

153 & 157 WALKER STREET

NEW SOUTH WALES

SOLAR REFLECTION ANALYSIS

RWDI #2507337

29 July 2025

SUBMITTED TO

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Development Pty Ltd**
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EXECUTIVE SUMMARY

RWDI Australia Pty Ltd (RWDI) has been engaged by Freecity North Sydney Development Pty Ltd to investigate the impact of solar reflections emanating from the proposed development at 153 & 157 Walker Street (“the Project”) in support of a Significant State Development Application (SSDA) (SSD-82599709). The results and conclusions of the study are summarised as follows:

Visual Glare Impact on Drivers

As with any glazed building, drivers travelling in the vicinity of the Project (i.e. along Walker Street, Little Walker Street, and Barry Street) were predicted to experience reflections emanating from the Project. Based on the detailed analysis results, the predicted reflections falling on all the studied driver receptors (D1 to D6) were below the veiling luminance threshold of 500 cd/m².

Additional details on when reflections were predicted to occur at the receptors, as well as predicted durations and intensities, can be found in Appendix B.



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1 INTRODUCTION

This Solar Reflectivity Assessment is submitted to the Department of Planning, Housing and Infrastructure (DPHI) on behalf of Freecity Group Holdings Pty Ltd (Freecity) in support of a State Significant Development Application (SSDA) (SSD-82599709) for mixed-use development at 153 & 157 Walker Street, North Sydney (the site). Per the SEARs Request (Table 1), this report presents the results of the visual glare potential of the Project.

The site is located at 153 & 157 Walker Street within the North Sydney Council Local Government Area (LGA). It is located at the southwest corner of North Sydney CBD (commonly referred to as the “commercial core”) and is approximately 2.5 km to the north of Sydney CBD and approximately 10 m to the southwest of Doris Filton Park. The site is bound by Walker Street to the west, Little Walker Street to the east, and by neighbouring buildings to the north and south. The site is legally referred to as Lot 0 SP 50411 and Lot 1 DP 84729, with an area of 1,928m².

The proposed development encompasses a 51-storey hotel and residential mixed-use tower with shared amenities on the lower ground and ground levels. Hotel and Residential lobbies are located on Ground level with a retail space on Lower Ground along Walker Street. Outdoor terraces are located on Levels 3, 5, 6 and 33.

An aerial image of the site is shown below in **Figure 1**.



Figure 1: Aerial Image of the Site (Source: Urbis)

The proposed development includes:

- Site preparation, including ground excavation and the demolition of existing structures at the site.
- Construction of a new fifty-one (51) storey mixed-use tower, which will accommodate:
 - Residential apartments, including a build-to-rent housing component.
 - Nine (9) affordable housing apartments equating to 3% of the total dwellings proposed.
 - A hotel that will be operated by one entity with a central management structure.
 - Ancillary lounge and wellness facilities.
 - Retail floorspace at ground level.
- Eleven (11) basement levels with car parking facilities and plant rooms to service the proposed development.
- One (1) loading zone at the Lower Ground Level.
- Vehicle access from Little Walker Street.
- Associated building plant, utilities and service connections.

This Solar Reflectivity Assessment addresses the following relevant Secretary’s Environmental Assessment Requirements (SEARs) set out in the table below.

Table 1: SEARs Compliance Table

SEARs Request	Response / Location in Report
<p>5. Environmental Amenity</p> <p>Assess amenity impacts on the surrounding locality, including lighting impacts, reflectivity, solar access, visual privacy, visual amenity, 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.</p>	<p>Section 3</p>

RWDI Australia Pty Ltd. (RWDI) has been engaged by Freecity North Sydney Development Pty Ltd to investigate the impact of solar reflections emanating from the proposed development at 153 & 157 Walker Street (“the Project”) in support of a Significant State Development Application (SSDA). This report provides the computer modelling results of reflected sunlight from the Project, as shown in Figure 1 above. It is RWDI’s understanding that the development will be surrounded by typical urban spaces such as busy roadways, railway, and other buildings.

This analysis was conducted in two parts. First, a ‘screening’ simulation estimated the frequency of occurrence of reflections which may cause glare for a broad area around the development. This was done in order to understand the potential for visual impacts on people due to the reflections. Note that the screening analysis intentionally assumed a very conservative direction in which the viewer is facing (horizontal, but directly towards the building).

Since reflections were predicted on sensitive spaces, the ‘detailed’ analysis phase was undertaken. This investigated the potential for glare at select locations in greater temporal detail and also included the effect of the direction viewers are likely to be facing.

2 BACKGROUND

2.1 Understanding Urban Reflections

While a common occurrence, solar reflections from buildings can lead to numerous visual issues including:

- Impair the vision of motorists and others who cannot easily look away from the source;
- Cause nuisance to pedestrians or occupants of nearby buildings; and
- Create undesirable patterns of light throughout the urban fabric.

