SOLAR LIGHT REFLECTIVITY ANALYSIS

CAMPBELLS STORES REDEVELOPMENT, SYDNEY

WC510-04F03(REV0)- SR REPORT

23 OCTOBER 2015

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DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report presents the results of a detailed study for the effect of potential solar glare from the proposed redevelopment of Campbell's Stores, located at 7-27 Circular Quay West, The Rocks. This study assesses compliance with the planning control requirements of the City of Sydney Development Control Plan 2012 regarding solar light reflectivity.

The analysis has been undertaken based on the architectural drawings prepared by the project architect Johnson Pilton Walker, received during October 2015. This study identifies any possible adverse reflected solar glare conditions affecting motorists and pedestrians within the local surrounding area, boat drivers, and occupants of neighbouring buildings. If necessary, recommendations are made to mitigate any potentially adverse effects.

A site survey has been undertaken to obtain photographs of the critical sightlines of motorists on surrounding streets. These photographs are calibrated and are able to be overlaid with a glare meter, which allows us to determine the extent, if any, of potential solar glare reflections from the subject development.

The results of the study indicate that, to avoid any adverse glare to motorists and pedestrians on the surrounding streets, boat drivers, occupants of neighbouring buildings, and to comply with the abovementioned planning control requirements, the following is recommended:

- The exterior surface finish of the Bay 6 skylight glass panels should be textured.
- Glare control blinds should be installed in all windows on Level 2 of the redevelopment which face east.
- All other glazing used on the balustrades of the development should have a maximum normal specular reflectance of visible light of 20%.

It should be noted that the most reflective surface on the façade of a building is the glazing. Reflected solar glare from concrete, brickwork, timber, etc, is negligible (ie: less than 1% normal specular reflectance) and hence will not cause any adverse solar glare effects. Note also that, for any painted or powder-coated metallic surfaces on the exterior façade of the development, the maximum normal specular reflectance of visible light for those types of surfaces is in the range of 1% to 5%, which is well within the abovementioned limit.

With the incorporation of this recommendation, the results of this study indicate that the subject development will not cause adverse solar glare to pedestrians and motorists in the surrounding area, or to boat drivers and occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity for the City of Sydney Development Control Plan 2012.

CONTENTS

1 METHODOLOGY

This study assesses compliance with the controls for solar glare from the City of Sydney Development Control Plan 2012.

The reflectivity analysis of the subject development has been carried out using the technique published by Hassall (1991). The limiting veiling luminance of 500 cd/m^2 for the comfort of motorists, as suggested in Hassall (1991), has been adopted as a basis of assessing the glare impact from the subject development. In meeting this criterion for vehicle motorists, conditions will also be satisfactory for pedestrians. The glare impact onto boat drivers and occupants of neighbouring buildings is also discussed in this assessment.

The various critical glazed aspects were determined for the development and are shown in Figure 1. Solar charts for each of these critical glazed aspects, including for the various inclined-plane glazed surfaces (ie: on the awning and roof of the redevelopment), are presented in Appendix B, and these are used to derive the check zones which are shown in Figures 2a, 2b and 2c. The check zones highlight the areas that are potentially affected by solar reflections from each critical glazed aspect. It should be noted that the check zones shown in Figures 2a, 2b and 2c do not take into account the effect of overshadowing by neighbouring buildings or the shielding effect of any existing trees or other obstructions. These effects are examined in the detailed analysis described in Section 2 of this report.

Study point locations are selected within the check zone areas where motorists are facing the general direction of the subject development. These are shown in Figures 2a, 2b and 2c. For each of the study point locations, photographs have been taken from the viewpoint of motorists using a calibrated camera. Views from the study point locations are presented in Appendix A of this report. A scaled glare protractor has been superimposed over each photograph.

The glare protractor is used to assess the amount of glare likely to be caused and to provide a direct comparison with the criterion of 500 cd/m^2. Alternatively, the glare protractor can be used to determine the maximum acceptable reflectivity index of the façade material of the development for the glare to be within the criterion of 500 cd/m^2.

If it is found that a section of the subject development will be within the zone of sensitive vision of a motorist at a selected study point location (the central area of the glare protractor), the glare protractor is used to determine what the maximum normal specular reflectance of visible light should be for the glazing or any other reflective material used on that section of the façade of the development to ensure that solar glare will not cause discomfort or threaten the safety of motorists or pedestrians, and hence to allow the subject development to comply with the relevant planning control requirements.

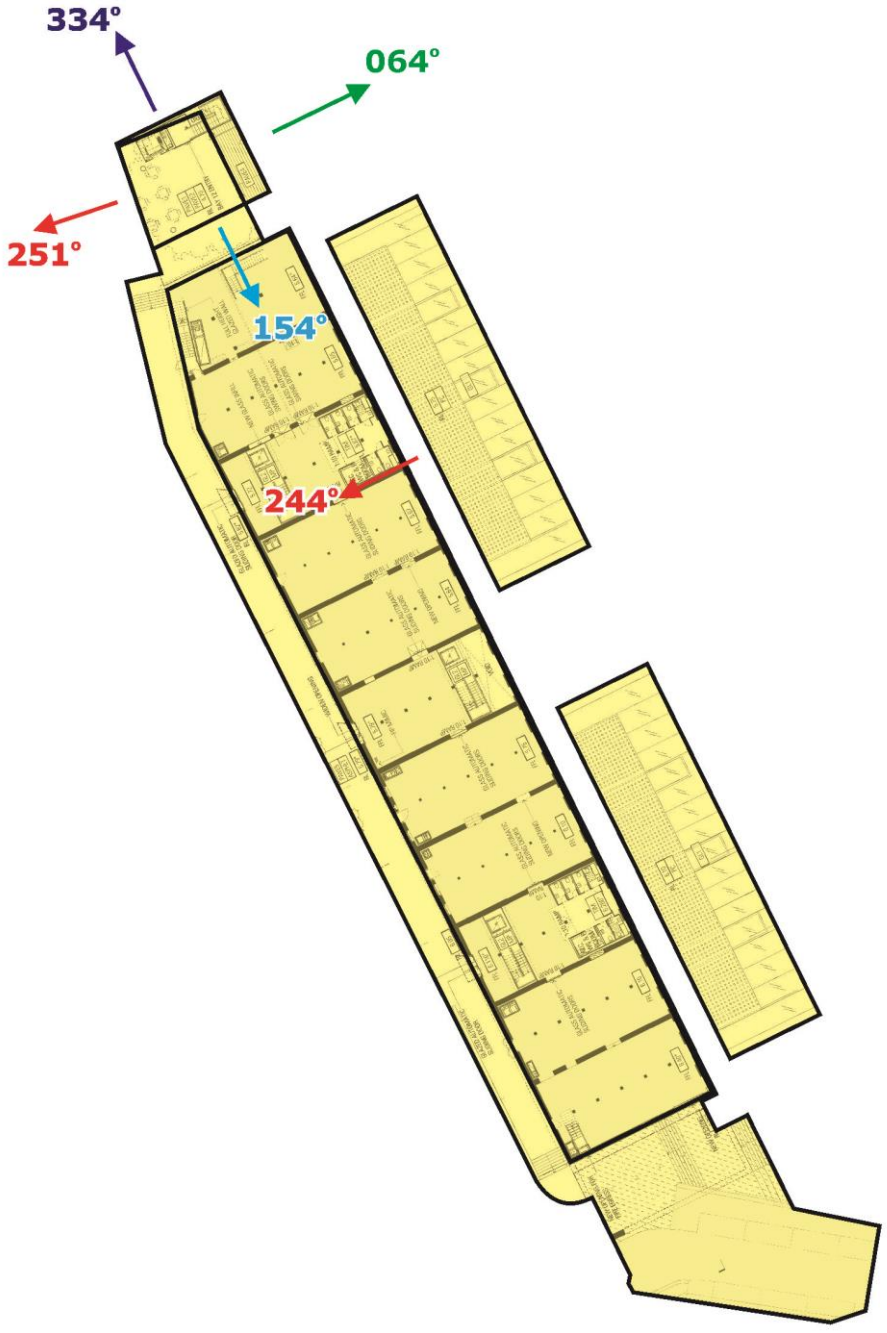

Figure 1: Critical Glazed Aspects of the Development

Figure 2a: Check Zones and Study Point Locations for the Main Building Façade of Bay 12 (the check zones are the areas where glare could potentially be observed)

