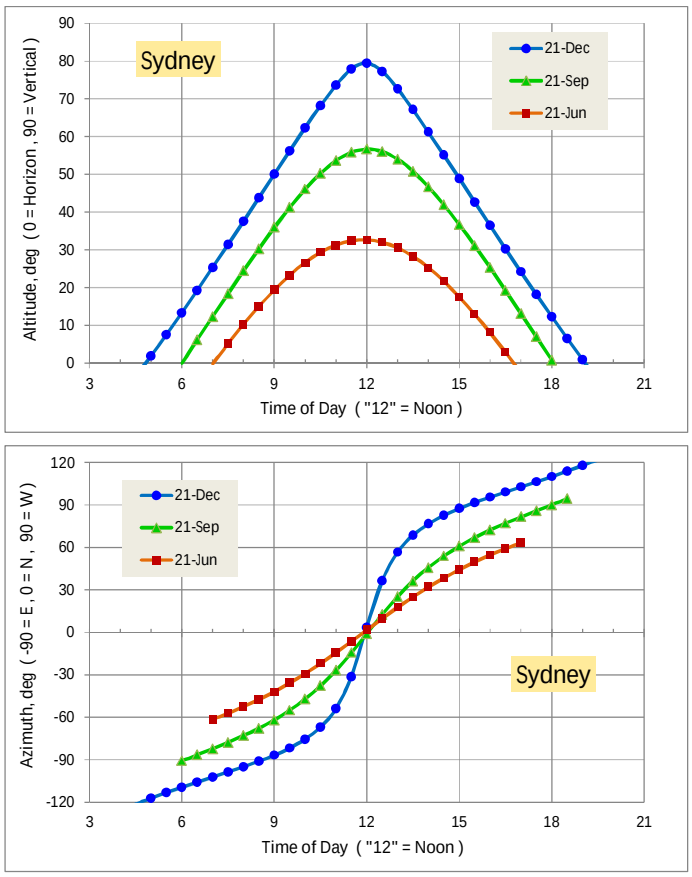


Table 2 Key Annual Solar Angle Characteristics at Project Site

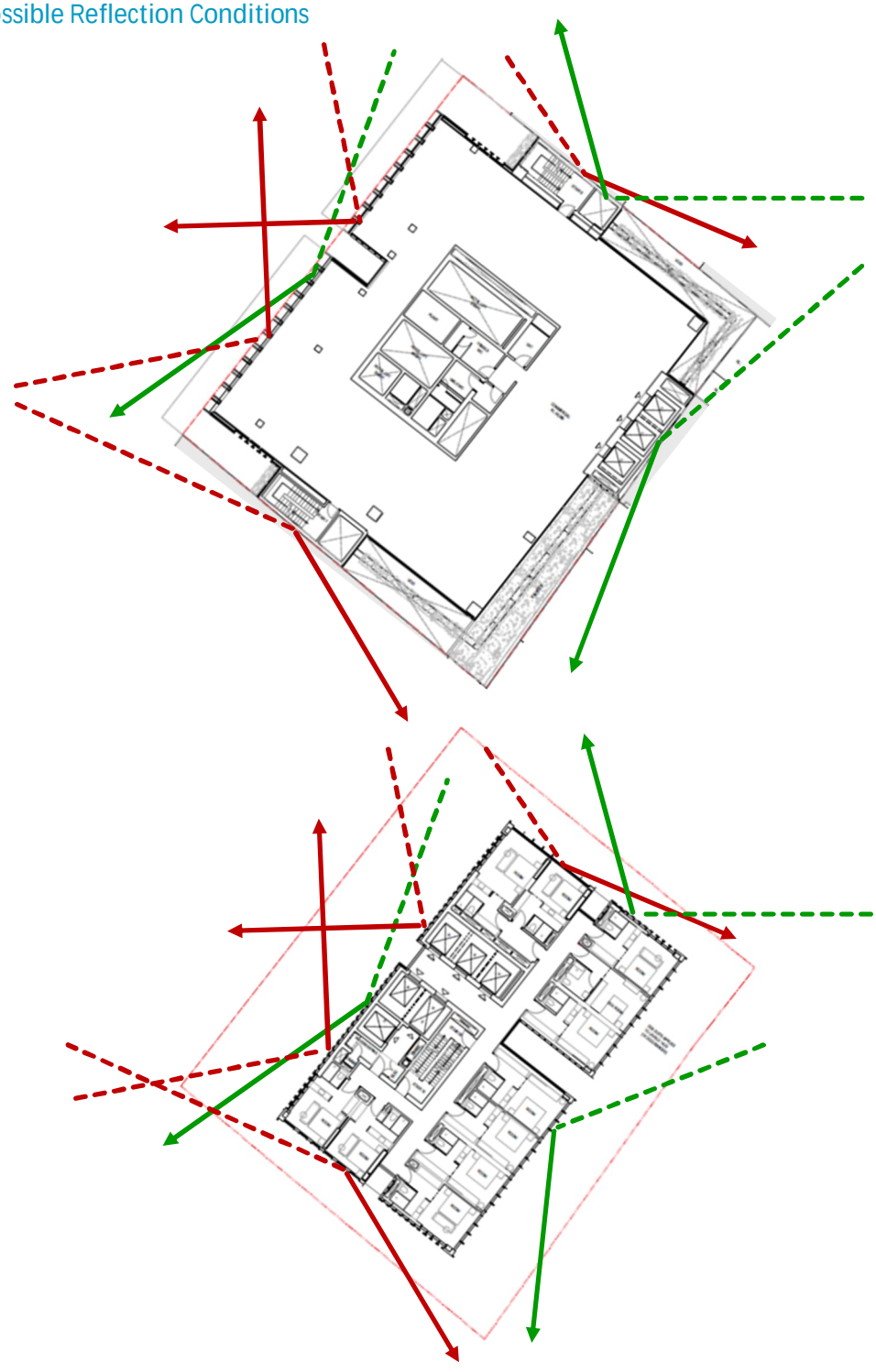
Day of Year	Sunrise	Sunset	Azimuth Range	Highest Altitude
Summer Solstice	4:49 am	7:05 pm	118.7° E of North to 118.6° W of North	79.5°
Equinox	6:01 am	6:04 pm	90.7° DUE EAST to 90.7° DUE WEST	56.7°
Winter Solstice	7:01 am	4.46 pm	61.4° E of North to 61.3° W of North	32.7°

