Solar Light Reflectivity Analysis

for the proposed development known as

Westmead Millennium Institute & Research Hub, NSW

August 24, 2010

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Document Control

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1.0 Introduction

This study is to investigate the potential impact of solar glare from the proposed development known as Westmead Millennium Institute and Research Hub, NSW. The site is located at 195 Hawkesbury Road, Westmead, at the north-western corner of the intersection of Hawkesbury Road and Hospital Road. The site is bounded by the Hospital Road to the north and Hawkesbury Road to the south. The proposed L-shaped development has a height of 7-storey above ground with its primary use for laboratory uses. An analysis of the potential impact of solar glare from the proposed development has been undertaken based on architectural drawings prepared by the project architect BVN Architecture, received on August 17, 2010.

With regards to solar reflectivity, currently there are no set requirements within the Parramatta DCP 2005. However, this study aims to identify, and make recommendations to rectify possible adverse reflected solar glare conditions affecting drivers and pedestrians.

The reflectivity analysis of the subject development has been carried out using the technique published by Mr David N. H. Hassall (1991)[1].

The limiting veiling luminance of 500 candelas per square metre for the comfort of vehicle drivers, 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 drivers, conditions will also be satisfactory for pedestrians. The glare impact onto occupants of neighbouring buildings is also discussed.

A figure showing the site location is presented in Figure 1. The various aspects of the proposed development are presented on Figure 2.

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

Figure 1: Aerial Image of the Proposed Development Site

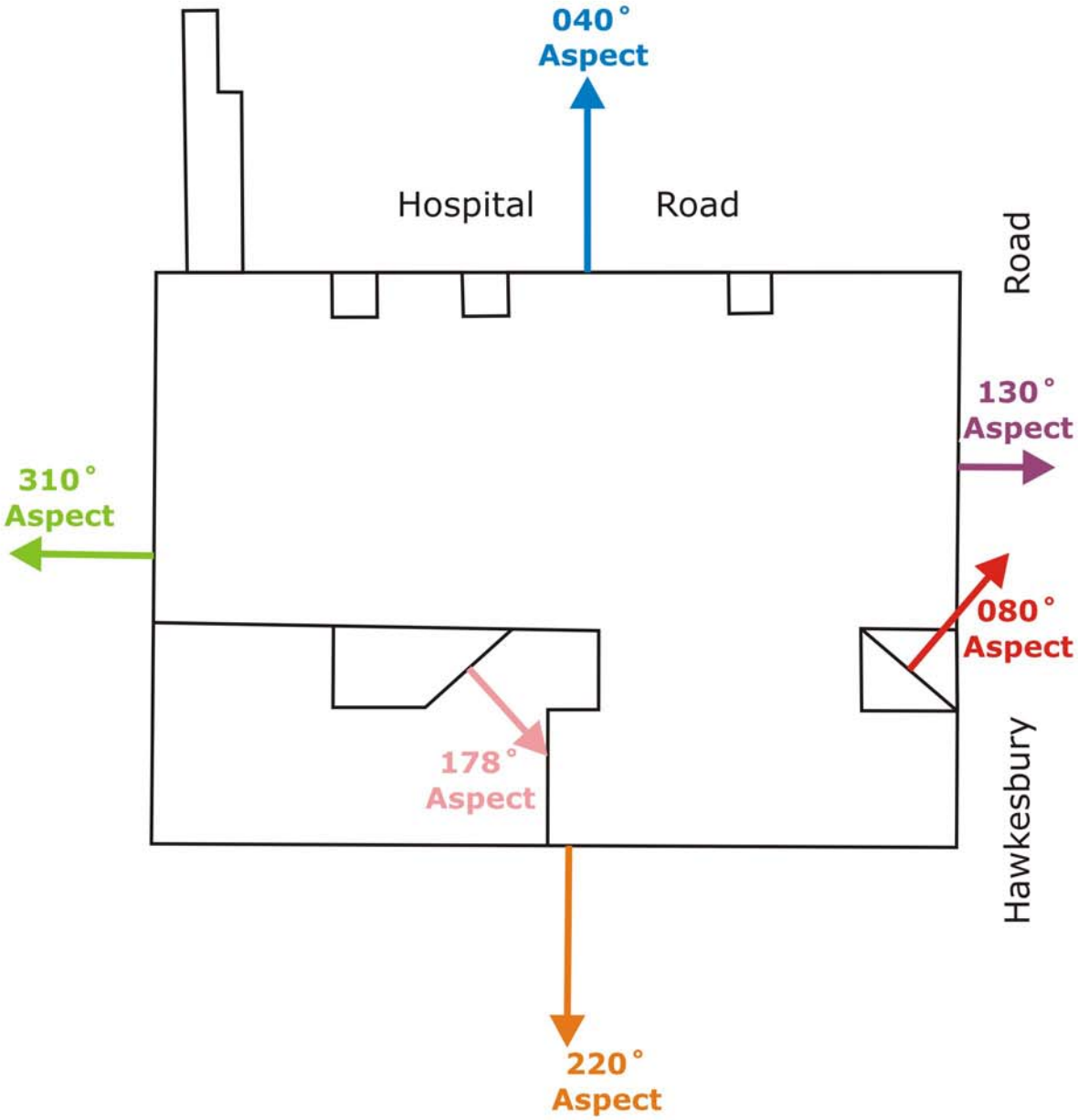

Figure 2: The Critical Aspects of the Proposed Development

2.0 Analysis

Solar charts for the various aspects of the development are presented in Appendix B. Check zones for the selected aspects have also been identified based on the data obtained from the solar charts. The check zones highlight the zones that are potentially affected by solar reflections from each aspect. The various check zones for the subject development are described in Figure 3.

It should be noted that the check zones described in Figure 3 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 in the following section of this report.

2.1 Impact onto Drivers and Pedestrians

From the study of the check zones and with consideration of the potential overshadowing effects of neighbouring buildings, 11 street level locations have been identified for analysis. These locations are indicated in Figure 3. Table 1 summarises the effect of the various aspects on the selected study locations.

Table 1: Aspects of the Site that affect each of the Study Points

Study Point	Aspects
Point 1	220° aspect
Point 2	220° aspect
Point 3	178° aspect
Point 4	130° and 220° aspects
Point 5	310° aspect
Point 6	040° and 310° aspects
Point 7	080° aspect
Point 8	080° aspect
Point 9	080° aspect
Point 10	040° aspect
Point 11	080° aspect

For each of the study point locations, photographs have been taken from the viewpoint of drivers and pedestrians 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 candelas per square metre. Alternatively, the glare protractor can be used to determine the maximum acceptable reflectivity index for the glare to be within the criterion of 500 candelas/m^2.

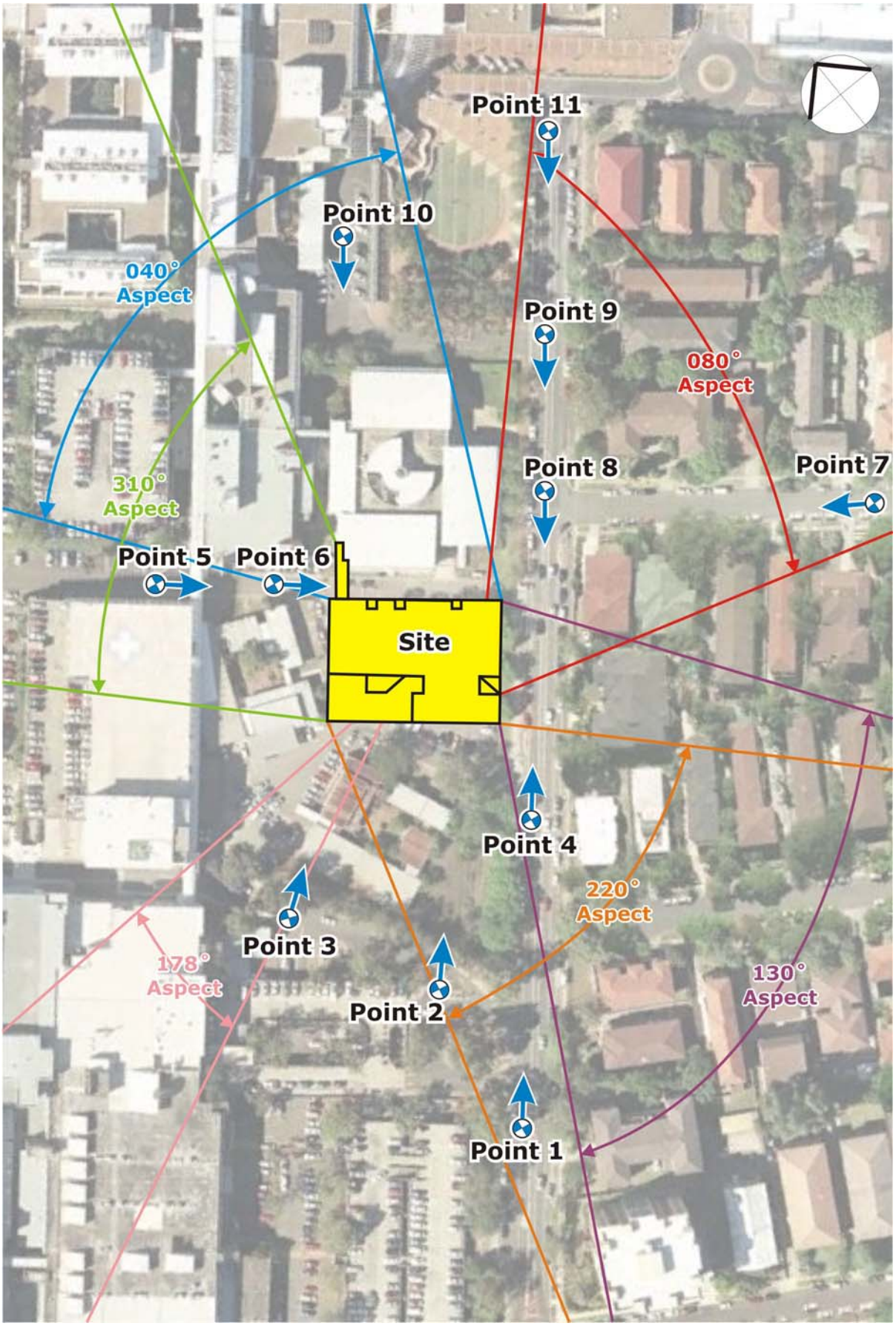

Figure 3: Check Zones and Layout of Study Points

2.1.1 Study Points 1 and 4 (for north-east bound drivers)

Points 1 and 4 are located south-west of the proposed development site, on Hawkesbury Road, with Point 4 located closer proximity to the development than Point 1. These points represent the critical sightlines of drivers heading north-east along Hawkesbury Road. Point 1 is located within the check zone for 220° aspect and Point 4 is located within the check zones for the 130° and 220° aspects of the proposed development.