However, the level of impact of these issues on people and property will be influenced by many other factors that are unique to the reflecting surface(s), the individual(s)/object(s) exposed to reflections and the environment around them. In a complex urban space, these factors are often difficult to reasonably predict, if they can be predicted at all.

As such, it must be acknowledged that there is an element of uncertainty and subjectivity to any reflection analysis, particularly when it comes to visual glare which is inherently a subjective experience and lacks a universally agreed upon quantifiable definition. The metric and threshold used by RWDI (detailed in Appendix A) are based on industry standard approaches in Australia, but as noted above, are subject to a degree of uncertainty/subjectivity. This means that the possibility of reflection impacts from a building can never be completely ruled out through simulation.

RWDI's approach is to instead provide a suitably conservative analysis of the potential effects of reflected sunlight and contextualise how the Project's reflections compare to other projects studied by RWDI, and if any predicted impacts would be considered atypical given the Project's context. Regulation and enforcement of performance requirements is the responsibility of others.

2.2 Methodology

The analysis was conducted using RWDI's in-house proprietary *Eclipse* simulation engine. The first phase was a 'Screening Analysis' which predicted the frequency of occurrence of reflections from the Project for every hour of a full calendar year. These values were computed on 'presentation surfaces' located approximately 1.5 m above grade-level for drivers and 2.5 m above local grade-level for train drivers within an approximately 500 m radius of the Project (Figure 2). Note that the screening analysis intentionally assumed a very conservative direction in which the viewer is facing (horizontal, but directly towards the building).

Should the potential for glare exist on roadways or other sensitive spaces, multiple 'receptor points' are selected to undergo the second 'Detailed Analysis' phase. This analysis works similarly to the screening simulation, except glare is tested at one-minute increments and a direction of view is explicitly prescribed. This yielded detailed predictions at specific locations of when reflections can occur, how long they can occur for, and the locations of problematic glare sources. The detailed study also provides the level of reflectivity reduction required to comply with local criteria.

As reflections were predicted on sensitive spaces, the detailed assessment was undertaken for this Project. Note that the detailed analysis was not intended to be an exhaustive investigation of all locations where reflections are possible. It was instead intended to provide an understanding of the range of possible reflection characteristics from the Project.

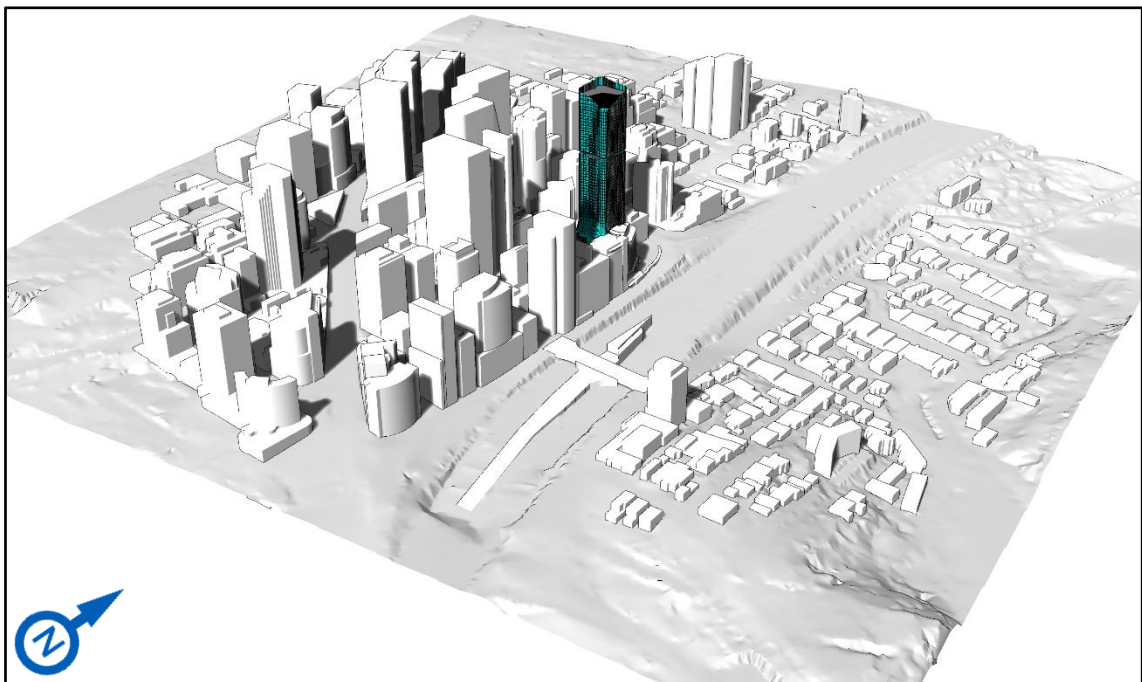


Figure 2: 3D Computer Model of the Project and Surrounding Context

2.3 Assumptions and Limitations

2.3.1 Meteorological Data

This analysis used 'clear sky' solar data computed at the location of Sydney Observatory Hill using the method promulgated by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). This approach used mathematical algorithms to derive solar intensity at a given location, ignoring the localised effects of cloud cover. This provides a 'worst case' scenario showing the full extent of when and where glare could ever occur.

