WINDTECH

Solar Light Reflectivity Analysis

for the proposed development known as

Prince of Wales Medical Research Institute, Neuroscience Research Precinct, Randwick

October 28, 2009

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Document Control

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0	17/12/2008	Initial (report reference number WA590-01F03(rev0))	AL	TR
1	28/10/2009	Updated report and recommendations to represent the latest architectural design	AL	AB

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1.0 Introduction

This study is to investigate the potential impact of solar glare from the proposed development known as the Neuroscience Research Precinct of the Prince of Wales Medical Research Institute, Randwick. The analysis takes into consideration potential reflectivity to the critical local surrounding street level locations, and to occupants of the surrounding buildings.

The site is bounded by Easy Street to the east, Barker Street to the south, and Hospital Road to the West. An analysis has been undertaken based on architectural drawings prepared by Cox Richardson, received on October 21, 2009.

With regards to solar reflectivity, this study addresses the requirement of the City of Sydney DCP October 2003, which states under Section 4.5: *Reflectivity*;

4.5.1 New buildings and facades should not result in glare that causes discomfort or threatens safety of pedestrians or drivers.

4.5.2 Visible light reflectivity from building materials used on the facades of new buildings should not exceed 20%.

4.5.3 A Reflectivity Report that analyses the potential solar glare from the proposed new development on pedestrians or motorists may be required.

A reflectivity analysis of the subject development has been carried out using the technique published by Mr David N. H. Hassall (1991)[1]. Note that some sections of the external façade of the proposed development feature inclined planes, which require a more detailed type of assessment for reflectivity as detailed by Hassall (1991).

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 proposal are presented on Figure 2.