4.2 Potential Solar Reflection Conditions at the Project Site

The range of possible incoming solar rays and outgoing reflections from the proposed redevelopment is shown in Figure 7.

Morning Rays: incoming
Morning Rays: reflections
Afternoon Rays: incoming
Afternoon Rays: reflections

Figure 7 Possible Reflection Conditions

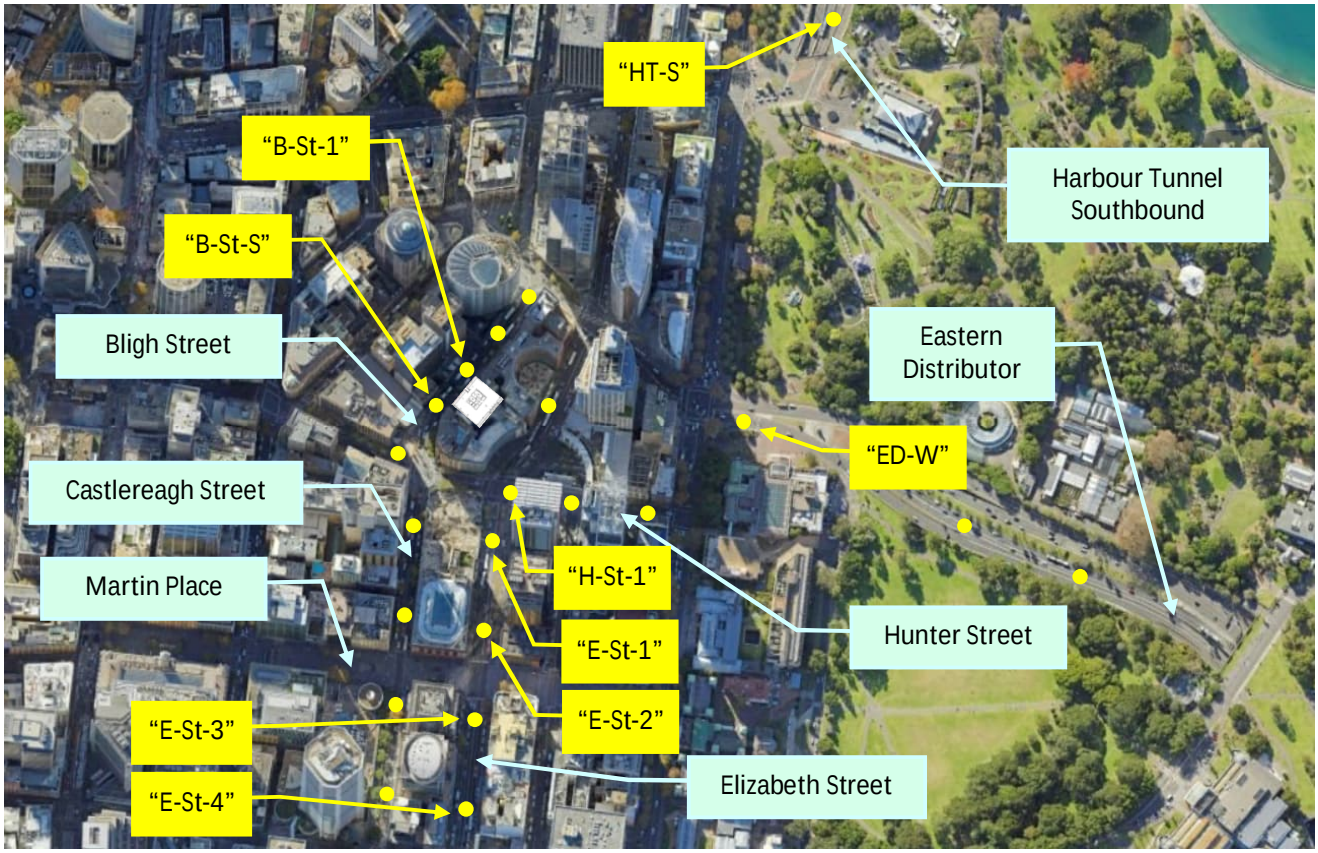


4.3 Traffic Disability Glare

4.3.1 Traffic Glare Assessment Locations

The traffic disability glare assessment locations are shown in Figure 8.

Figure 8 Traffic Disability Glare Assessment Locations



4.3.2 "Stage 1" Review - Screening

Several façade-solar ray combinations were seen to be unable to create reflections of concern for relevant motorist disability:

- Bligh Street traffic is one-way going south. Once drivers have passed the development site, it will be impossible for them to experience reflective glare impact from Bligh Street façade reflections – refer Receiver "B-St-S".
- In relation to southbound traffic emerging from the Sydney Harbour Tunnel– refer Receiver "HT-S", reflections off the proposed development's Bligh Street façade from the west are never "low enough", ie south of west, to enable reflections impacting this position.
- Receiver "ED-W" at the Eastern Distributor exit near Macquarie Street cannot be impacted by reflective glare from the proposed development due to blockage from Chifley Tower.

4.3.3 "Stage 2" Review

Table 3 summarises the potential reflectivity conditions for the proposed development that were identified in the 2019 SLR Glare Study.

Table 3 Potentially Adverse Reflectivity Conditions

Street	Traffic	Façade(s)	Are Reflections Possible	Time
Bligh Street	Southbound	Bligh Street (Office)	YES (close to site, "B-St-1" Fig.6)	Late Afternoon (mid-summer)
Elizabeth Street	Northbound	Southeast (Hotel)	YES, refer "E-St-1/2/3", Fig.5 (south of site for several blocks)	Morning rays (mid-winter)
Castlereagh Street	Northbound	Southeast	NO: Reflections off the SE façade are intercepted by intervening buildings between Elizabeth and Castlereagh Street south of Hunter Street	Morning rays (mid-winter)
Hunter Street	Westbound	Southwest Southeast	NO: Reflections off both facades low enough to be "seen" by Receiver "H-St-1" are intercepted by the building on the NW corner of Hunter Street and Phillip Street.	Morning rays (summer) Afternoon rays (summer)