2.3.2 Radiation Model

RWDI's analysis is only applicable to the visual impacts of solar radiation (i.e. visible wavelengths only) on people including drivers in the vicinity of the development. It did not consider the impact of the building related to any other forms of radiation, such as thermal energy, cellular telephone signals, RADAR arrays, etc.

2.3.3 Study and Surrounds Models

The analysis was conducted based on a 3D model of the Project provided by Architectus to RWDI on June 30, 2025.

The surrounding model was generated based on publicly available data and previous RWDI projects in the area. This analysis included the existing surroundings and excluded buildings currently under assessment or approved (i.e. not yet under construction), as this would be conservative on the reflections falling on the public realm. All data sources were cross-checked against LiDAR data published by the NSW Department of Finance, Services, and Innovation. This dataset was also used to generate the ground surface and has a stated vertical and horizontal accuracy of 0.3m and 0.8m, respectively (both at a 95% confidence interval).

Potential reductions of solar reflections due to the presence of vegetation or other non-architectural obstructions (such as railings) were not included, nor were reflections from other buildings, per standard industry practice. Light that has reflected off several surfaces was assumed to have a negligible impact. As such, only a single reflection from the Project was included in the analysis.

This analysis assumed that all reflective elements are in their as-designed condition, (i.e. clean, free from damage, degradation, distortion, etc.) and that the building envelopes of all buildings are complete and uncompromised (i.e. any elements of the walls/roofs that are not designed to be exposed to sun, are shielded).

The results presented in this report are highly dependent on both the form and materiality of the Project. Should there be any changes to the design, it is recommended that RWDI be contacted and requested to review their potential effects on the findings of this report.

2.3.4 Facade Material Reflectance

All glazing has been assumed to have a nominal 20% reflectivity for visible light which increases with the angle of incidence as the rays approach perpendicular to the surface. Glass balustrades have been assumed to have a nominal visible reflectance and transmittance of 20% and 80%, respectively. While the nominal reflectivity values of the IGUs are noted above, the reflectivity of glass will increase exponentially as light strikes it at increasingly glancing angles. This effect was included in the simulations.

The locations of the reflective materials on the facades are illustrated in Figure 3.