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

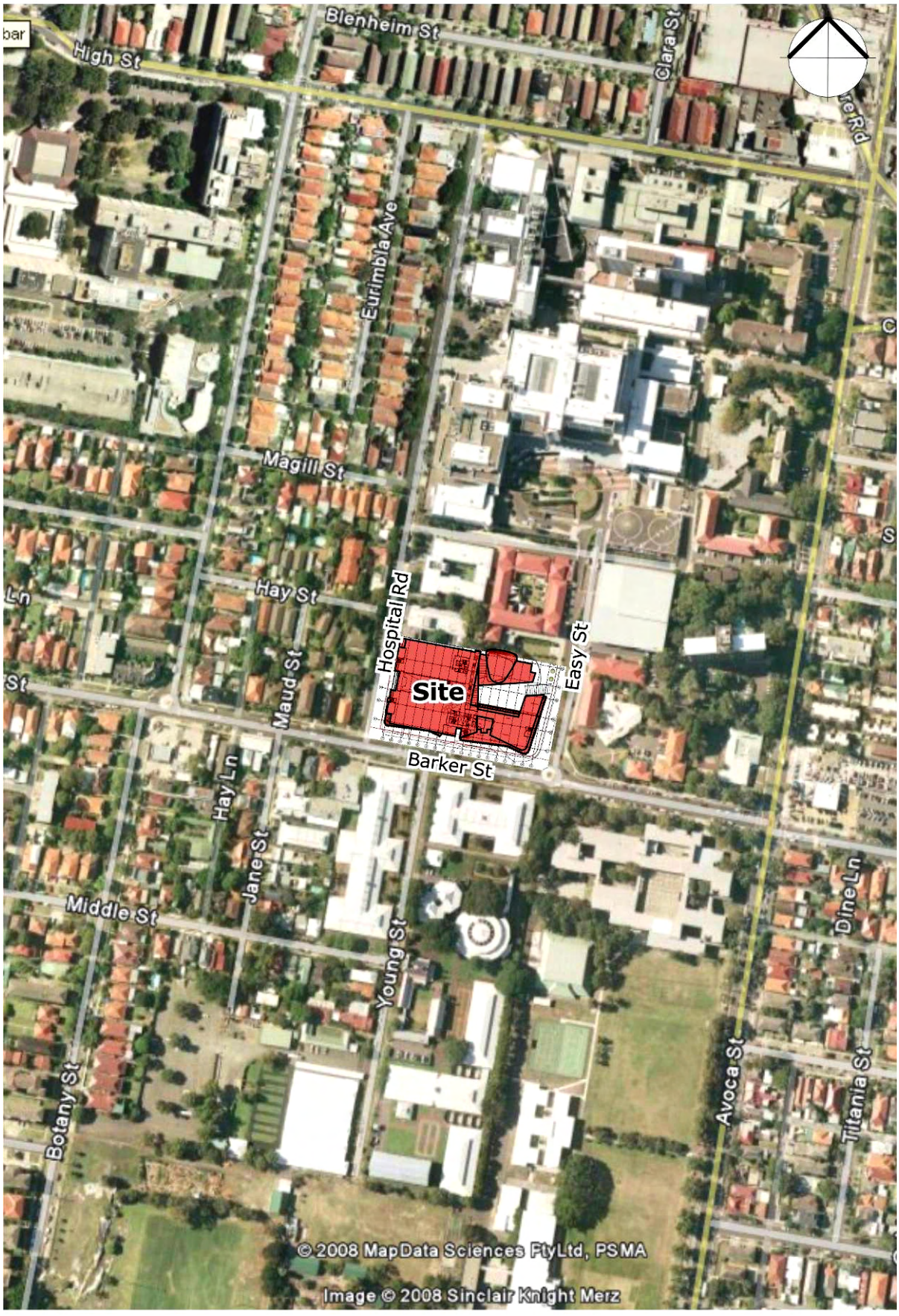


Figure 1: Aerial Image of the Proposed Development

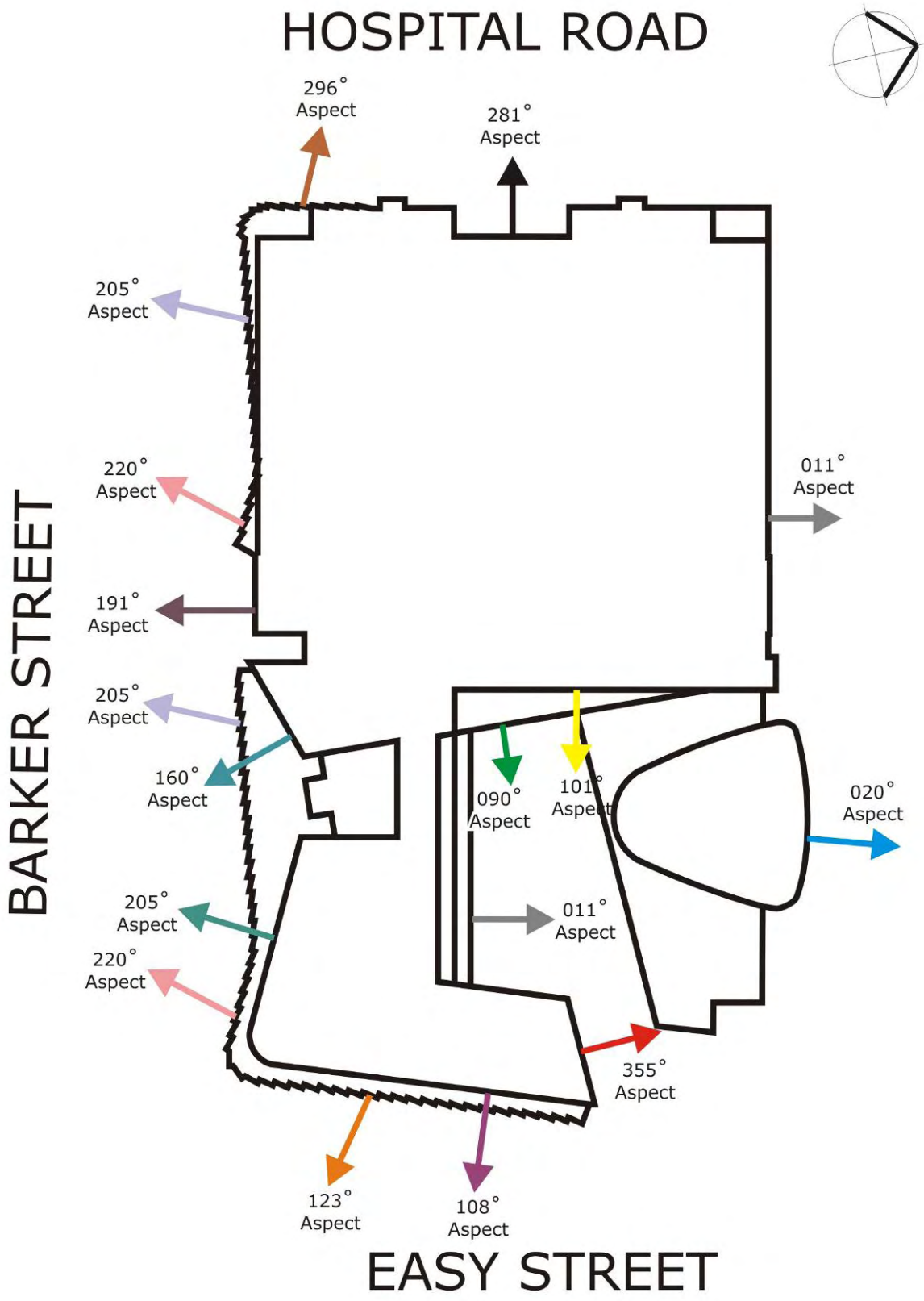


Figure 2: The Critical Non-Inclined Plane Aspects

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.

For the analysis of potential adverse glare for this project, the sections of the glazed façade that are angled with inclined-planes are analysed in a separate analysis (see Section 2.2 of this report). The local surrounding areas potentially affected by the vertical glazed façade sections of the development are discussed in Section 2.1 below.

2.1 Impact on Drivers & Pedestrians: Non-Inclined Plane Sections of the Glazed Facade

The various check zones for the subject development are described in Figure 3 for the areas potentially affected by the glazed non-inclined (vertical) planes of the proposed development. 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 following detailed analysis in this report.

From the study of the check zones, and with consideration of the potential overshadowing effects of neighbouring buildings, 6 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 summarises the aspects of the site that affect each study point location.

Table 1: Non-Inclined Aspects and the Relevant Study Points

Study Point	Aspects
Point 1	002˚ aspect
Point 2	011˚, 281˚ and 296˚ aspects
Point 3	191˚ and 281˚ aspects
Point 4	011˚ aspect
Point 5	090˚, 101˚, 108˚ and 191˚
Point 6	160˚, 205˚ and 220˚ aspects

For each of the study point locations, photographs has 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.

