



11 – 17 Dorcas Street
Dorcas Development Nominees Pty Ltd
External Reflected Glare Report

Permit Amendment | Revision [01]

Document Control Record

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Revision History

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Executive Summary

Inhabit has been engaged by Dorcas Development Nominees Pty Ltd to undertake an external reflected glare and reflected heat assessment for the proposed multi-storey residential development located at 11 – 17 Dorcas Street, South Melbourne, Victoria. Due to the proximity to the Shrine of Remembrance, project-specific criteria for reflected glare and heat have been established based on the Reflectivity Expert Witness Report prepared by Inhabit, dated 28 October 2020.

In accordance with the Reflectivity Expert Witness Report, reflected glare from the proposed development to the Shrine of Remembrance and nearby transport infrastructure has been assessed against a veiling luminance performance criterion of 500 Cd/m² defined by Hassall (1991) using the Holladay (1927) formula. This criterion must not be exceeded during ANZAC (April sunrise to midday) and Remembrance Day (November 10am to 2pm) services. For other times of the year, this criterion must not be exceeded for more than 2% of annual daylight hours.

Reflected heat has also been assessed against a performance criterion of 1000 W/m². This criterion must not be exceeded at any time throughout the year.

Further to the requirements nominated in the Reflectivity Expert Witness Report, the City of Port Phillip planning permit requires that reflected glare also be assessed to occupants of surrounding buildings and aircraft.

Based on findings from this assessment, all glare and heat criteria have been satisfied in accordance with the Reflectivity Expert Witness Report. The project therefore satisfies Condition 22 of Planning Permit 217/2019 issued by the City of Port Phillip.

The following table summarises the results. For more information refer to Appendix A – Detailed Results.

Table 1: Summary of reflectivity results.

Region	Description	Region Type	Performance Criteria	Annual Frequency Performance Criteria Exceeded	Satisfies Expert Witness Requirements?
1	Shrine of Remembrance – Anzac Avenue	Significant Open Space	< 500 Cd/m ² (Hassall, 1991)	<2% (5pm Apr & Aug) (0% during ANZAC / Remembrance Day Services)	Yes
2	Shrine of Remembrance – Western Hillside	Significant Open Space		0% (0% during ANZAC / Remembrance Day Services)	Yes
3	Shrine of Remembrance – Forecourt	Significant Open Space		<1% (6pm Oct) (0% during ANZAC / Remembrance Day Services)	Yes
4	Shrine of Remembrance – Central	Significant Open Space		<2% (7am Mar & Sep) (0% during ANZAC / Remembrance Day Services)	Yes
5	Shrine of Remembrance – Northeast	Significant Open Space		<1% (6pm Aug) (0% during ANZAC / Remembrance Day Services)	Yes
6	St Kilda Road – Southbound	Road		0%	Yes
7	St Kilda Road – Northbound	Road		0%	Yes
8	Dorcas St – Westbound	Road		2% (5pm Feb, Aug and Sep)	Yes
9	Dorcas St – Eastbound (Near)	Road		2% (10am Aug & 7pm Dec and Jan)	Yes
10	Dorcas St – Eastbound (Far)	Road		<2% (7pm Jan & Dec)	Yes
11	Surrounding Buildings – North	Building	< 887 Cd/m ² (Ho et al. 2011)	0%	Not defined in Expert Witness Report.
12	Surrounding Buildings – West	Building		0%	
-	Aircraft	Aircraft	< 500 Cd/m ² (Hassall, 1991)	0%	
-	Reflected Heat	N/A	< 1000 W/m ² (Reflectivity Expert Witness Report)	0%	Yes

1.0 Introduction

Inhabit has been engaged by Dorcas Development Nominees Pty Ltd to assess the proposed multi-storey residential development located at 11 – 17 Dorcas Street, South Melbourne, for likelihood of external reflected glare and the potential impact to the surrounding area and nearby transport infrastructure. Reflected heat has also been assessed.

1.1 Purpose and Scope

The purpose of this assessment is to determine the frequency that external reflected glare to transport infrastructure and public spaces, and reflected heat exceeds the nominated performance criteria.

1.2 Reference Information

This assessment has been based on the following sources of information.

- Architectural Drawing Set by Wood Marsh, dated 16th December 2021
- Planning Permit No. 217/2019
- Reflectivity Expert Witness Report (Rev 0, dated 28/10/2020) prepared by Inhabit
- Façade design workshops held at Wood Marsh offices on 20th April and 3rd May 2021

1.3 Reflected Glare

Reflective glazed façades with modern high-performance coatings will always cause a degree of reflected glare impact to the surroundings. Non-matte surfaces including shiny metallic cladding can also result in reflected glare. The solar reflections off a building façade can lead to numerous visual and thermal issues.

In addition to causing nuisance to pedestrians or occupants of nearby buildings, visual glare may create a safety hazard to motorists, railway drivers and others whose tasks restrict them from simply looking away. This type of glare is referred to as Disability Glare and occurs when the observer is unable to distinguish one object from another within their field of vision.

To quantify the impact of solar reflections from the development, the following glare factors must be considered:

- Frequency
- Duration
- Intensity
- Receiving location
- Viewing direction

1.4 Reflected Heat

Reflected heat impacts are caused by the reflection of solar infrared radiation onto a receiver. This receiver may be human or may be property easily damaged by heat. While the impact of heat is dependent on most the factors listed above for glare, heat impact does not depend on the receiver's directionality. Therefore heat impact can occur wherever facade reflections are concentrated towards a relatively small receiver area, and may occur at different times and locations to potential glare impacts.

1.5 Limitations

This simulation has been based on the methodology and the assumptions included in this report, using material performance values specific to the project. Where specific material performance values are not available, standard industry values have been used as default.

This report only assesses glare in terms of veiling luminance using the industry standard Hassall Methodology. Due to the subjectivity of visual amenity and comfort, a standard does not exist, and therefore this report does not assess visual comfort.

Building performance simulations are idealised representations of the actual building that cannot fully represent all of the intricacies of the building once built. As a result, simulation results only represent an interpretation of the building performance. No guarantee or warranty for the building performance in practice can be based on simulation results alone.

2.0 Performance Criteria

The City of Port Phillip typically prescribes a façade material reflectivity value of no more than 15 – 20%. Following the outcome of the Victorian Civil and Administrative Tribunal (VCAT) held on 12 November 2020, Planning Permit No. 217/2019 Condition #22 requires the following specific requirements for this project:

“External building materials and finishes must not result in hazardous or uncomfortable solar reflectivity and glare to pedestrians, public transport operators and commuters, motorists, aircraft, or occupants of surrounding buildings and public spaces in accordance with the parameters contained in the recommendations at Part VI of the Reflectivity Evidence prepared by Inhabit dated 28 October 2020, to the satisfaction of the Responsible Authority.”

The Reflectivity Evidence (Reflectivity Expert Witness Report) nominates criteria for the Shrine of Remembrance and roads only. For the purposes of this assessment, additional criteria for surrounding buildings and aircraft based on work by Ho et al. (2011) have been defined. The following table summarises the various criteria adopted.

Table 2: Summary of performance criteria adopted.

Receiver Group	Assessment Type	Performance Criteria	Reference
Shrine of Remembrance	External Reflected Glare	< 500 Cd/m ² during ANZAC and Remembrance Day services; and < 500 Cd/m ² for no less than 98% of annual daylight hours	Reflectivity Expert Witness Report Hassall, 1991
Roads	External Reflected Glare	< 500 Cd/m ² for no less than 98% of annual daylight hours	Reflectivity Expert Witness Report Hassall, 1991
Neighbouring Buildings	External Reflected Glare	< 887 Cd/m ² (adjusted to 1100 Cd/m ² to account for the visible light transmittance of neighbouring windows)	Ho et al., 2011
Aircraft	External Reflected Glare	< 500 Cd/m ²	Hassall, 1991
All	Reflected Heat	< 1000 W/m ²	Reflectivity Expert Witness Report

Note that when the reflected glare exceeds the performance criteria, but direct glare from the sun is also present in the observer's field, the veiling luminance from both direct and reflected glare is compared. If direct glare is greater than reflected glare, reflected glare is considered acceptable as the observer would already be exposed to glare from the sun.

Where the glare criteria are exceeded for the Shrine of Remembrance and Road receiver groups, glare is to be assessed using the Daylight Glare Probability (DGP) metric and must achieve a DGP of less than 0.40.

3.0 Site and Context

3.1 Site

The proposed building is located at 11-17 Dorcas Street in South Melbourne. The project is generally surrounded by medium-high rise buildings, mostly located along the nearby St Kilda Road corridor. On the opposite side of St Kilda Road lies the Shrine of Remembrance that sits slightly elevated compared to the project.



Figure 1 Site location and context (Source: Nearmap)

3.2 Critical Observer Locations

Based on the site location, surrounding roads and public spaces have been identified as potential areas for study. The critical observer locations and viewing directions considered in this assessment are:

- Shrine of Remembrance
- St Kilda Road
- Dorcas Street

The following illustrates the study locations.