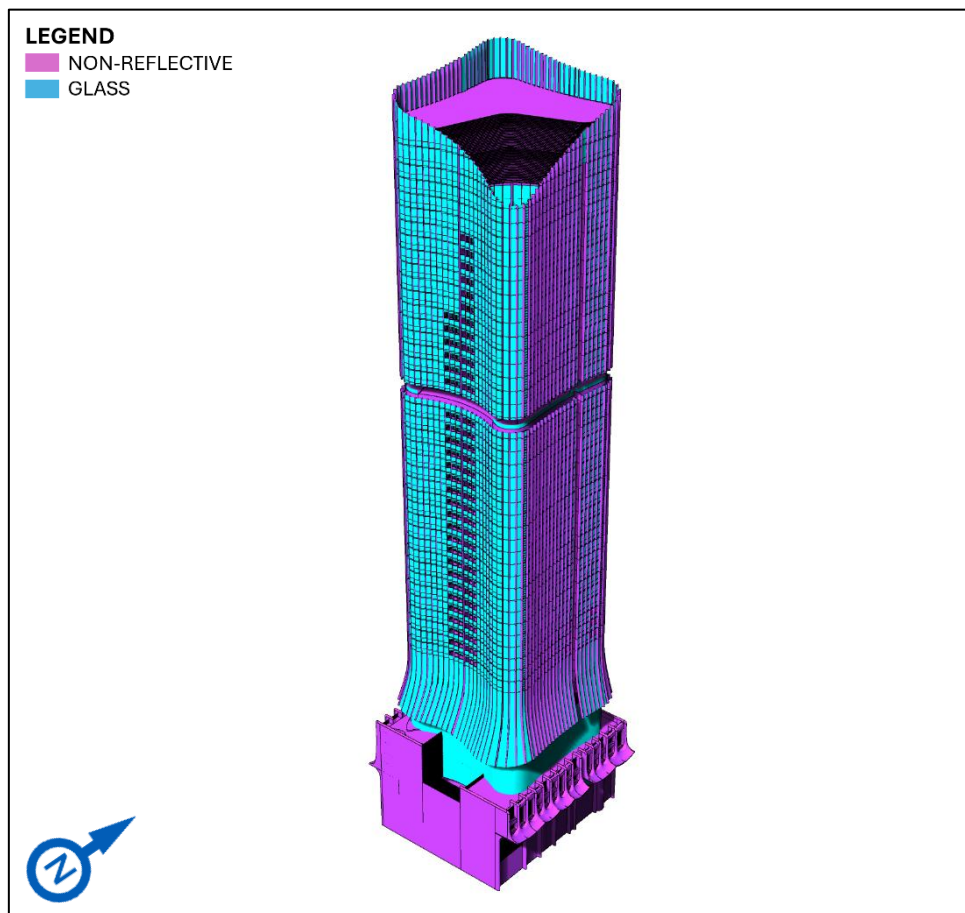


Figure 3: Locations of Reflective Building Elements (Surrounding Context removed for Clarity)

2.3.5 Human Factors

This analysis also assumes reasonable and responsible behaviour on the part of people in the vicinity of the development. A reasonable and responsible person would not purposely look towards a bright reflection, purposely prolong their exposure to reflected light, or otherwise intentionally try to cause discomfort/harm to themselves or others and/or damage to the property.

3 RESULTS AND DISCUSSION

3.1 Screening-Level Analysis

3.1.1 Presentation of Results

This section presents the screening results pertaining to the solar impacts of the Project on the surrounding urban area.

The **Percentage of Time Above the Veiling Luminance Threshold** plot (Figure 4) identifies the percentage of day-time hours where the veiling luminance was predicted to exceed the 500 cd/m² limit proposed by Hassall. *Note that, as a conservative assumption, at each location, it is assumed that the viewer is always facing horizontally towards the source of any reflection that can reach them.*

The veiling luminance-based results present predictions for a 62-year-old viewer. This represents approximately the 80th percentile age of the residents of New South Wales, which means that veiling luminance will be lower than these predictions for 80% of the population.

It is important to understand that the figures do not show a specific moment in time, but rather present aggregated reflection predictions for an entire year.

In order to attain a complete understanding of the impact that reflections may have on people, other factors must be considered, including the duration of the reflections, when they occur and where the viewer is looking. The following plot serves to illustrate the general characteristics of reflections from the Project and informed the locations of the receptor points selected for the detailed phase of work, which analysed these factors in greater detail.