Figure 2b: Check Zones and Study Point Locations for the Skylights on the Bay 6 Roof (the check zones are the areas where glare could potentially be observed)

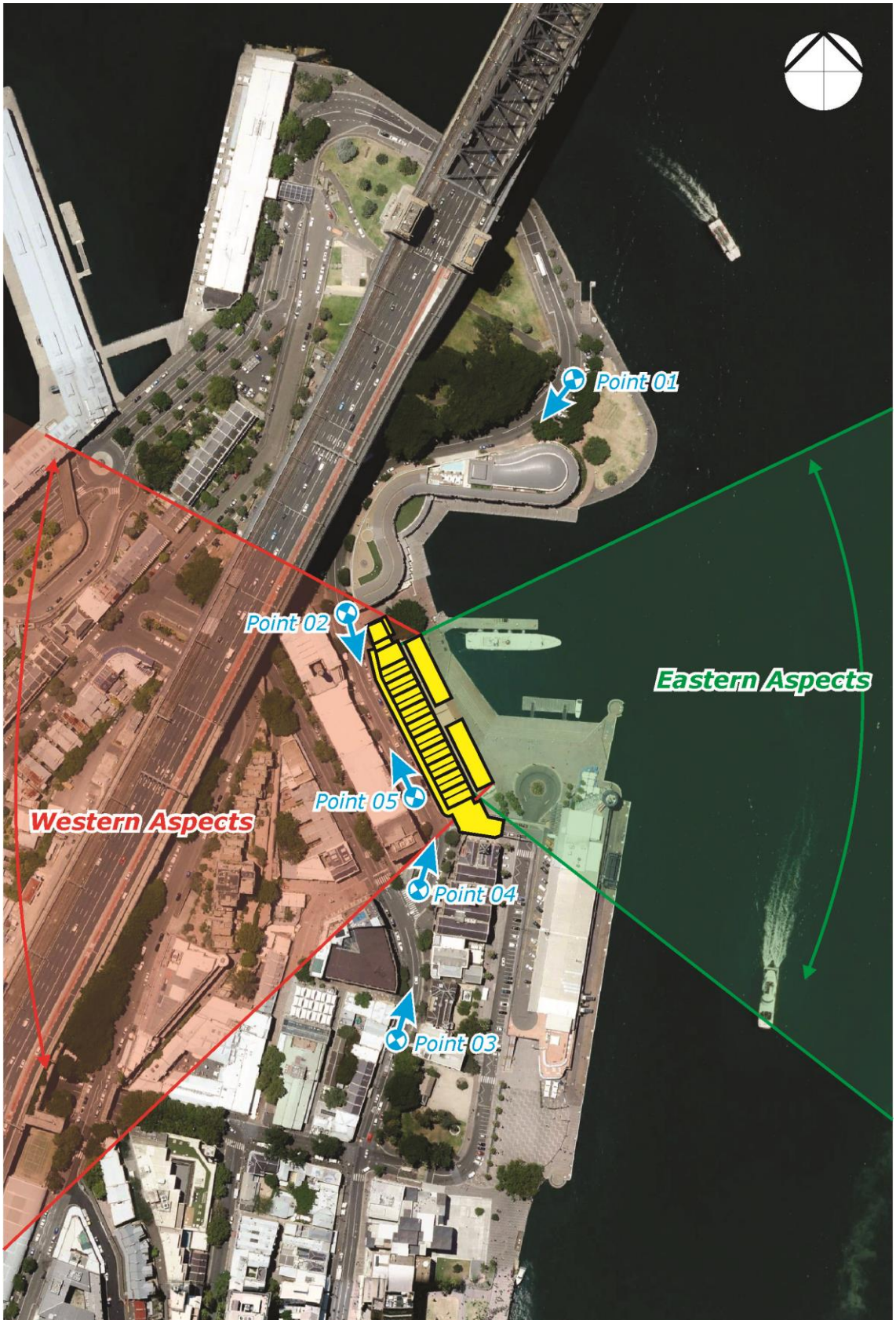

Figure 2c: Check Zones and Study Point Locations for the Glazed Awnings (the check zones are the areas where glare could potentially be observed)

2 ANALYSIS

2.1 Impact onto Motorists and Pedestrians

From the study of the check zones shown in Figures 2a, 2b and 2c, a total 5 street level locations have been identified for detailed analysis. A summary of the location of each study point, and the aspects of the subject development could potentially reflect solar glare to each study point location, is shown in Table 1 below. Note that, as mentioned in Section 1, the check zones shown in Figures 2a, 2b and 2c do not take into account the effect of overshadowing by neighbouring buildings or the shielding effect of any existing trees or other obstructions. These effects are examined in the detailed analysis described in the following sub-sections.

It should be noted that, although motorists heading south on the Harbour Bridge, or heading north towards the Harbour Bridge, will be within the check zones defined in Figures 2a, 2b or 2c, the development will not be visible by motorists from these locations and hence solar glare from the subject development will not affect motorists or pedestrians as they travel over the Harbour Bridge.

Table 1: Aspects of the Proposed Development that could reflect Solar Glare to each Study Point

Study Point	Location and Viewpoint	Aspect(s) of the Development
1	Hickson Road, heading south.	Northern and eastern aspects.
2	Hickson Road, heading south.	Northern and western aspects
3	George Street, heading north.	Southern aspects
4	Hickson Road, heading north.	Southern aspects
5	Hickson Road, heading north.	Northern and southern aspects.

2.1.1 Drivers heading south along Hickson Road

Points 1 and 2 are located along Hickson Road, to the north of the development site. These points represent the critical sightlines of drivers heading south along Hickson Road at these locations. A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers at these locations were obtained using a calibrated camera. Each photograph has been scaled to enable the glare meter to be overlaid onto these images, as shown in Figure A1 and A2 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoints at Points 1 and 2 indicates that the subject development is visible but is not within the zone of sensitive vision of motorists. Hence there will be no adverse solar glare observed by motorists or pedestrians heading south along Hickson Road.

2.1.2 Drivers heading north along George Street

Point 3 is located along George Street, to the south of the development site. This point represents the critical sightline of drivers heading north along George Street at this location. A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers at this location was obtained using a calibrated camera. The photograph has been scaled to enable the glare meter to be overlaid onto this image, as shown in Figure A3 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 3 indicates that the subject development is not visible and is not within the zone of sensitive vision of motorists. Hence there will be no adverse solar glare observed by motorists or pedestrians heading north on George Street.

2.1.3 Drivers heading north along Hickson Road

Points 4 and 5 are located along Hickson Road, to the south of the development site. These points represent critical sightlines of drivers heading north along Hickson Road at these locations. A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers at these locations were obtained using a calibrated camera. Each photograph has been scaled to enable the glare meter to be overlaid onto these images, as shown in Figures A4 and A5 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Points 4 and 5 indicates that the proposed development is visible but is not within the zone of sensitive vision of motorists. Hence there will be no adverse solar glare observed by motorists or pedestrians heading north along Hickson Road.