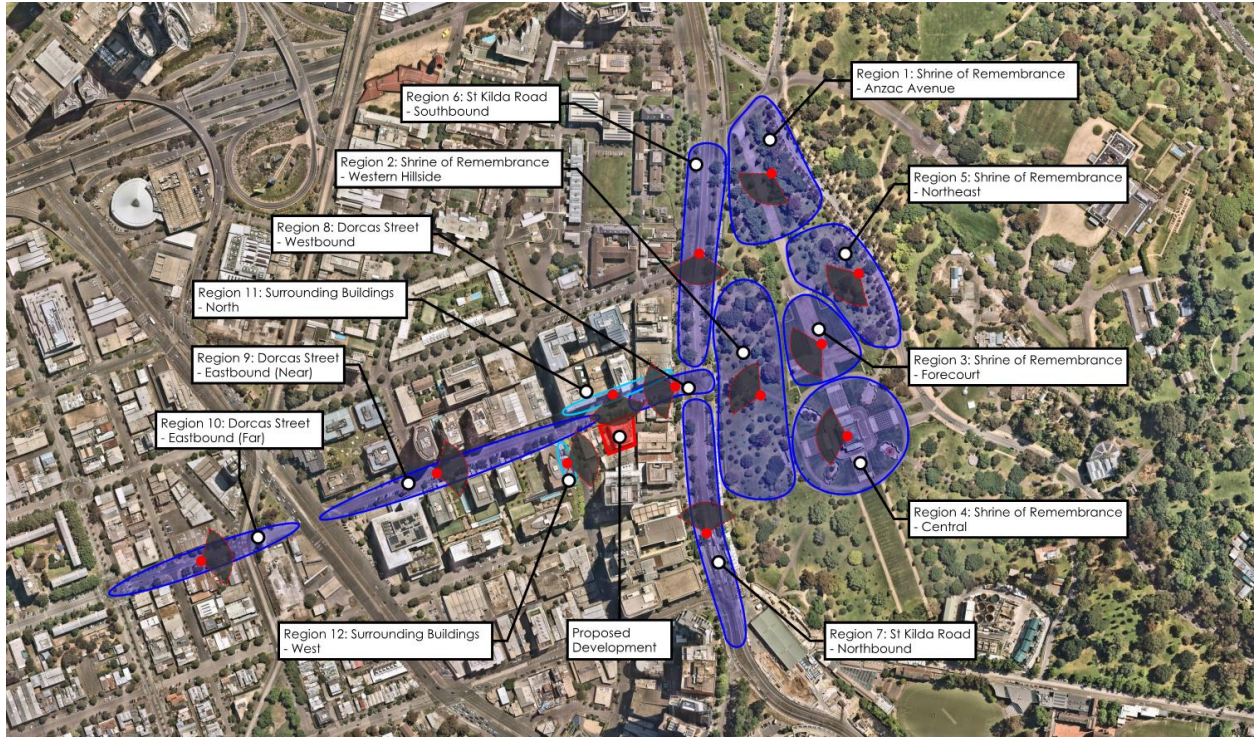


Figure 2: Regions (in blue) identified for detailed study.

4.0 Methodology

4.1 Tools and Software

The proposed development and the surrounding buildings have been modelled in 3D modelling software, Rhinoceros 7. An in-house simulation tool developed by Inhabit using Grasshopper was then used to assess the spatial range of glare and heat and quantify the luminance and radiation values across the 3D environment. The results are then collated to quantify the annual frequency that the criterion is exceeded. This tool is a 3D implementation of the industry standard Hassall Method, which allows for complex façade geometry and neighbouring obstructions.

4.2 Veiling Luminance

For both road and rail driver safety, Hassall (1991) nominates a veiling luminance of 500 candelas per square metre (Cd/m^2) as a practical limit for safety. This limit has been derived using the Holladay (1927) formula to determine the risk of glare due to light reflections. For pedestrians, Ho et al. (2011) nominates a veiling luminance of $887 \text{ Cd}/\text{m}^2$ as the upper limit for glare. Prolonged exposure to veiling luminance above this increases the risk of afterimage and eventual retinal damage. Refer to Appendix B for further information.

4.3 Weber-Fechner Law

When considering glare and the relative impact to the sensory system, the relationship between light and perception is logarithmic. This means that for every unit increase in veiling luminance, the increase in perception is only a factor of the change in veiling luminance. This phenomenon can be described by the Weber-Fechner Law of psychophysics and applies to all basic human senses: vision, hearing, taste, touch, and smell.

As this relationship is logarithmic and not linear, the relative impact on the receiver's perception is difficult to quantify and can sometimes be imperceptible to the human eye. As it is not always possible to eliminate reflected glare with glazed facades, understanding this relationship allows for qualitative discussion to contextualise any glare exceedance.

4.4 Spectral and Diffuse Reflection

Reflected glare is defined by the McGraw-Hill Dictionary of Architecture and Construction (2003) as glare resulting from specular reflection of high brightness in polished or glossy surfaces in the field of view. Therefore when considering the impact of reflected glare, the critical material properties are the combination of reflectivity and specularity together.

Reflectivity in the context of this assessment is a measure of visible light that is reflected from a surface when illuminated by a light source such as the sun.

Specularity can be described as how smooth a surface is on a microscopic level. The higher the surface specularity, the more mirror-like or shiny the surface is. Specular reflection reflects all light which arrives from a given direction at the corresponding opposite angle. Conversely, surfaces with low specularity results in a diffuse reflection caused by light being reflected in a broad range of directions.

It is important to note that a material with high reflectivity and low specularity has less potential to result in reflected glare when compared to a high reflectivity and high specularity. This is due to a lower specular reflection which predominantly drives glare impact.

In this assessment, glazed and non-matte metallic façade elements have been defined conservatively as having high specularity.

4.5 Direct Glare and Reflected Glare

For periods when the unobstructed sun is within the observer's field of view, the veiling luminance caused by the sun (i.e. direct glare) and the reflected sun (i.e. reflected glare) are calculated based on the corresponding angle between the observer's visual axis and the glare source. Where direct glare is greater than reflected glare, the veiling luminance performance criterion is considered to be met.

4.6 Reflected Heat

To determine the project's performance against the reflected heat criterion, the concentrations of simultaneous reflections are assessed, factoring in the intensity of each individual reflection. For concave facades, the greatest concentration of heat typically occurs to the north (in the southern hemisphere) of the curved façade with the sun at high elevations. As the reflected heat from one typical window may range between 100 – 500 W/m² (depending on solar elevation, angle of incidence, and material solar reflectance value), the 1000 W/m² criterion can be exceeded with as little as two images of the sun reflected on the same location. This approach to reflected heat allows for early approximations and therefore inform the mitigation strategy if applicable.

5.0 Modelling Inputs

5.1 Annual Sun Path

The assessment has used the sun's position in the sky (azimuth and altitudes) from the following coordinates:

- 37.83° S, 144.97° E

5.2 Sky Conditions

Sunny clear sky conditions have been assumed and the varying luminous efficacy based on solar elevation (Hassall, 1991) has been used in this analysis. This represents a conservative scenario for the risk of reflected glare. An overcast or polluted sky will reduce the intensity of solar reflections thereby reducing the risk of glare.

5.3 Time of Analysis

Hourly calculations have been performed for all daylight hours, on the 21st day of each month throughout the year. The 21st day of each month has been selected to account for the summer and winter solstices, covering representative solar positions throughout the year. This time resolution provides an appropriate representation of annual glare impact.

5.4 Model Geometry

A 3D massing model of the proposed development has been generated based on the architectural drawings. Shading devices have been modelled 450mm deep on the north façade, 400mm on the east, and 350mm on the south and west. Massing geometry of neighbouring buildings have been included to provide context and accuracy in solar obstructions. Terrain has also been included, specifically the hill on which the Shrine of Remembrance is built.

The following illustrates the 3D model geometry.