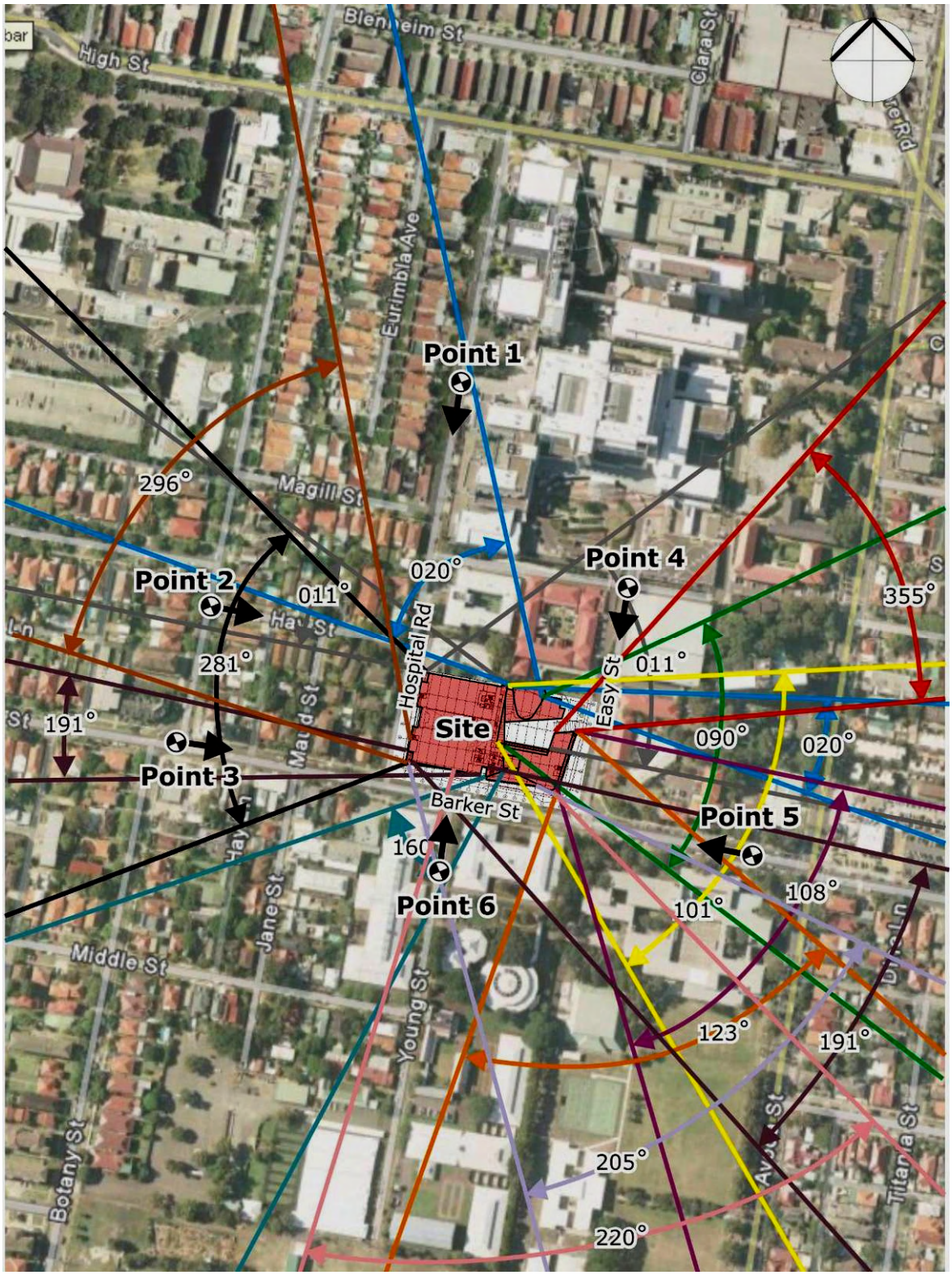


Figure 3: Check Zones and Layout of Study Points for the Non-Inclined Aspects

2.1.1 Point 1 (Hospital Road)

Point 1 is located to the north of the proposed development on Hospital Road. This point represents a critical sightline of drivers heading south along Hospital Road. This point is located within the check zones for the 002˚ aspect of the proposed development.

The site survey of this point, shown in Figure A1 of Appendix A, indicates that the view of the proposed development is obscured by the existing densely foliating trees lining the east side of Hospital Road.

Hence there will be no adverse glare from the 002˚ aspect of the proposed development to drivers and pedestrians facing south along Hospital Road at Point 1.

2.1.2 Point 2 (Hay Street)

Point 2 is located to the north-west of the proposed development on Hay Street. This point represents a critical sightline of drivers heading east along Hay Street. This point is located within the check zones for the 011˚, 281˚ and 296˚ aspects of the proposed development.

The site survey of this point, shown in Figure A2 of Appendix A, indicates that the proposed development is obscured from view by the existing densely foliating trees lining the west side of Hospital Road.

Hence there will be no adverse glare from the 011˚, 281˚ and 296˚ aspects of the proposed development to drivers and pedestrians facing east along Hay Street at Point 2.

2.1.3 Point 3 (Barker Street)

Point 3 is located to the west of the proposed development on Barker Street. This point represents a critical sightline of drivers heading east along Barker Street. This point is located within the check zones for the 191˚ and 281˚ aspects of the proposed development.

The site survey of this point, shown in Figure A3 of Appendix A, indicates that the top 3 levels of the 191˚ aspect are within the zone of sensitive vision. It is therefore recommended that the glazing on the top 3 levels of the 191˚ aspect have a normal specular reflectivity of visible light not exceeding 9%.

With the above recommendation satisfied, there will be no adverse glare from the 191˚ and 281˚ aspects of the proposed development to drivers and pedestrians facing east along Barker Street at Point 3.

2.1.4 Point 4 (Easy Street)

Point 4 is located to the north-east of the proposed development on Easy Street. This point represents a critical sightline of drivers heading south along Easy Street. This point is located within the check zones for the 011˚ aspect of the proposed development.

The site survey of this point, shown in Figure A4 of Appendix A, indicates that the third level of the 011˚ aspect is within the zone of sensitive vision. It is therefore recommended that the third level of the 011˚ aspect at the eastern edge have a normal specular reflectivity of visible light not exceeding 9%.

With the above recommendation satisfied, there will be no adverse glare from the 011˚ aspect of the proposed development to drivers and pedestrians facing south along Easy Street at Point 4.

2.1.5 Point 5 (Barker Street)

Point 5 is located to the south-east of the proposed development on Barker Street. This point represents a critical sightline of drivers heading west along Barker Street. This point is located within the check zones for the 090˚, 101˚, 108˚ and 191˚aspects of the proposed development.

The site survey of this point, shown in Figure A5 of Appendix A, indicates that none of the abovementioned aspects are within the zone of sensitive vision.

Hence there will be no adverse glare from the 090˚, 101˚, 108˚ and 191˚ aspects and the east facing inclined awning of the proposed development to drivers and pedestrians facing west along Barker Street at Point 5.