2.2 Boat Drivers on Circular Quay

When viewed from boat drivers on Circular Quay, an analysis of the check zone diagrams presented in Figures 2a, 2b and 2c indicates that solar glare could be potentially observed from the northern and eastern aspect of Bay 12, the Bay 6 skylight and the awnings along the eastern side of the redevelopment. However, the existing tree, which is to be retained, on the eastern side of Bay 12 will shadow the northern and eastern aspects of Bay 12 at the times of day when glare could potentially be observed by boat drivers on Circular Quay. Furthermore, the upper levels of the redevelopment will overshadow the eastern awnings at the times of day when glare could potentially be observed by boat drivers on Circular Quay. The Bay 6 skylight will have an angular width of less than 0.5^{o} when viewed from boats since the redevelopment will only be visible within the zone of sensitive vison of boat drivers from a long distance away due to the orientation of the shipping lanes in relation to the position of the redevelopment. As such, the intensity of visible glare from the Bay 6 skylight will not exceed 500 cd/m^2. Hence it is not expected that adverse solar glare will be observed by boat drivers on Circular Quay.

2.3 Occupants of Neighbouring Buildings

When viewed from the neighbouring buildings to the west of the redevelopment, an analysis of the check zone diagrams presented in Figures 2b and 2c indicates that solar glare could be potentially observed from the Bay 6 skylight and the eastern awnings. As the angle of incidence of the sunlight reflected to the neighbouring buildings will be shallow, the potential solar glare could be adverse. However, further analysis indicates that the upper levels of the redevelopment will obstruct the view of the eastern awning from the neighbouring buildings to the west. Nonetheless, the results of the study indicate that to avoid adverse glare for occupants of the neighbouring buildings to the west, it is recommended that the exterior surface finish of the Bay 6 skylight glass panels should be textured.

Furthermore, our past experience involving more than 250 projects, and also research by Rofail and Dowdle (2004), tends to indicate that Buildings which cause a nuisance to occupants of neighbouring buildings are those that have a normal specular reflectivity of visible light greater than 20%. This seems to justify the suggested limit of 20% reflectivity by many local government authorities and state planning bodies.

Hence a general recommendation is made that all glazing and other reflective materials used on the façade of the subject development have a maximum normal specular reflectivity of visible light of 20% to avoid adverse solar glare to occupants of neighbouring buildings.

2.4 Occupants of the Redevelopment

When viewed from Level 2 of the redevelopment, an analysis of the check zone diagram presented in Figure 2c indicates that solar glare could be potentially observed from the eastern awnings. As the angle of incidence of the sunlight reflected to the redevelopment will be shallow, the potential solar glare could be adverse. Hence, the results of the study indicate that to avoid adverse glare for occupants on Level 2 of the redevelopment, it is recommended that glare control blinds be installed in all windows on Level 2 of the redevelopment which face east.

2.5 Typical Normal Specular Reflectivity from Building Surfaces

It should be noted that the most reflective surface on the façade of a building is the glazing. Reflected solar glare from concrete, brickwork, timber, etc, is negligible (ie: less than 1% normal specular reflectance) and hence will not cause any adverse solar glare effects. The following sub-sections provide some general reflectance values of more reflective materials used on building facades.

2.5.1 Glazed Surfaces

A glazing supplier will be able to provide information on the maximum normal specular reflectance of visible light of different types of glazing. Some typical reflectivity values of different types of glazing are listed as follows:

- Clear float glass – typically 5% to 8%
- Low-e solar control glazing – typically 8% to 12%
- Other types of compliant performance glazing – up to 20%

2.5.2 Painted and/or Powder-Coated Metallic Surfaces

In the event that some portions of the external façade of the development feature power-coated or painted metallic surfaces, it is not expected that adverse glare will be observed from those surfaces since the maximum normal specular reflectance of visible light of these types of façade materials range from 1% to 5%. This is well within the maximum limits specified in previous sections of this report.

3 CONCLUSION

An analysis has been undertaken to assess the potential for solar glare from the proposed redevelopment of Campbell's Stores, located at 7-27 Circular Quay West, The Rocks. This study assesses compliance with the planning control requirements of the City of Sydney Development Control Plan 2012 regarding solar light reflectivity.

The analysis has been undertaken based on the architectural drawings prepared by the project architect Johnson Pilton Walker, received during October 2015. This study identifies any possible adverse reflected solar glare conditions affecting motorists and pedestrians within the local surrounding area, boat drivers, and occupants of neighbouring buildings. If necessary, recommendations are made to mitigate any potentially adverse effects.

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With the incorporation of this recommendation, the results of this study indicate that the subject development will not cause adverse solar glare to pedestrians and motorists in the surrounding area, or to boat drivers and occupants of neighbouring buildings, and will comply with the planning controls regarding reflectivity for the City of Sydney Development Control Plan 2012.

REFERENCES

City of Sydney, "City of Sydney Development Control Plan 2012".

Hassall, D.N., "Reflectivity, Dealing with Rogue Solar Reflections", (published by author), 1991.

Phillips, R.O., "Sunshine and Shade in Australasia", Sixth Edition, CSIRO Publishing, 1992.

Rofail, A.W., and Dowdle, B., "Reflectivity Impact on Occupants of Neighbouring Properties", International Conf. on Building Envelope Systems & Technologies, Sydney, 2004.

