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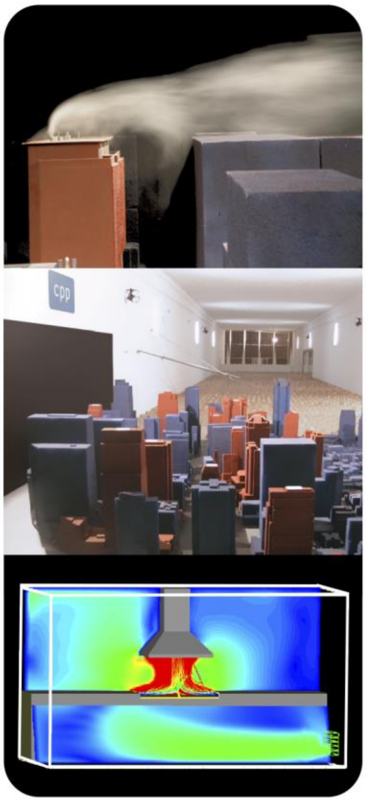
Final Report



Solar Reflectivity Assessment for:
270-272 Pacific Highway
Crows Nest, NSW

Prepared for:
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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Ascent Property Group to provide an assessment on the potential for sunlight to reflect off exterior cladding surfaces of the proposed development and generate solar disability glare onto vehicular traffic using surrounding public roadway locations, Figure 1. The proposed development is bordered by Pacific Hwy to the east, Shirley Rd to the north and Bruce St to the south.

The proposed development consists of a building with height of approximately 54 m above Pacific Highway, Figure 2, and is surrounded by mixture of low to medium-rise buildings.

Figure 1: Aerial view of the proposed development site (Google Earth, 2020).