A site survey of these points has been undertaken, and photographs showing the viewpoint of drivers heading north-east along Hawkesbury Road were obtained using a calibrated camera. Each photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figures A1 and A4 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 1 indicates that a portion of the 130° and 220° aspects of the proposed development are within the zone of sensitive vision. Point 1 is not within the check zone for 130° aspect and hence there will be no adverse solar glare from the 130° aspect to drivers and pedestrians facing north-east along Hawkesbury Road at Point 1. For the solar glare to be reflected to Point 1 from the 220° aspect of the proposed development, the angle of azimuth and angle of inclination of the sun would need to be 226° and between 4˚ to 9˚ respectively. The standard sun chart for the Sydney region indicates that the sun does not operate within these ranges and solar glare cannot be reflected to Point 1 from the 220° aspect of the proposed development. Hence there will be no adverse solar glare from the 130° and 220° aspects of the proposed development to drivers and pedestrians facing north-east along Hawkesbury Road at Point 1.

An analysis of the glare meter overlaid onto the viewpoint at Point 4 indicates that no part of the development falls within the zone of sensitive vision. Hence, there will be no adverse glare reflected from the proposed development to drivers and pedestrians facing north-east along Hawkesbury Road at Point 4.

2.1.2 Study Points 2 and 3 (for north-east bound drivers)

Points 2 and 3 are located to the south-west of the proposed development site, on Old Hawkesbury Road. These points represent critical sightlines of drivers heading north-east along Old Hawkesbury Road. Point 2 is located within the check zone for the 178˚ aspect of the proposed development. Point 3 is located within the check zones for the 220˚ aspect of the proposed development.

A site survey of these points has been undertaken, and photographs showing the viewpoint of drivers heading north-east along Old Hawkesbury Road were obtained. Each photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figures A2 and A3 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 2 indicates that the view of the proposed development is obscured by existing trees south-west of the site. Hence there will be no adverse glare reflected from the proposed development to drivers and pedestrians facing north-east along Old Hawkesbury Road at Point 2.

An analysis of the glare meter overlaid onto the viewpoint at Point 3 indicates that the view of the proposed development is obscured by existing trees south-west of the site. Hence there will be no adverse glare reflected from the proposed development to drivers and pedestrians facing north-east along Old Hawkesbury Road at Point 3.

2.1.3 Study Points 5 and 6 (for south-east bound drivers)

Points 5 and 6 are located to the north of the proposed development site, on Hospital Road, with Point 6 located closer to the development site than Point 5. These points represent critical sightlines of drivers heading south-east along Hospital Road. Point 5 is located within the check zone for the 310˚ aspect of the proposed development. Point 6 is located within the check zones for the 040˚ and 310˚ aspects of the proposed development.

A site survey of these points has been undertaken, and photographs showing the viewpoint of drivers heading south-east along Hospital Road were obtained. Each photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figures A5 and A6 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 5 indicates that a portion of the 040˚ and 310˚ aspects of the proposed development and link bridge falls within the zone of sensitive vision. Point 5 is not within the check zone for 040˚ aspect and hence there will be no adverse solar glare from the 040˚ aspect to drivers and pedestrians facing south-east along Hospital Road at Point 5. For the solar glare to be reflected to Point 5 from the 310° aspect of the proposed development, the angle of azimuth and angle of inclination of the sun would need to be 310° and between 0˚ to 7˚ respectively. The standard sun chart for the Sydney region indicates that the sun does not operate within these ranges and solar glare cannot be reflected to Point 5 from the 310° aspect of the proposed development. Hence there will be no adverse solar glare from the 310° aspect of the proposed development to drivers and pedestrians facing south-east along Hospital Road at Point 5.

An analysis of the glare meter overlaid onto the viewpoint at Point 6 indicates that a portion of the 040˚ aspect of the proposed development falls within the zone of sensitive vision. For the solar glare to be reflected to Point 6 from the 040˚ aspect of the proposed development, the angle of azimuth and angle of inclination of the sun would need to be 123.5˚ and between 0˚ to 9˚ respectively. The standard sun chart for the Sydney region indicates that the sun does not operate within these ranges and solar glare cannot be reflected to Point 6 from the 040˚

aspect of the proposed development. Hence, there will be no adverse glare reflected from the proposed development to drivers and pedestrians facing south-east along Hospital Road at Point 6.

2.1.4 Study Point 7 (for north-west bound drivers)

Point 7 is located to the south-east of the proposed development site, on Jessie Street. This point represents a critical sightline of drivers heading north-west along Jessie Street. Point 7 is located within the check zone for the 080˚ aspect of the proposed development.

A site survey of this point has been undertaken, and photograph showing the viewpoint of drivers heading north-west along Jessie Street was obtained. Each photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figure A7 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 7 indicates that the view of the proposed development is obscured by existing trees south-east of the site. Hence there will be no adverse glare reflected from the proposed development to drivers and pedestrians facing north-west along Jessie Street at Point 7.

2.1.5 Study Points 8, 9 and 11 (for south-west bound drivers)

Points 8, 9 and 11 are located to the east of the proposed development site, on Hawkesbury Road, with Point 8 located closest to the development site, followed by Point 9 and finally Point 11. These points represent critical sightlines of drivers heading south-west along Hawkesbury Road. Points 8, 9 and 11 are located within the check zone for the 080˚ aspect of the proposed development.

A site survey of these points has been undertaken, and photographs showing the viewpoint of drivers heading south-west along Hawkesbury Road were obtained. Each photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figures A8, A9 and A11 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 8 indicates that no part of the development falls within the zone of sensitive vision. Hence there will be no adverse glare reflected from the proposed development to drivers and pedestrians facing south-west along Hawkesbury Road at Point 8.

An analysis of the glare meter overlaid onto the viewpoint at Point 9 indicates that a portion of the 080˚ and 130˚ aspects of the proposed development is within the zone of sensitive vision. Point 9 is not within the check zone for 130° aspect and hence there will be no adverse solar glare from the 130° aspect to drivers and pedestrians facing south-west along Hawkesbury Road at Point 9. For light to be reflected to Point 9 from the 080˚ aspect, the angle of azimuth and angle of inclination of the sun would need to be 111.5° and between 0˚ to 4˚ respectively. At these low heights, the surrounding buildings are sufficiently tall enough

to block incident light from hitting the 080˚ aspect of the façade. Hence there will be no adverse glare reflected from the 080˚ aspect of the proposed development to drivers and pedestrians facing south-west along Hawkesbury Road at Point 9.

An analysis of the glare meter overlaid onto the viewpoint at Point 11 indicates that a portion of the 080˚ and 130˚ aspects of the proposed development is within the zone of sensitive vision. Point 11 is not within the check zone for 130° aspect and hence there will be no adverse solar glare from the 130° aspect to drivers and pedestrians facing south-west along Hawkesbury Road at Point 11. For light to be reflected to Point 11 from the 080˚ aspect, the angle of azimuth and angle of inclination of the sun would need to be 114.4° and between 0˚ to 3˚ respectively. At these low heights, the surrounding buildings are sufficiently tall enough to block incident light from hitting the 080˚ aspect of the façade. Hence there will be no adverse glare reflected from the 080˚ aspect of the proposed development to drivers and pedestrians facing south-west along Hawkesbury Road at Point 11.

2.1.6 Study Point 10 (for south-west bound drivers)

Point 10 is located to the north-east of the proposed development site,. This point represents a critical sightline of drivers heading south-west when they exit the car park. Point 10 is located within the check zone for the 040˚ aspect of the proposed development.

A site survey of this point has been undertaken, and photograph showing the viewpoint of drivers heading south-west in the car park was obtained. Each photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figure A10 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 10 indicates that a portion of the 040˚ aspect of the proposed development falls within the zone of sensitive vision. For light to be reflected to Point 10 from the 040˚ aspect, the angle of azimuth and angle of inclination of the sun would need to be 35° and between 8˚ to 10˚ respectively. The standard sun chart for the Sydney region indicates that the sun does not operate within these ranges and solar glare cannot be reflected to Point 10 from the 040° aspect of the proposed development. Hence there will be no adverse solar glare from the 040° aspect of the proposed development to drivers and pedestrians facing south-west exiting the car park at Point 10.

2.2 Impact onto Occupants of Neighbouring Buildings

More research is required to properly assess what is considered an acceptable level of veiling luminance to occupants of surrounding buildings. Rofail and Dowdle (2004)[2] have highlighted the subjectivity of glare impact to occupants of surrounding buildings as it is highly affected by a number of factors, some of these are listed below:

- the intensity of glare
- duration of glare impact
- the type of use of the building
- the type of glazing used on the neighbouring building (eg. clear or tinted)
- shading elements on the façade of the neighbouring building
- level of tolerance by the occupant of the neighbouring building

Our past experience, involving approximately 200 projects, tends to indicate that buildings that tend to cause nuisance to occupants of neighbouring buildings are those that have a normal specular reflectivity of visible light greater than 20 percent. This seems to justify the suggested limit of 20 percent reflectivity by many local government authorities and state planning bodies. This reflectivity is defined as the level of luminance or normal specular reflectivity of visible light.

Hence, a general recommendation is made that all glazing used on the facades of the development have a normal specular reflectivity of visible light of 20 percent or less to avoid adverse solar glare to occupants of neighbouring buildings.

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

3.0 Conclusion

An analysis has been undertaken to assess the potential impact of solar glare from the proposed development known as Westmead Millennium Institute and Research Hub, NSW. The analysis has been carried out using the technique published by Mr David N. H. Hassall, and the architectural drawings prepared by the project architect BVN Architecture, received on August 17, 2010.

With regards to solar reflectivity, currently there are no set requirements within the Parramatta DCP 2005. However, this study aims to identify, and make recommendations to rectify possible adverse reflected solar glare conditions affecting drivers and pedestrians. To avoid any adverse glare to drivers and pedestrians on the surrounding streets of the proposed development site, the following recommendations have been made:

- All glazing on the façade of the development should have a maximum normal specular reflectivity of visible light of 20 percent.

There is no additional requirement for this development. With the abovementioned limit to the normal specular reflectivity of visible light from the proposed glazing, the proposed development will not cause adverse solar glare to drivers or pedestrians in any of the surrounding streets and other outdoor areas.

It is also expected that no adverse glare impacts will result with regards to the occupants of neighbouring buildings if the glazing type(s) selected for the external facades of the development have a normal specular reflectivity of visible light of 20 percent or less. Other highly reflective materials should also be avoided on the façades to avoid adverse glare to the occupants of neighbouring buildings.