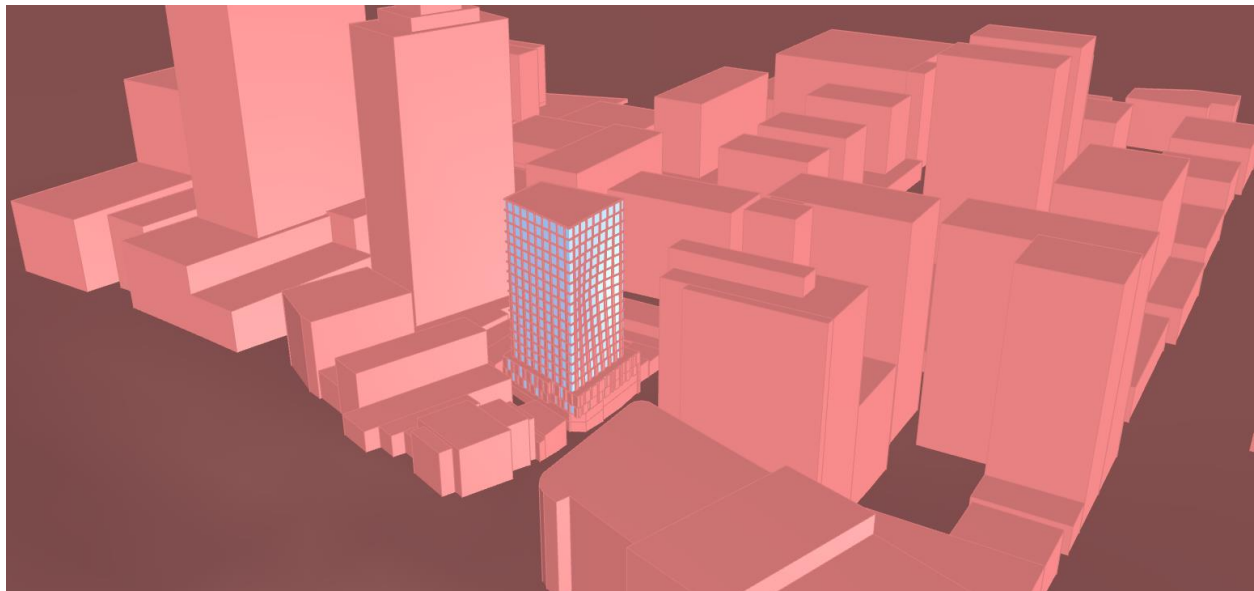


Figure 3: Northeast perspective of model geometry

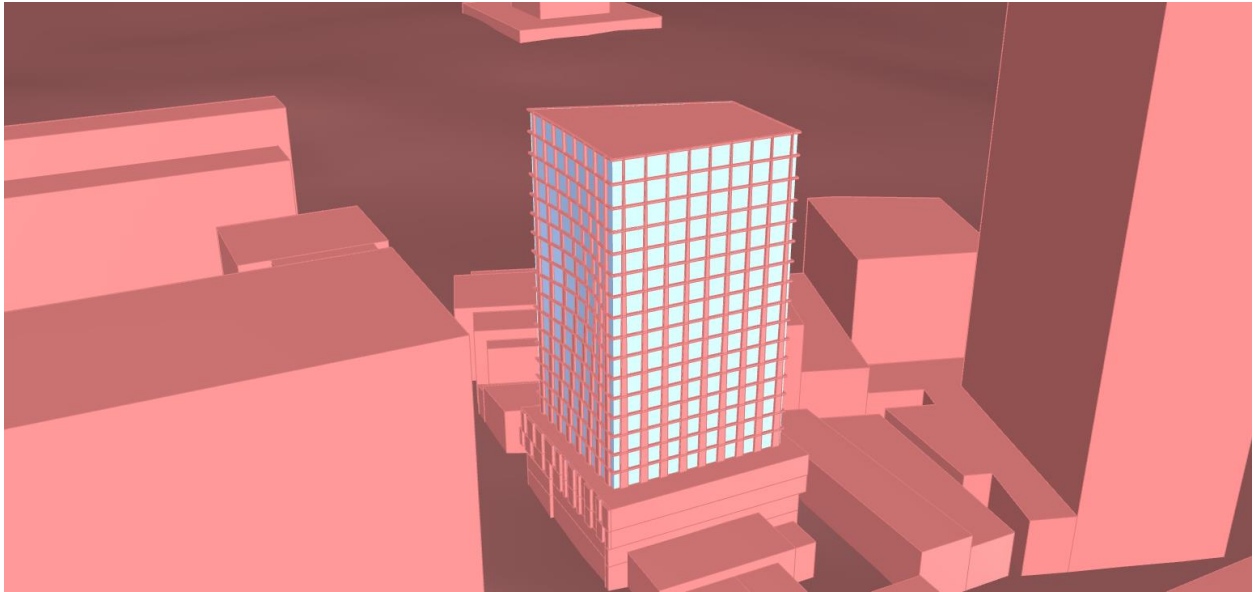


Figure 4: Northwest perspective of model geometry



Figure 5: Top perspective view of model geometry.

5.5 Material Properties

The following material properties have been adopted for this assessment.

Table 3: Material properties assigned.

Element	Reflectance	Comment
Glazed Façade	15% (Visible Light Reflectance) 10% (Solar Energy Reflectance)	Representative of typical DGU. The nominal material reflectance is measured normal (i.e. perpendicular) to the surface. Due to the fundamental laws of material reflectivity, the reflectance of a material is angular-dependent, and increases as the reflection becomes more glancing. This behaviour is accounted for in this assessment.
Shading Devices	n/a	Material is assumed to be matte finish with negligible specular light reflectance.

6.0 Results

6.1 Reflected Glare

The table below summarises the annual frequency that the performance criterion is exceeded within each study region.

Table 4: Regions identified for further detailed study.

Region	Description	Region Type	Performance Criteria	Annual Frequency Performance Criteria Exceeded	Satisfies Expert Witness Requirements?
1	Shrine of Remembrance – Anzac Avenue	Significant Open Space	< 500 Cd/m ² (Hassall, 1991)	<2% (5pm Apr & Aug)	Yes
2	Shrine of Remembrance – Western Hillside	Significant Open Space		0%	Yes
3	Shrine of Remembrance – Forecourt	Significant Open Space		<1% (6pm Oct)	Yes
4	Shrine of Remembrance – Central	Significant Open Space		<2% (7am Mar & Sep)	Yes
5	Shrine of Remembrance – Northeast	Significant Open Space		<1% (6pm Aug)	Yes
6	St Kilda Road – Southbound	Road		0%	Yes
7	St Kilda Road – Northbound	Road		0%	Yes
8	Dorcas St – Westbound	Road		2% (5pm Feb, Aug and Sep)	Yes
9	Dorcas St – Eastbound (Near)	Road		2% (10am Aug & 7pm Dec and Jan)	Yes
10	Dorcas St – Eastbound (Far)	Road		<2% (Jan & Dec 7pm)	Yes
11	Surrounding Buildings – North	Building	< 887 Cd/m ² (Ho et al. 2011)	0%	Not defined in Expert Witness Report.
12	Surrounding Buildings – West	Building		0%	
-	Aircraft	Aircraft	< 500 Cd/m ² (Hassall, 1991)	0%	

The following charts indicate the times of year when potential reflected glare exceeds the performance criteria in each region. Orange indicates when the performance criteria has been exceeded, and purple indicates when the performance criteria is exceeded however direct glare is greater than reflected glare. When the observer experiences both direct and reflected glare, the direct and reflected glare is compared. When direct glare is greater than reflected glare, the criterion is considered to be met.

6.1.1 Significant Open Space Regions

Anzac Avenue

	AM						PM								
	5	6	7	8	9	10	12	1	2	3	4	5	6	7	8
Jan															
Feb															
Mar															
Apr															
May															
Jun															
Jul															
Aug															
Sep															
Oct															
Nov															
Dec															

500 Veiling Luminance Criterion (Cd/m²)
 98.6% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 1.4% Criteria exceeded - Exposure to reflected glare only

Shrine of Remembrance - Western Hillside

	AM						PM								
	5	6	7	8	9	10	12	1	2	3	4	5	6	7	8
Jan															
Feb															
Mar															
Apr															
May															
Jun															
Jul															
Aug															
Sep															
Oct															
Nov															
Dec															

500 Veiling Luminance Criterion (Cd/m²)
 100.0% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 0.0% Criteria exceeded - Exposure to reflected glare only

Region 1: Shrine of Remembrance – Anzac Avenue

Shrine of Remembrance - Forecourt

	AM						PM								
	5	6	7	8	9	10	12	1	2	3	4	5	6	7	8
Jan															
Feb															
Mar															
Apr															
May															
Jun															
Jul															
Aug															
Sep															
Oct															
Nov															
Dec															

500 Veiling Luminance Criterion (Cd/m²)
 99.3% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 0.7% Criteria exceeded - Exposure to reflected glare only

Region 3: Shrine of Remembrance – Forecourt

Region 2: Shrine of Remembrance – Western Hillside

Shrine of Remembrance - Central

	AM						PM								
	5	6	7	8	9	10	12	1	2	3	4	5	6	7	8
Jan															
Feb															
Mar															
Apr															
May															
Jun															
Jul															
Aug															
Sep															
Oct															
Nov															
Dec															

500 Veiling Luminance Criterion (Cd/m²)
 98.6% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 1.4% Criteria exceeded - Exposure to reflected glare only

Region 4: Shrine of Remembrance – Central

Shrine of Remembrance - Northeast

	AM						PM								
	5	6	7	8	9	10	12	1	2	3	4	5	6	7	8
Jan															
Feb															
Mar															
Apr															
May															
Jun															
Jul															
Aug															
Sep															
Oct															
Nov															
Dec															

500 Veiling Luminance Criterion (Cd/m²)
 99.3% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 0.7% Criteria exceeded - Exposure to reflected glare only

Region 5: Shrine of Remembrance – Northeast



6.1.2 Road Regions

St Kilda Rd - Southbound

	AM							PM								
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan																
Feb																
Mar																
Apr																
May																
Jun																
Jul																
Aug																
Sep																
Oct																
Nov																
Dec																

500 Veiling Luminance Criterion (Cd/m²)
 100.0% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 0.0% Criteria exceeded - Exposure to reflected glare only

St Kilda Rd - Northbound

	AM							PM								
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan																
Feb																
Mar																
Apr																
May																
Jun																
Jul																
Aug																
Sep																
Oct																
Nov																
Dec																

500 Veiling Luminance Criterion (Cd/m²)
 100.0% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 0.0% Criteria exceeded - Exposure to reflected glare only

Region 6: St Kilda Road – Southbound

Dorcas St - Westbound

	AM							PM								
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan																
Feb																
Mar																
Apr																
May																
Jun																
Jul																
Aug																
Sep																
Oct																
Nov																
Dec																

500 Veiling Luminance Criterion (Cd/m²)
 96.5% Acceptable - Within performance criteria
 1.4% Acceptable - Exposure to direct and reflected glare
 2% Criteria exceeded - Exposure to reflected glare only

Region 7: St Kilda Road – Northbound

Dorcas St - Eastbound (Near)

	AM							PM								
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan																
Feb																
Mar																
Apr																
May																
Jun																
Jul																
Aug																
Sep																
Oct																
Nov																
Dec																

500 Veiling Luminance Criterion (Cd/m²)
 96.5% Acceptable - Within performance criteria
 1.4% Acceptable - Exposure to direct and reflected glare
 2% Criteria exceeded - Exposure to reflected glare only

Region 8: Dorcas Street – Westbound

Dorcas St - Eastbound (Far)

	AM							PM								
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan																
Feb																
Mar																
Apr																
May																
Jun																
Jul																
Aug																
Sep																
Oct																
Nov																
Dec																

500 Veiling Luminance Criterion (Cd/m²)
 98.6% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 1.4% Criteria exceeded - Exposure to reflected glare only

Region 9: Dorcas Street – Eastbound (Near)

Region 10: Dorcas Street – Eastbound (Far)



6.1.3 Building Regions

Surrounding Buildings - North

	AM							PM								
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan																
Feb																
Mar																
Apr																
May																
Jun																
Jul																
Aug																
Sep																
Oct																
Nov																
Dec																

1100 Veiling Luminance Criterion (Cd/m²)
 100.0% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 0.0% Criteria exceeded - Exposure to reflected glare only

Surrounding Buildings - West

	AM							PM								
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan																
Feb																
Mar																
Apr																
May																
Jun																
Jul																
Aug																
Sep																
Oct																
Nov																
Dec																

1100 Veiling Luminance Criterion (Cd/m²)
 100.0% Acceptable - Within performance criteria
 0.0% Acceptable - Exposure to direct and reflected glare
 0.0% Criteria exceeded - Exposure to reflected glare only

Region 11: Surrounding Buildings – North

Region 12: Surrounding Buildings – West

6.1.4 Glare Impact to Aircraft

No upward reflections were identified in the model. Upward reflections are only possible where upward inclined glass is proposed. The project does not include any upward inclined glass (all windows are vertical).