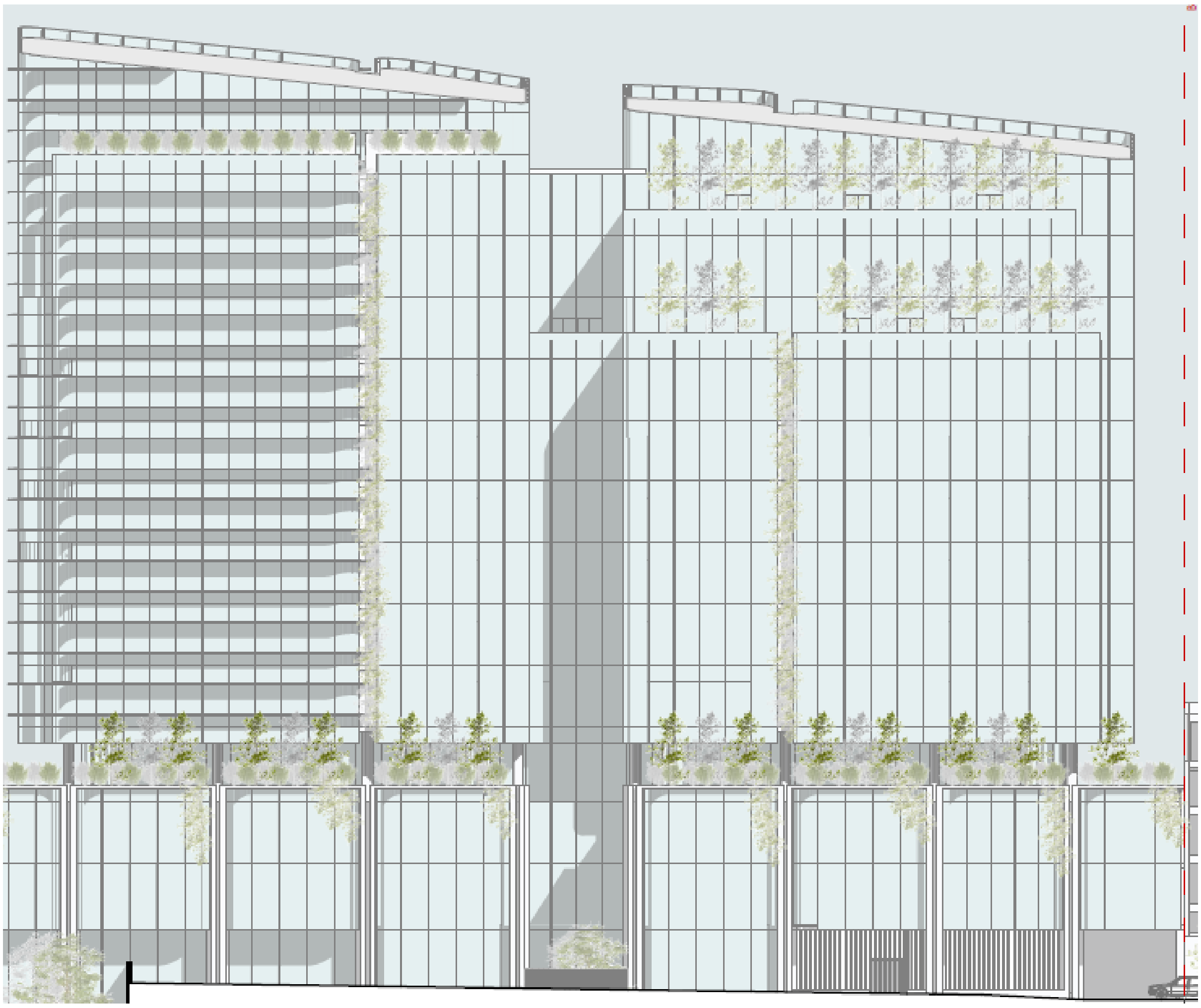

Figure 2: West Elevation. Structures and massing within the proposed development.

2 NORTH SYDNEY COUNCIL CONSIDERATIONS

CPP have not sighted criteria in the North Sydney Development Control Plan (2013) quantifying acceptable levels of solar disability glare for new developments proposed for the Crows Nest region, with the exception of a general requirement relating to glare under Part B Development Controls, Section 2 Commercial and Mixed Use Development, 2.3 Environmental Criteria, 2.3.4 Reflectivity-Provisions:

" P1 Buildings should provide a greater proportion of solid to void on all facades and use non-reflective materials.

P2 Buildings should use non- reflective glass and/ or recess glass behind balconies.

P3 Sun shields, such as awnings, canopies and pergolas should be provided to glazed areas."

Many other Australian Council development controls, such as those City of Sydney and Auburn, make a general recommendation for reflectivity limits for building materials to not exceed 20%:

Sydney Development Control Plan 2012, General Provisions, Section 3.2.7 Reflectivity

(2) Generally, light reflectivity from building materials used on facades must not exceed 20%

It is not explicitly defined in Councils' DCP to which component to reflections, specular or diffuse, the prescribed limit is applicable. CPP presumes the reflectivity limit is applicable to the specular component of reflections as they are most associated with traffic disability glare. It is therefore assumed exterior elements on the facades studied in this report will have a specular reflectivity coefficient of 20% or less. This is defined as the percentage of solar reflection when light strikes and reflects normal to the façade plane.

This study does not directly study non-glazing materials/surfaces that produce more diffuse than specular reflections; diffuse reflections are often associated with discomfort glare rather than disability glare.

3 ASSESSMENT METHODOLOGY

This report assesses the potential for disability glare from solar reflections from the proposed development taking into consideration:

- Seasonal and diurnal solar paths (sun altitude and azimuth) at the project altitude, and the relative angle of the incident and reflected solar rays (reflectivity coefficients of glazing increase with increasing incident angle),
- An assumed specular reflectivity coefficient of 20%, per Council requirements, for the external glazing is used in the calculations, and the incident angle of the solar rays is also accounted for (allowance is made for reflectivity coefficients of glazing to increase with increasing incident angle),
- Receiver locations of interest (the alignment of adjoining public roadways being of particular interest, Figure 3), and
- Architectural drawings provided by fitzpatrick + partners dated April 22.