APPENDIX A - GLARE OVERLAYS FOR THE CRITICAL SIGHT-LINES

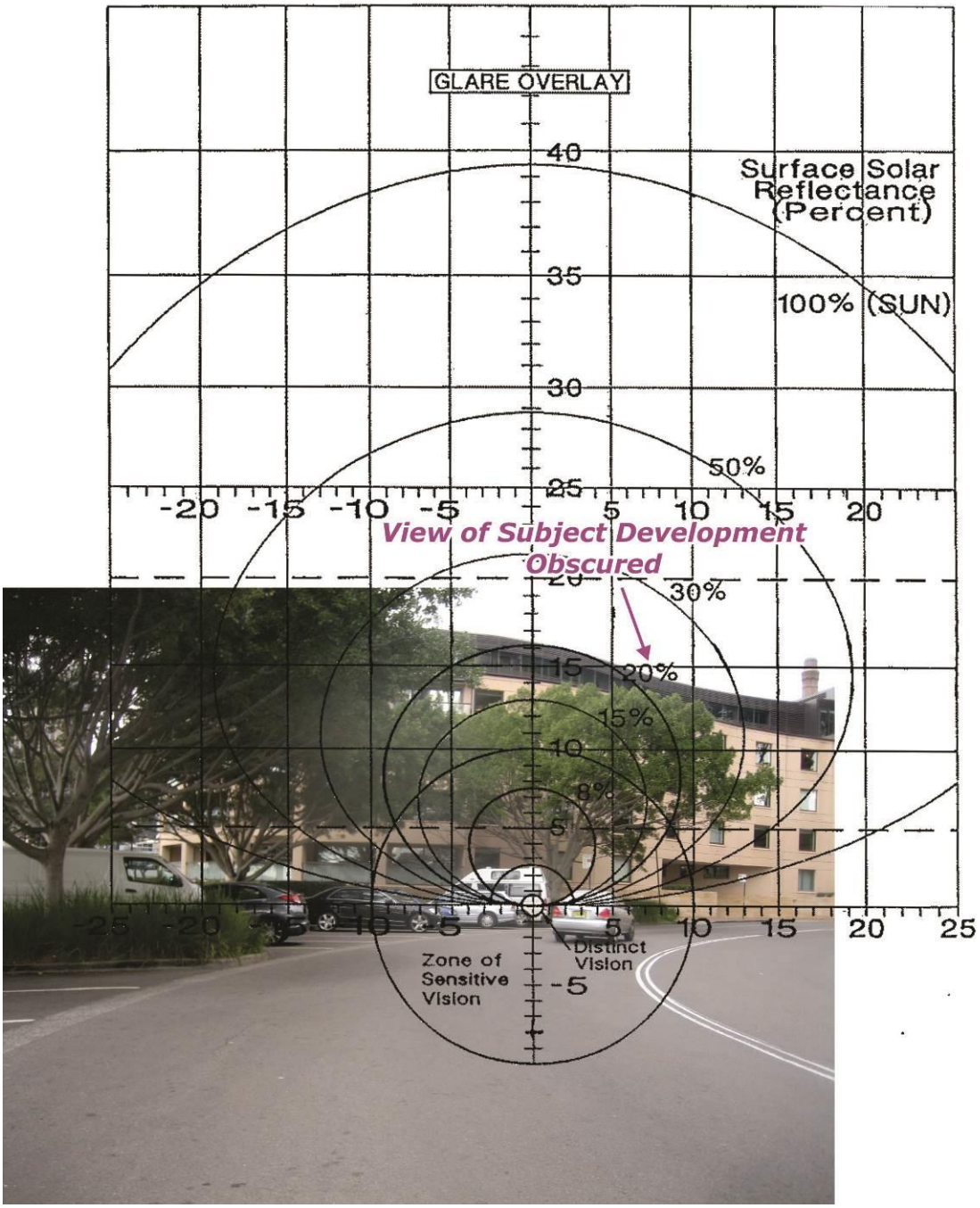

Figure A1: Glare Overlay for Point 1

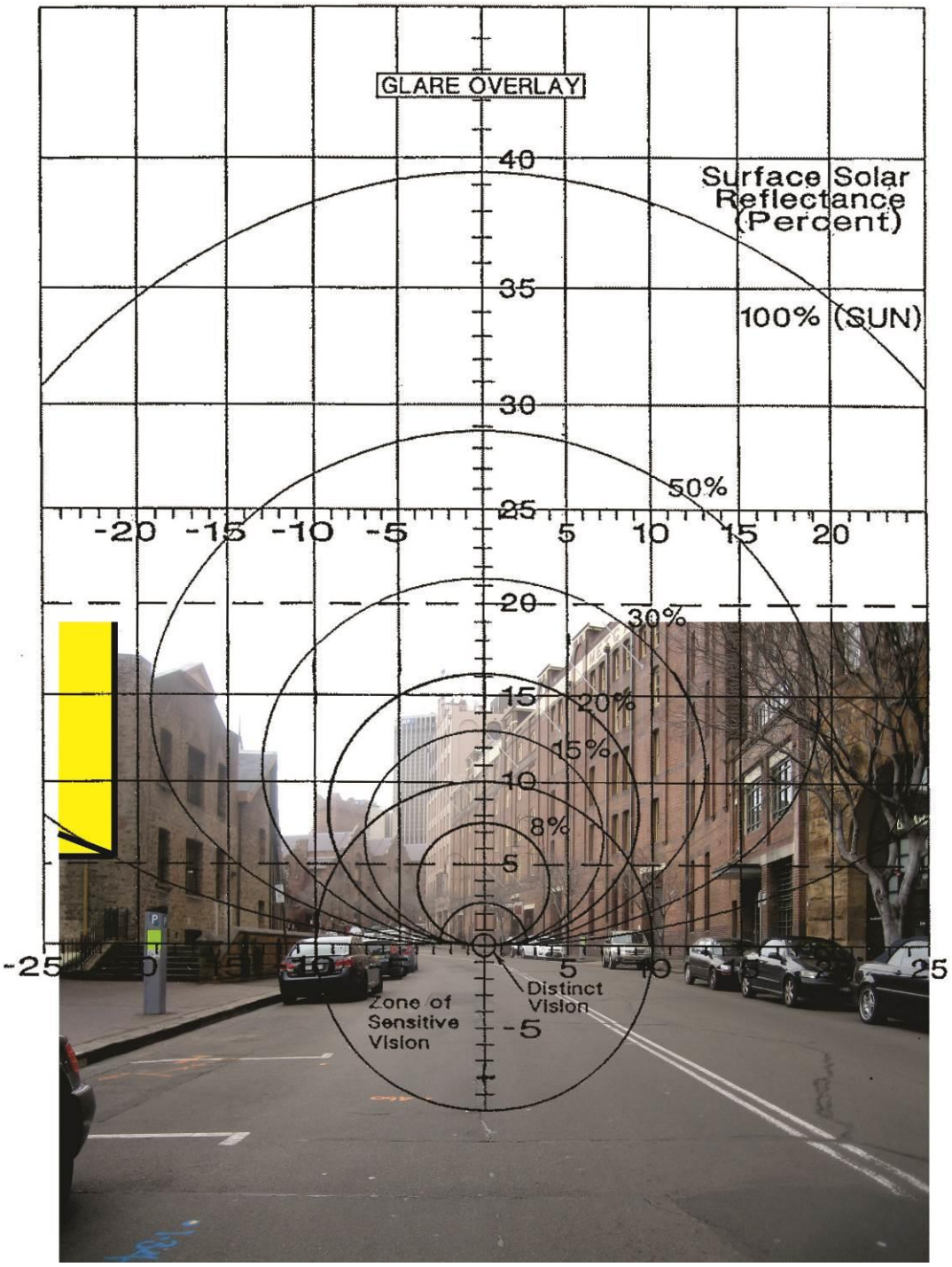

Figure A2: Glare Overlay for Point 2

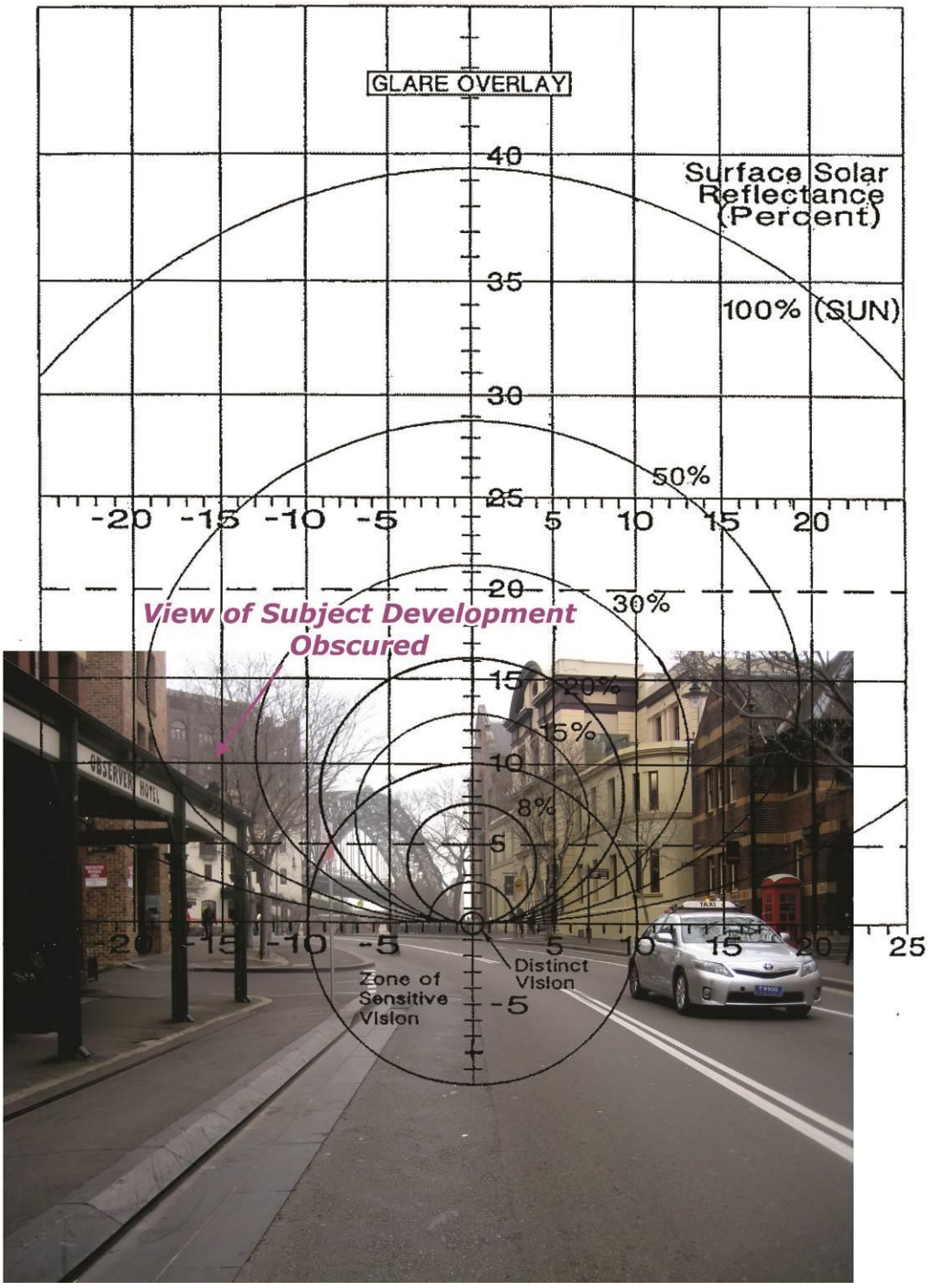

Figure A3: Glare Overlay for Point 3