Appendix A

Analysis of Sight-Lines from the Various Study Locations

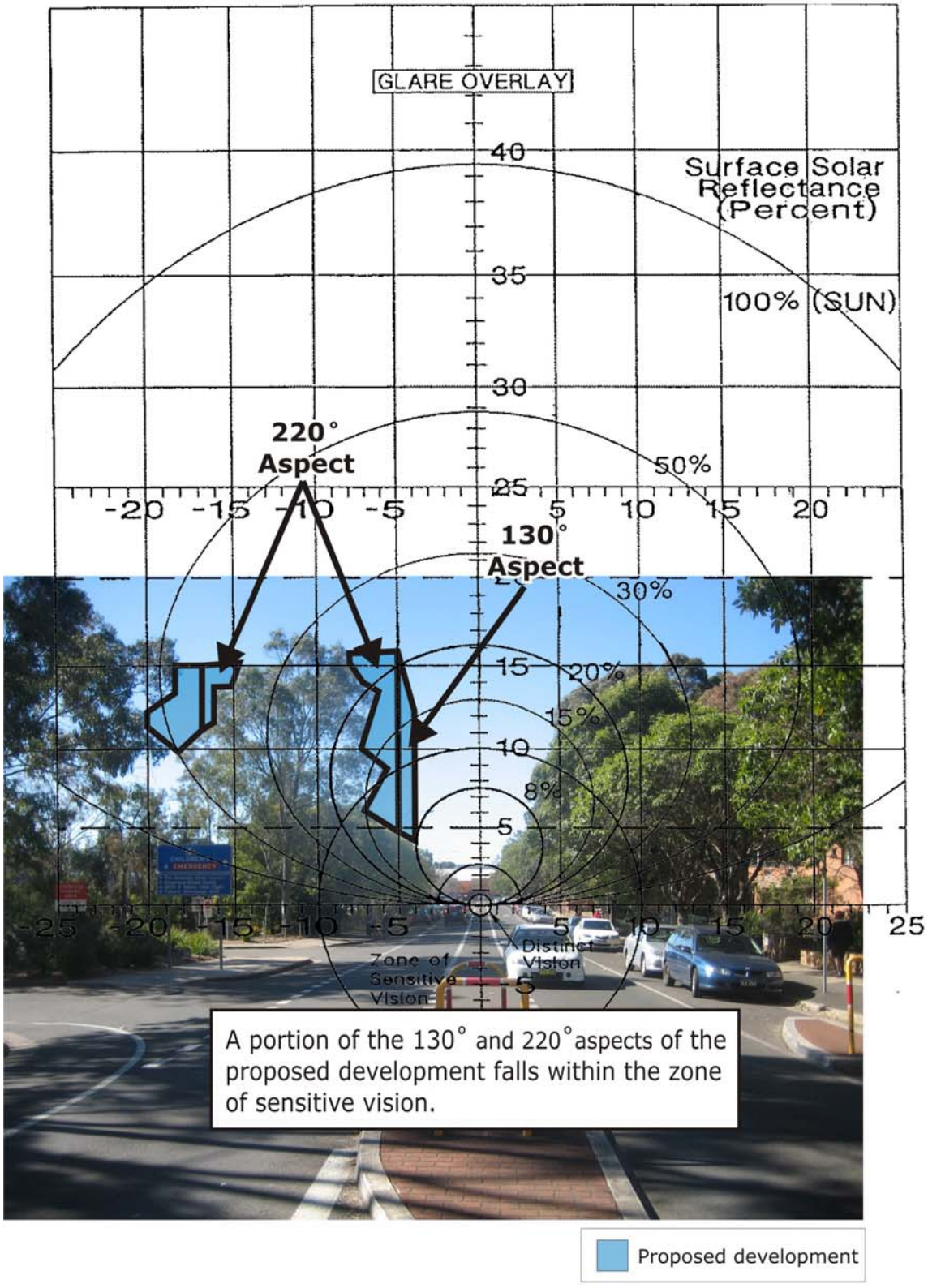

Figure A1: Glare Overlay for Point 1

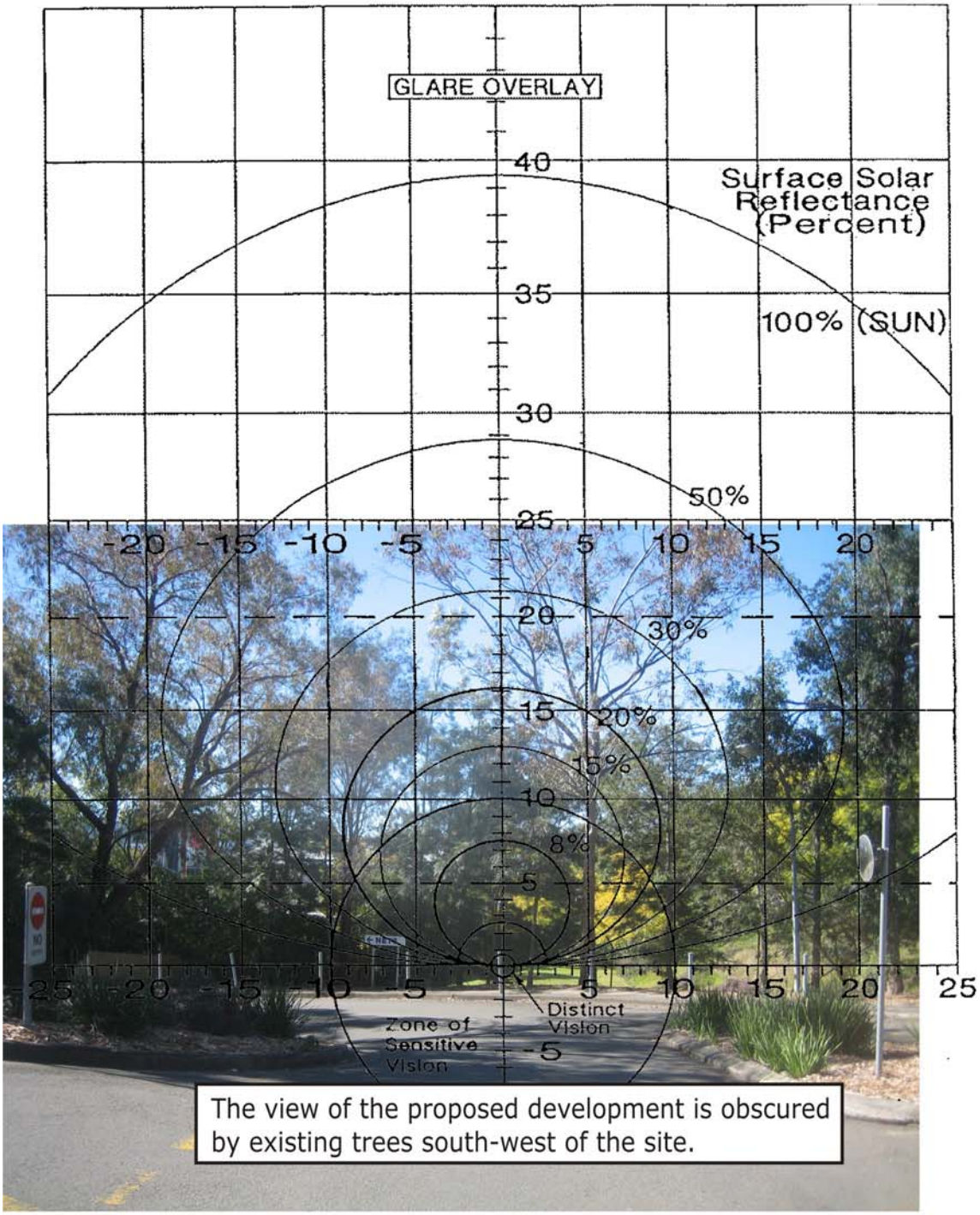

Figure A2: Glare Overlay for Point 2

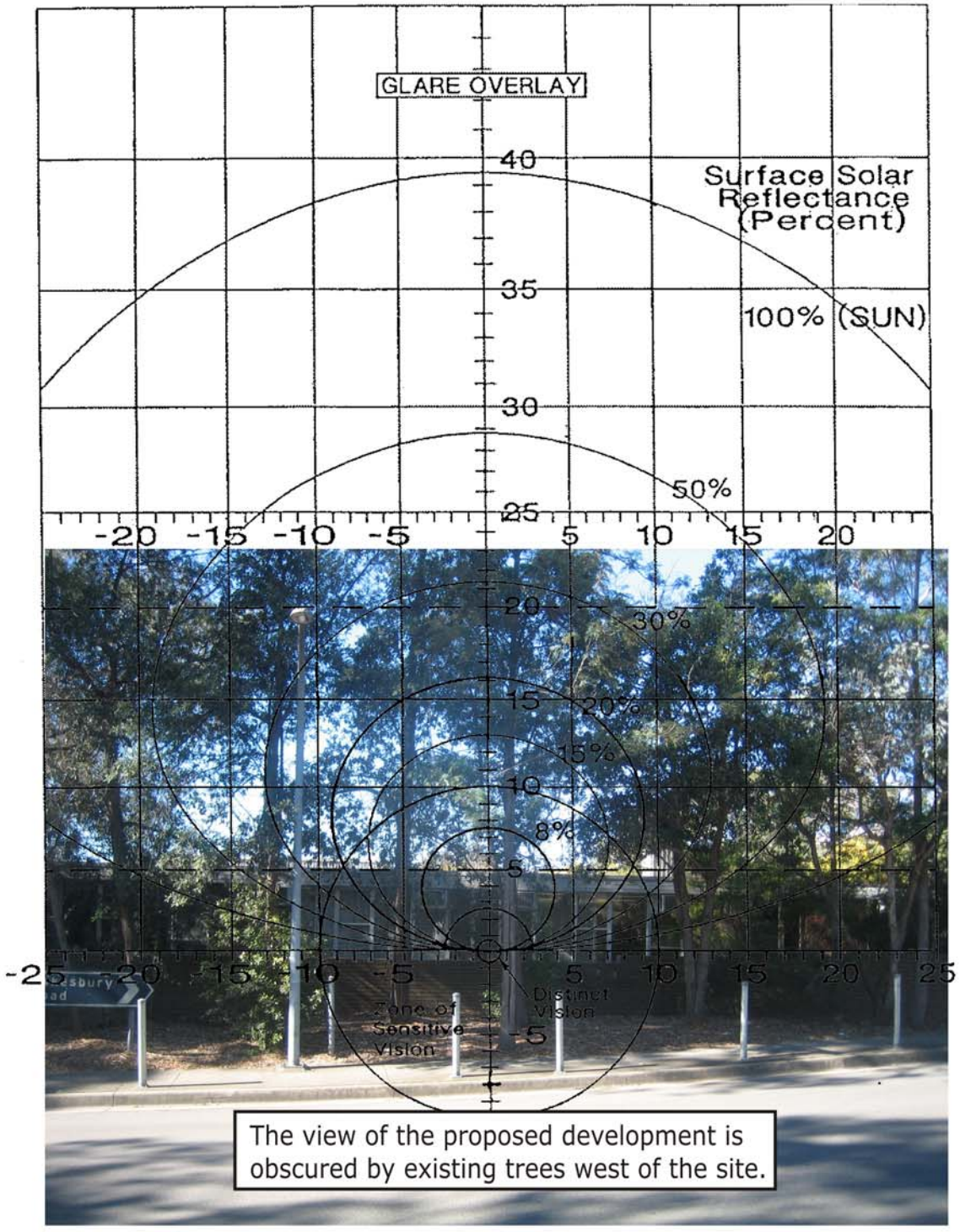