6.2 Reflected Heat

The following table summarises findings of the reflected heat assessment.

Region	Description	Region Type	Performance Criteria	Annual Frequency Performance Criteria Exceeded	Satisfies Expert Witness Requirements?
-	Reflected Heat	N/A	< 1000 W/m ²	0%	Yes

Inhabit has worked with the design team to refine the proposed façade design to limit the degree of concentrated heat reflected off the building while maintaining the intent of a curved north façade. Through an iterative design approach, the north façade incorporates deliberate faceting and angles that limit the degree of heat focusing.

The following outputs illustrate two scenarios when the sun is in front of the building when the daily concentration of heat will be highest. The green areas indicate the reflected radiation from each window on the ground (viewed in plan). The numbers indicate the reflected solar power from each reflection (W/m²). We note that this assessment is conservative as it does not include the horizontal and vertical 450mm deep shading elements that will help reduce these reflected areas.

The first output represents January 1pm when the sun is at its highest altitude and solar radiation output is greatest. The second is during the equinox (April, 1pm) when more reflections overlap, but the solar output is significantly lower. Throughout the year, the overlapping areas do not exceed the criterion, therefore compliance with the Reflectivity Expert Witness Report is achieved.

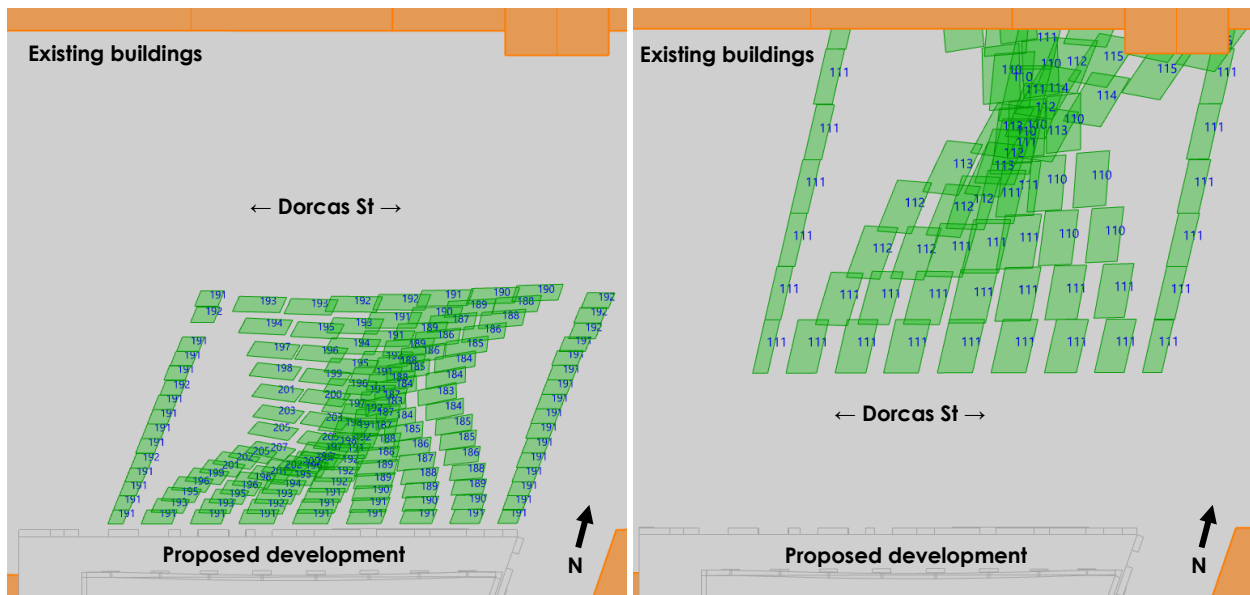


Figure 6: Plan view of reflected heat of each window on the ground (Left: January 1pm; Right: April 1pm). Values represent reflected solar radiation [W/m²].

7.0 Discussion

7.1 Reflected Glare

The following table summarises the key comments.

Region	Description	Annual Frequency Performance Criteria Exceeded	Comment
1	Shrine of Remembrance – Anzac Avenue	<2% (5pm Apr & Aug)	Exceedance occurs outside ANZAC and Remembrance Day services, and occurs no more than 2% of annual daylight hours.
2	Shrine of Remembrance – Western Hillside	0%	No exceedances identified.
3	Shrine of Remembrance – Forecourt	<1% (6pm Oct)	Exceedance occurs outside ANZAC and Remembrance Day services, and occurs no more than 2% of annual daylight hours.
4	Shrine of Remembrance – Central	<2% (7am Mar & Sep)	Exceedance occurs outside ANZAC and Remembrance Day services, and occurs no more than 2% of annual daylight hours. We note that reflectivity during the ANZAC Day dawn service period is less than 20 Cd/m ² (limit of 500 Cd/m ²). The assessment assumes a clear sky and observers in this region are standing at the main Shrine building, facing directly towards the proposed development. This is considered conservative.
5	Shrine of Remembrance – Northeast	<1% (6pm Aug)	Exceedance occurs outside ANZAC and Remembrance Day services, and occurs no more than 2% of annual daylight hours.
6	St Kilda Road – Southbound	0%	No exceedances identified.
7	St Kilda Road – Northbound	0%	No exceedances identified.
8	Dorcas St – Westbound	2% (5pm Feb, Aug & Sep)	Due to the high upward angles of the glare source on the building (~60°), glare is likely to be outside the viewing limits from inside the vehicle (i.e. obstructed by the vehicle roof).
9	Dorcas St – Eastbound (Near)	2% (10am Aug & 7pm Dec and Jan)	Exceedance occurs no more than 2% of annual daylight hours.
10	Dorcas St – Eastbound (Far)	<2% (7pm Jan & Dec)	Exceedance occurs no more than 2% of annual daylight hours.
11	Surrounding Buildings – North	0%	No exceedances identified.
12	Surrounding Buildings – West	0%	No exceedances identified.
-	Aircraft	0%	No exceedances identified.

7.2 Daylight Glare Probability

As the glare criteria (combination of veiling luminance and frequency) have not been exceeded, assessment using Daylight Glare Probability (DGP) is not required. We note that the DGP method considers overall light levels within the viewer's field of view, therefore can be more realistic of actual glare conditions. As a result, DGP can often be less conservative than the Hassall veiling luminance approach.

7.3 Mitigation Strategies Adopted

Some degree of reflected glare will always occur on a glazed façade exposed to the sun. Modern high-performance coatings can typically increase the reflectivity of the material; therefore increasing the potential for reflected glare.

For this project, glare has been mitigated through the use of the expressed shading design, forming a vertical and horizontal grid across the façade. The depth of shading expression varies depending on the façade orientation, and the depth has been defined specifically to address reflected glare. The glare mitigation strategy, included minimum 450mm deep shading to the north, 400mm to the east, and 350mm to the south and west. The 450mm deep shading design on the north will also assist in reducing the reflected heat from the north, however as previously discussed, these elements have been conservatively omitted from the heat study.

8.0 Conclusion

Inhabit has carried out assessments for potential reflected glare and reflected heat from the proposed façade of 11-17 Dorcas Street, South Melbourne. Based on findings from this assessment, all glare and heat criteria have been satisfied in accordance with the Reflectivity Expert Witness Report, dated 28 October 2020. As the glare criteria (combination of veiling luminance and frequency) have not been exceeded, assessment using Daylight Glare Probability (DGP) is not required. The project therefore satisfies Condition 22 of Planning Permit 217/2019 issued by the City of Port Phillip.

9.0 References

- Hassall, David N. H. 1991, *Reflectivity: dealing with rogue solar reflections* / written and illustrated by David N.H. Hassall D.N.H. Hassall] [Newport, N.S.W].
- Holladay, L. L. 1927, *Action of a Light-Source in the Field of View in Lowering Visibility*, *J. Opt. Soc. Am.* 14, 1-15.
- Ho, C. K., Ghanbari, C. M., and Diver, R. B. (August 5, 2011). "Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation." *ASME. J. Sol. Energy Eng.* August 2011; 133(3): 031021.

Appendix A – Detailed Results

The following charts present the maximum veiling luminance in each region throughout the year.

Region 1: Shrine of Remembrance – Anzac Avenue

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	620	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	648	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Legend

98.6%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
1.4%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)



Figure 7: Representative perspective. Glare points exceeding the limit are shown in red (April and August 5pm).