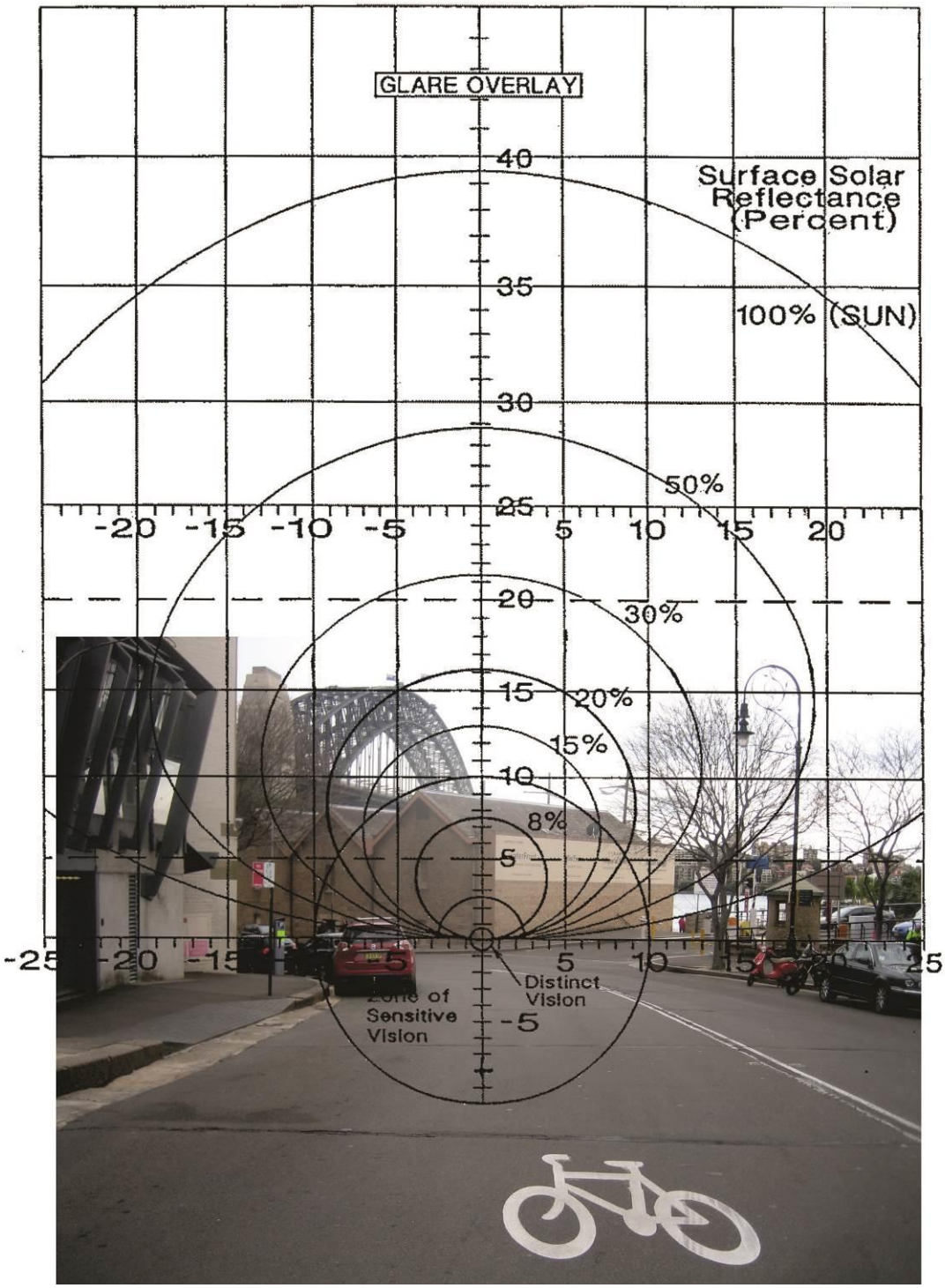

Figure A4: Glare Overlay for Point 4

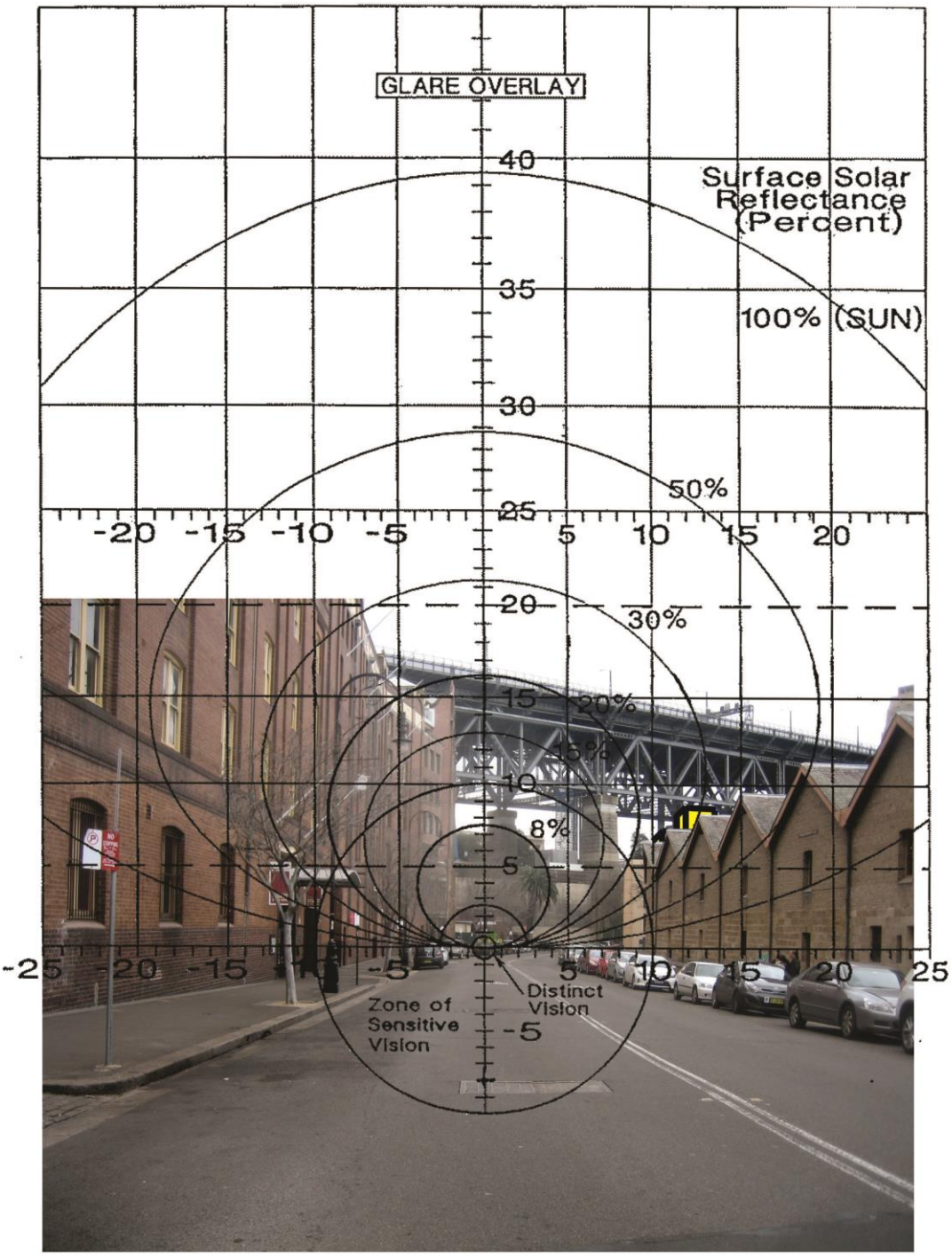

Figure A5: Glare Overlay for Point 5

APPENDIX B - SOLAR CHARTS FOR THE VARIOUS CRITICAL ASPECTS

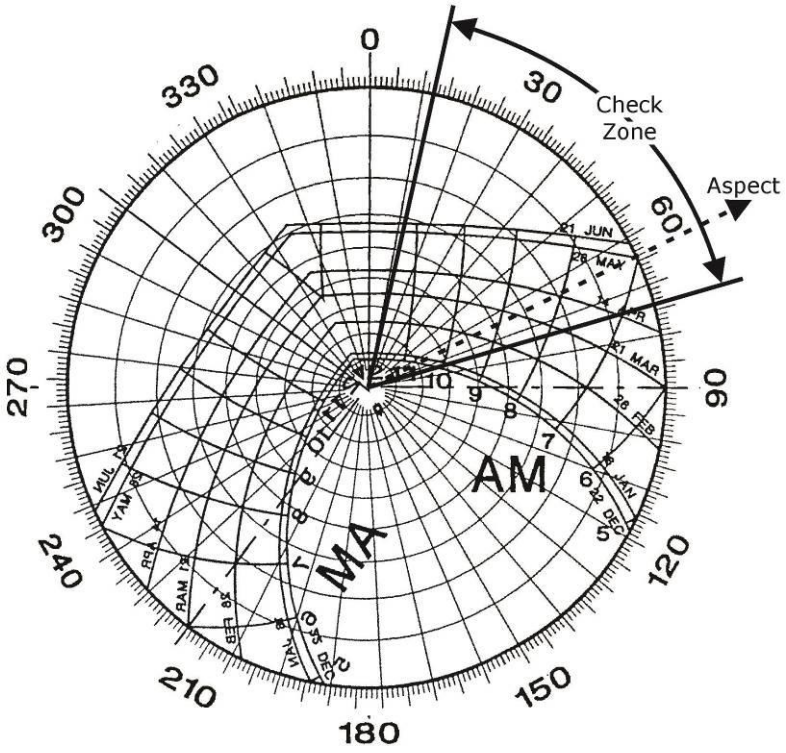