3.1.2 Results

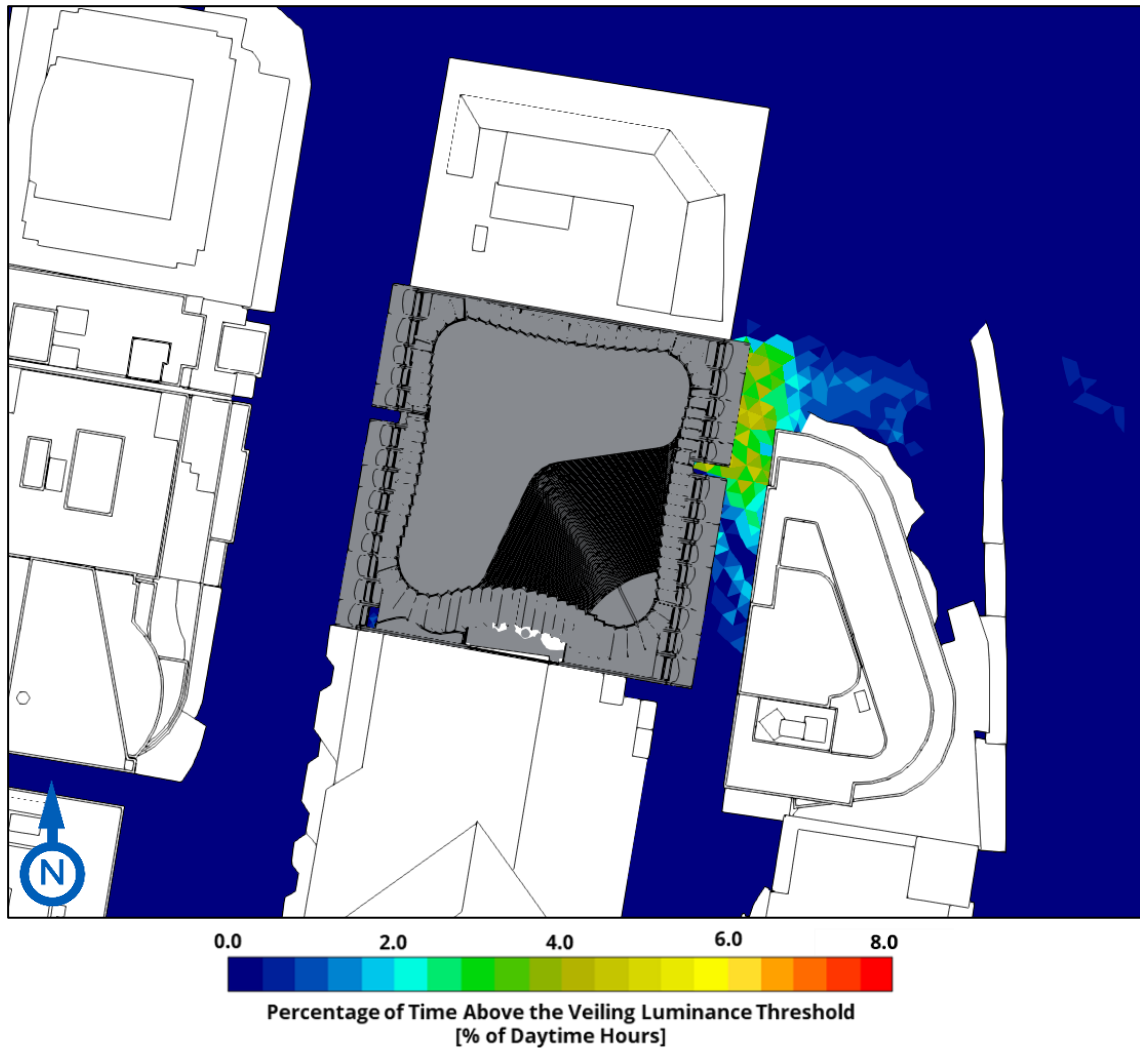


Figure 4: Frequency (% of Daylit Hours) Where Veiling Luminance Above Threshold were Predicted at Pedestrian Height for an 80th Percentile Resident (Age 62)

3.2 Detailed Analysis

3.2.1 Receptor Locations

Based on the findings of the Screening Analysis, 6 representative points were selected for the Detailed Analysis. These points are described in Table 2 and illustrated in Figure 5. Unless otherwise indicated, all points are located at a height of 1.5m above local grade.

Table 2: Receptor Descriptions

Receptor Number	Receptor Description
D1	Southbound drivers on Warringah Freeway
D2	Northbound drivers on Walker Street, at Mount Street Intersection
D3	Northbound drivers on Walker Street, before parking entrance
D4	Eastbound drivers on Berry Street, at Walker Street Intersection
D5	Southbound drivers on Little Walker Street, turning into Proposed Building entrance
D6	Southbound drivers on Walker Street, at Berry Street Intersection



Figure 5: Receptor Locations (Underlay Credit: Bing Maps)



3.2.2 Presentation of Results

Table 3 below summarises the level of visual impact predicted at each of the studied receptors based on the simulation results. The minute-by-minute results for each point are presented as ‘Annual Reflection Impact Diagrams’ which distil an entire year’s worth of data into a single diagram. The diagrams for each receptor, as well as an explanation for how to read the diagrams, are provided in Appendix B. Additional details of RWDI’s criteria are found in Appendix A.

Table 3: Summary of Overall Predicted Impacts on Receptors

Receptor Number	Receptor Type	Max Veiling Luminance (cd/m ²)	Duration / Total Number of Minutes with High Impact Reflection (Veiling Luminance > 500 cd/m ²)	% of High Impacts Where the Sun Is Also Visible
D1	Driver	22	N/A	N/A
D2	Driver	238	N/A	N/A
D3	Driver	231	N/A	N/A
D4	Driver	77	N/A	N/A
D5	Driver	261	N/A	N/A
D6	Driver	112	N/A	N/A

3.3 Overall Observations and Conclusions

1. Like any contemporary building, the reflective surfaces of the Project are naturally causing solar reflections in the surrounding area.
2. The screening analysis predicted a low potential for visual glare, even with its highly conservative assumption that the viewer would always be looking horizontally towards the source of the reflection. The most frequent reflections on roads were predicted to occur up to 8% of the daytime hours annually on Little Walker Street, when drivers are turning and facing the Proposed Building. Note that this frequency of glare potential is only possible based on the conservative assumption that drivers were unsafely looking toward the source of the reflection (e.g., at the Project) rather than the road ahead.
3. The detailed analysis, which accounted for more realistic view directions and operated at one-minute increments, predicted that all the studied driver receptors have the potential to be exposed to reflections emanating from the Project. However, none of these reflections were predicted to exceed the veiling luminance threshold of 500cd/m².
4. For further details, refer to the visual impact diagrams for all receptors (D1-D6) as shown in Appendix B.
5. Given the safety risks associated with glare impacts on drivers, RWDI's analysis is intentionally conservative. It assumed clear skies for all daytime hours and ignored the effects of any landscaping, the use of sunglasses, as well as obstructions to reflected light due to the car body.
6. It is important to note that the results presented in this report are highly dependent on both the form and materiality of the Project. Should there be any changes to the design, it is recommended that RWDI be contacted and requested to review their potential effects on the findings of this report.
7. Note also that thermal impacts due to solar reflections emanating from the Project are outside the current scope.