Region 2: Shrine of Remembrance – Western Hillside

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	15	47	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	3	63	0	0	0	0	0	0	0	0	0	0	69	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	27	93	0	0	0	0	0	0	0	0	0	0	34	0	0
Nov	1	30	60	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	1	23	47	0	0	0	0	0	0	0	0	0	0	0	0	0

Legend

100.0%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
0.0%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

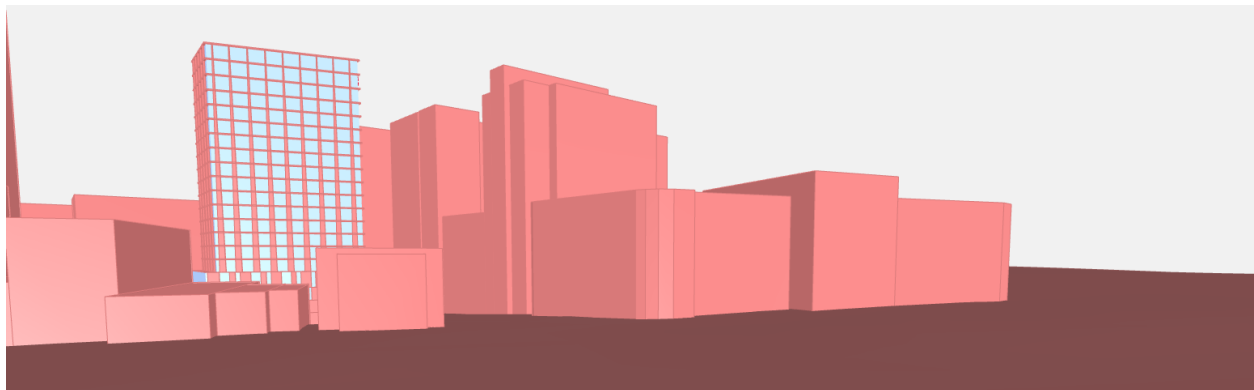


Figure 8: Representative perspective. Glare points exceeding the limit are shown in red (none identified).

Region 3: Shrine of Remembrance – Forecourt

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	6	37	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	27	0	0	0	0	0	0	0	0	0	0	0	713	0	0
Nov	8	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	21	117	0	0	0	0	0	0	0	0	0	0	0	0	191	0

Legend

99.3%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
0.7%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

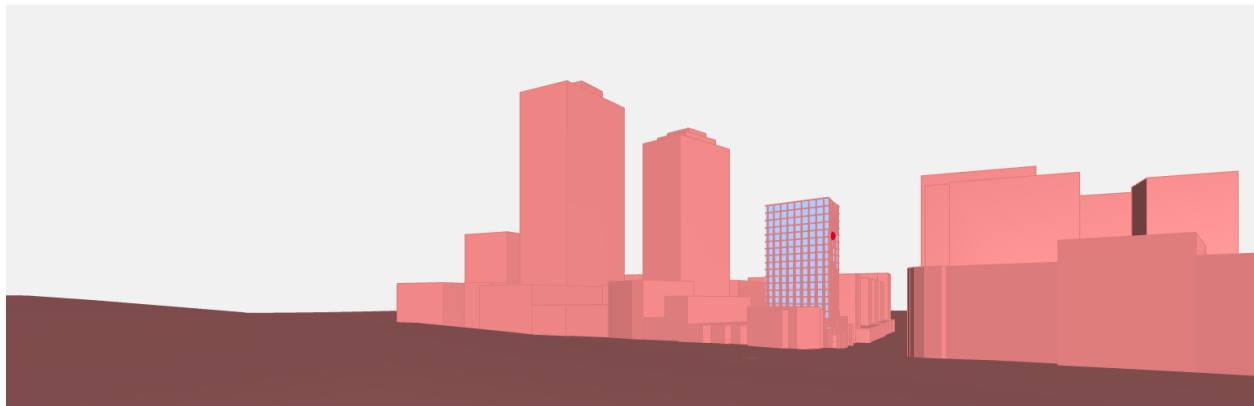


Figure 9: Representative perspective. Glare points exceeding the limit are shown in red (6pm October).

Region 4: Shrine of Remembrance – Central

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	0	413	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	901	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	588	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	264	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Legend

98.6%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
1.4%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

We note that the above results are for the 21st of each month. Veiling luminance assessed for April 25th 7am is <15 Cd/m² (limit of 500 Cd/m²). All other hours on this day is 0 Cd/m².

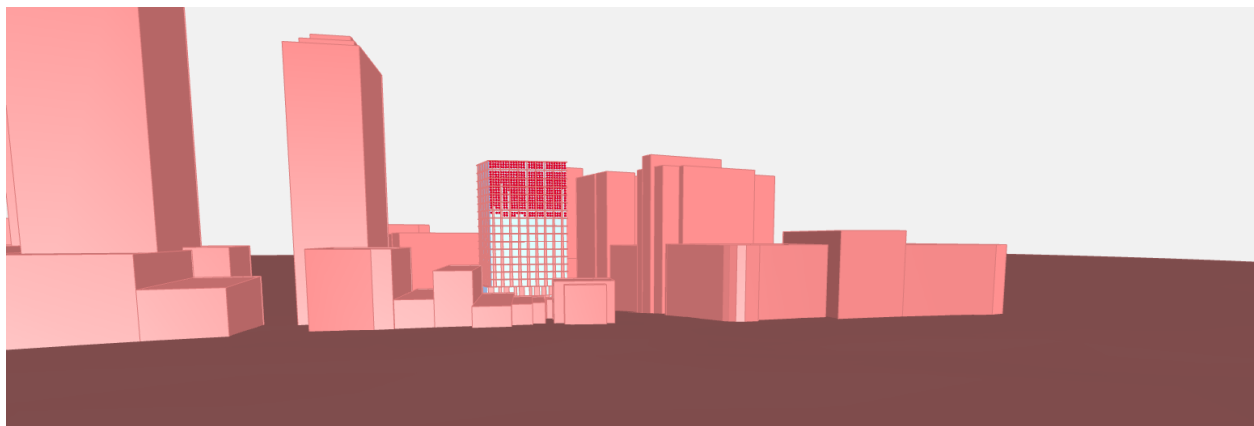


Figure 10: Representative perspective. Glare points exceeding the limit are shown in red (March and September, 7am).

Region 5: Shrine of Remembrance – Northeast

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	27	0	0	0	0	0	0	0	0	0	0	0	2182	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Legend

99.3%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
0.7%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

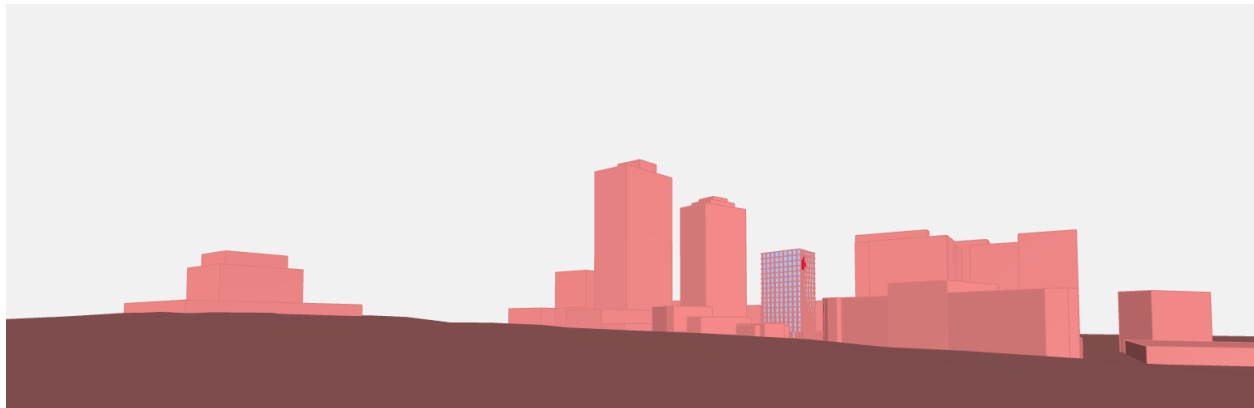


Figure 11: Representative perspective. Glare points exceeding the limit are shown in red (6pm October).

Region 6: St Kilda Road – Southbound

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	0	0	121	113	0	0
Feb	0	0	0	0	0	0	0	0	0	0	0	0	112	89	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	111	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	190	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	115	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	92	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	127	0	0	0

Legend

100.0%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
0.0%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

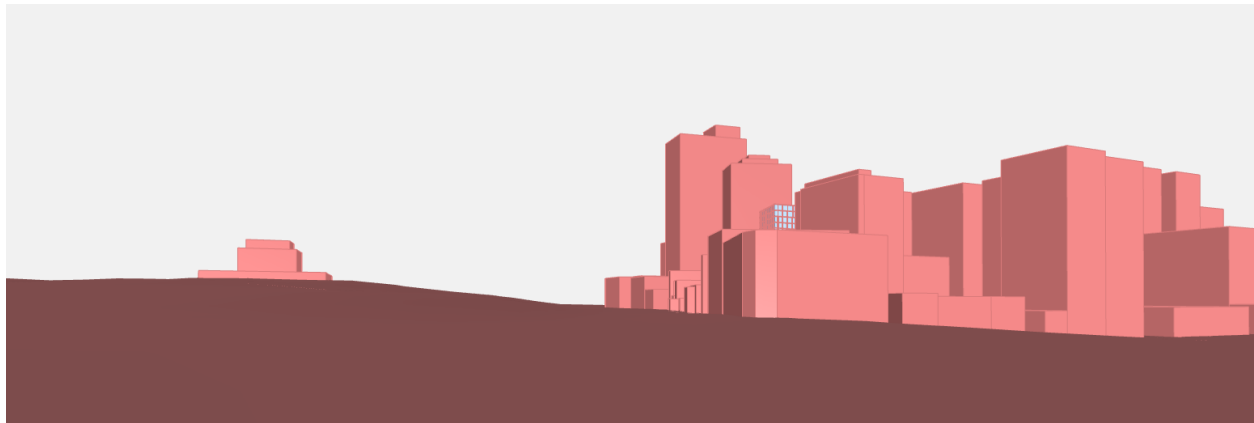


Figure 12: Representative perspective. Glare points exceeding the limit are shown in red (none identified).