4.3.4 "Stage 3" Detailed TI Value Calculations

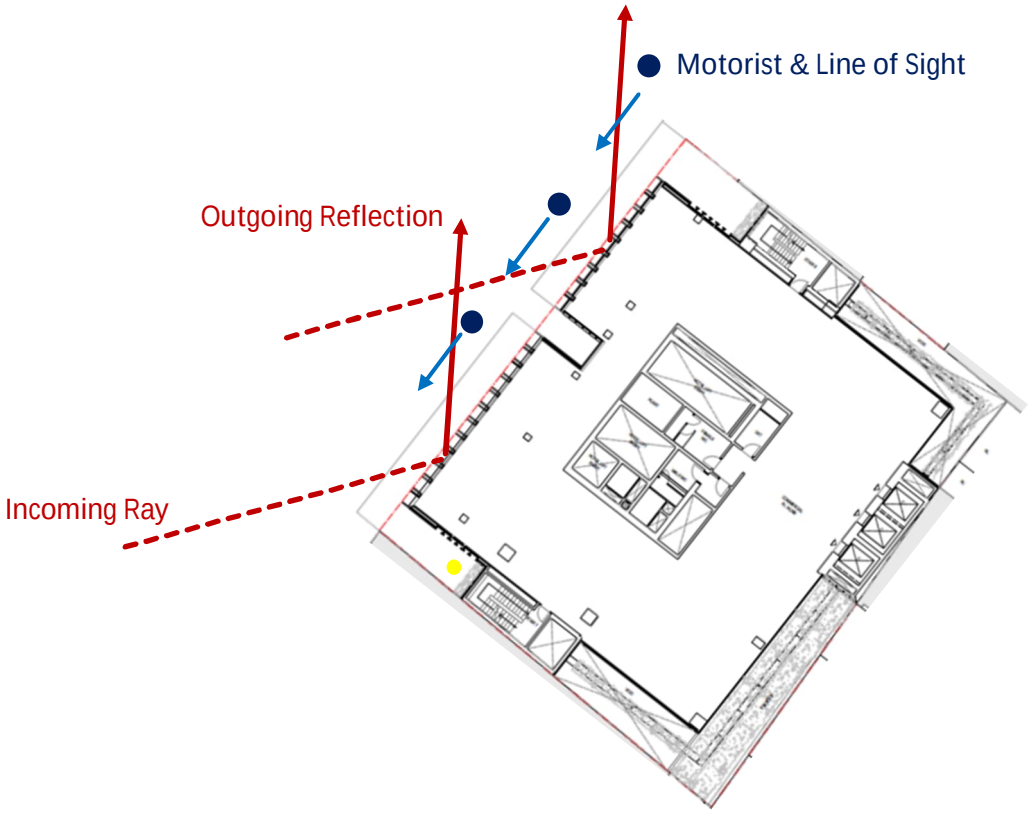
Two areas of potential glare were identified in the Stage 2 Preliminary Analysis.

- Late afternoon summer solar rays reflecting off the proposed development's Bligh Street façade (Office floors) onto southbound traffic on Bligh Street (close to the site); and
- Morning solar rays reflecting off the proposed development's southeast facing façade (Hotel floors) onto northbound Elizabeth Street traffic (south of Hunter Street).

Bligh Street Office Floor Reflections onto Bligh Street

The potential reflections identified for southbound Bligh Street traffic occur for incoming solar ray azimuth angles in the range 105°W to 115°W, ie south of west, late afternoon mid-summer rays – refer Figure 9.

Figure 9 Possible Bligh Street Reflection Conditions



TI Value calculations for the reflection condition shown in Figure 9 are all minimal (all less than 1) as a result of the following:

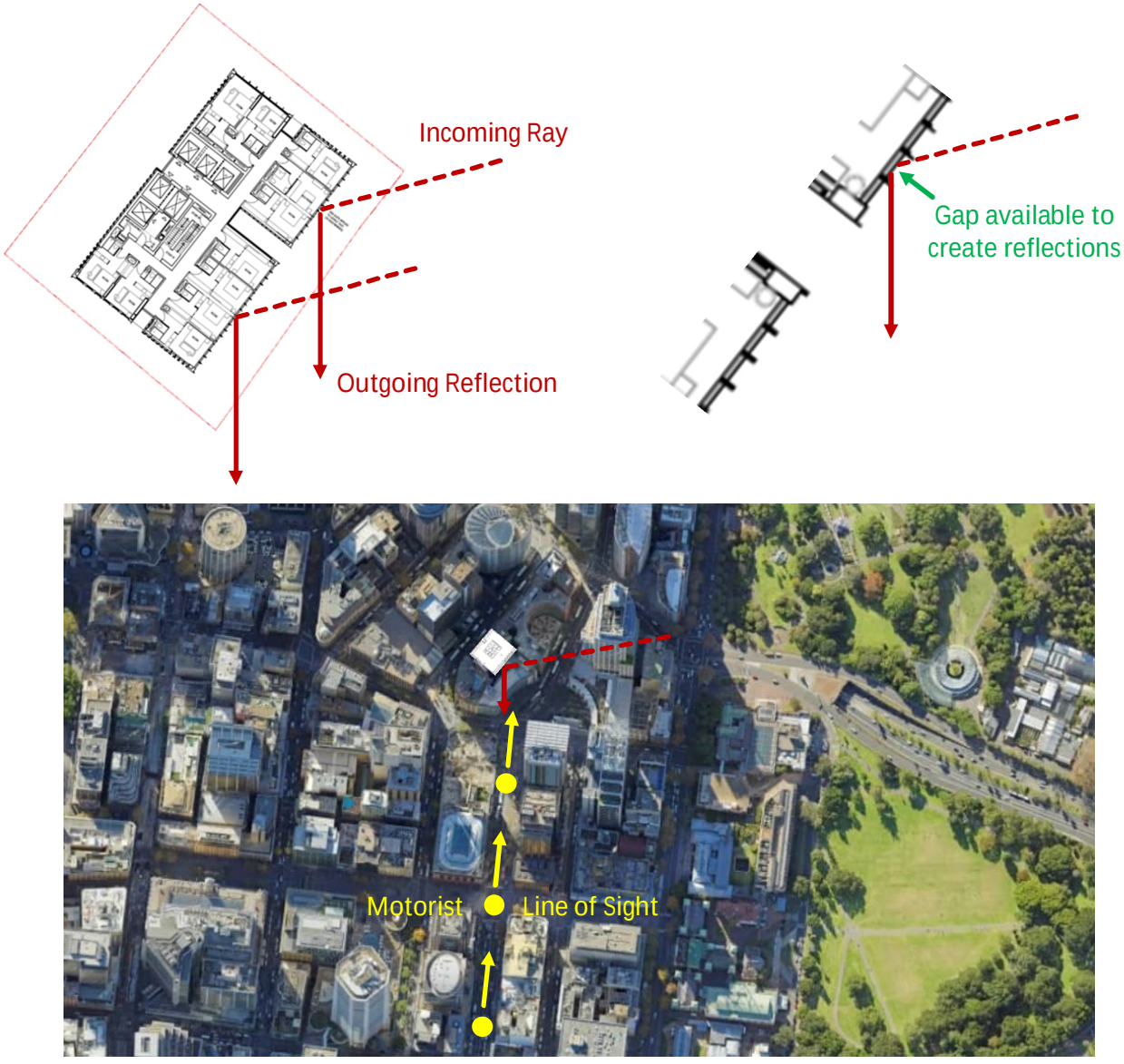
- Very low altitude incoming solar rays are intercepted by buildings upstream of the site
- For solar rays able to impact the Bligh Street façade and reflect downwards onto Bligh Street, the angle between the line of sight of drivers and the reflected ray observed by the driver is relatively large (TI Values are at a maximum when viewing a reflected ray directly, tending to zero when the angle between the line of sight and reflection is perpendicular)
- It is virtually impossible for the Bligh Street Office floor façade to see an entire solar disc because of the deep ribbed geometry of the façade – 600 mm deep fins spaced approximately 1.5 m apart.

Southeast Façade Hotel Floor Reflections onto Elizabeth Street

The potential reflections identified for northbound Elizabeth Street traffic occur for incoming solar ray azimuth angles in a tight angle range between 75°E to 80°E, ie east of north, mid-season early morning rays – refer Figure 10.

Views of the proposed development seen by Elizabeth Street motorists are also shown in Figure 10.

Figure 10 Possible Elizabeth Street Reflection Conditions

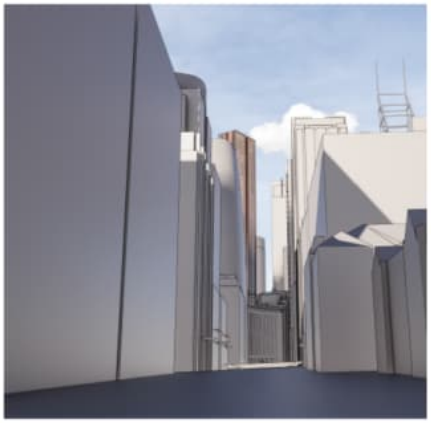


(Fig.10 cont'd)

Views seen by Elizabeth Street northbound motorists

Elizabeth & Martin Place

Elizabeth & Market Street



TI Value calculations for the reflection condition shown in Figure 10 are all zero for all but the highest floors of the proposed development, thanks to the interception of incoming solar rays by Chifley Tower.