Figure B1: Sun Chart for Aspect 064°

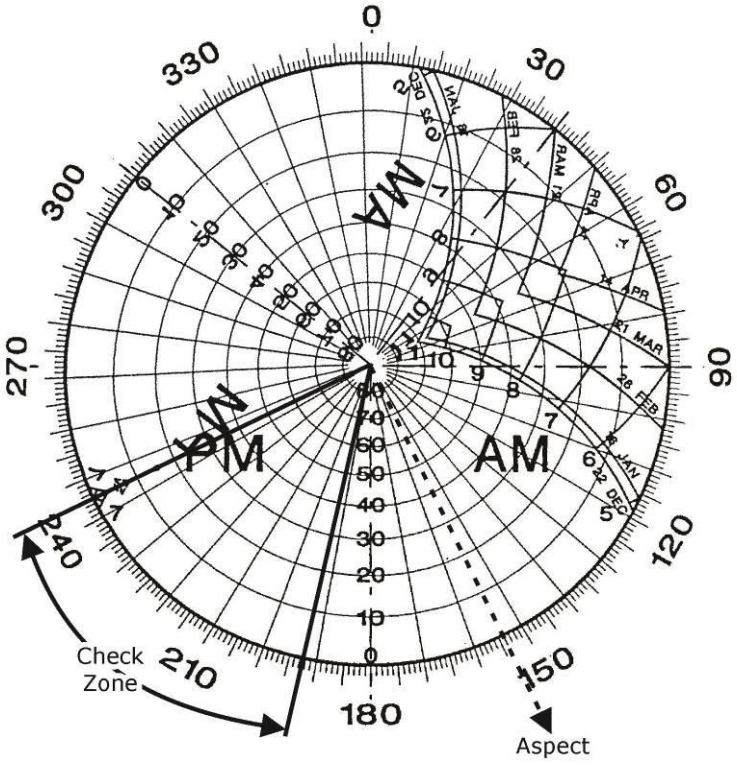

Figure B2: Sun Chart for Aspect 154°

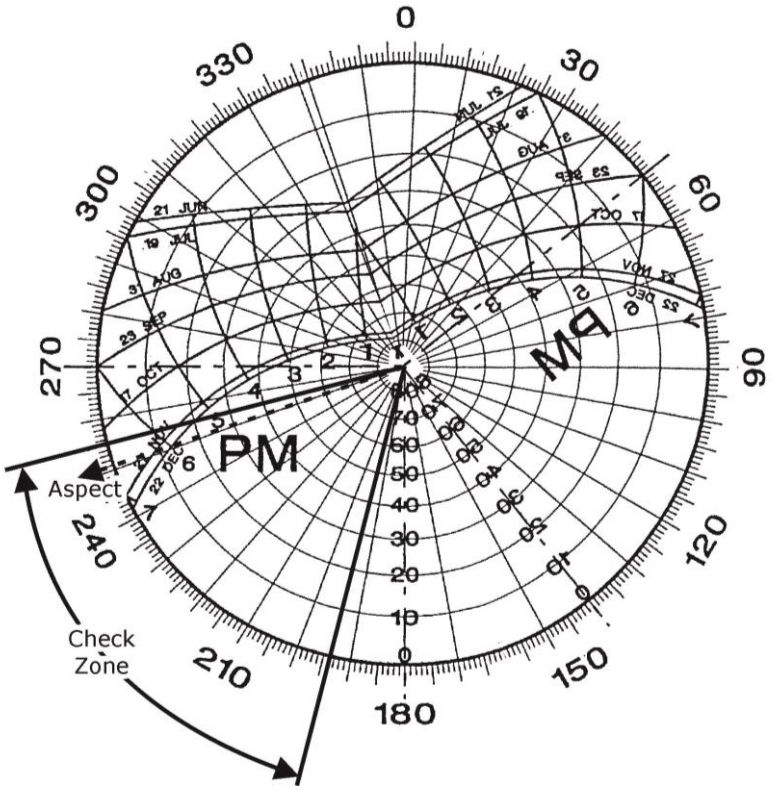

Figure B3: Sun Chart for Aspect 251°

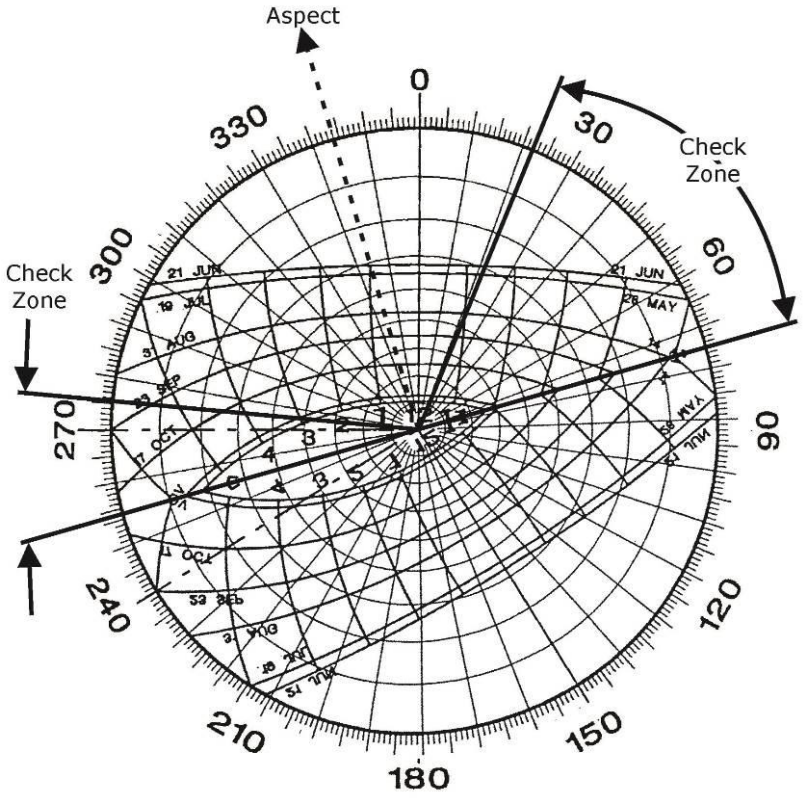

Figure B3: Sun Chart for Aspect 344°