Region 7: St Kilda Road – Northbound

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	15	39	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	13	50	123	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	50	142	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	9	43	112	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	14	36	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Legend

100.0%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
0.0%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)



Figure 13: Representative perspective. Glare points exceeding the limit are shown in red (none identified).

Region 8: Dorcas Street – Westbound

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	123	276	537	498	0	0
Feb	0	0	0	0	0	0	0	0	0	0	95	236	564	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	74	188	456	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	92	242	650	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	144	382	586	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	172	333	459	0	0	0
Dec	0	444	0	0	0	0	0	0	0	0	143	284	543	0	0	0

Legend

96.5%	Within performance criteria - Results < 500 Cd/m ²
1.4%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
2.0%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

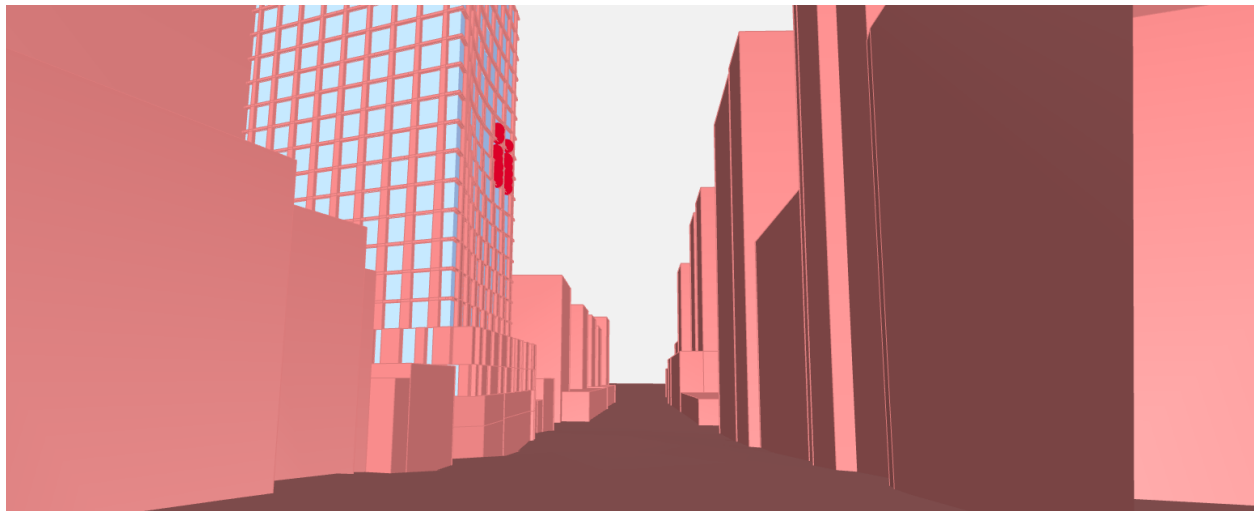


Figure 14: Representative perspective. Glare points exceeding the limit are shown in red (5pm September).

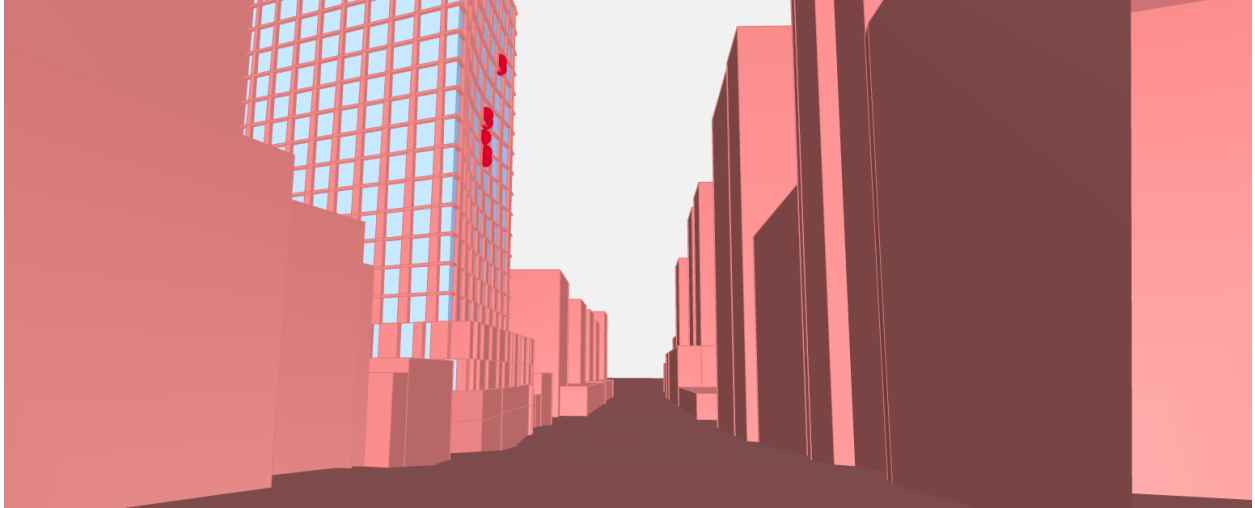


Figure 15: Representative perspective. Glare points exceeding the limit are shown in red (5pm October).

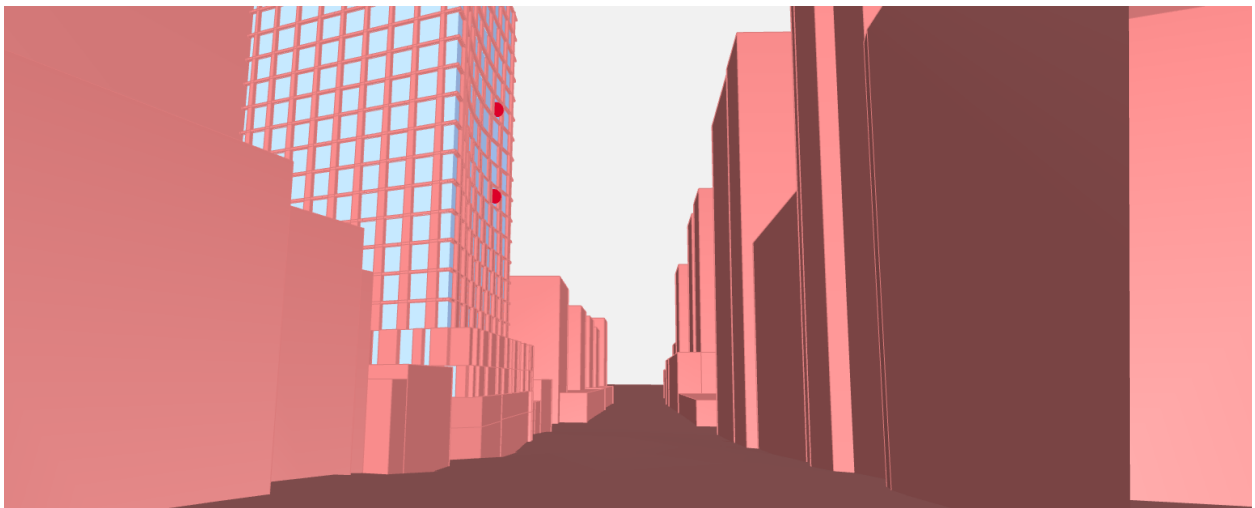


Figure 16: Representative perspective. Glare points exceeding the limit are shown in red (5pm Feb).

Region 9: Dorcas Street – Eastbound (Near)

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1815	0
Feb	0	0	0	0	0	322	174	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	593	366	195	70	0	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	167	62	0	0	0	0	0	0	0	0
May	0	0	0	0	0	401	85	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	437	59	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	496	188	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	545	180	67	0	0	0	0	0	0	0	0
Sep	0	0	0	0	673	349	153	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	220	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	827	0

Legend

96.5%	Within performance criteria - Results < 500 Cd/m ²
1.4%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
2.0%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

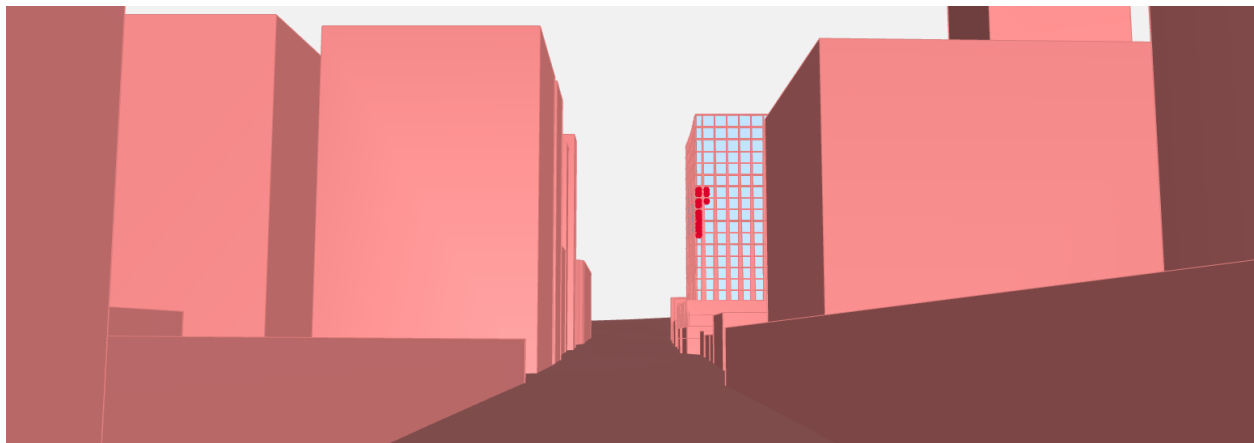


Figure 17: Representative perspective. Glare points exceeding the limit are shown in red (7pm January).