Figure A3: Glare Overlay for Point 3

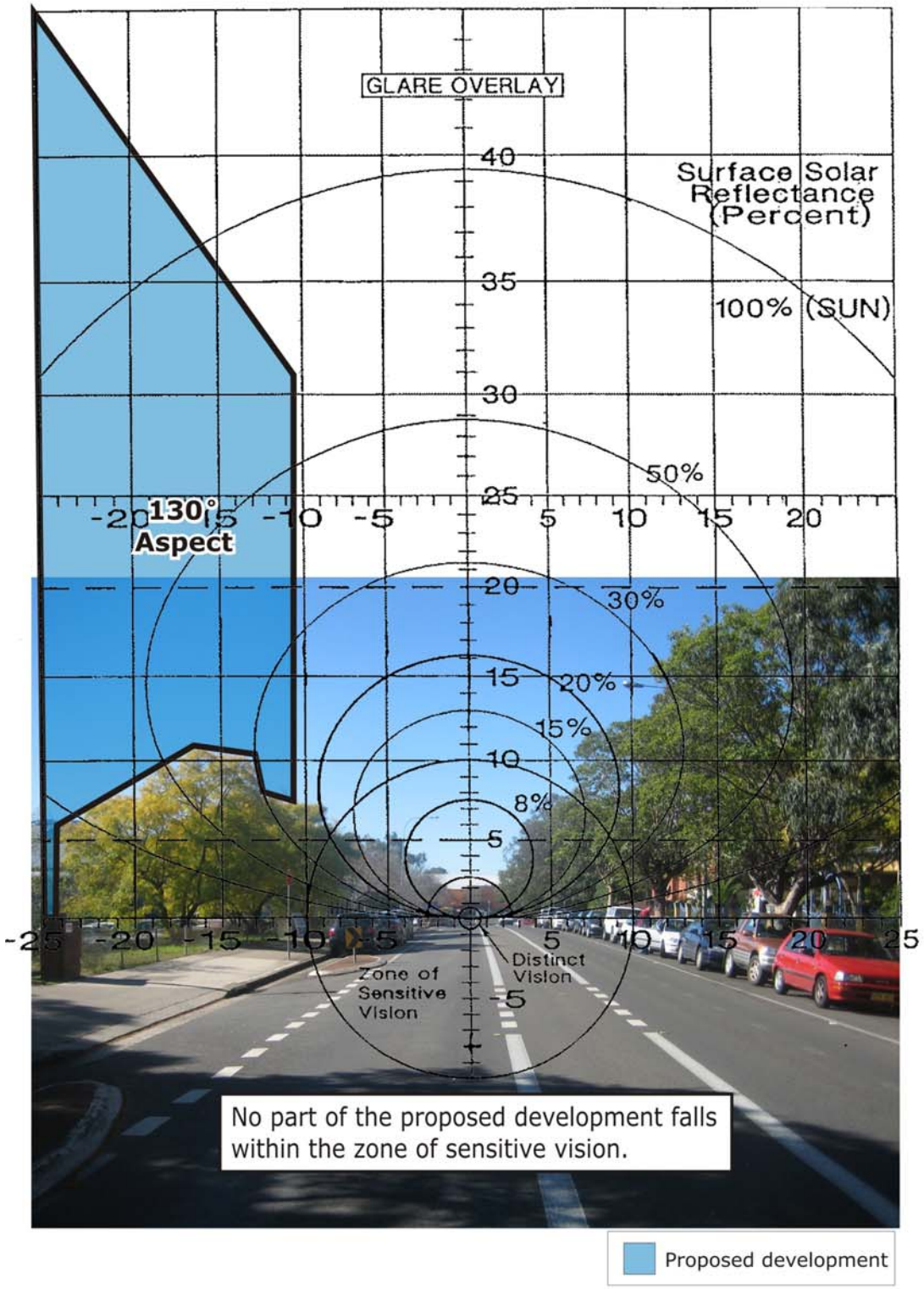

Figure A4: Glare Overlay for Point 4

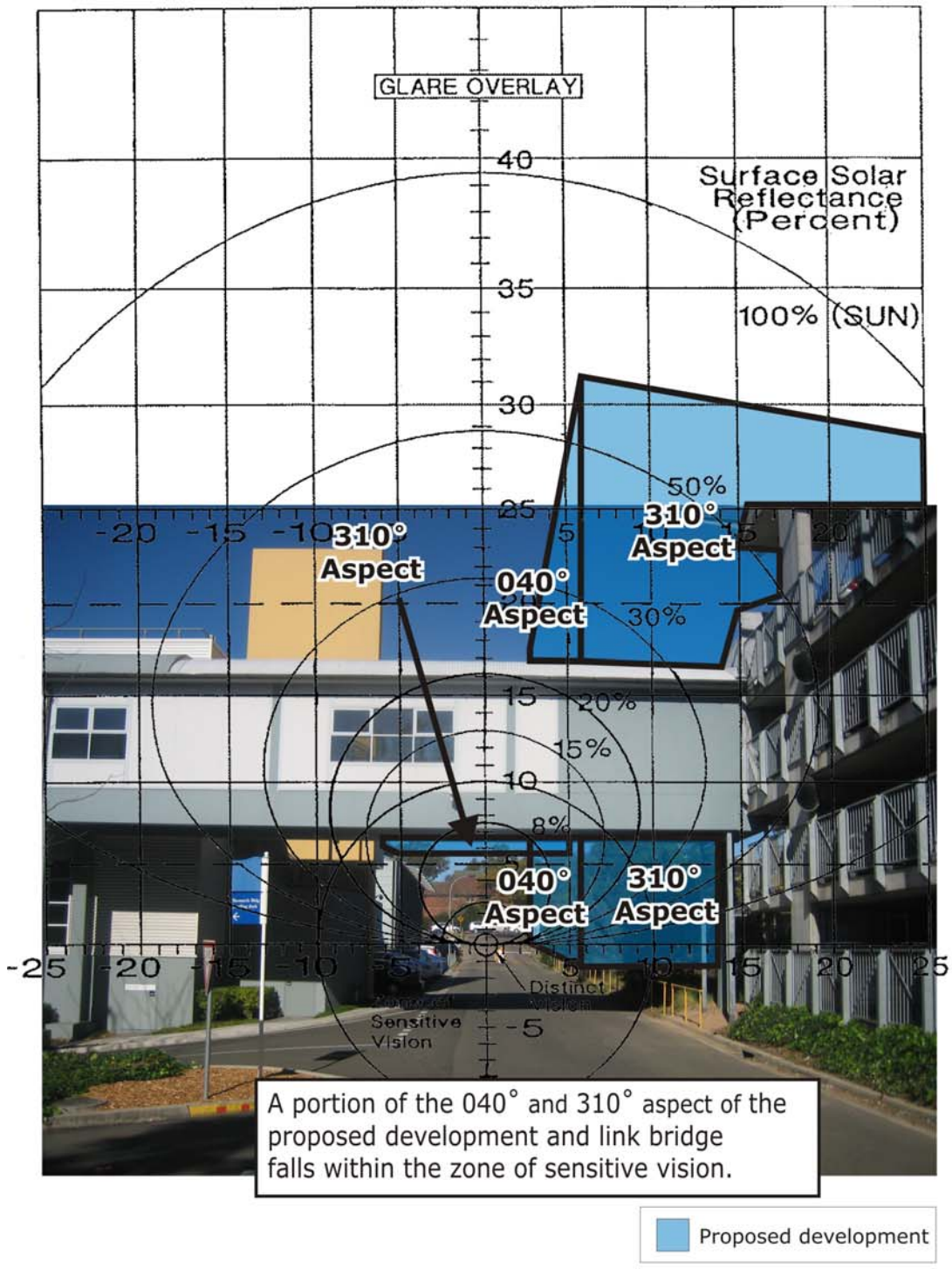

Figure A5: Glare Overlay for Point 5

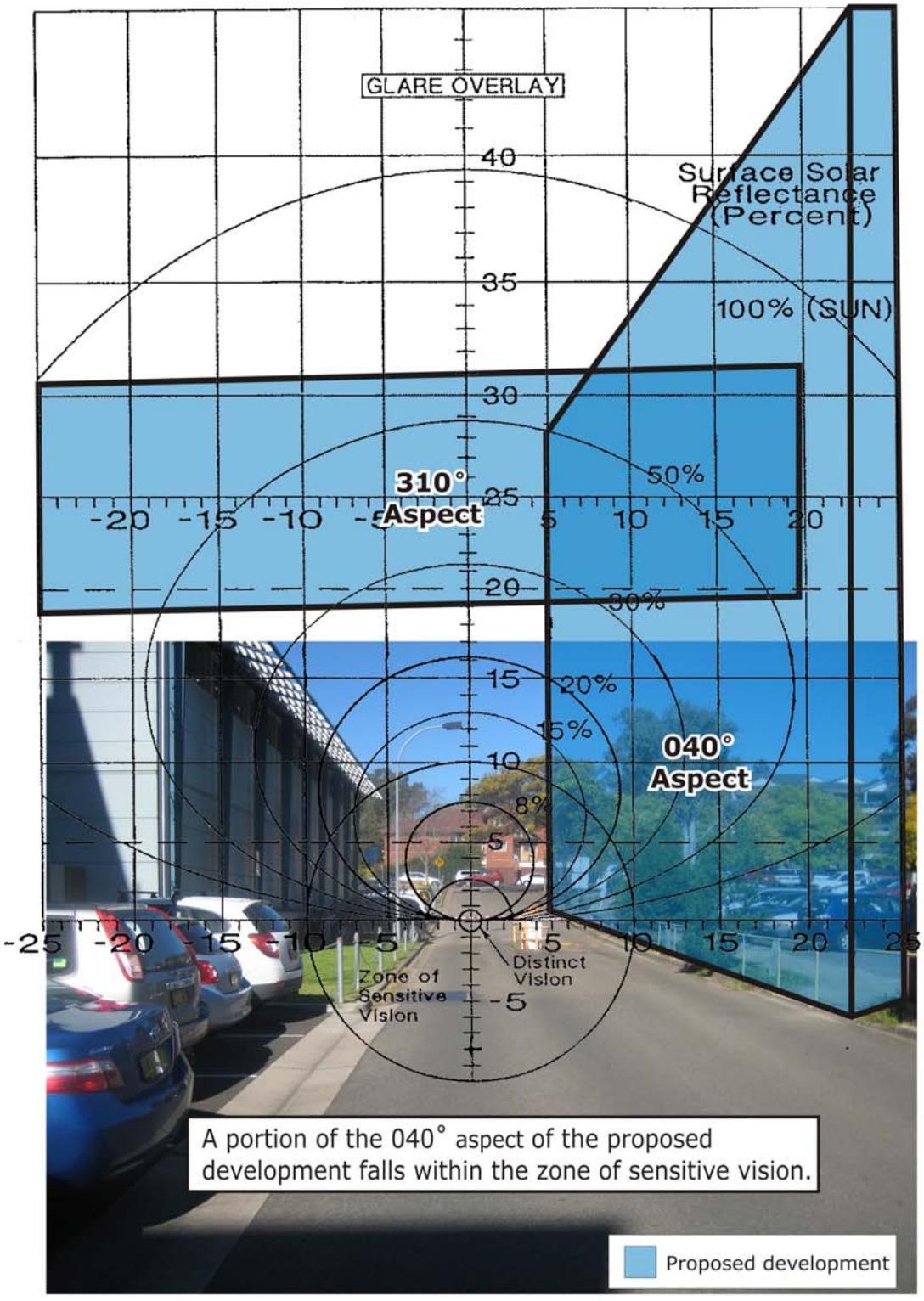