For the reflection conditions where incoming solar rays are able to impact the proposed development's SE façade upper Hotel floors and then reflect downwards towards Elizabeth Street, the detailed Stage 3 calculations yield TI Values less than 2 as a result of the following:

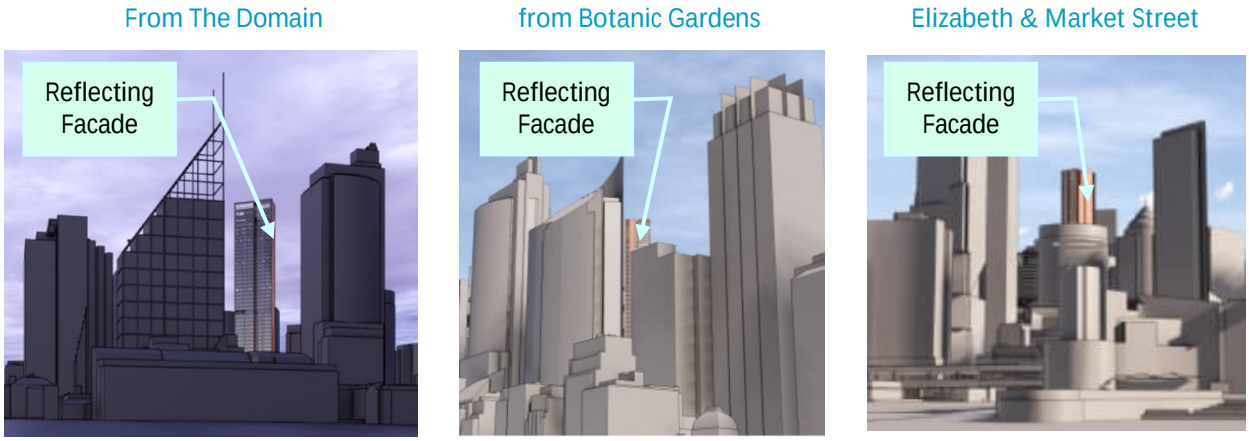
- Reflections only become apparent for motorists close to Market Street, ie reflections do not exist for locations north of Market Street due to the Chifley Tower blockage effect.
- TI Values decrease with distance – the distance from the proposed development to where reflection become apparent on Elizabeth Street is over 450 m
- Finally, Figure 10 shows that, for the solar angles of concern, incoming solar rays are only able to impact on a relatively small width of façade (less than 500 mm) due to the blockage effect of the vertical fins present. Glare usually only can arise when a motorist is able to view a full solar disc (typically an area of glazing of at least 1 m diameter.

4.4 Pedestrian Discomfort Glare

The preliminary (Stage 2) calculations showed that there would be numerous potential reflection conditions occurrences for pedestrians surrounding the proposed development given its height (just over 200 m from ground level).