4 GENERAL STATEMENT OF LIMITATIONS

This report entitled *153 & 157 Walker Street - Solar Reflection Analysis*, dated 23 July 2025, was prepared by RWDI Australia Pty Ltd ("RWDI") for Freecity North Sydney Development Pty Ltd ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared.

Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilise the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

APPENDIX A

RWDI REFLECTION CRITERIA

APPENDIX A: RWDI REFLECTION CRITERIA



Visual Glare

RWDI has extensive experience in the analysis and assessment of the impacts of sunlight and solar energy reflected from buildings¹.

We have adopted the typical Australian criteria put forth by Hassall², which defines glare as occurring when the veiling luminance of a reflection exceeds 500 cd/m².

Veiling luminance was computed using the CIE General Disability Glare Equation³. This equation is a more robust formulation of the classical Stiles-Holladay glare equation that accounts for the effects of age and eye colour when predicting veiling luminance. This formulation remains valid for light sources between 0.1° and 100° away from the direction of view.

RWDI conservatively assumed a light-blue eye colour (pigmentation factor of 1.2) and an observer age of 62 years old for this work. Based on the most recent Australian Census, this age represents approximately the 80th percentile age for the residents of New South Wales. This means that in reality, veiling luminance would be lower than these predictions for 80% of the population.

It should be noted that the 500 cd/m² limit assumes an adaptation luminance corresponding to a dawn or dusk time frame and may be overly conservative during brighter parts of the day.

APPENDIX A: RWDI REFLECTION CRITERIA



References

1. Danks, R., Good, J., & Sinclair, R., "Assessing reflected sunlight from building facades: A literature review and proposed criteria." *Building and Environment*, 103, 193-202, 2016.
2. Hassall, D., "Reflectivity: Dealing with Rogue Solar Reflections" *University of New South Wales*, 1991.
3. Vos, J., et al. "CIE equations for disability glare." *CIE TC Report CIE 146* (2002): 2002.

APPENDIX B

ANNUAL REFLECTION IMPACT DIAGRAMS

APPENDIX B: ANNUAL REFLECTION IMPACT DIAGRAMS



Presentation of Results

Results are illustrated using “annual impact diagrams”. These plots condense the minute-by-minute annual dataset into a single image. The vertical axis represents the time of the day, and the horizontal axis indicates the day of the year. A sample of such a diagram is shown in Figure B1.

Please note that the referenced times are in local standard time. When Daylight Savings Time is observed, the time should be shifted by an hour when appropriate.

The colours on this plot indicate when all reflections falling on a specific point were predicted and if the predicted veiling luminance exceeds the disability glare threshold (500 cd/m²) for an 80th percentile resident (62 years old). Hatching (i.e., dark green areas) indicates when the sun would be within 30° of a motorist's direction of view.

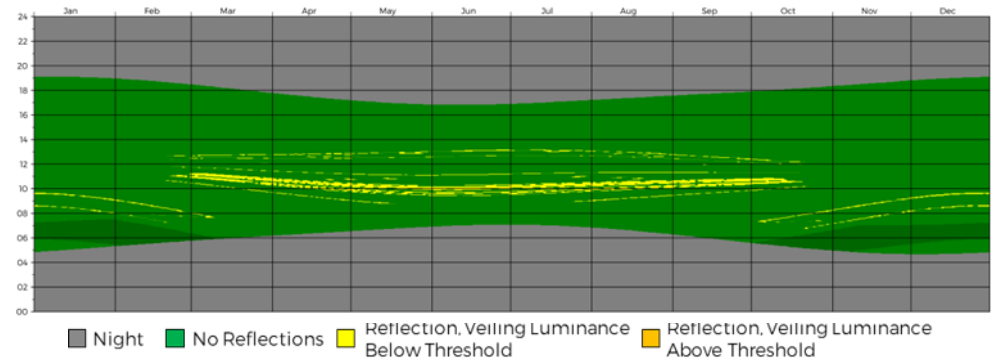


Figure B1: Annual Reflection Impact Diagram for Driver Receptor D4

DETAILED ANALYSIS RESULTS



Driver Receptor D1

Receptor D1 was chosen to assess the visual impact associated with solar reflections affecting southbound drivers on Warringah Freeway.

The simulations indicated that intermittent reflections may fall on this point between 5:30 am and 11:00 am AEST throughout the year, and between 2:00 pm and 4:30 pm AEST from late March to mid September.

The maximum veiling luminance predicted was 22 cd/m².