Figure A6: Glare Overlay for Point 6

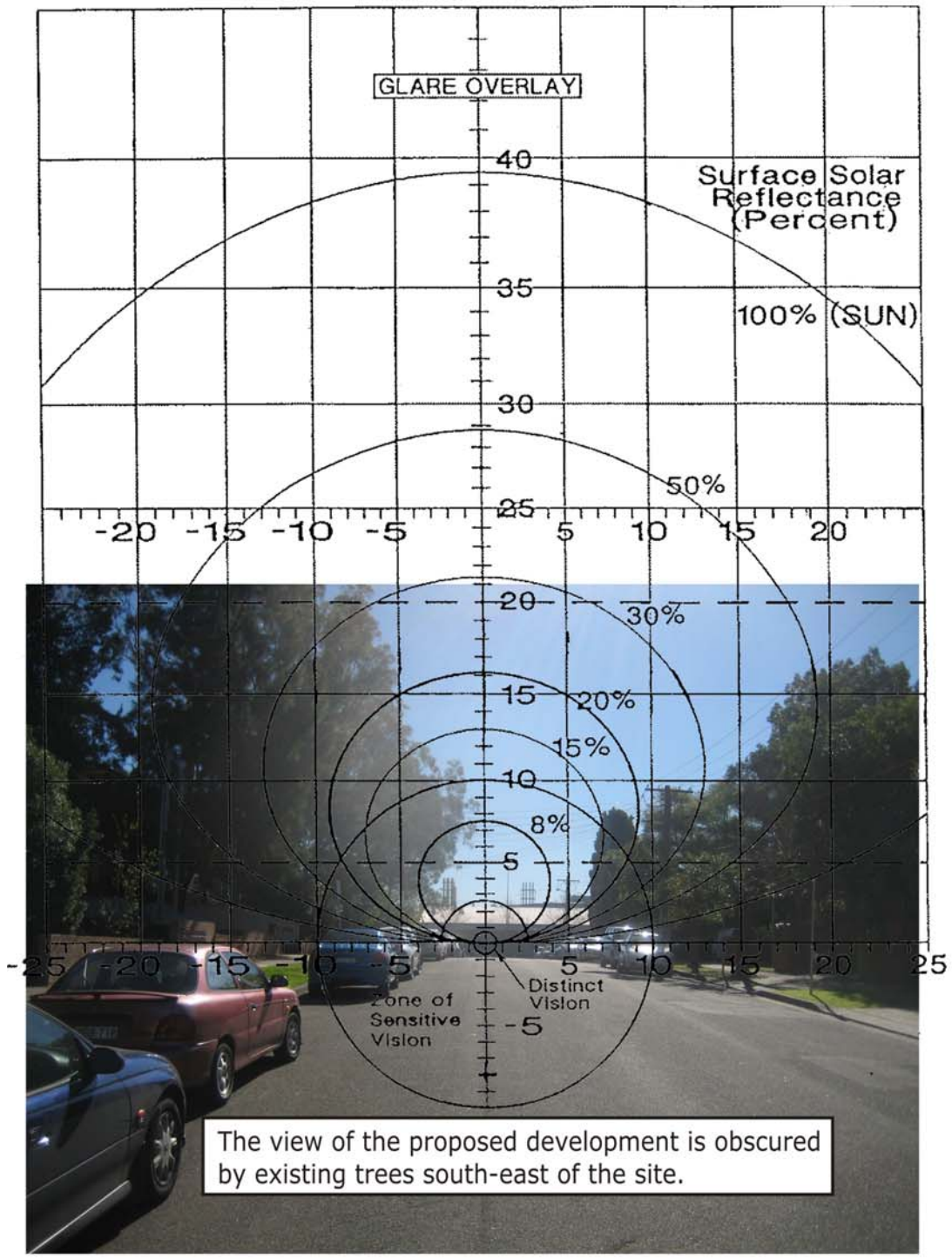

Figure A7: Glare Overlay for Point 7

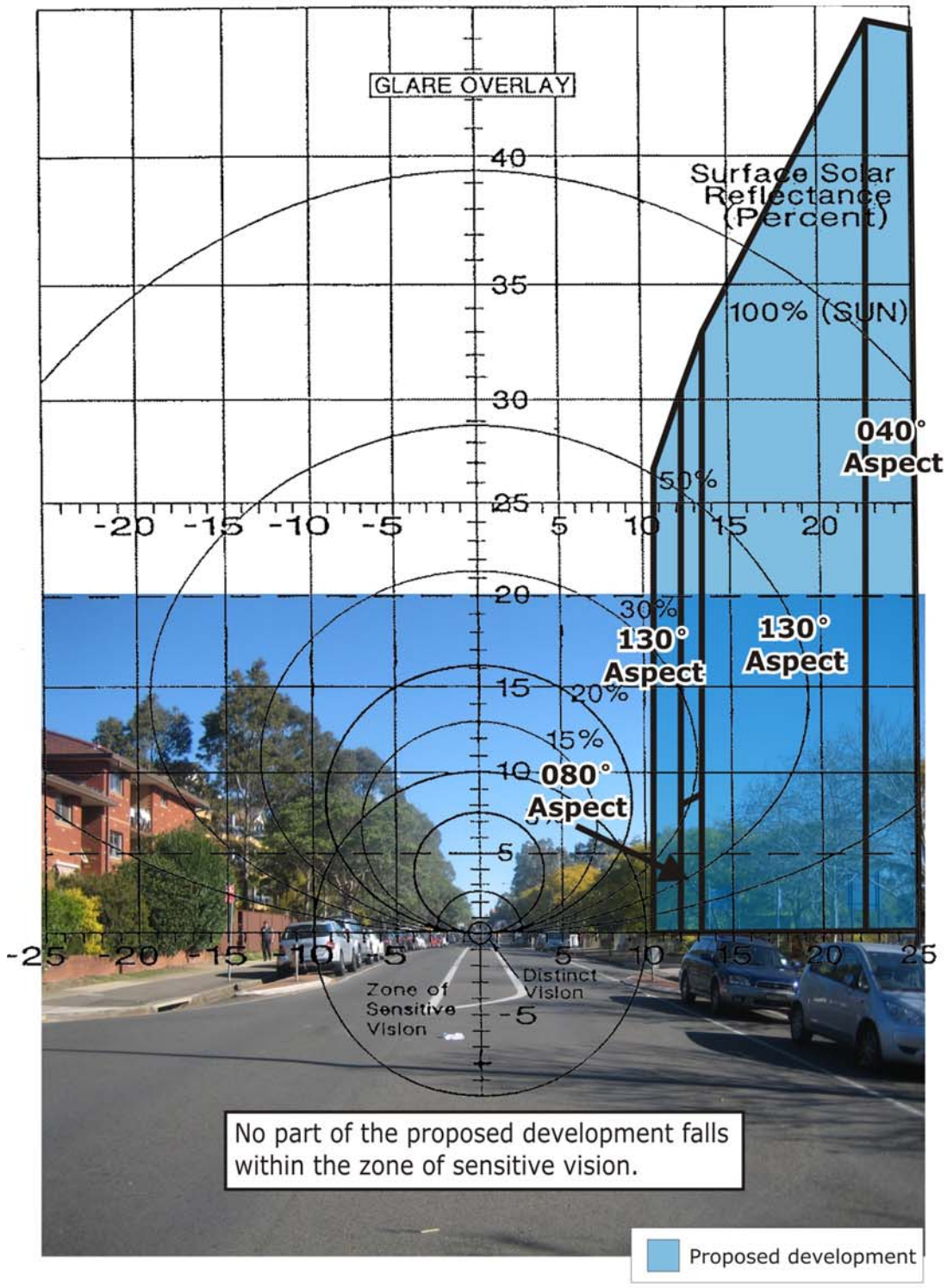

Figure A8: Glare Overlay for Point 8

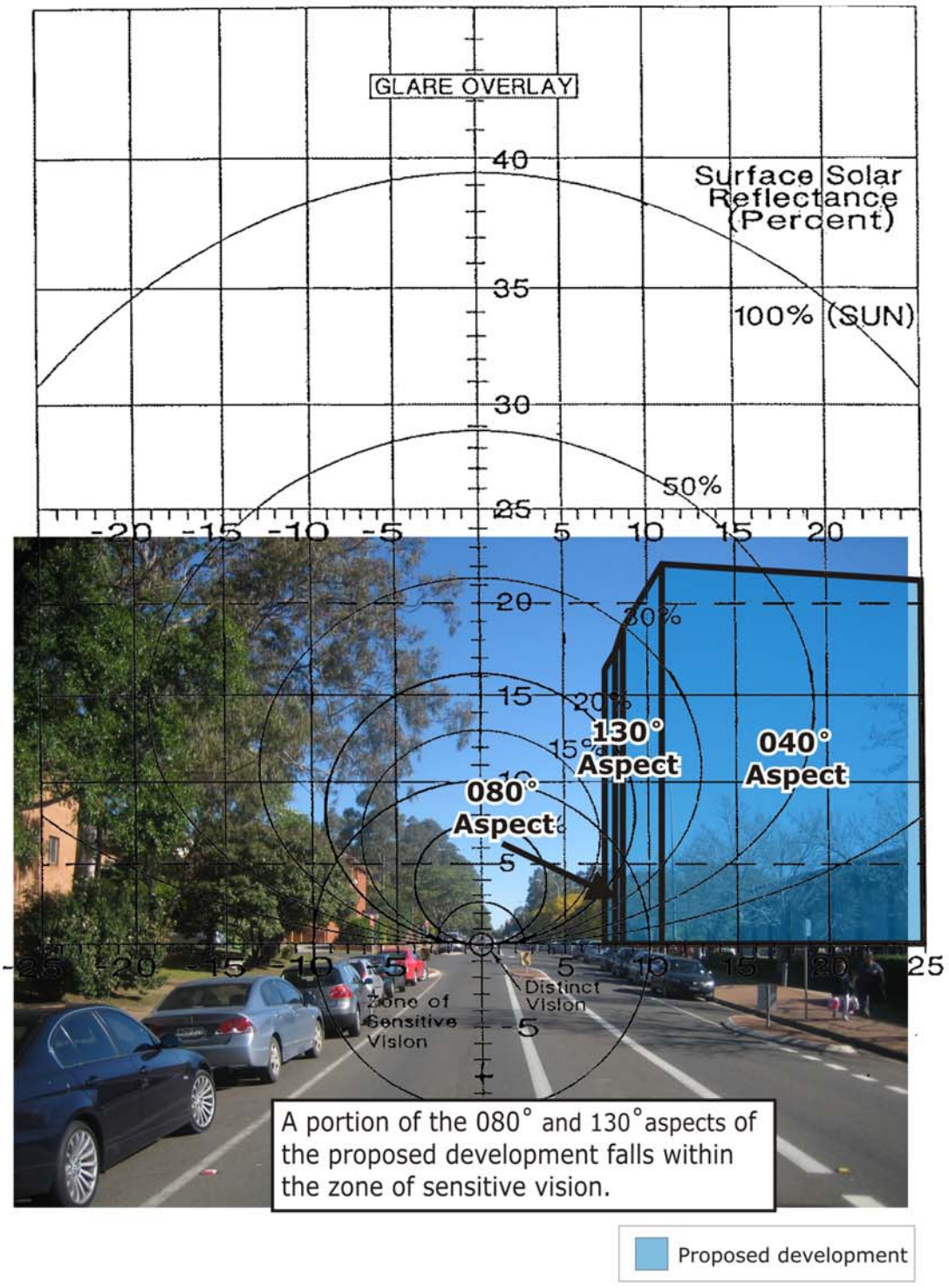