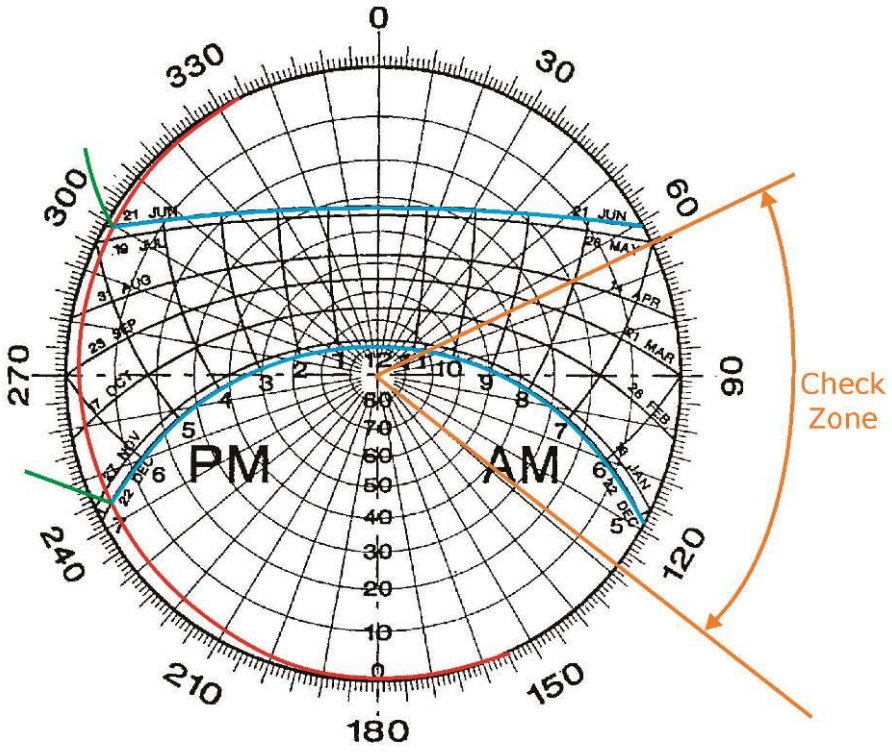

Figure B5: Sun Chart for Aspect 064°, Angle of Inclination 02°

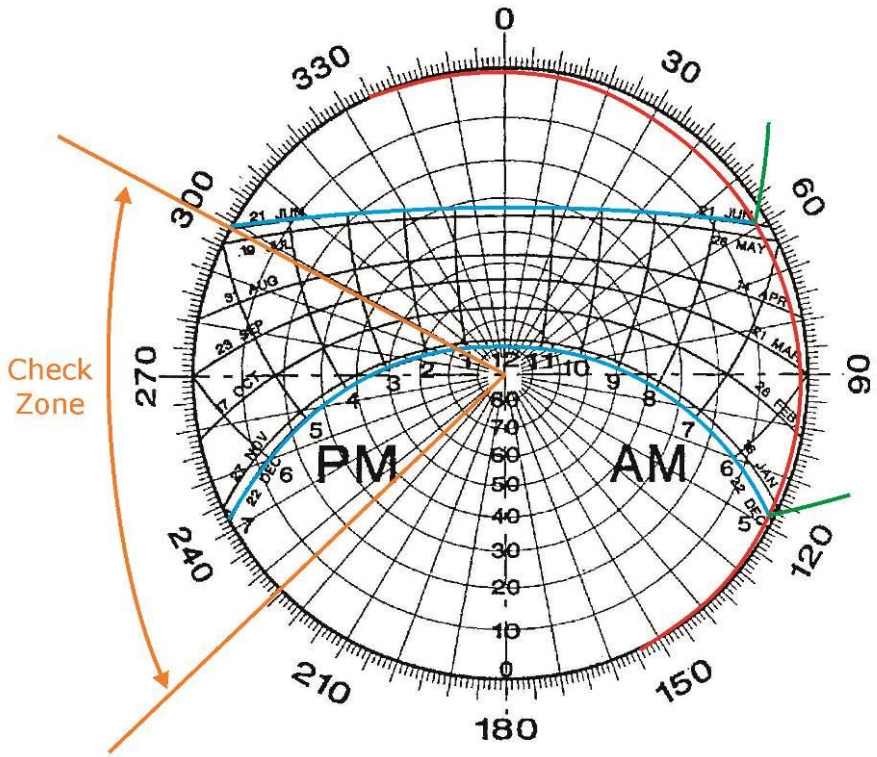

Figure B6: Sun Chart for Aspect 244°, Angle of Inclination 02°

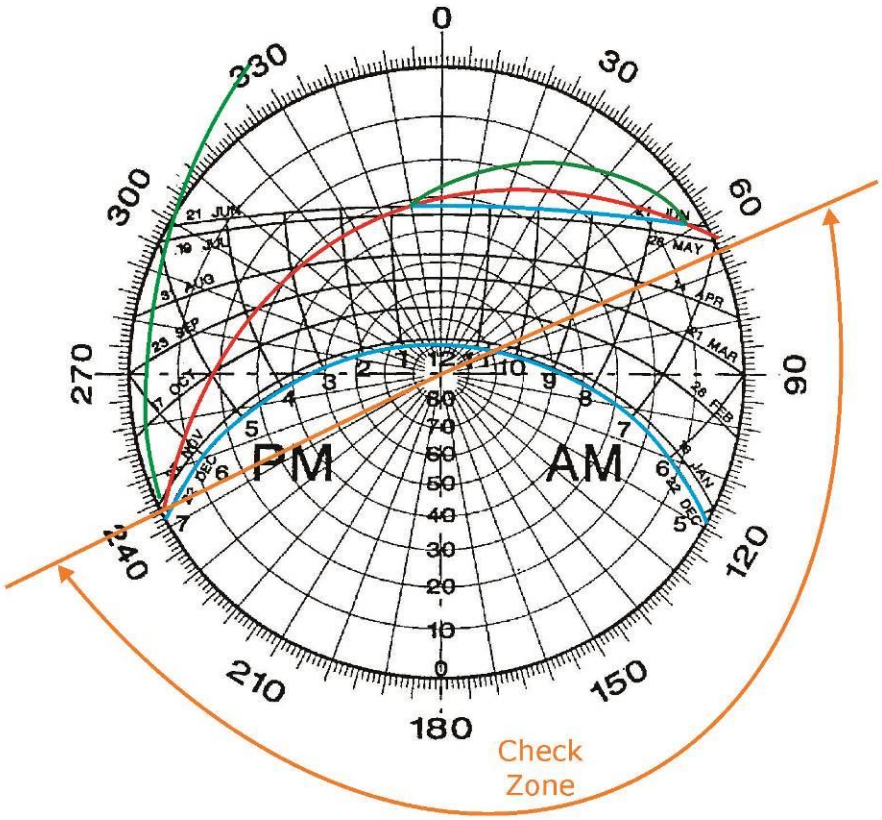

Figure B7: Sun Chart for Aspect 154°, Angle of Inclination 33°