Calculations in this report assume the façade surfaces of the proposed development will produce specular type reflections, such as glazing, where the reflected ray angle is equal to the incident solar ray angle, being valid for many smooth surface façade materials. Curved surfaces are not quantified in this report.

CPP use, in part, methodology developed by Hassall (1991), and the concept of veiling luminance and contrast when quantifying the potential for hazard rogue specular solar reflections from the proposed development onto selected surrounding receiver locations, Figure 3. Hassall suggests a veiling luminance limit of 500 cd/m^2 as calculated from the Holladay formula. Threshold Increment (TI) is the percentage by which the contrast must be increased relative to the background to make the object just visible due to the addition of glare (generated by the solar reflections) and is also considered in this study to further assess the acceptability of potential glare events.

Proprietary software was used to calculate veiling luminance values at expected maximum impact locations of vehicles travelling in the directions as marked in Figure 3 where potential future changes in traffic conditions have been considered.

Certain building materials other than glass, including metallic framing and supports, produce diffuse reflections 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 disability glare reflections than flat surface glazing. Notwithstanding, these materials and surfaces have potential to produce discomfort glare, and to reduce this impact it is recommended that all non-glazed façade surfaces adopt low lustre, non-glossy, textured or matte finishes.

From a thermal perspective, concave façade curvature is known to potentially concentrate reflections to hazardous levels at focal points a distance from the development site. This report does not evaluate thermal properties or visual glare impacts of solar reflections from any concave facade elements of the proposed building if they are present.

Figure 3: Investigated impact locations of vehicles travelling in indicated directions.

In the first instance as a 'worse' case scenario is assumed whereby the proposed building was modelled as isolated from surrounding buildings and the investigated locations in Figure 3 consider future changes to traffic conditions along the adjacent roadways by assuming traffic can travel in both directions. The façade reflective surfaces are assumed to be flat and vertical.

Results of the assessment are visualised using the publicly available SunCalc tool (Hoffmann), which plots the movement of the sun and sunlight-phase at a specific location and time in the year, Figure 4. The solar plot in Figure 4 plots the incoming solar rays (radial yellow line) from the Sun (orange circle) reflecting off the façade of a building (green line) in the southern hemisphere, onto a receiver location (labelled "a"). The orange radial line, red radial line, and yellow arc mark the Sun's sunrise position, sunset position, and trajectory, respectively, on this particular day. The shaded yellow region shows the variation of the path of the sun throughout the year; the closer the Sun is to the centre, the higher the sun is above the horizon.