Figure A9: Glare Overlay for Point 9

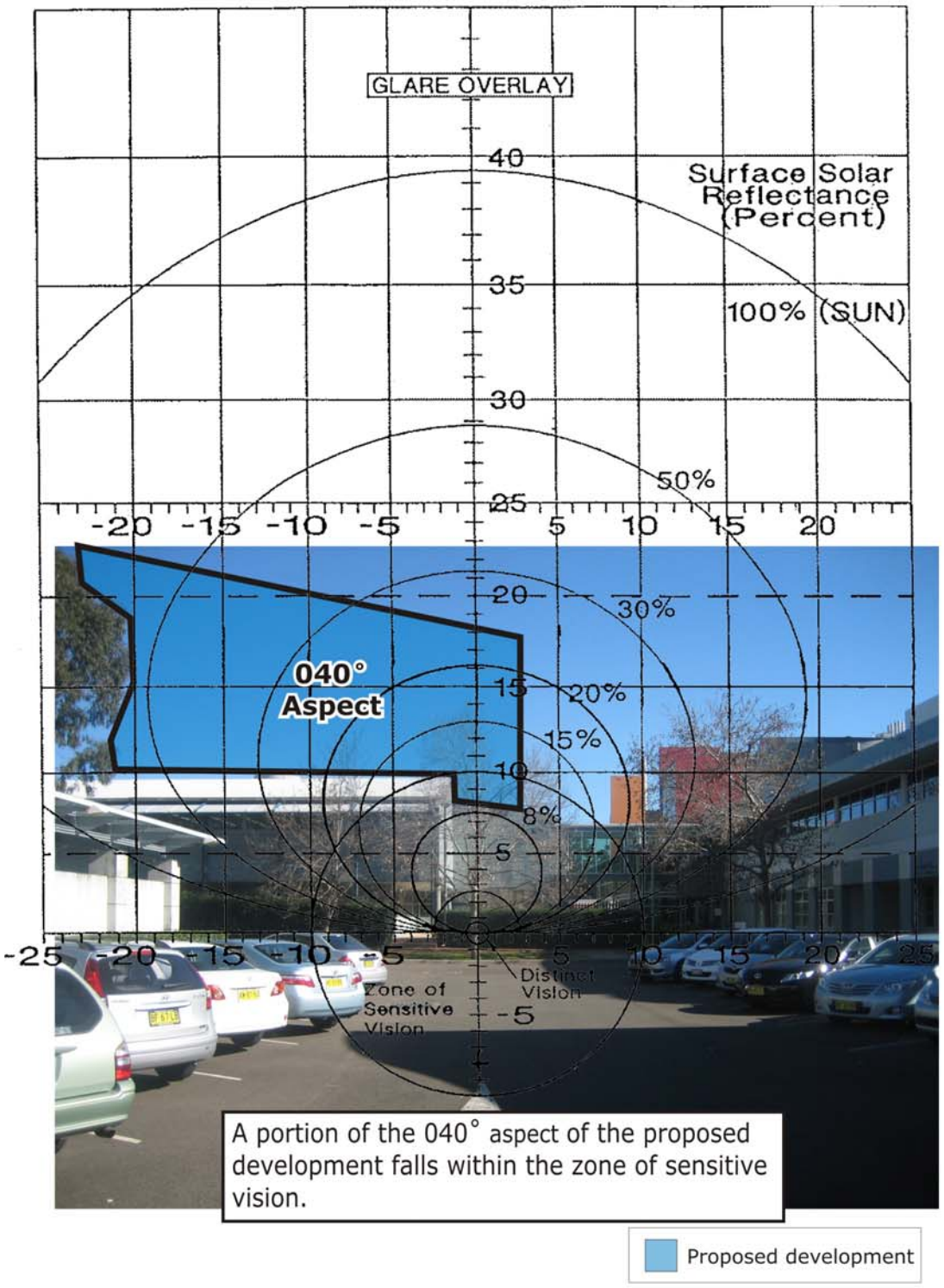

Figure A10: Glare Overlay for Point 10

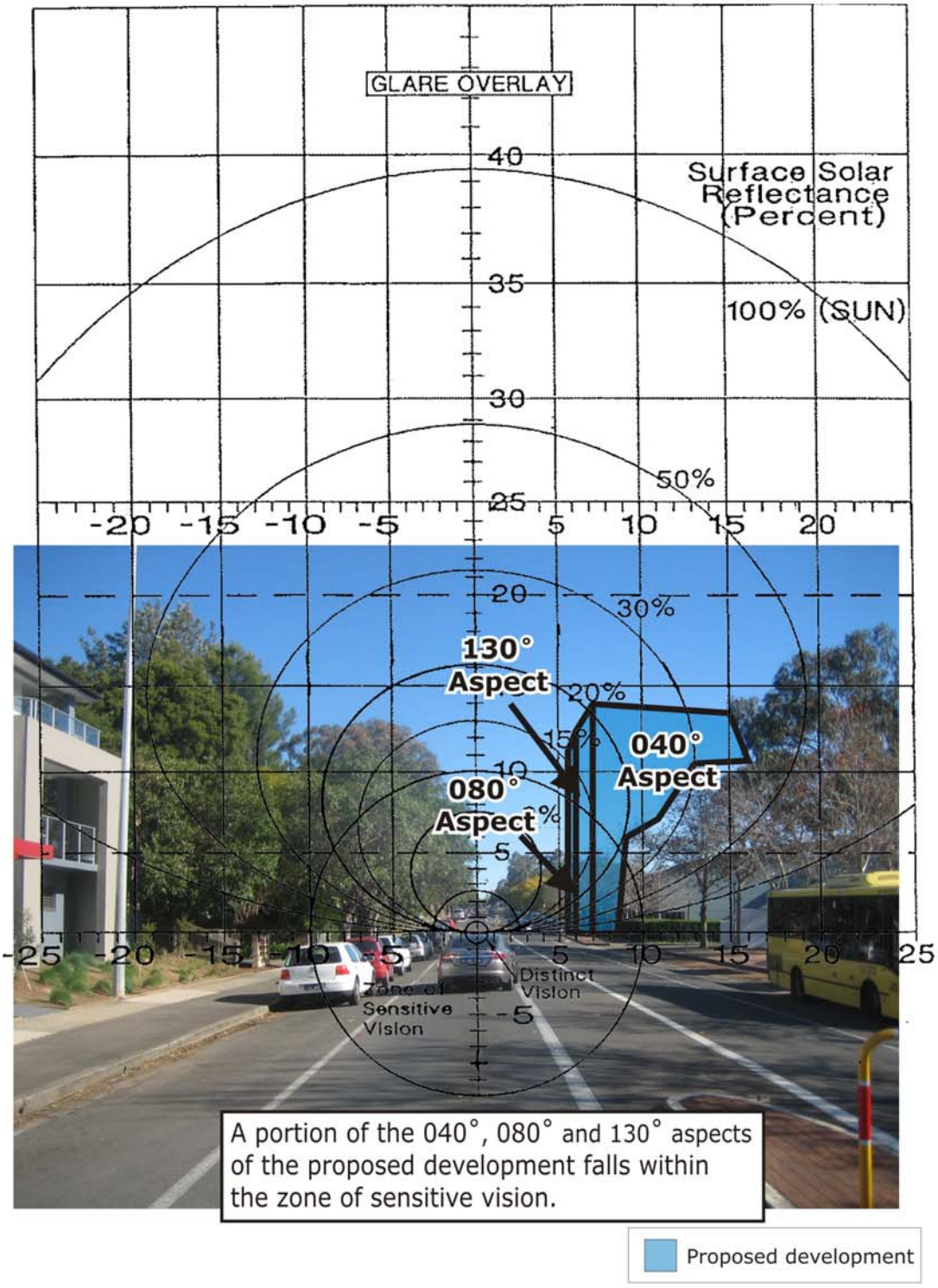

Figure A11: Glare Overlay for Point 11

Appendix B

Solar Charts for the Various Aspects of the Proposed Development