2.1.6 Point 6 (Young Street)

Point 6 is located to the south of the proposed development on Young Street. This point represents a critical sightline of drivers heading north along Young Street. This point is located within the check zones for the 160˚, 205˚ and 220˚ aspects of the proposed development.

The site survey of this point, shown in Figure A6 of Appendix A, indicates that levels 2 and 3 of the 205˚ and 220˚ aspects between grid lines Q and L, as indicated in the architectural drawings, are within the zone of sensitive vision. It is therefore recommended that the glazing at the aforementioned location have a normal specular reflectivity of visible light not exceeding 8%.

With the above recommendation satisfied, there will be no adverse glare from the 160˚, 205˚ and 220˚ aspects of the proposed development to drivers and pedestrians facing north along Young Street at Point 6.

2.2 Impact on Drivers & Pedestrians: Inclined Plane Sections of the Glazed Facade

With consideration of the potential overshadowing effects of neighbouring buildings, 4 street level locations have been identified for the analysis of potential adverse glare from the inclined-plane awning. Points 4 and 5 from the non-inclined plane analysis are also assessed in this analysis (see Figure 3), and Points 7 and 8, each located on Barker Street, are also assessed (see Figure 4).

To assess potential adverse glare at these study point locations, a line is drawn from each study point location to the centre of each inclined plane panel (represented by Points A to E as shown in Figure 4). Using the angles of reflection, a line is then drawn to show the hypothetical sun path required to be reflected to each of the study point locations. The hypothetical sun path lines are then resolved into azimuth and elevation angles and compared with the Solar Position Diagram for Sydney shown in Figure B13 in Appendix B to determine if the sun can actually be in the location(s) necessary to cause adverse glare. A detailed summary of potential adverse glare at each of these study point locations is described below.

2.2.1 Point 4 (Easy Street)

Point 4 is located to the north-east of the proposed development on Easy Street. This point represents a critical sightline of drivers heading south along Easy Street. This point is located within the check zones for the 011˚ aspect of the proposed development.

The site survey of this point, shown in Figure A4 of Appendix A, indicates the eastern edge and the east-facing inclined awning is within the zone of sensitive vision for drivers and pedestrians facing south along Easy Street at Point 4. However, it should be noted that the glass panes of the east-facing inclined awning are angled away from the line-of-sight of Point 4, and hence there will be no adverse glare from the east-facing inclined awning to drivers and pedestrians facing east along Easy Street at Point 4.

2.2.2 Point 5 (Barker Street)

Point 5 is located to the south-east of the proposed development on Barker Street. This point represents a critical sightline of drivers heading west along Barker Street. This point is located within the check zones for the 090˚, 101˚, 108˚ and 191˚aspects of the proposed development.

The site survey of this point, shown in Figure A5 of Appendix A, indicates that a single glass pane of the east-facing inclined awning and the south-facing inclined awing are within the zone of sensitive vision. The glare overlay in Figure A5 indicates that the glass pane of the east-facing awning is approximately 0.5 degrees (or 30 minutes of arc) in width. As a rule of thumb, any glazing that has a width or height of 30 minutes arc or less will reflect a negligible amount of solar glare back to an observer.

The glass panes of the south-facing inclined awning are angled away from the line-of-sight of Point 5, and hence there will be no adverse glare from the south-facing inclined awning to drivers and pedestrians facing west along Barker Street at Point 5.

2.2.3 Point 7 (Barker Street)

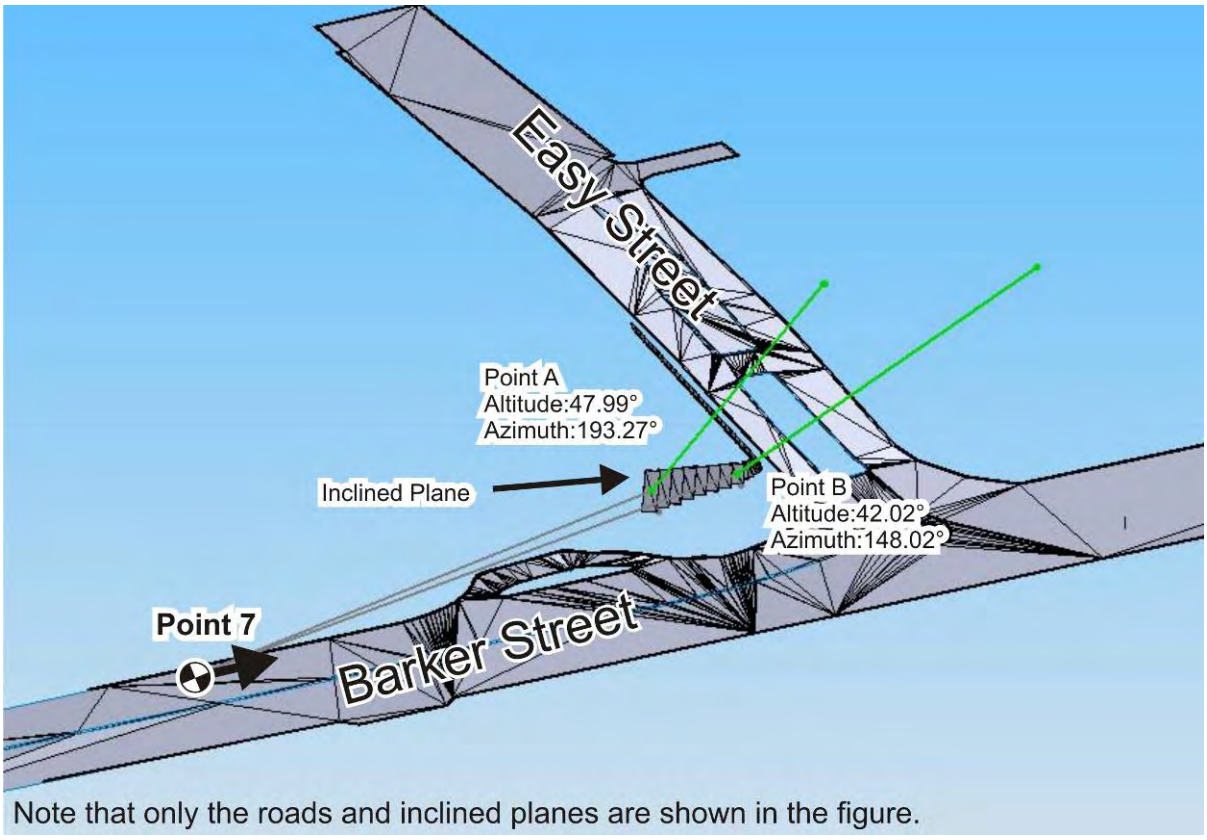
Point 7 is located to the south of the proposed development on Barker Street. This point represents a critical sightline of drivers heading east along Barker Street.