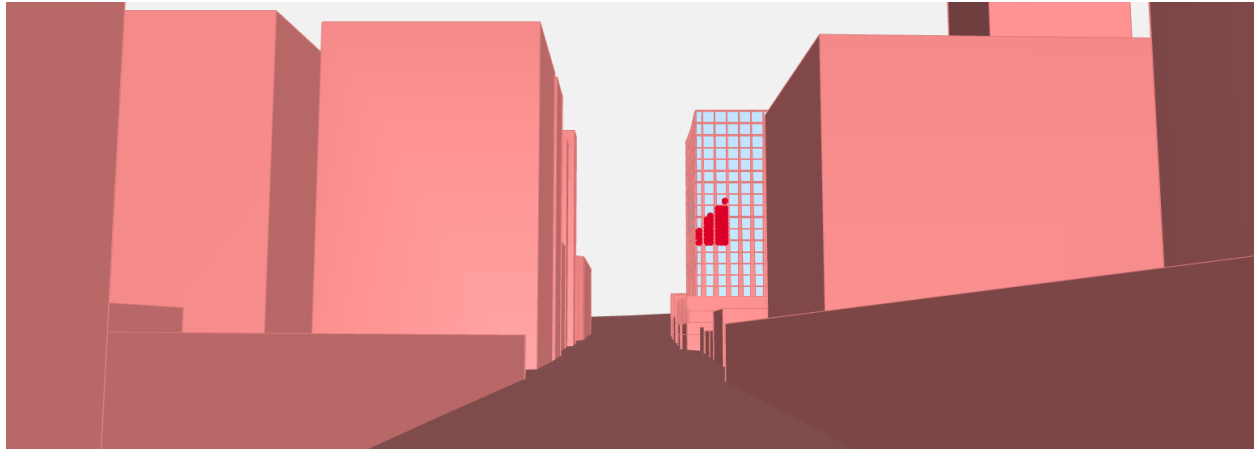


Figure 18: Representative perspective. Glare points exceeding the limit are shown in red (7pm December).

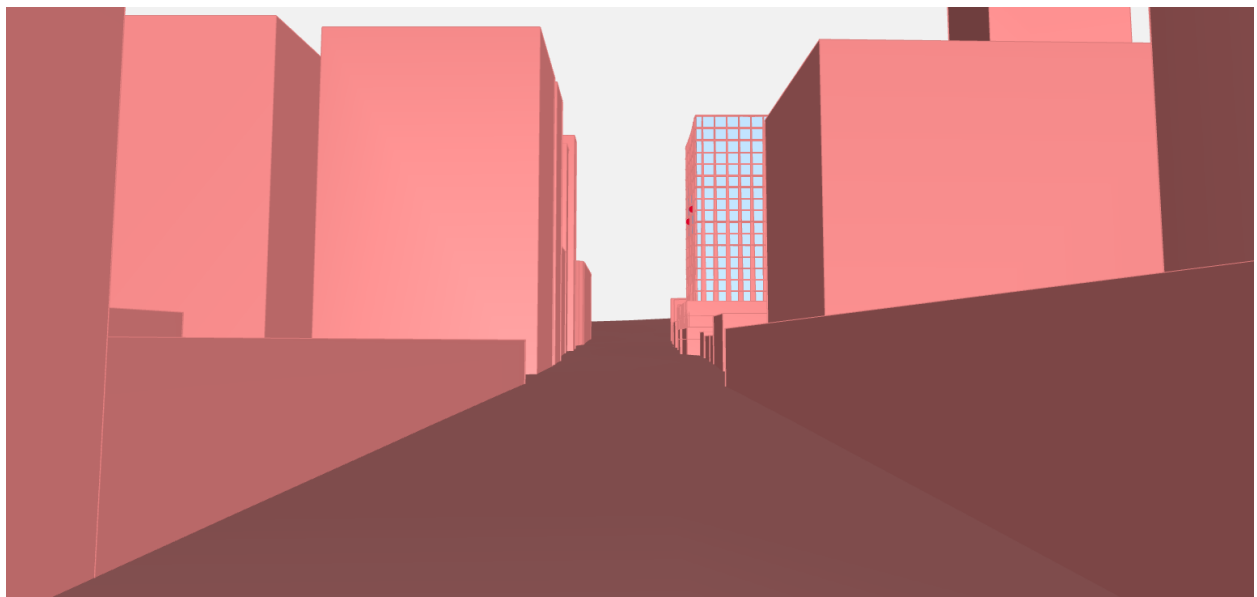


Figure 19: Representative perspective. Glare points exceeding the limit are shown in red (10am August).

Region 10: Dorcas Street – Eastbound (Far)

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	945	0
Feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	582	0

Legend

100.0%	Within performance criteria - Results < 500 Cd/m ²
0.0%	Within performance criteria - Results ≥ 500 Cd/m ² (exposure to direct and reflected glare)
0.0%	Not within performance criteria - Results ≥ 500 Cd/m ² (exposure to reflected glare only)

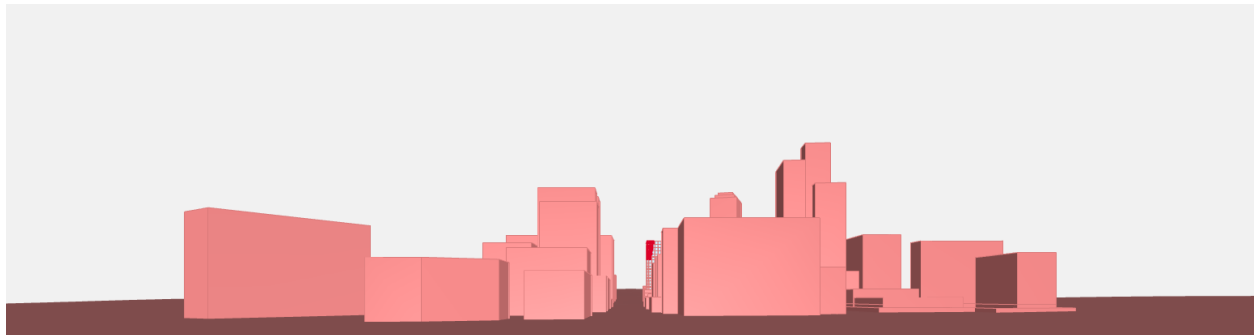


Figure 20: Representative perspective. Glare points exceeding the limit are shown in red (Dec and Jan 7pm).

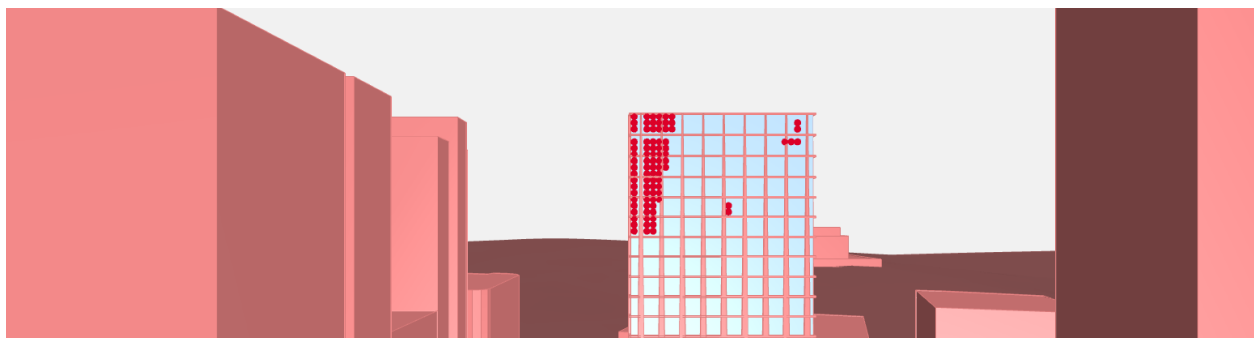


Figure 21: Closeup perspective. Glare points exceeding the limit are shown in red (Dec and Jan 7pm).

Region 11: Surrounding Buildings – North

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	0	0	0	0	0	0	0	0	0	61	63	0	0	0
Feb	0	0	0	0	0	0	0	0	0	66	82	87	75	34	0	0
Mar	0	0	0	0	0	67	79	80	80	93	125	137	52	0	0	0
Apr	0	0	0	0	45	86	112	118	120	146	214	115	0	0	0	0
May	0	0	0	17	46	83	155	170	175	218	253	128	6	0	0	0
Jun	0	0	0	10	44	84	175	202	205	197	290	230	0	0	0	0
Jul	0	0	0	0	42	76	150	172	172	208	234	236	12	0	0	0
Aug	0	0	0	0	43	84	110	118	119	142	205	119	20	0	0	0
Sep	0	0	0	0	0	70	81	80	81	99	131	133	32	0	0	0
Oct	0	0	0	0	0	0	0	0	0	75	91	86	47	20	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0	69	44	0	0	0
Dec	0	0	0	0	0	0	0	0	0	0	0	0	57	0	0	0

Legend

100.0%	Within performance criteria - Results < 900* Cd/m ²
0.0%	Within performance criteria - Results ≥ 900* Cd/m ² (exposure to direct and reflected glare)
0.0%	Not within performance criteria - Results ≥ 900* Cd/m ² (exposure to reflected glare only)

* Plus adjustment for reflection perceived through glass with a nominal visible light transmittance of 60%.