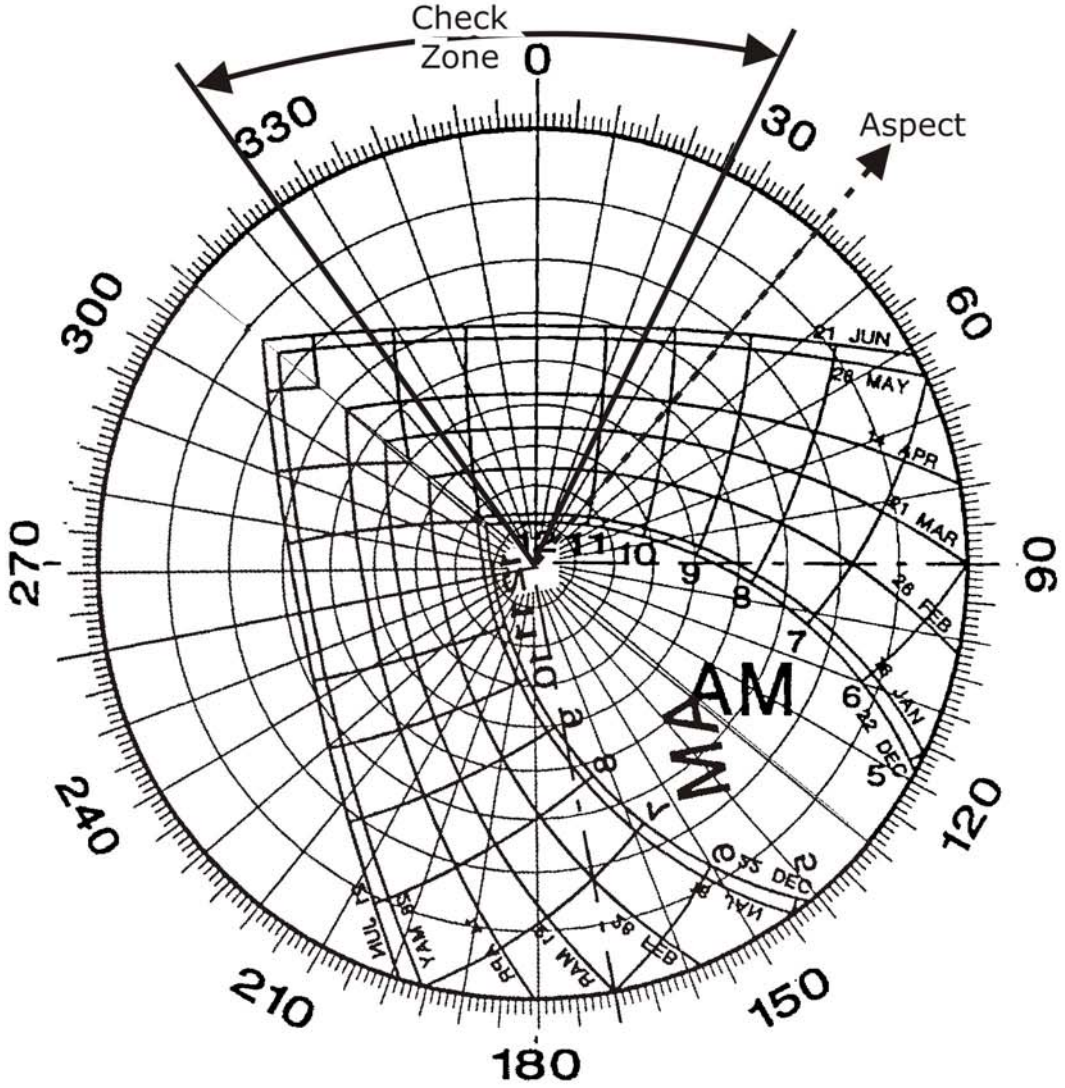

Figure B1: Sun Chart for Aspect 040°

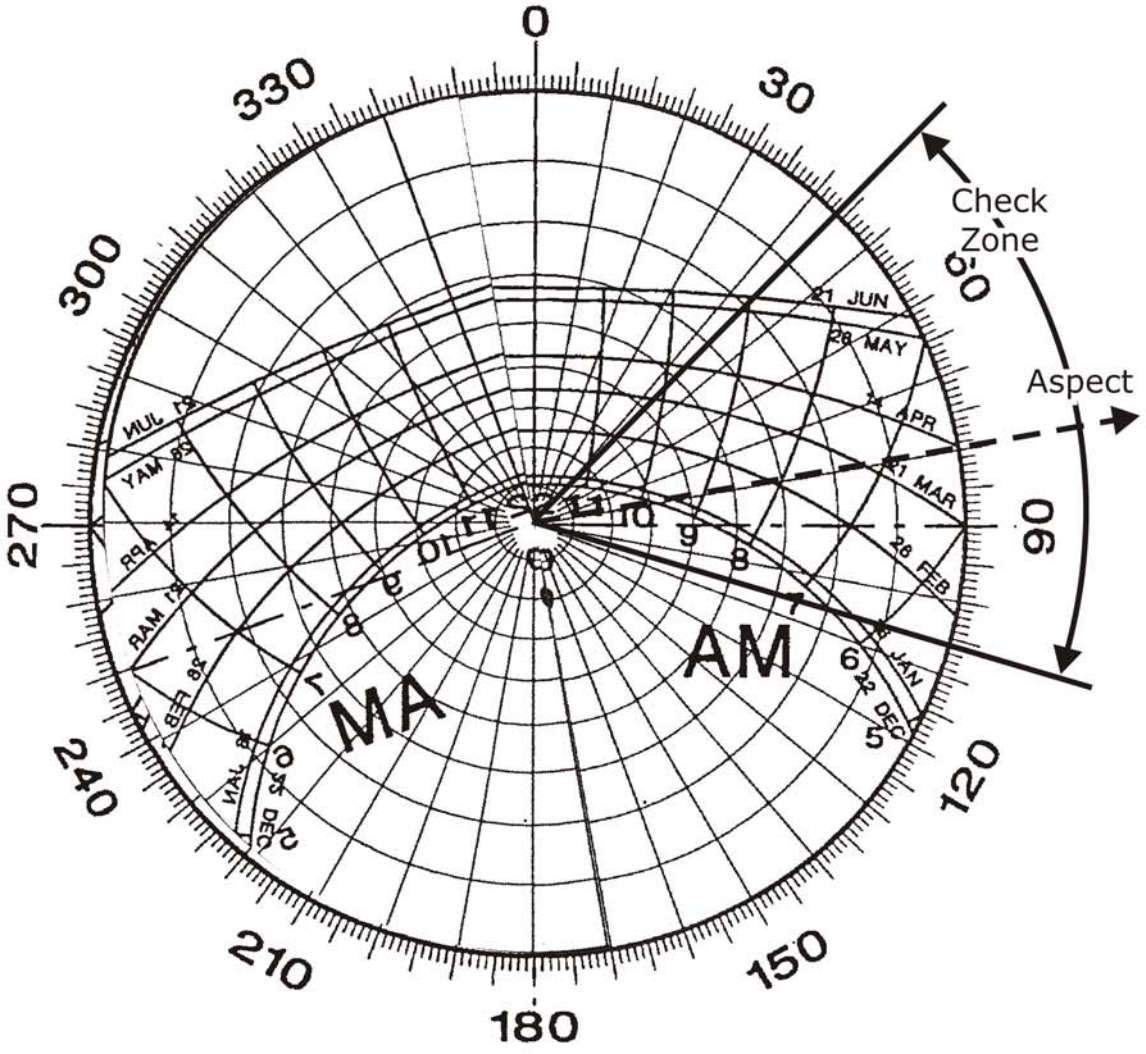

Figure B2: Sun Chart for Aspect 080°

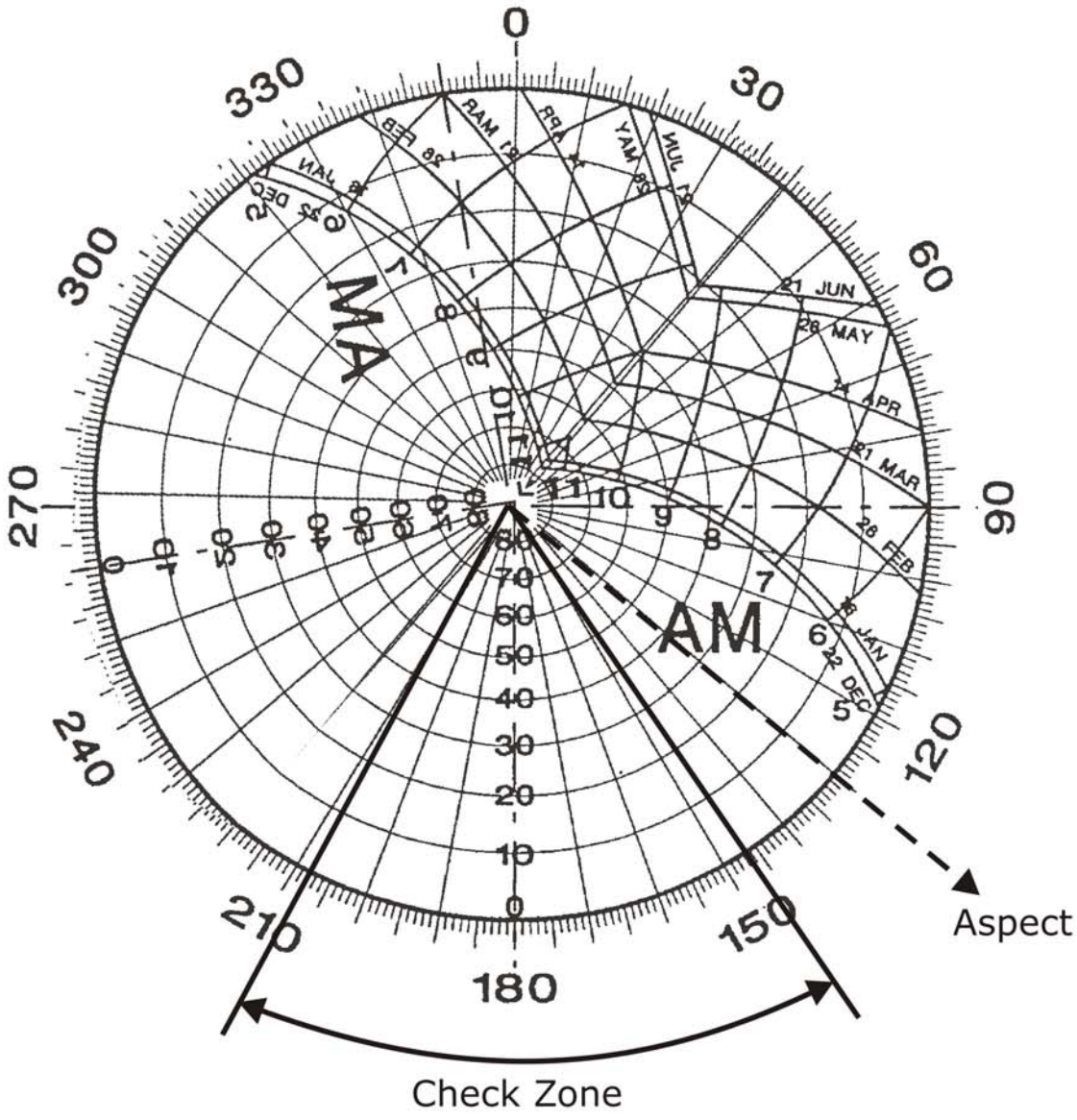

Figure B3: Sun Chart for Aspect 130°

