

Final Report Rev.1

Reflectivity Report for Stage 2
State Significant Development
Application (SSDA 3):

**SYDNEY INTERNATIONAL
CONVENTION, EXHIBITION AND
ENTERTAINMENT PRECINCT
(SICEEP), THE HAYMARKET:
WESTERN PLOT**

Sydney, Australia

CPP Project 7093

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EXECUTIVE SUMMARY

Cermak Peterka Petersen Pty. Ltd. has been engaged by Lend Lease to assess the proposed Haymarket Precinct of Sydney International Convention Centre, Exhibition and Entertainment Precinct (SICEEP) in terms of Solar Reflectivity. This report supports a State Significant Development (SSD) Development Application (DA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

This report addresses the List of Deliverables for SSDA3, Façade Reflectivity Statement i.e. 'Addresses reflectivity impacts to the surrounding area. A high level of environmental amenity must be demonstrated'.

This report utilises the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity to assess impacts. Specifically, Section 3.2.7 states that “A Reflectivity Report that analyses potential for solar glare from the proposed building design may be required for tall buildings”.

Lend Lease will ensure all exterior façade elements used throughout the development will limit light reflectivity to 20% or less as required under the Sydney Development Control Plan 2012 best practice guideline.

This report quantifies the potential for solar reflectivity glare impact upon motorist using roadways intersecting and surrounding the SICEEP Haymarket precinct with focus on the Western Plot in this report. CPP use in part methodology developed by Hassall (1991) and the concept of veiling glare and contrast when quantifying the potential for hazard rogue reflections to be cast onto surrounding motorway receiver locations. Pedestrian impacts are assessed more broadly in this report in terms of amenity and usability of the site. This report does not assess solar glare impact onto surrounding buildings nor glare from artificial lighting.

With the measures to be adopted by the designers as described in this report regarding choice of façade materials and façade articulation, the proposed Western Plot W2 development does not present a driver hazard in terms of solar glare and will meet the Sydney Development Control Plan 2012 controls for reflectivity.

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1. INTRODUCTION

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2. CLIENT PROVIDED INFORMATION

2.1. Introduction

This report supports a State Significant Development (SSD) Development Application (DA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The Application (referred to as SSDA 3) follows the submission of a staged SSD DA (SSDA 2) submitted in March 2013 to the Department of Planning and Infrastructure that set out a Concept Proposal for a new mixed use neighbourhood at Darling Harbour known as 'The Haymarket'. The Haymarket forms part of the Sydney international convention, exhibition and entertainment precinct (SICEEP) Project, which will deliver Australia's global city with new world class convention, exhibition and entertainment facilities and support the NSW Government's goal to "make NSW number one again".

More specifically this subsequent DA seeks approval for a residential building (student accommodation) within the Western development plot (Darling Drive) of The Haymarket and associated public domain works. The DA has been prepared and structured to be consistent with the Concept Proposal DA (SSDA2).

2.2. Overview of Proposed Development

The proposal relates to a detailed ('Stage 2') DA for a residential building (student accommodation) in the Darling Drive Plot of The Haymarket together with associated public domain works. The Haymarket Site is to be developed for a mix of residential and non-residential uses, including but not limited to residential buildings, commercial, retail, community and open space. The Darling Drive Plot is one of six development plots identified in the Concept Proposal DA.

More specifically, this SSD DA seeks approval for the following components of the development:

- Demolition of existing site improvements;
- Associated tree removal and planting;
- Construction and use of one residential building within the Darling Drive Plot, to be used for student accommodation purposes;
- Public domain improvements, including:
 - Realignment and upgrade of Darling Drive (part); and

- provision of a new urban square (known as Macarthur Place) located at the termination of The Goods Line.
- Extension, realignment and augmentation of physical infrastructure / utilities as required.

2.3. Background

On 21 March 2013 a critical step in realising the NSW Government's vision for the SICEEP Project was made, with the lodgement of the first two SSD DAs with the Department of Planning and Infrastructure. The key components of these proposals are outlined below.