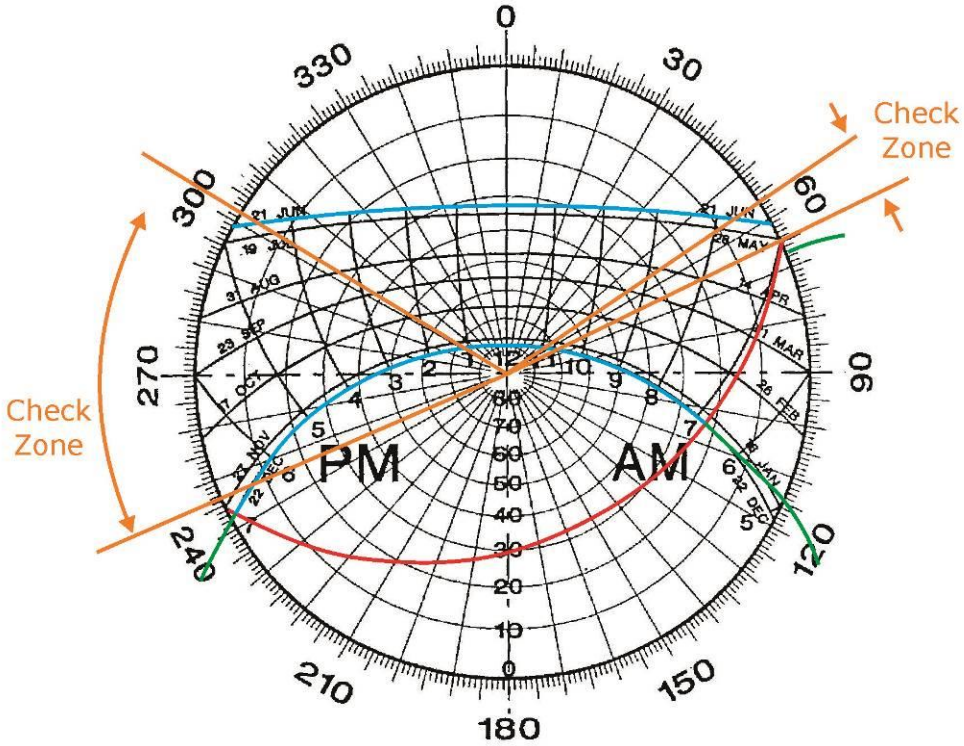

Figure B8: Sun Chart for Aspect 334°, Angle of Inclination 33°

APPENDIX C - STANDARD SUN CHART FOR THE SYDNEY REGION

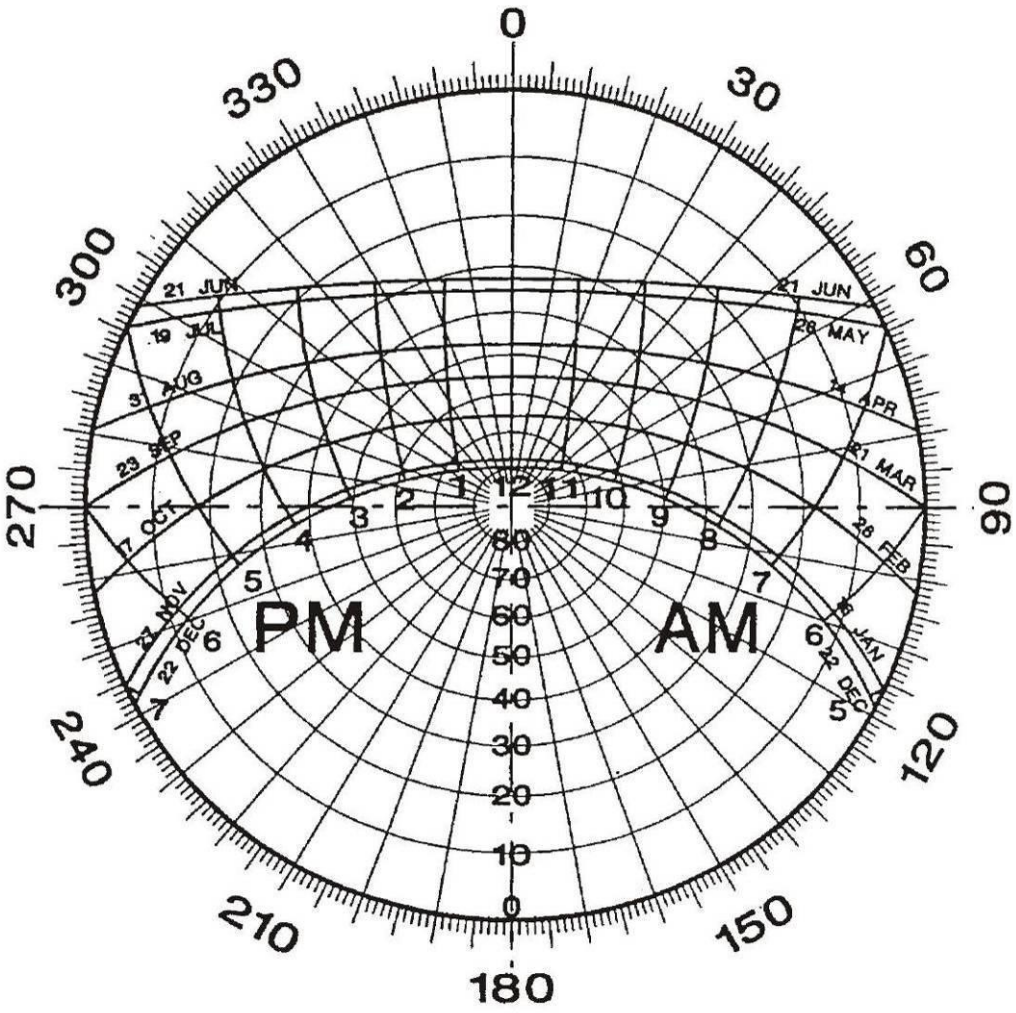

Figure C1: Standard Sun Chart for the Sydney Region