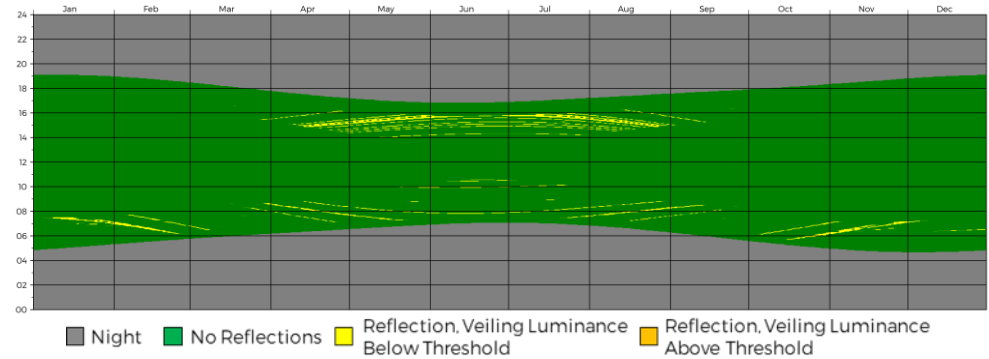


Figure 2: Annual Reflection Impact Diagram for Driver Receptor D1

DETAILED ANALYSIS RESULTS



Driver Receptor D2

Receptor D2 was chosen to assess the visual impact associated with solar reflections affecting northbound drivers on Walker Street, at Mount Street Intersection.

The simulations indicated that intermittent reflections may fall on this point between 12:00 pm and 5:00 pm AEST from early August to mid May.

The maximum veiling luminance predicted was 238 cd/m².

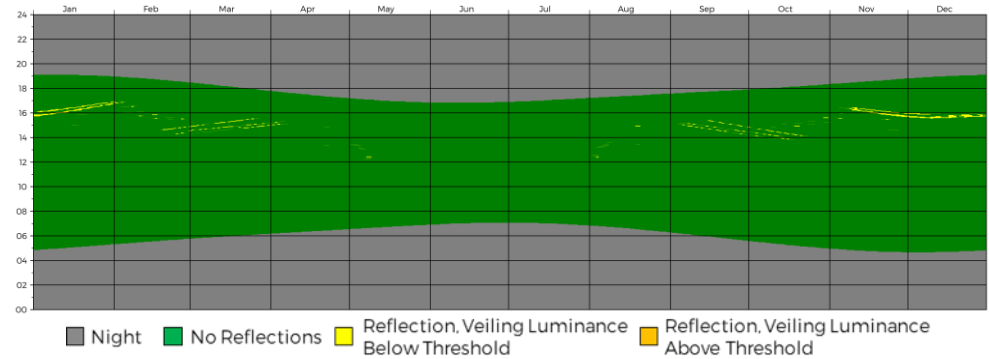


Figure 3: Annual Reflection Impact Diagram for Driver Receptor D2

DETAILED ANALYSIS RESULTS



Driver Receptor D3

Receptor D3 was chosen to assess the visual impact associated with solar reflections affecting northbound drivers on Walker Street, before parking entrance.

The simulations indicated that intermittent reflections may fall on this point between 12:00 pm and 2:30pm AEST from mid February to late October, and between 1:00 pm 5:00 pm AEST from late September to mid March.

The maximum veiling luminance predicted was 231 cd/m².

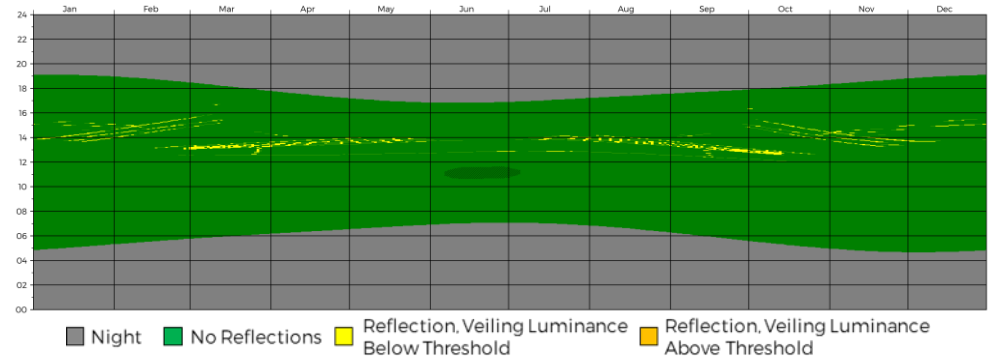


Figure 4: Annual Reflection Impact Diagram for Driver Receptor D3

DETAILED ANALYSIS RESULTS



Driver Receptor D4

Receptor D4 was chosen to assess the visual impact associated with solar reflections affecting eastbound drivers on Berry Street, at Walker Street Intersection.

The simulations indicated that intermittent reflections may fall on this point between 6:45 am and 10:00 am AEST from early October to mid March, and between 9:00 am and 1:15 pm AEST from mid February to mid October.

The maximum veiling luminance predicted was 77 cd/m².