The results of the analysis shown in Figure 4 indicate that the range of angular co-ordinates [altitude, azimuth] from the sky that would result in reflections to this study point range from [048˚, 193˚] to [042˚, 148˚]. The sun chart for the Sydney area as shown in Figure B13 of Appendix B indicated that the sun's path will not ever reach these locations. Hence there will be no adverse glare from the inclined-plane glazed sections of the façade of the proposed development to drivers or pedestrians facing east along Barker Street at Point 7.

2.2.4 Point 8 (Barker Street)

Point 8 is located to the south-east of the proposed development on Barker Street. This point represents a critical sightline of drivers heading west along Barker Street.

The results of the analysis shown in Figure 4 indicate that the range of angular co-ordinates [altitude, azimuth] from the sky that would result in reflections to this study point range from [038.5˚, 218˚] to [042˚, 280˚]. The sun chart for the Sydney area as shown in Figure B13 of Appendix B indicated that the sun's path will reach these locations. Further analysis indicates that potentially adverse glare can occur from the inclined-plane glazed sections of the façade of the proposed development between 3:15pm to 3:45pm (eastern standard time) for all days of the year. To mitigate this potentially adverse effect to westbound drivers on Barker Street, it is recommend that the inclined glazed panels around the south-east corner of the site be made from a clear or body-tinted glass so as to have a maximum normal specular reflectivity of 7 percent.



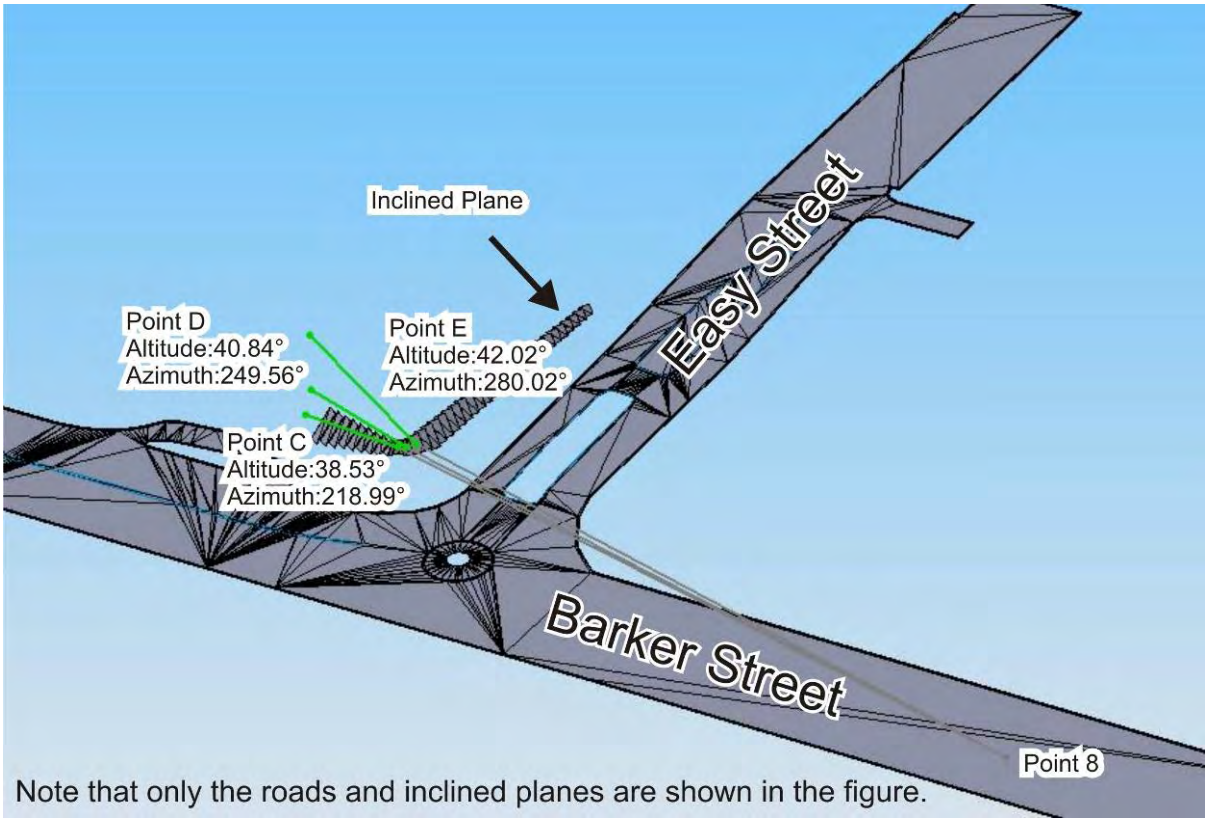


Figure 4: Solar Reflections to Study Points 7 and 8 from the Inclined Aspects

2.3 Impact on Drivers & Pedestrians: Inclined Plane Sections of the Roof Feature

With respect to the sight-lines from the various study locations as shown in Figures 3 and 4, and in Appendix A, the inclined roof feature of the proposed development is outside the zone of sensitive vision for all study points. Hence there will be no adverse glare reflected from the inclined roof feature to motorists and pedestrians in the surrounding streets.