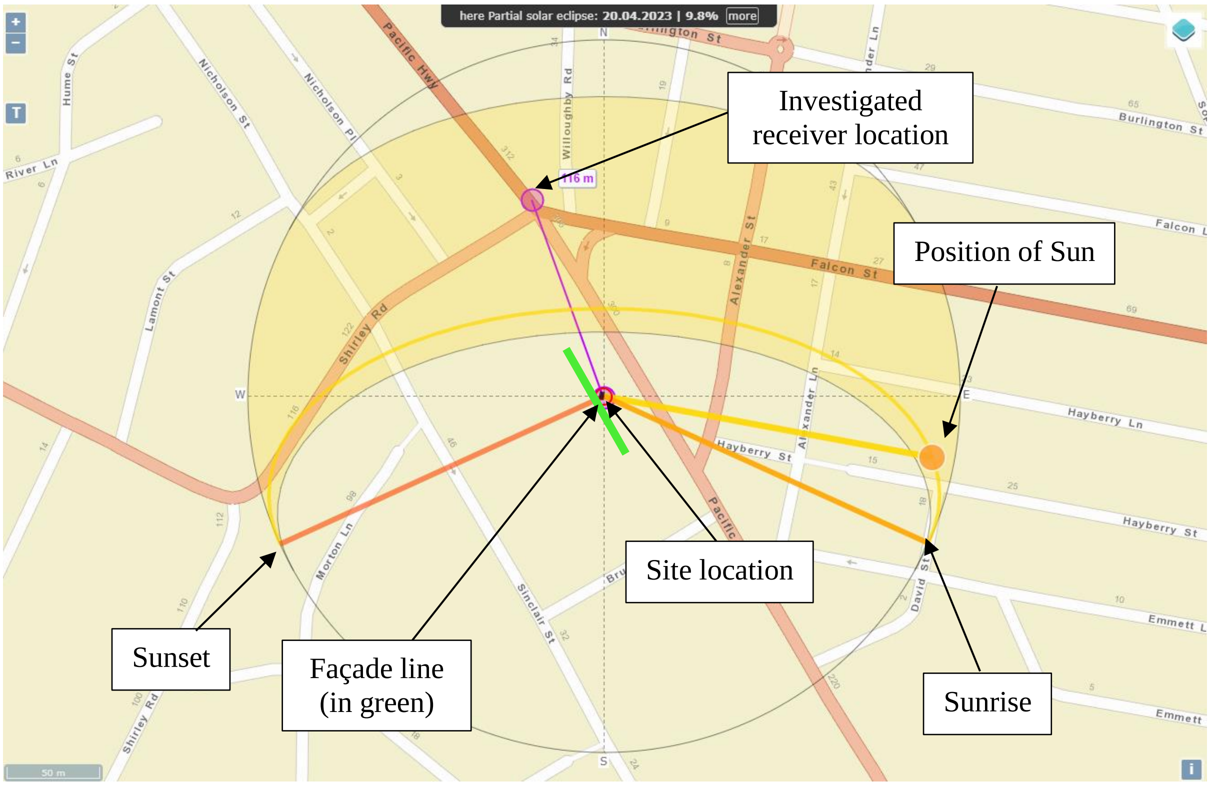

Figure 4: Example usage of the SunCalc tool to visualise solar rays reflecting from a façade.

3 REFLECTIVITY IMPACT RESULTS

3.1 Summary

The summary table below lists the investigated locations that were found to potentially experience a level of solar glare from the proposed building. The following sections of the report will discuss the assessment results in detail, including recommendations for mitigating glare issues.

Table 1: Summary of reflectivity assessment results along surrounding roadways.

Façade	Street Name	Potential Glaring Location	Veiling Luminance (Cd/m²)	Approximate Time Period (GMT +10)	Season	Discussion
North	Pacific Highway	12	~265	2.30pm to 4pm	Late autumn to late winter	
	Shirley Road	19	~400	7am to 8am	Mid autumn and early spring	
	Willoughby Lane	42	~470	4pm to 6pm	Late summer to early autumn, Mid spring to late spring	
East	Pacific Highway	7	~240	12.30pm to 2pm	Mid autumn to early spring	
	Alexander Street	33	>500	5.30am to 7am	Late summer to early autumn, Mid spring to late spring	Limit external reflectivity coefficient to 10% for glazing on east façade. Incident solar rays likely blocked by upstream buildings during this time period.
	Falcon Street	39	~170	8.30am to 10am	Late autumn to late winter	
	Willoughby Lane	42	>500	5am to 7am	Late spring to late summer	Limit external reflectivity coefficient to 10% for glazing on east façade. Incident solar rays likely blocked by upstream buildings during this time period.
	Alexander Lane	43	~440	6am to 7am	Early autumn and mid spring	
West	Sinclair Street	23	~250	2.30pm to 4pm	Late autumn to late winter	

4 SOLAR REFLECTIVITY ASSESSMENT

4.1 North Facade

4.1.1 Pacific Highway

Assessment showed there is potential for drivers at Location 12, Figure 3, travelling southeast along Pacific Highway toward the development site, to experience low levels of glare from glazing to the North façade in the late afternoon during mid-year.

Analysis showed that between approximately 2.30pm to 4pm, drivers travelling southeast at Location 12, Figure 5, experienced solar glare with veiling luminance up to approximately 265 Cd/m^2, which is lower than the prescribed veiling luminance limit of 500 Cd/m^2 (Hassall 1991).