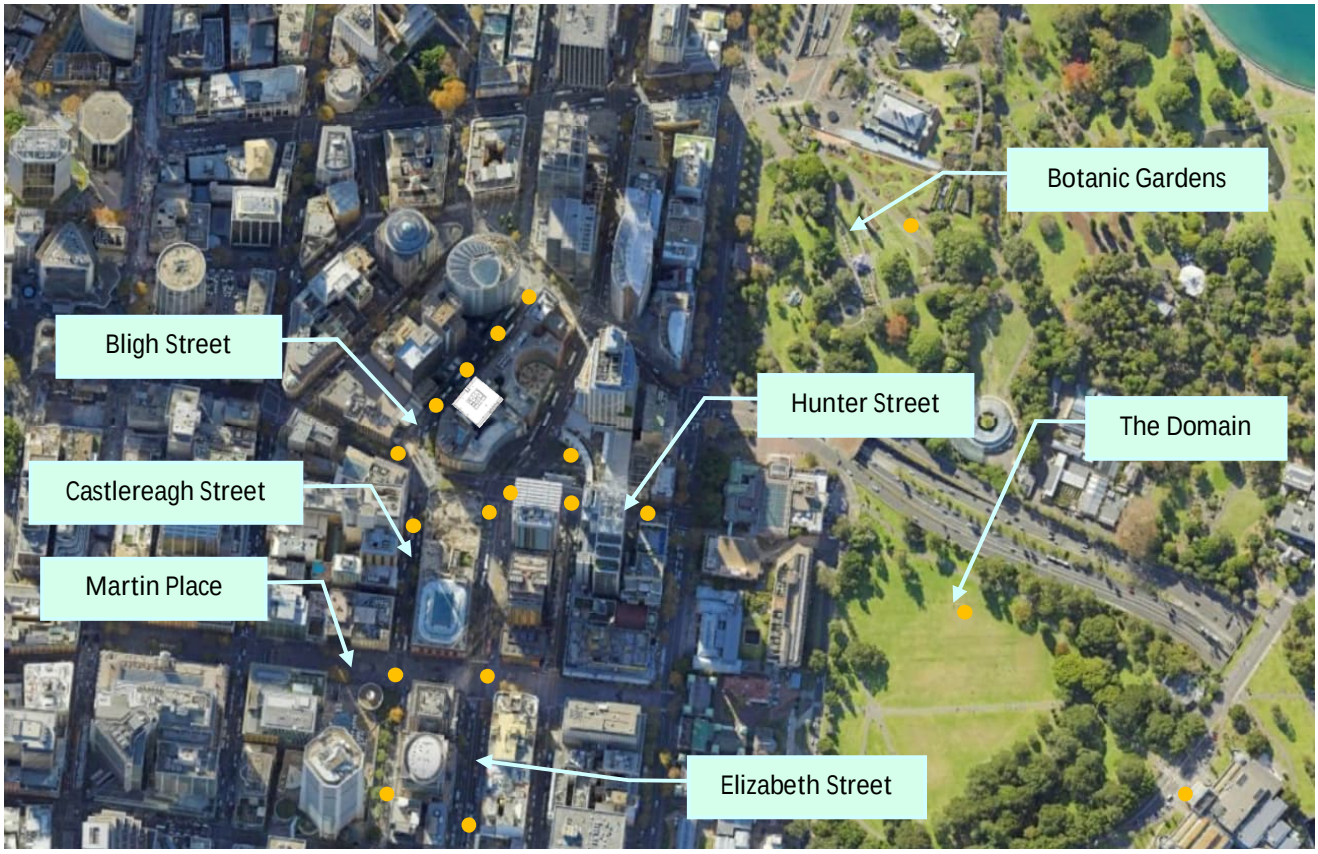
In addition to pedestrian areas immediately surrounding the site, a range of representative views of the proposed development from some more distant locations is shown in Figure 11.

Figure 11 Views of the Proposed Development from Various Pedestrian Vantage Points



Near-field pedestrian locations examined for discomfort glare are shown in Figure 12. Other locations were also examined further afield, including locations around Circular Quay (west side). It should be noted that the proposed development cannot be observed from virtually all vantage points close to the Opera House due to the blockage effect of intervening buildings: Governor Phillip and Governor Macquarie towers, AMP Towers, etc.

Figure 12 Pedestrian Discomfort Glare Assessment Locations



Detailed (Stage 3) calculations for all pedestrian locations examined yielded TI Values all below the recommended 2/3 criteria levels due to a combination of the following:

- A large number of incoming solar ray and outgoing reflected ray conditions are eliminated due to blockage from the numerous tall buildings surrounding the site.
- TI Values decrease with distance – TI Values drop off significantly for pedestrian positions at distant locations such as Circular Quay;
- Due to the "ribbing" present on almost all facades, eg Bligh Street facade for Bligh Street pedestrian locations south of the site, almost all potential incoming solar angles of concern can only impact a relatively small width of façade due to the blockage effect of the vertical fins present. As noted before, glare usually can only arise when a receiver is able to view a full solar disc (typically an area of glazing of at least 1 m diameter.
- Finally, pedestrians have the capacity to adjust their line of sight to reduce any potential effects of discomfort glare and are usually focussed on horizontal view lines when at pedestrian crossings, etc.