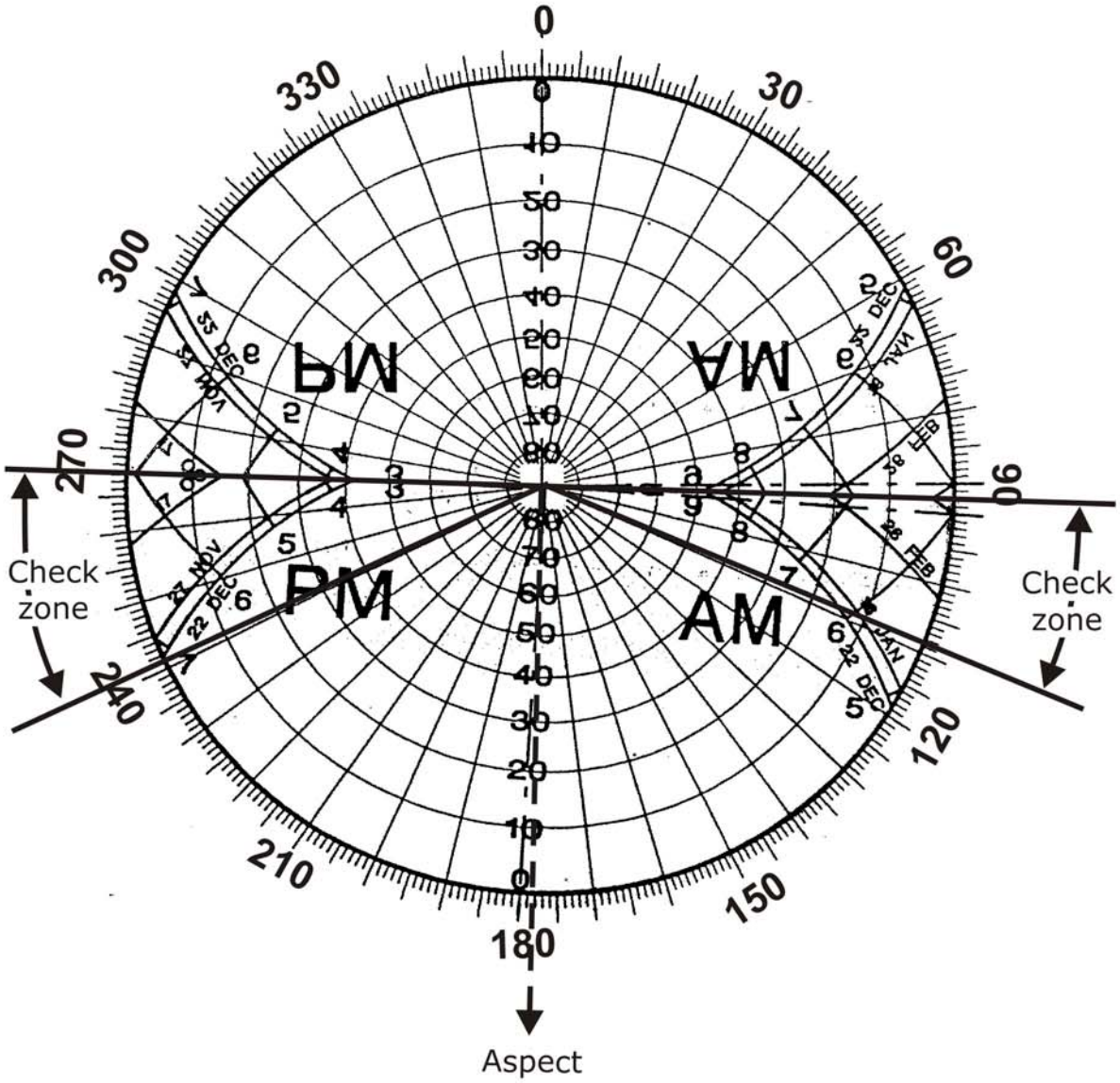

Figure B4: Sun Chart for Aspect 178°

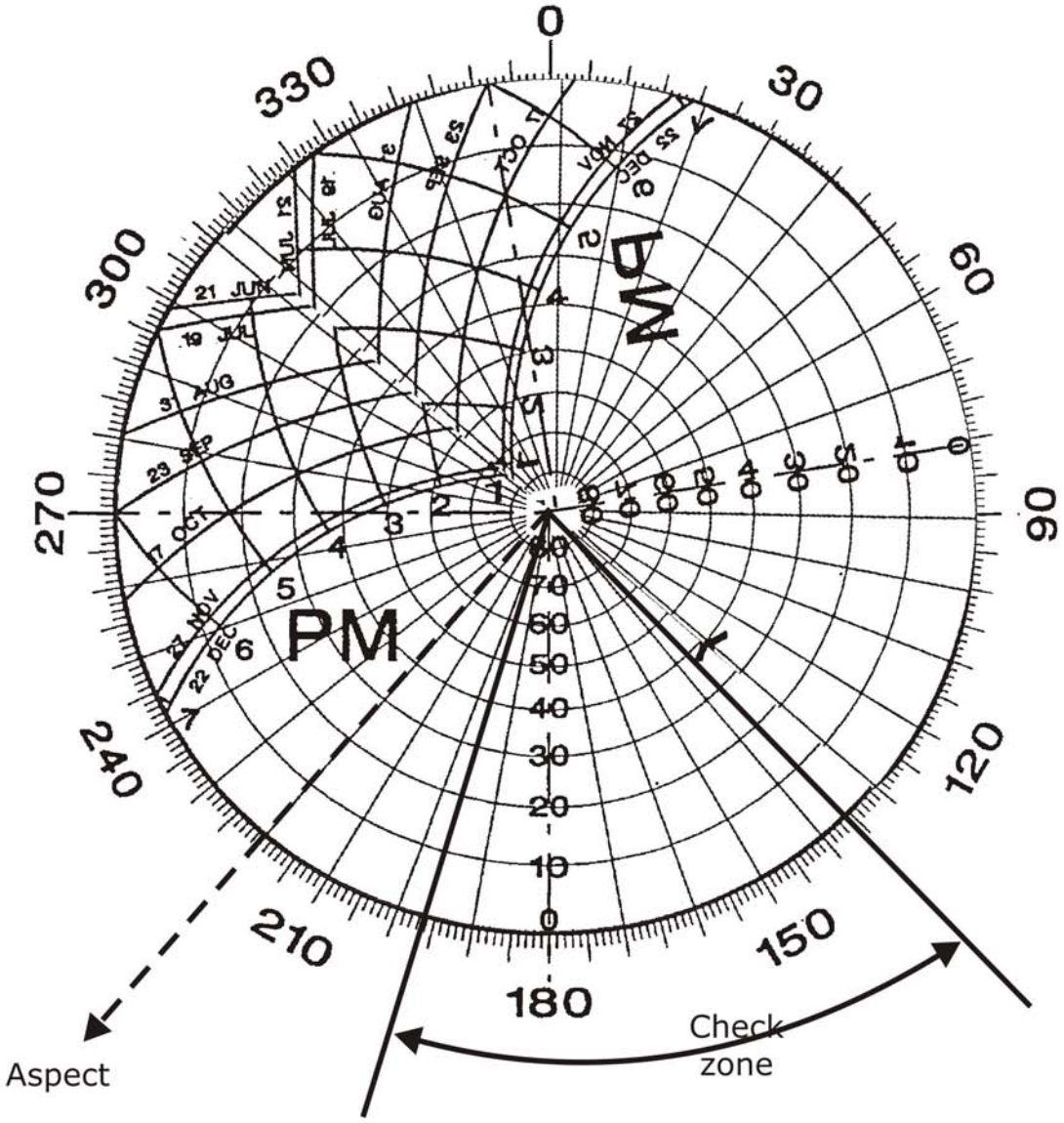

Figure B5: Sun Chart for Aspect 220°

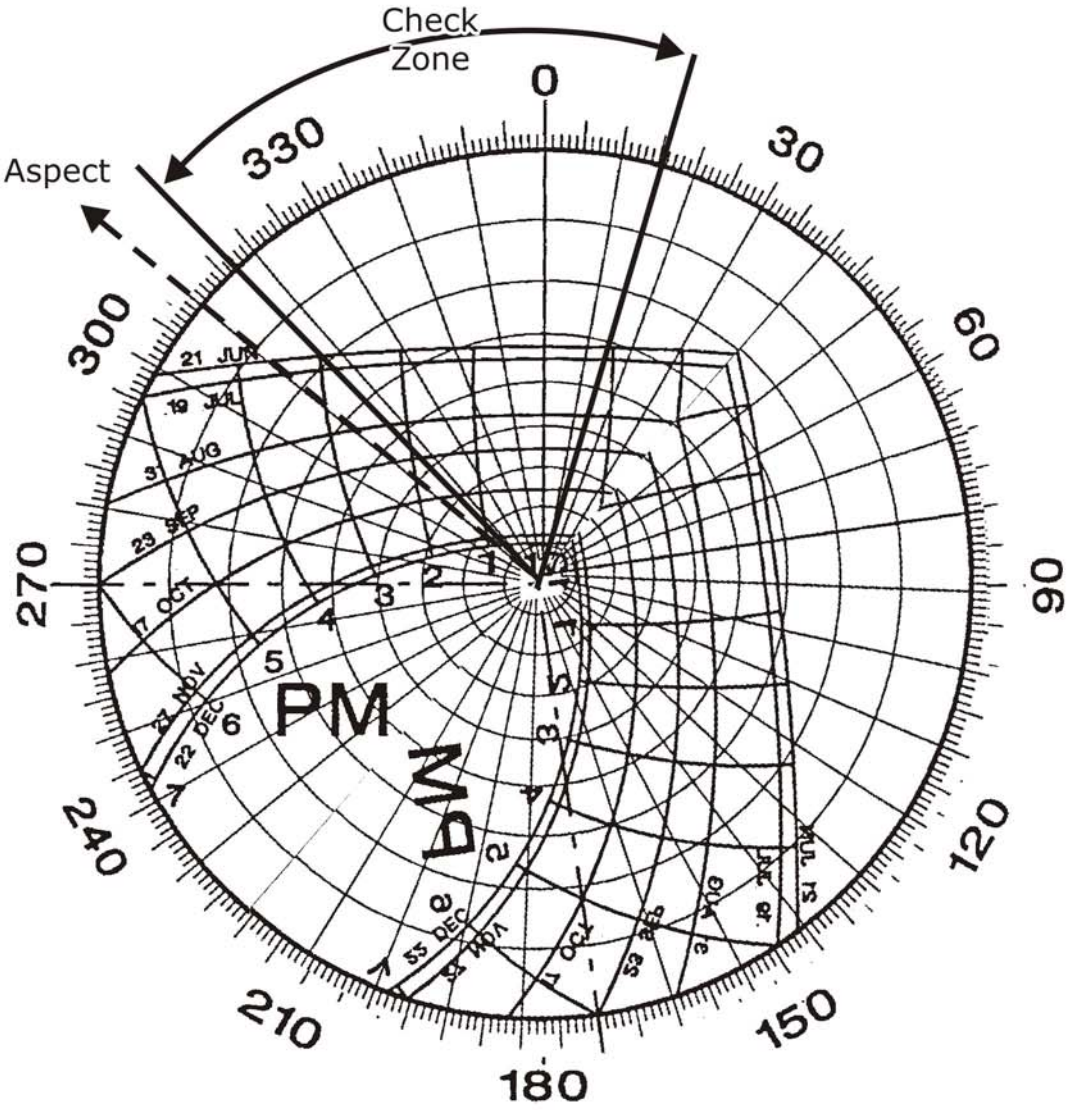

Figure B6: Sun Chart for Aspect 310°