Drivers at other locations analysed along Pacific Highway travelling toward the development site were found to experience lower levels of veiling luminance values for shorter periods of time from the North façade. Thus, it is expected solar reflections from the North façade will not negatively impact the vision of drivers' who are travelling southeast along Pacific Highway.

Figure 5: Representation of incident and reflection of solar rays from the North façade onto Pacific Highway.

4.1.2 Shirley Road

Assessment showed there is potential for drivers at Location 19, Figure 3, travelling northeast along Shirley Road toward the development site, to experience low levels of glare from the North façade in the morning during early and late of the year.

Analysis showed that between approximately 7.00am to 8.00am, drivers travelling northeast at Location 19, Figure 6, experienced solar glare with veiling luminance up to approximately 400 Cd/m^2, which is lower than the prescribed veiling luminance limit of 500 Cd/m^2 (Hassall 1991).

Drivers at other locations analysed along Shirley Road travelling toward the development site were found to experience lower levels of veiling luminance values for shorter periods of time from the North façade. Thus, it is expected solar reflections from the North façade will not negatively impact the vision of drivers’ who are travelling northeast along Shirley Road.

Figure 6: Representation of incident and reflection of solar rays from the North façade onto Shirley Road.

4.1.3 Willoughby Lane

Assessment showed there is potential for drivers at Location 42, Figure 3, travelling south along Willoughby Lane toward the development site, to experience low levels of glare from the North façade in the late afternoon during early and late of the year.

Analysis showed that between approximately 4.00pm to 6.00pm, drivers travelling south at Location 42, Figure 7, experienced solar glare with veiling luminance up to approximately 470 Cd/m^2, which is lower than the prescribed veiling luminance limit of 500 Cd/m^2 (Hassall 1991).

Drivers at other locations analysed along Willoughby Lane travelling toward the development site were found to experience lower levels of veiling luminance values for shorter periods of time from the North façade. Thus, it is expected solar reflections from the North façade will not negatively impact the vision of drivers' who are travelling south along Willoughby Lane.

Figure 7: Representation of incident and reflection of solar rays from the North façade onto Willoughby Lane.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the North façade.

4.2 East Façade

4.2.1 Pacific Highway

Assessment showed there is potential for drivers at Location 7, Figure 3, travelling northwest along Pacific Highway toward the development site, to experience low levels of glare from the East façade in the afternoon during early of the year (mid-autumn) to late of the year (early spring).

Analysis showed that between approximately 12.30pm to 2.00pm, drivers travelling northwest at Location 7, Figure 8, solar glare with veiling luminance up to approximately 240 Cd/m^2, which is lower than the prescribed veiling luminance limit of 500 Cd/m^2 (Hassall 1991). Further, it is noted the solar reflections experienced will be from a higher altitude sun angle exceeding the driver's visual cut-off angles blocked by the sun visor and top of windscreen for the typical sedan vehicle.

Drivers at other locations analysed along Pacific Highway travelling toward the development site were found to experience lower levels of veiling luminance values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling northwest along Pacific Highway.