2.4 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%. This seems to justify the suggested limit of 20% 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.

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[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 & Recommendations

A reflectivity analysis of the proposed development known as the Neuroscience Research Precinct of the Prince of Wales Medical Research Institute in Randwick has been carried out using the technique published by Mr David N. H. Hassall.

To avoid any adverse glare to drivers and pedestrians on the surrounding streets of the proposed development site, and to comply with Section 4.5 of the October 2003 City of Sydney DCP, the following recommendations have been made on the reflectance properties of the glazing to be used on the facade;

- The glazing on the top 3 levels of the 191˚ aspect, and the third level of the 011˚ aspect at the eastern edge, should have a maximum normal specular reflectivity of visible light of 9%.

- The glazing on Levels 2 and 3 of the 205˚ and 220˚ aspects (between longitudinal lines Q and L as indicated in the architectural drawings) should have a maximum normal specular reflectivity of visible light of 8%.

- The inclined panels on the awning around the south-eastern corner of the site should be mode from a clear or body-tinted glass so as to have a maximum normal specular reflectivity of 7%.

- All remaining glazed areas of the façade of the development should have a maximum normal specular reflectivity of visible light of 20 percent. Other highly reflective materials should also be avoided on the façades to avoid adverse glare to the occupants of neighbouring buildings.

With these recommendations satisfied, the results of this analysis indicate that 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 it is expected that no adverse glare impacts will result with regards to the occupants of neighbouring buildings.

An alternative to the treatments listed above could be to provide shading across the relevant sections of the building façade. This could be achieved by vertical and/or horizontal fins, blade walls, slab overhangs, etc, or by external louvres or other façade elements. Another alternative for some of the lower areas could be to add densely foliating evergreen trees, capable of obscuring the view of the development from the zone of sensitive vision for drivers at the various affected locations.