2.4. Public Private Partnership SSD DA (SSD 12_5752)

The Public-Private Partnership (PPP) SSD DA (SSDA 1) includes the core facilities of the SICEEP Project, comprising the new, integrated and world-class convention, exhibition and entertainment facilities along with ancillary commercial premises and public domain upgrades.

2.5. The Haymarket Concept Proposal (SSD 13_5878)

The Haymarket Concept Proposal SSD DA (SSDA 2) establishes the vision and planning and development framework which will be the basis for the consent authority to assess detailed development proposals within the Haymarket Site.

More specifically the Stage 1 Concept Proposal seeks approval for the following key components and development parameters:

- Staged demolition of existing site improvements, including the existing Sydney Entertainment Centre (SEC), Entertainment Centre Car Park, and part of the pedestrian footbridge connected to the Entertainment car park and associated tree removal;
- A network of streets, lanes, open space areas and through-site links generally as shown on the Public Domain Concept Proposal, to facilitate reintegration of the site into the wider urban context and connection with the broader SICEEP Site;
- Street layouts;
- Development plot sizes, development plot separation, building envelopes (maximum height in RLs), building separation, building depths, building alignments and a benchmark for natural ventilation and solar provision for the precinct;
- Land uses across the site, including residential and non-residential uses;
- A maximum total gross floor area (GFA) across The Haymarket Site of 197,236m² for the mixed use development (excluding ancillary above ground car parking), comprising of:

- A maximum of 49,545m² non-residential GFA; and
 - A maximum of 147,691m² residential GFA;
- Above ground parking including public car parking;
- Residential car parking rates to be utilised in the subsequent detailed (Stage 2) Development Applications, being:
 - Zero (0) spaces per studio apartment;
 - Maximum one (1) space per two (2) one bedroom apartments;
 - Maximum one (1) space per one bedroom + study apartment, plus one (1) additional space per five (5) apartments;
 - Maximum one (1) space per two bedroom apartment, plus one (1) additional space per five (5) apartments; and
 - Maximum two (2) spaces per 3+ bedroom apartment.
- Design Guidelines to guide future development and the public domain; and
- A remediation strategy.

This report has been prepared to support a detailed Stage 2 SSD DA for a residential building (student accommodation) and associated public domain works within The Haymarket (SSDA 3), consistent with the Concept Proposal SSD DA.

2.6. Site Description

The SICEEP Site is located within Darling Harbour. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the Light Rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south (refer to Figure 1).

The Haymarket Site is:

- located in the south of the SICEEP Site, within the northern portion of the suburb of Haymarket;
- bounded by the Powerhouse Museum to the west, the Pier Street overpass and Little Pier Street to the north, Harbour Street to the east, and Hay Street to the south; and
- irregular in shape and occupies an area of approximately 43,807m².



The Concept Proposal DA provides for six (6) separate development plots across the Haymarket Site (refer to Figure 2):

1. North Plot;
2. North East Plot;
3. South East Plot;
4. South West Plot;
5. North West Plot; and
6. Western Plot (Darling Drive).

The Application Site area relates to the southern portion of the Western Plot W2 and surrounds as detailed within the architectural and landscape plans submitted in support of the DA. At this stage only massing drawings are available for W1 and this building is assessed in general terms ahead of detail drawings being available.



Figure 2: Concept Proposal Development Plots

The Application Site area relates to the southern portion of the Western Plot and surrounds as detailed within the architectural and landscape plans submitted in support of the DA (see Figure 3 – Works Boundary for subject DA).