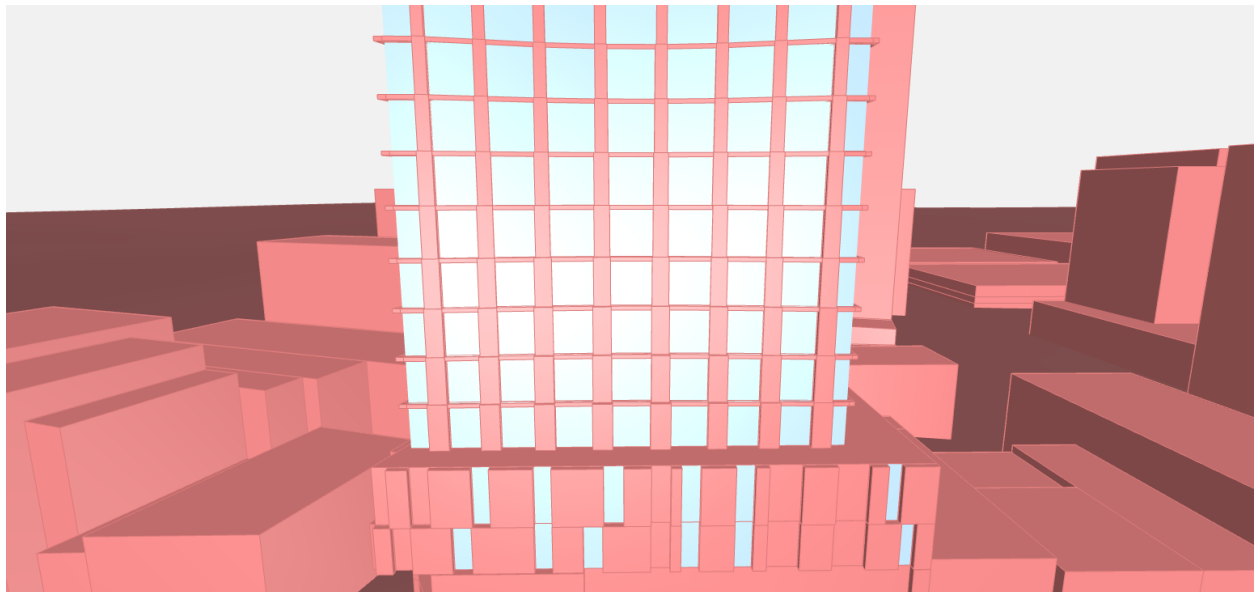


Figure 22: Representative perspective. Glare points exceeding the limit are shown in red (none identified).

Region 12: Surrounding Buildings – West

	AM								PM							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Jan	0	0	104	249	0	0	0	0	0	0	0	0	145	254	945	0
Feb	0	0	189	421	0	0	0	0	0	0	0	0	123	197	360	0
Mar	0	0	564	0	0	0	0	0	0	0	0	56	62	0	0	0
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	62	68	0	0	0
Oct	0	0	324	0	0	0	0	0	0	0	0	89	128	292	0	0
Nov	0	60	147	291	0	0	0	0	0	0	0	101	156	422	542	0
Dec	0	0	99	205	0	0	0	0	0	0	0	0	170	300	582	0

Legend

100.0%	Within performance criteria - Results < 887* Cd/m ²
0.0%	Within performance criteria - Results ≥ 887* Cd/m ² (exposure to direct and reflected glare)
0.0%	Not within performance criteria - Results ≥ 887* Cd/m ² (exposure to reflected glare only)

* Adjusted to 1100 Cd/m² to account for reflection perceived through windows.

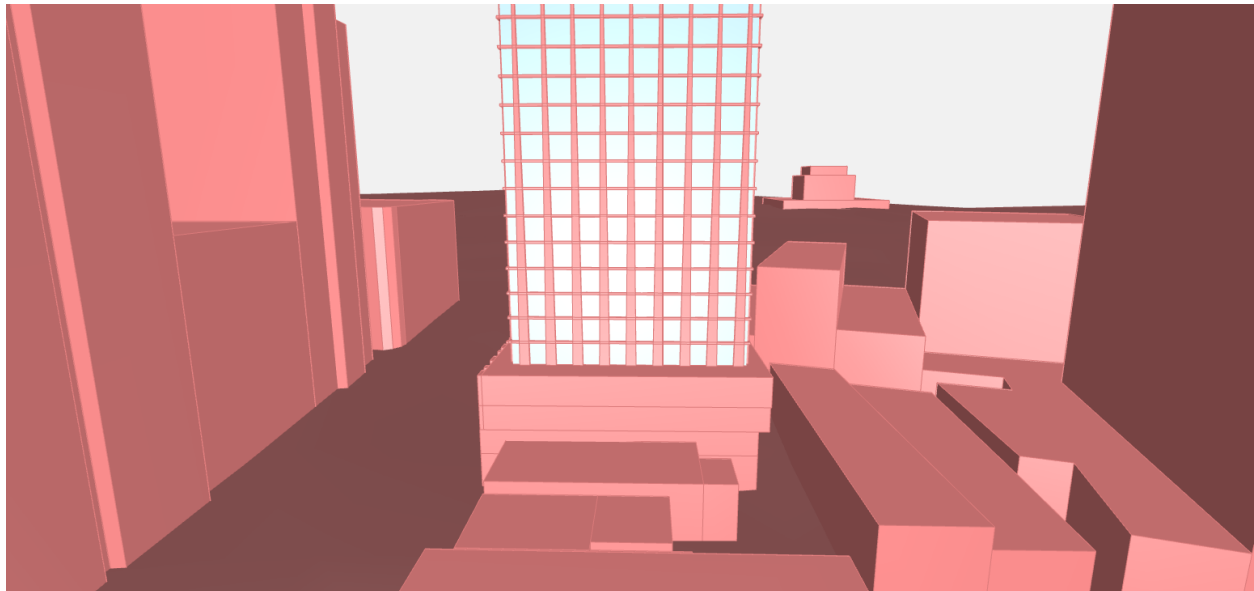


Figure 23: Representative perspective. Glare points exceeding the limit are shown in red (None identified).

Appendix B – Calculation of Veiling Luminance

This glare assessment has been calculated using the Holladay formula that determines a veiling luminance of 500 Cd/m² is a practical limit to the amount of reflected solar glare to which a driver should be exposed. While this criterion is an appropriate limit for vehicle drivers for safety, the limit for pedestrians and the general public is higher given the nature of their activity.

The following provides some approximate luminance levels for different light sources. Note that the maximum tolerable luminance by direct observation is 7,500 Cd/m².

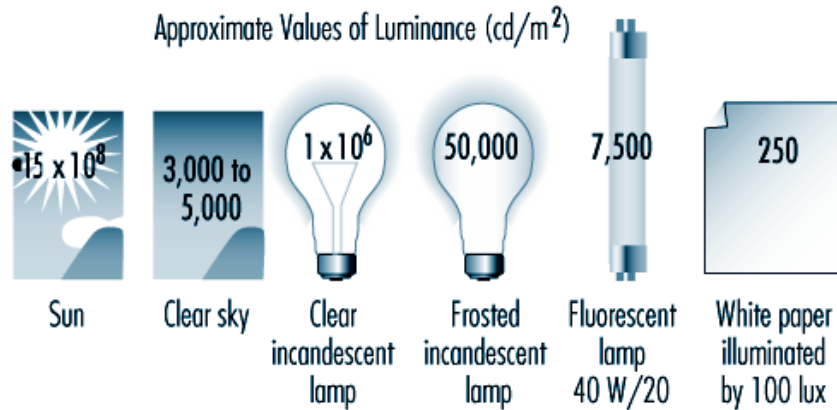


Figure 24 Approximate values of luminance for several light sources (Source: http://www.ilocis.org/documents/chpt46e.htm#JD_Figure46.11)

The Holladay formula calculates the equivalent veiling luminance or glare. It assesses the acceptability of solar reflections that fall within a driver's field of vision.

The equivalent veiling luminance for the façade is calculated using the following formula.

$$L_v \left(\frac{Cd}{m^2} \right) = \frac{10 \cdot EG}{\theta^2} \quad \text{Equation 1}$$

- L_v is the equivalent veiling luminance or glare
- θ is the angle between the centre of the glare source and the line of sight. It is valid from 1.5° to 60°.
- EG is the illumination on the observer's eye produced by the glare source in the plane perpendicular to the line of sight in lux. It is calculated using the following formula.

$$EG = E \cdot R \cdot \cos\theta \quad \text{Equation 2}$$

- E is the solar illumination (lux) on the surface, calculated as a product of solar power (W/m²) and luminous efficacy (lumens/W). Solar power is calculated as a function of the altitude (ALT) of the sun and is as per the following formula.

$$\begin{aligned} \text{Solar Power (W/m}^2\text{)} &= \text{ALT} * 50 \text{ (For ALT} \leq 10^\circ\text{)} \\ \text{Solar Power (W/m}^2\text{)} &= 500 + (\text{ALT} - 10) * 15 \text{ (For ALT} > 10^\circ\text{)} \end{aligned} \quad \text{Equation 3}$$

- A luminous efficacy of 150 lumens/W corresponding to clear sky conditions has been used.
- R is the angular dependent reflectance of the surface.

The issue of solar glare and its effect on human vision is very complex and one for which science has not so far provided a definitive answer. One of the main problems is the great variation in individual human response to a given amount of glare. One person's slight inconvenience is another's blinding light.

The equivalent veiling luminance method models the sun path in relation to the proposed building development. Reflection conditions are modelled for all daylight hours throughout the year. This method is

more accurate as it depends on the power of the solar radiation (W/m^2) for various altitudes, luminance efficacy (lumens/watt), sun position (azimuth and altitude) for various times of the day, observer's viewing direction (bearing), aspect of reflecting surface, reflectivity and specularity of surface.

This assessment assumes specular reflective façade surfaces, where the reflected ray angle is equal to the incident solar ray angle. It assumes that the equivalent veiling luminance is only calculation for periods of the day when the sun's azimuth is no greater than 90° of the various aspects of the proposed development.