Appendix A

Analysis of Sight-Lines from the Various Study Locations

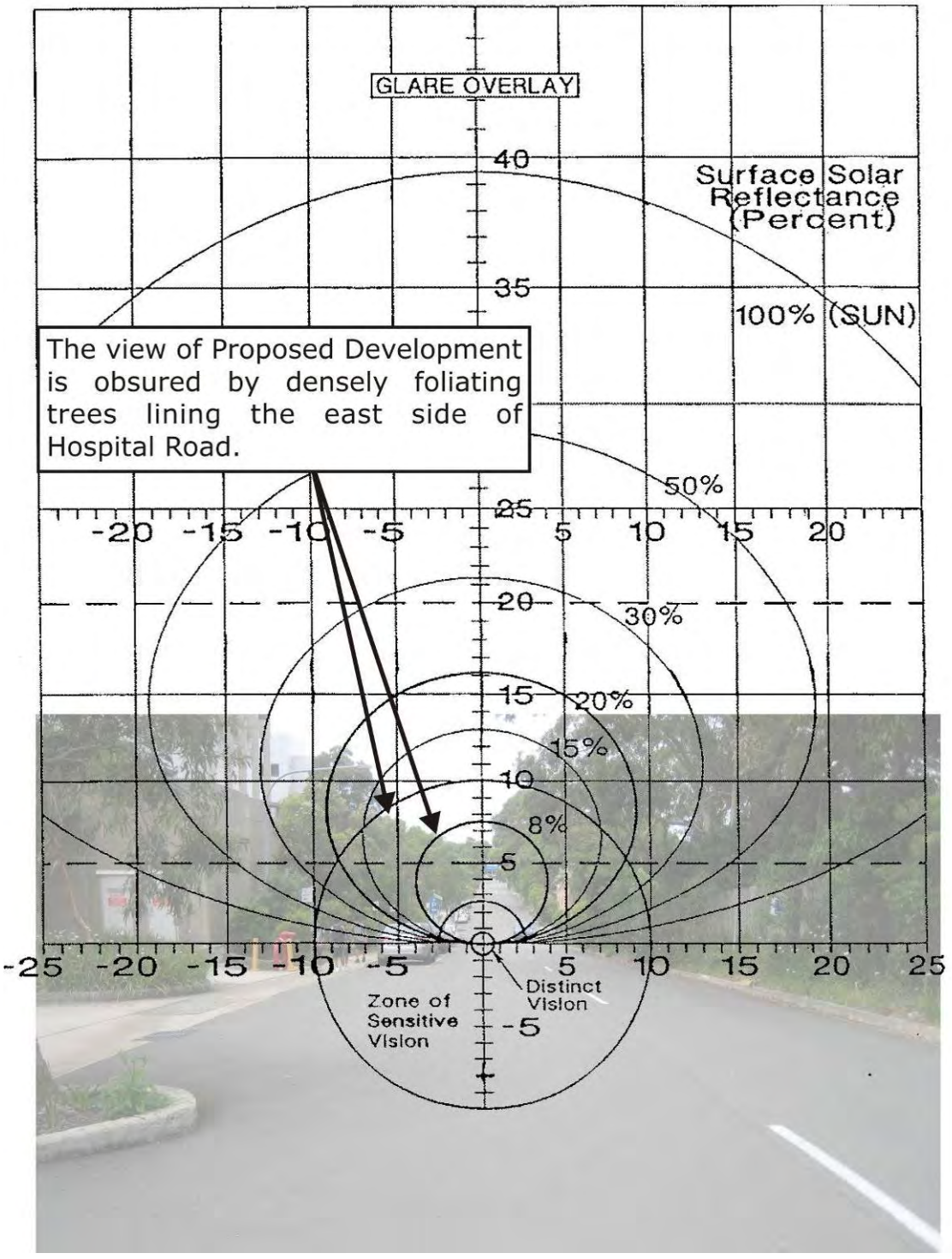

Figure A1: Glare Overlay for Point 1

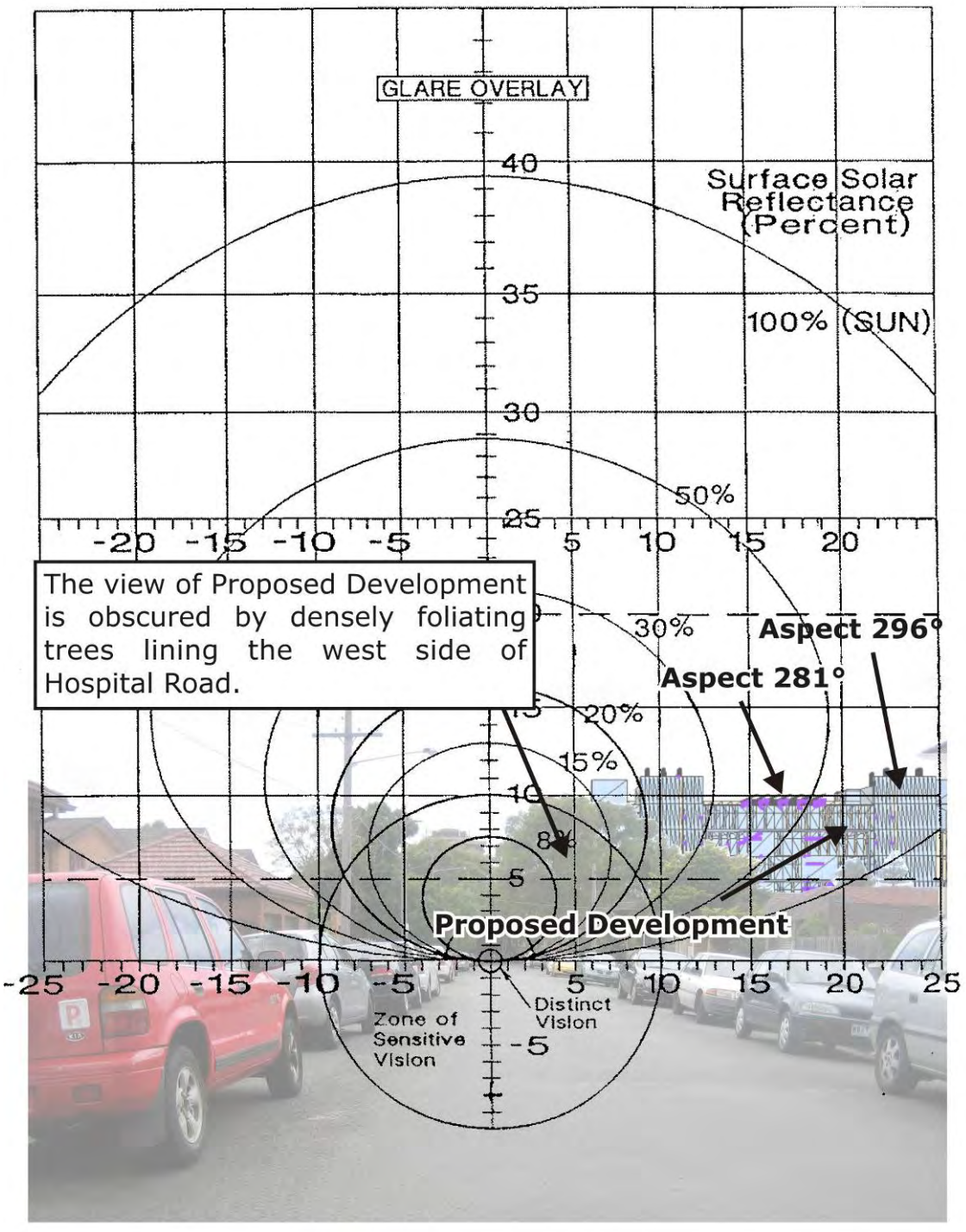