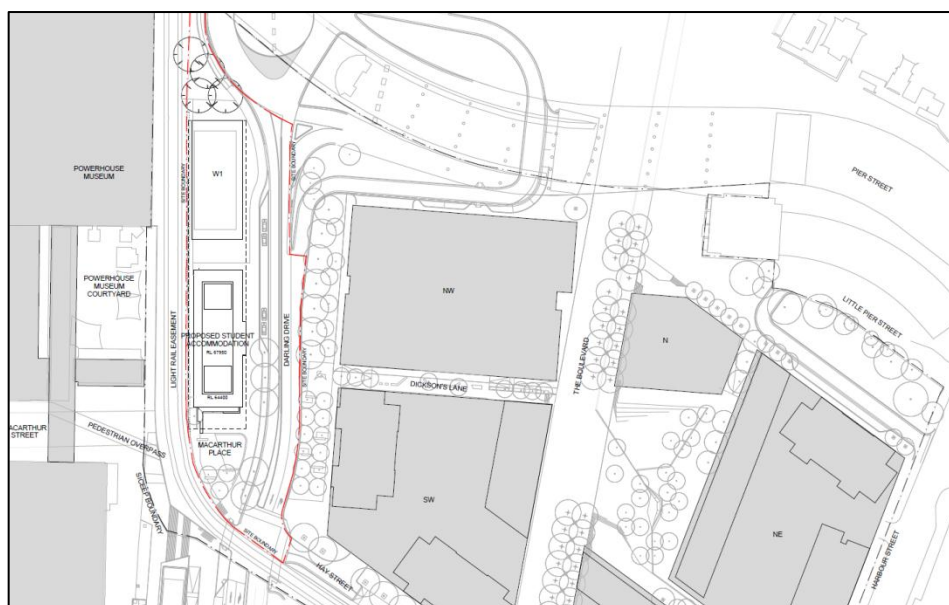


Figure 3: Works Boundary for subject DA

2.7. Planning Approvals Strategy

The SICEEP Project will result in the lodgement of numerous SSD DAs for the various components of the redevelopment project. SSD DAs have already been lodged for the PPP component of the SICEEP Project (comprising the convention centre, exhibition centre, entertainment facility and ancillary commercial premises and associated public domain upgrades), and the Stage 1 Concept Proposal for The Haymarket. Separate 'Stage 2' SSD DAs for the development of the South West Plot and the North West Plot and associated public domain works will be lodged concurrently with this application. Future applications will be lodged for the Hotel complex, and the remaining development plots of The Haymarket Site.

3. REFLECTIVITY IMPACT CONSIDERATIONS

To assess the impacts of the proposal, this report considers the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity, specifically:

Provisions

- (1) A Reflectivity Report that analyses potential for solar glare from the proposed building design may be required for tall buildings.
- (2) Generally, light reflectivity from building materials used on facades must not exceed 20%.
- (3) For buildings in the vicinity of arterial roads/major roads and Sydney Airport, proof of light reflectivity is required and is to demonstrate that light reflectivity does not exceed 20%.

As outlined under 3.2.7, Lend Lease will ensure all exterior façade elements used throughout the Western Plot development will limit light reflectivity to 20% or less. For glazing producing specular type reflections this is defined as the percentage solar reflection when light strikes and reflects normal to the façade plane. When incident solar rays strike near parallel to the façade plane (large incident angle of typically greater than 70° also referred to as glancing reflections), it is known that the reflectivity of all glazing types increases dramatically towards the properties of a mirror, Figure 4.

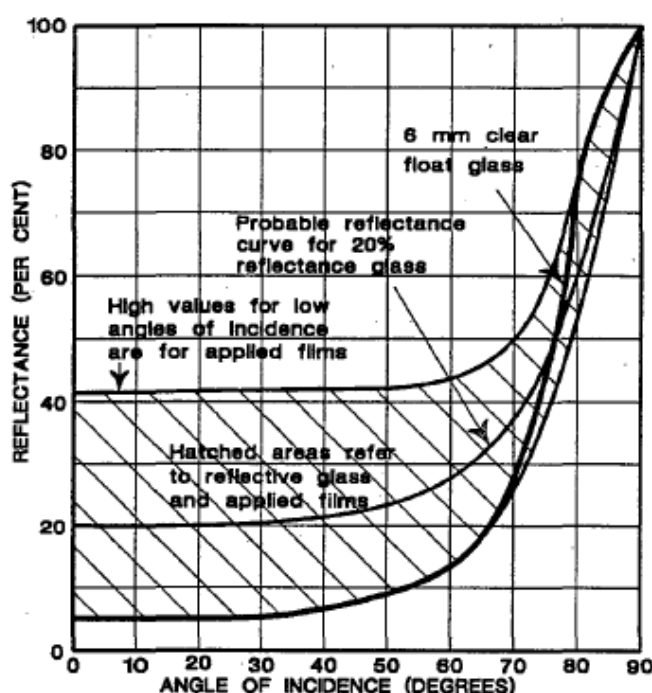


Figure 4: Façade Reflectivity versus angle of incidence (Hassall, 1991)