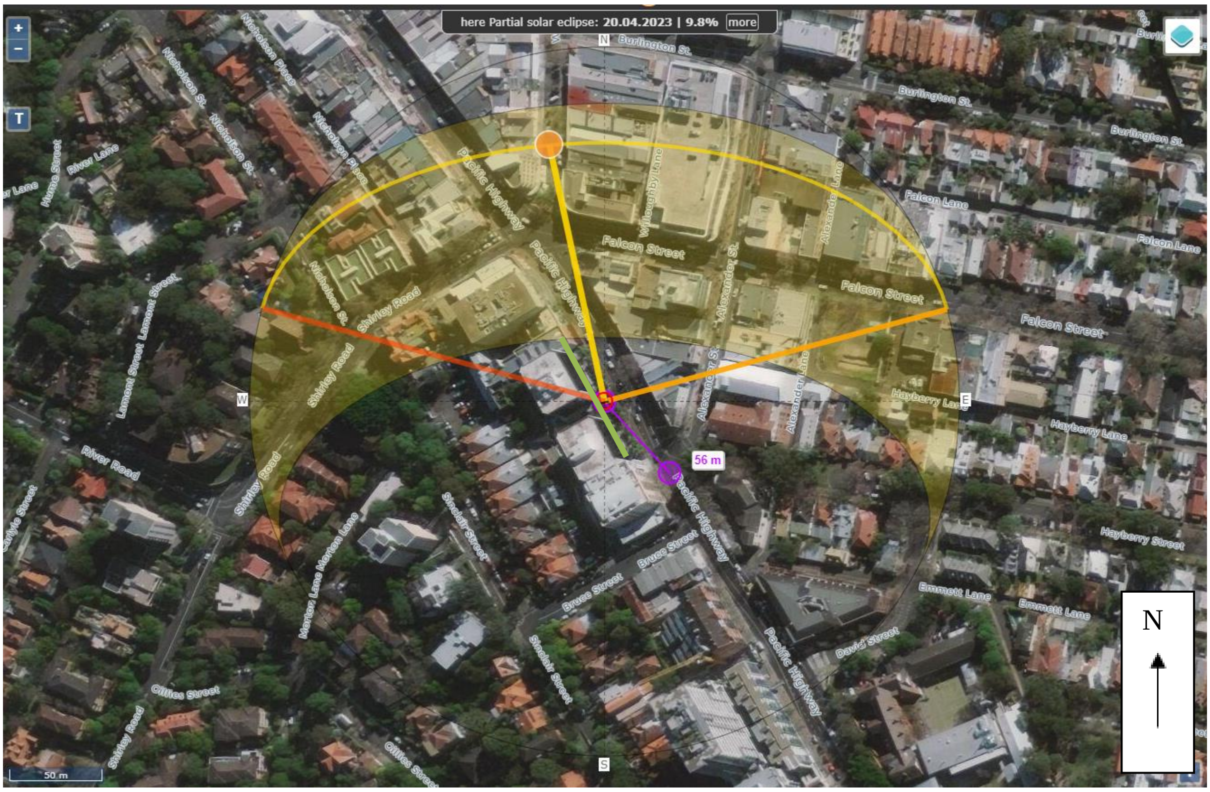

Figure 8: Representation of incident and reflection of solar rays from the East façade onto Pacific Highway.

4.2.2 Alexander Street

Assessment showed there is potential for drivers at Location 33, Figure 3, travelling south Alexander Street toward the development site, to experience medium levels of glare from the East façade in the morning during early and late of the year.

Analysis showed that between approximately 5.30am to 7.00am, drivers travelling south at Location 33, Figure 9, experienced medium levels of veiling luminance exceeding the 500 Cd/m^2 limit (Hassall 1991). CPP site visit suggested that the ‘canyon’ of buildings lining Alexander Street will largely block these solar reflections before impacting a driver travelling toward the site.

Notwithstanding, it is recommended that a reflectivity coefficient of 10% or less be used for all East façade glazing fronting Pacific Highway to minimise reflections onto streetscapes to the northeast. Preference for matt finishes to non-glazed materials, to reduce any potential glare impact.

Figure 9: Representation of incident and reflection of solar rays from the East façade onto Alexander Street.

4.2.3 Falcon Street

Assessment showed there is potential for drivers at Location 39, Figure 3, travelling west Falcon Street toward the development site, to experience low levels of glare from the East façade in the morning during mid-year.

Analysis showed that between approximately 8.30am to 10.00am, drivers travelling west at Location 39, Figure 10, solar glare with veiling luminance up to approximately 170 Cd/m^2, which is lower than the prescribed veiling luminance limit of 500 Cd/m^2 (Hassall 1991).