The detailed Cd/m^2 results (corresponding to the assessed TI Values) yielded Cd/m^2 values well below the usual limiting 500 Cd/m^2 criterion.

5 CONCLUSIONS AND RECOMMENDATIONS

Façade Reflective Characteristics

For the present study, the proposed redevelopment has (conservatively) been assumed to have façade elements, stainless steel cladding and glazing, with a reflectivity value no greater than 20%. While final glazing selection is still taking place, it is understood that the stainless steel cladding will almost certainly have a matt finish with a reflectivity value of considerably less than 20%

Preliminary Screening Analysis

In a preliminary screening analysis, several potential glare geometries were excluded, including:

- Southbound Bligh Street traffic, south of the site - motorists looking in the opposite direction to incoming reflections)
- Harbour Tunnel southbound traffic emerging from tunnel – blockage from intervening buildings

In the next preliminary TI Value analysis, SLR identified areas that may be affected by potential adverse glare.

- Late afternoon solar rays reflecting off the proposed development's Bligh Street façade Office floors onto Bligh Street traffic (located north of the site); and
- Morning solar rays reflecting off the proposed development's SE façade Hotel floors onto northbound Elizabeth Street traffic.

In the final detailed TI Value analysis, potential glare occurrences were analysed further.

Bligh Street Reflections – Road Traffic Disability Glare

- Very low altitude incoming solar rays are intercepted by buildings upstream of the site.
- For solar rays able to impact the Bligh Street façade and reflect downwards onto Bligh Street, the angle between the line of sight of drivers and the reflected ray observed by the driver is relatively large (TI Values are at a maximum when viewing a reflected ray directly, tending to zero when the angle between the line of sight and reflection is perpendicular).
- It is virtually impossible for the Bligh Street Office floor façade to see an entire solar disc because of the deep ribbed geometry of the façade – 600 mm deep fins spaced approximately 1.5 m apart.

The detailed TI analysis demonstrated that there would be no glare from the Bligh Street façade.

Elizabeth Street Upper Hotel Floor Reflections – Road Traffic Disability Glare

- Reflections only become apparent for motorists close to Market Street, ie reflections do not exist for locations north of Market Street due to blockage from Chifley Tower.
- TI Values decrease with distance – the distance from the proposed development to where reflections become apparent on Elizabeth Street is over 450 m
- Finally, Figure XX shows that, for the solar angles of concern, incoming solar rays are only able to impact on a relatively small width of façade (less than 500 mm) due to the blockage effect of the vertical fins present. Glare usually only can arise when a motorist is able to view a full solar disc (typically an area of glazing of at least 1 m diameter.

The detailed TI analysis demonstrated that there would be no glare from the southeast facing façade.

Pedestrian Discomfort Glare

Detailed (Stage 3) calculations for all pedestrian locations examined yielded TI Values all below the recommended 2/3 criteria levels due to a combination of the following:

- A large number of incoming solar ray and outgoing reflected ray conditions are eliminated due to blockage from the numerous tall buildings surrounding the site.
- TI Values decrease with distance – TI Values drop off significantly for pedestrian positions at distant locations such as Circular Quay;
- Due to the "ribbing" present on almost all facades, eg Bligh Street facade for Bligh Street pedestrian locations south of the site, almost all potential incoming solar angles of concern can only impact a relatively small width of façade due to the blockage effect of the vertical fins present. As noted, glare usually can only arise when a receiver is able to view a full solar disc (typically an area of glazing of at least 1 m diameter.
- Finally, pedestrians have the capacity to adjust their line of sight to reduce any potential effects of discomfort glare and are usually focussed on horizontal view lines when at pedestrian crossings, etc.

It should also be noted that the detailed TI Analysis results from the 2019 SLR Glare Study yielded Cd/m^2 values well below the usual limiting 500 Cd/m^2 criterion.

OVERALL SUMMARY

Despite the relatively tall height of the proposed redevelopment, no glare conditions of concern were identified due to a façade design featuring extensive vertical fins that disrupt both incoming solar rays and outgoing reflections combined with significant blockage to a large range of solar rays (both incoming and outgoing) from the numerous tall buildings surrounding the site.

6 FEEDBACK

At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via https://www.slrconsulting.com/en/feedback. We recognise the value of your time and we will make a $10 donation to our 2022 Charity Partner – Lifeline, for every completed form.

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