Thus, even for glazing with low reflectivity coefficients, the potential for glare increases significantly when incoming solar rays can impact on a building close to parallel to the plane of the glazing, i.e. a glancing reflection. The following report quantifies potential for solar reflections of all incident angles on glazing to impact upon the surrounds taking into consideration:

- Seasonal and diurnal solar paths (sun altitude and azimuth) at the SICEEP latitude and longitude and the relative angle between incident solar rays and façade orientation.
- Reflectivity coefficients of the external glazing being used.
- Roadway receiver locations of interest; the alignment of adjoining public roads.

Where the combination of these factors suggests there is potential for hazardous rogue reflections to impact on surrounding areas, the potential magnitude of reflections can be quantified and compared with acceptability criterion described below. This report quantifies the potential for solar reflectivity glare impact upon motorist using roadways intersecting and surrounding the SICEEP Western Plot precinct. CPP use in part methodology developed by Hassall (1991) and the concept of veiling glare and contrast when quantifying the potential for hazard rogue reflections onto surrounding receiver locations. In many instances the potential for a façade to generate rogue reflections can be eliminated without the need for calculation by taking into account the above factors as well as shading offered by surrounding building massing.

Pedestrian impacts are less likely to be of safety concern and are assessed more broadly in this report in terms of general amenity and usability of the site. A pedestrian can more readily divert their viewing angle away from the glare source or halt walking momentarily. It must be appreciated it is impractical to mitigate potential solar reflections at all potential pedestrian receiver locations across and surrounding the precinct.

Similarly, this report does not assess the impact of reflected solar glare onto surrounding building windows. Notwithstanding, designers have no glass sloping toward the sky in order to minimise solar reflections back onto surrounding multi-storey buildings, i.e. all glass is either aligned vertically or sloping downward toward the ground.

4. GLARE ACCEPTABILITY CRITERION

Consider an object that is just visible in the absence of glare. The object will no longer be visible when glare is introduced and it will be necessary to increase the contrast to make the object visible again. Threshold Increment (TI) is the percentage by which the contrast must be increased to make the object just visible and is the parameter calculated in this study to assess the acceptability or otherwise of potential reflectivity glare events.

TI is a parameter used in the design of Road Lighting, e.g. AS/NZS 1158.1.1:2005 where a maximum TI value of 20% is used for all roadway lighting categories and is the TI acceptability criterion adopted in this study for assessing solar glare impact on passing traffic.

Where high TI values are identified it is useful to investigate the angular limits of façade reflections relative to the motorist observer using a glare protractor (Hassall 1991). The glare protractor comprises a series of loops indicating whether a glare source will be above a predetermined veiling glare limit for the resultant % level of cladding reflectivity.

Calculations in this report assume specular type reflective façade surfaces, where the reflected ray angle is equal to the incident solar ray angle; being valid for most smooth surface glazing materials. Other building materials including surface fritted glazing, masonry, brickwork, tiles, and metal deck roofing produce diffuse components of reflection that are not directly quantified by the methodology adopted in this report. By definition, diffuse reflections have a greater scatter of reflected angles with lower concentration of reflected light in any given direction and are generally less likely to cast hazardous distant glare reflections than glazing.

5. REFLECTIVITY IMPACT RESULTS

The Western Plot buildings are tall in relation to surrounding roadways, so reflections from the facades are able to extend significant distances; especially early morning and late afternoon events when the solar altitude angle is low. Also important is the solar shading available from surrounding and proposed developments and the massing of the Sydney CBD.

Darling Drive, the light rail and Pier Street were considered most at risk to solar glare from the development and were primarily assessed for reflectivity impact in this report. With reference to the Holladay formula (Hassall, 1991); the greatest potential for glare impact upon drivers is when the angle between the centre of the glare source and line of sight is small. Therefore the greatest potential for glare impacts is for motorists travelling *toward* the SICEEP Western Plot site.