Drivers at other locations analysed along Falcon Street travelling toward the development site were found to experience lower levels of veiling luminance values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling west along Falcon Street.

Figure 10: Representation of incident and reflection of solar rays from the East façade onto Falcon Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the East façade.

4.2.4 Willoughby Lane

Assessment showed there is potential for drivers at Location 42, Figure 3, travelling south Willoughby Lane toward the development site, to experience low levels of glare from the East façade in the morning during early and late of the year.

Analysis showed that between approximately 5.00am to 7.00am, drivers travelling south at Location 42, Figure 11, experienced medium levels of veiling luminance exceeding the 500 Cd/m^2 limit (Hassall 1991). As Willoughby Lane is classified as “minor road” with limited cars and moderate traffic, allowable veiling luminance can be greater for 500 Cd/m^2. Furthermore, CPP site visit suggested that the ‘canyon’ of buildings lining Willoughby Lane will largely block these solar reflections before impacting a driver travelling toward the site.

Notwithstanding, it is recommended that a reflectivity coefficient of 10% or less be used for all East façade glazing fronting Pacific Highway to minimise reflections onto streetscapes to the northeast. Preference for precast concrete façade instead of metal cladding on non-glazed materials, to reduce any potential glare impact.

Figure 11: Representation of incident and reflection of solar rays from the East façade onto Willoughby Lane.

4.2.5 Alexander Lane

Assessment showed there is potential for drivers at Location 43, Figure 3, travelling south Alexander Lane toward the development site, to experience low levels of glare from the East façade in the morning during early of the year (early autumn) to late of the year (mid spring).

Analysis showed that between approximately 6.00am to 7.00am, drivers travelling south at Location 43, Figure 12, solar glare with veiling luminance up to approximately 440 Cd/m^2, which is lower than the prescribed veiling luminance limit of 500 Cd/m^2 (Hassall 1991). A lower reflectivity coefficient for east façade glazing to 10% or lower will further reduce the reflected veiling luminance intensity.

Drivers at other locations analysed along Alexander Lane travelling toward the development site were found to experience lower levels of veiling luminance values for shorter periods of time from the East façade. Thus, it is expected solar reflections from the East façade will not negatively impact the vision of drivers' who are travelling south along Alexander Lane.

Figure 12: Representation of incident and reflection of solar rays from the East façade onto Alexander Lane.

4.3 West Facade

4.3.1 Sinclair Street

Assessment showed there is potential for drivers at Location 23, Figure 3, travelling northwest along Sinclair Street toward the development site, to experience low levels of glare from the west façade in the afternoon during mid- year.

Analysis showed that between approximately 2.30pm to 4.00pm, drivers travelling northwest at Location 23, Figure 13, experienced solar glare with veiling luminance up to approximately 250 Cd/m^2, which is lower than the prescribed veiling luminance limit of 500 Cd/m^2 (Hassall 1991).

Drivers at other locations analysed along Sinclair Street travelling toward the development site were found to experience lower levels of veiling luminance values for shorter periods of time from the west façade. Thus, it is expected solar reflections from the west façade will not negatively impact the vision of drivers' who are travelling northwest along Sinclair Street.

Figure 13: Representation of incident and reflection of solar rays from the west façade onto Sinclair Street.

Drivers at the remaining investigated locations on the other surrounding streets were found to not experience solar reflections from the west façade.

5 CONCLUSION

The proposed 270-272 Pacific Highway development in Crows Nest, NSW was studied to determine the potential for sunlight to reflect off exterior cladding surfaces of the proposed development and generate solar disability glare onto vehicular traffic using surrounding public roadway locations.

Surrounding existing buildings will provide solar blockage to many potential receiver locations surrounding the site and most of the investigated locations were found the experience levels of glare within criteria levels. Notwithstanding, it is recommended the reflectivity coefficient of glazing to the east façade should not exceed 10% to minimize impact of glare at all locations.

It is expected the proposed development as currently configured, and with recommendations contained in this report, will not produce significant disability glare onto vehicles travelling toward the development.

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