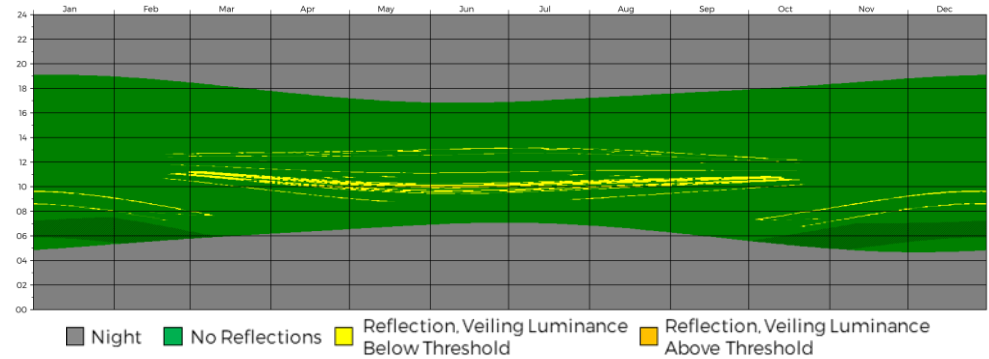


Figure 5: Annual Reflection Impact Diagram for Driver Receptor D4

DETAILED ANALYSIS RESULTS



Driver Receptor D5

Receptor D5 was chosen to assess the visual impact associated with solar reflections affecting southbound drivers on Little Walker Street, turning into Proposed Building entrance.

The simulations indicated that intermittent reflections may fall on this point in pockets of 15 minutes at 5:15 am AEST from late October to early November, at 5:45 am AEST around mid February, and at 6:45 am AEST from late March to early April and around mid September.

Also, between 7:30 am and 8:15 am AEST from mid May to late July, and between 9:30 am and 12:00 pm AEST from late September to mid March.

The maximum veiling luminance predicted was 261 cd/m².

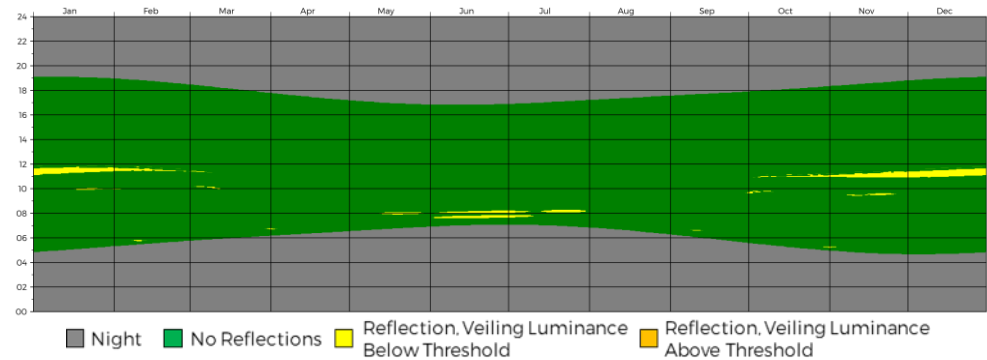


Figure 6: Annual Reflection Impact Diagram for Driver Receptor D5

DETAILED ANALYSIS RESULTS



Driver Receptor D6

Receptor D6 was chosen to assess the visual impact associated with solar reflections affecting southbound drivers on Walker Street, at Berry Street Intersection.

The simulations indicated that intermittent reflections may fall on this point between 7:30 am and 4:15 pm AEST from mid July to early June.

The maximum veiling luminance predicted was 112 cd/m².

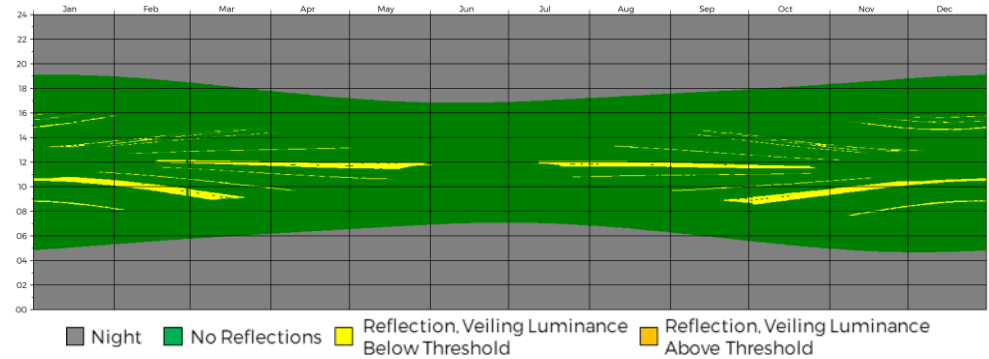


Figure 7: Annual Reflection Impact Diagram for Driver Receptor D6