Darling Drive and light rail travelling north toward the site

The greatest potential for the proposed SICEEP Haymarket Western Plot developments to generate reflections onto northbound motorists on Darling Drive is solar interaction with the eastern facades of W1 and W2. Only W2 is analysed in detail in this report as façade detailing has only been developed for W2 at this stage. Glazing on this façade is always vertical.

The highest TI values calculated for this facade were caused by early afternoon reflection conditions. Higher altitude solar rays during the winter months strike the eastern façade glazing of W2 from the north with reflections towards the south along Darling Drive.

An example of this reflection condition is on March 21st, which is illustrated in Figure 5 showing reflections off the east façade glazing of W2 between mid and upper levels. The impact point is on Darling Drive at the intersection of Hay Street travelling north, Figure 5.

reflections start	1:25 pm	TI = 7
reflections cease	1:30 pm	TI = 8

TI values were found to be below criterion levels due largely to the relatively high altitude of the sun (refer Holladay formula). Further, at midday the altitude angle of incident solar rays is high enough to be cut off by the windscreen roof of most vehicles.



Figure 5: Afternoon reflection condition off the Western Plot (Image to follow)

There is also potential for the proposed SICEEP Haymarket Western Plot developments to generate reflections onto the light rail reflecting from the western facades of the Western Plot. Analogously, TI values were found to be below criterion levels due largely to the relatively high altitude of the sun in this reflection condition.

Pier Street (east side of SICEEP Haymarket Precinct travelling west toward the site)

The greatest potential for the proposed Western Plot developments to generate reflections onto westbound motorists on Pier Street is solar interaction with the northern facade of W1. The highest TI values calculated for this facade were caused by evening reflection conditions. The altitude angle of the incident solar rays is sufficiently low to be blocked by existing buildings to the west.

The exact footprint position and height of the northern W1 façade is yet to be finalised and will be important in terms of providing solar blockage to the northern façade of the Haymarket NW Plot building.

Other Surrounding Locations

Given the mid-rise height of the development, there is limited potential for facades of the proposed Western Plot to cast solar reflections beyond the roadways listed above.

Lend Lease will ensure all exterior façade elements used throughout the development will limit light reflectivity to 20% or less in line with the Sydney Development Control Plan 2012. Low glazing reflectivity coefficient on these facades will also be of benefit to pedestrian users of the precinct.

Diffuse Reflections

Other façade and roof ancillaries to be developed during detailed design should each be assessed for potential to generate nuisance reflections. Elements such as external louvers, metallic awnings, photovoltaic arrays, signage, blade walls, and masonry walls have potential to generate localised glare of both a diffuse and specular nature. Assessment of these is not made in the current study but will be assessed during detailed design.

Also included on the east façade will be angled metal façade panels with powdercoat finish / symonite or similar material. These are intended to break up the mass of the building by creating various reflections at different times of day. These panels are each about 1.5 – 2m wide x 3m high and are angled at about 3.5-4 degrees either up, down, left or right. The facing direction of the panel is arranged as a random spread across the façade. These will be investigated further during detailed design to ensure panels angled with greatest potential to impact upon approaching drivers are surface treated to minimise glare.

6. CONCLUSIONS

Lend Lease will ensure all exterior façade elements used throughout the development will limit light reflectivity to 20% or less as outlined under the Sydney Development Control Plan 2012 best practice guideline.

To meet the qualitative requirements of the Sydney Development Control Plan 2012, this reflectivity analysis has assessed the potential for the proposed developments to cause adverse glare events at surrounding motorway locations.

In summary, with the measures to be adopted by the designers as described in this report regarding choice of façade materials and façade articulation, the proposed SICEEP Haymarket Western Plot W2 development does not present a driver hazard in terms of solar glare and will meet the Sydney Development Control Plan 2012 controls for reflectivity.

7. REFERENCES

- Australia/New Zealand Standard AS/NZS 1158.1.1:2005 "Lighting for Roads and Public Spaces" Part 1.1: Vehicular Traffic (Category V) lighting – Performance and design requirements".
- Hassall (1991) "Reflectivity, Dealing with Rogue Solar Reflections" Faculty of Architecture, University of NSW.

Architectural Drawings

Assessment of reflectivity in this report has been based upon development drawings prepared by Lend Lease May 2013.