Figure A2: Glare Overlay for Point 2

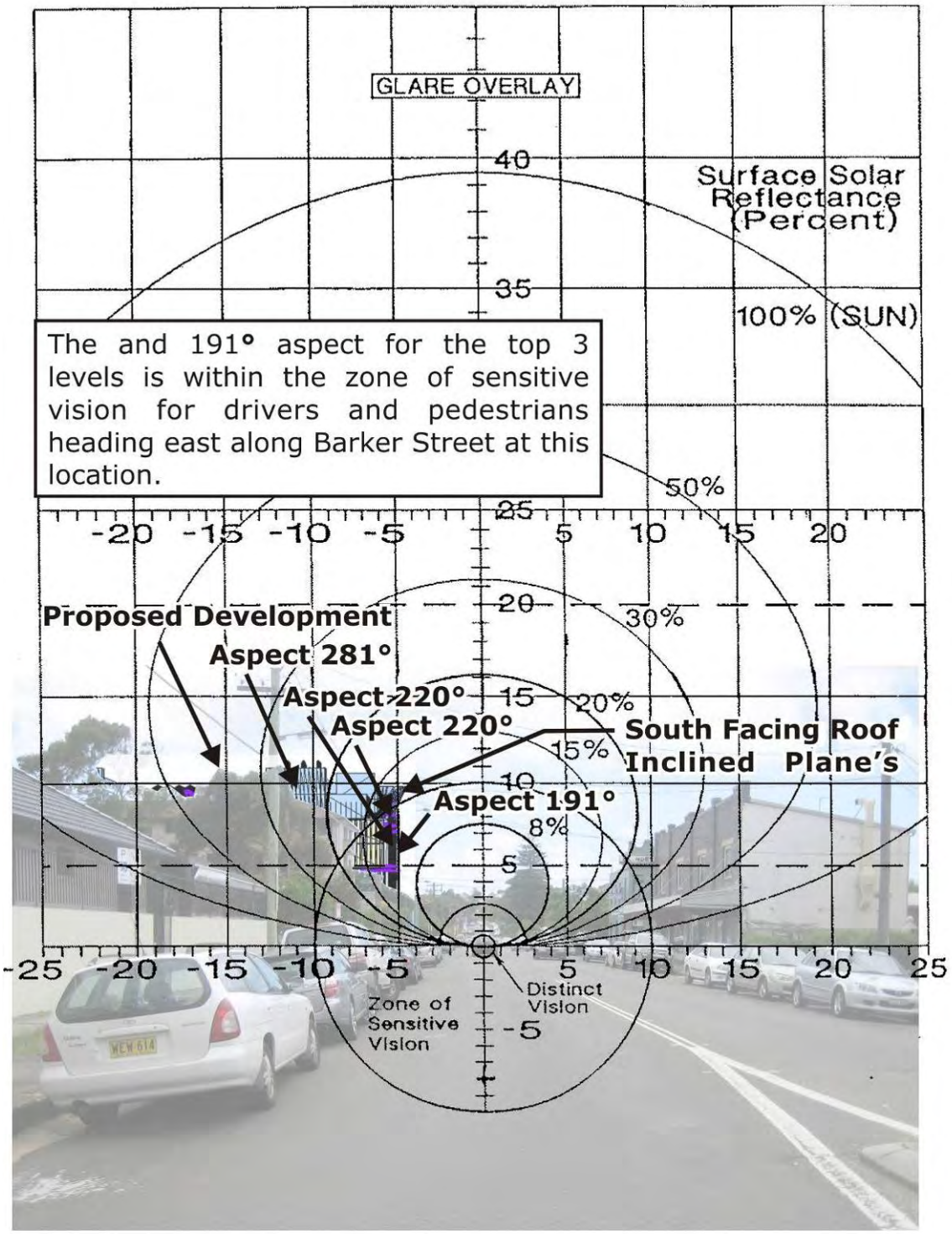

Figure A3: Glare Overlay for Point 3

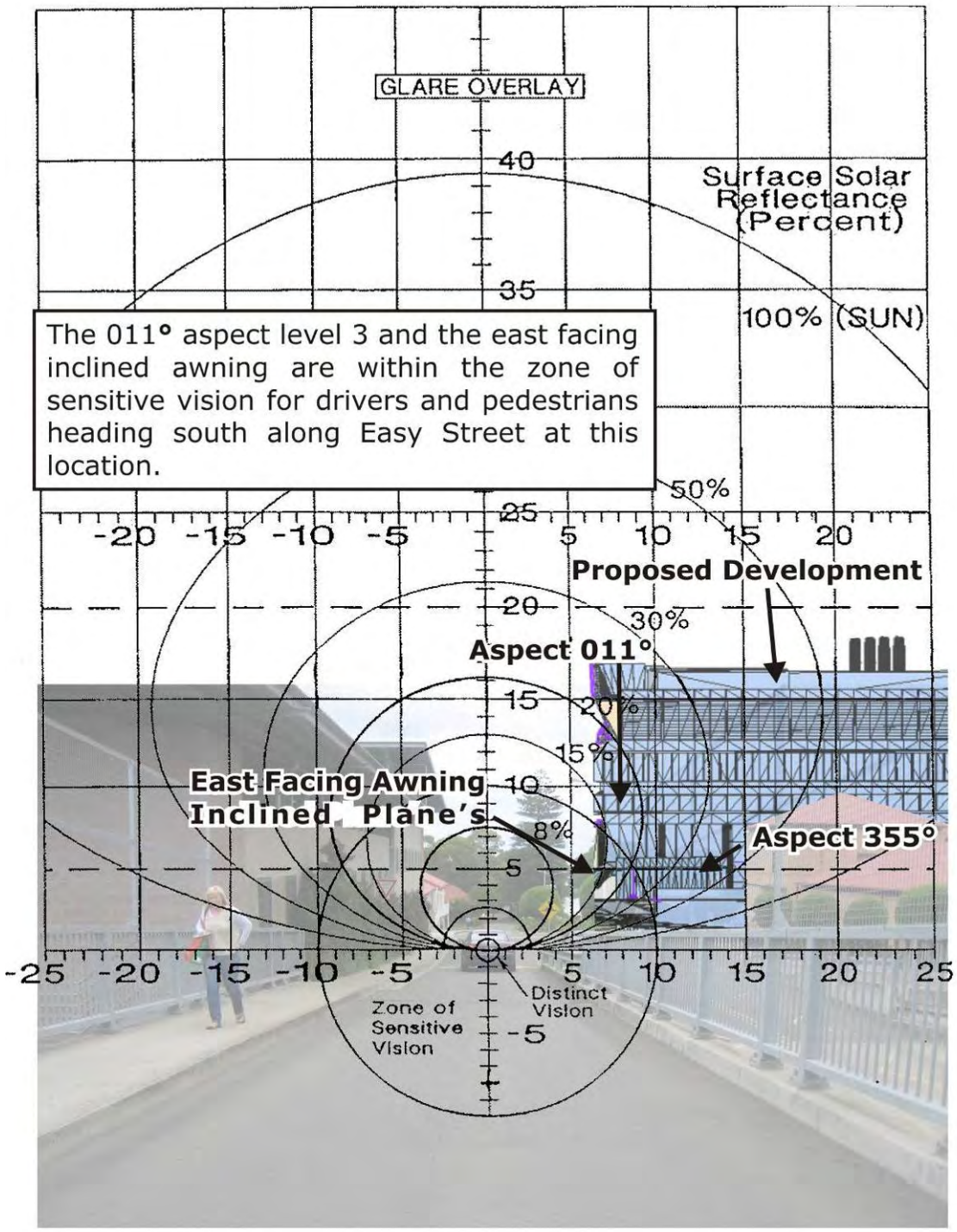

Figure A4: Glare Overlay for Point 4

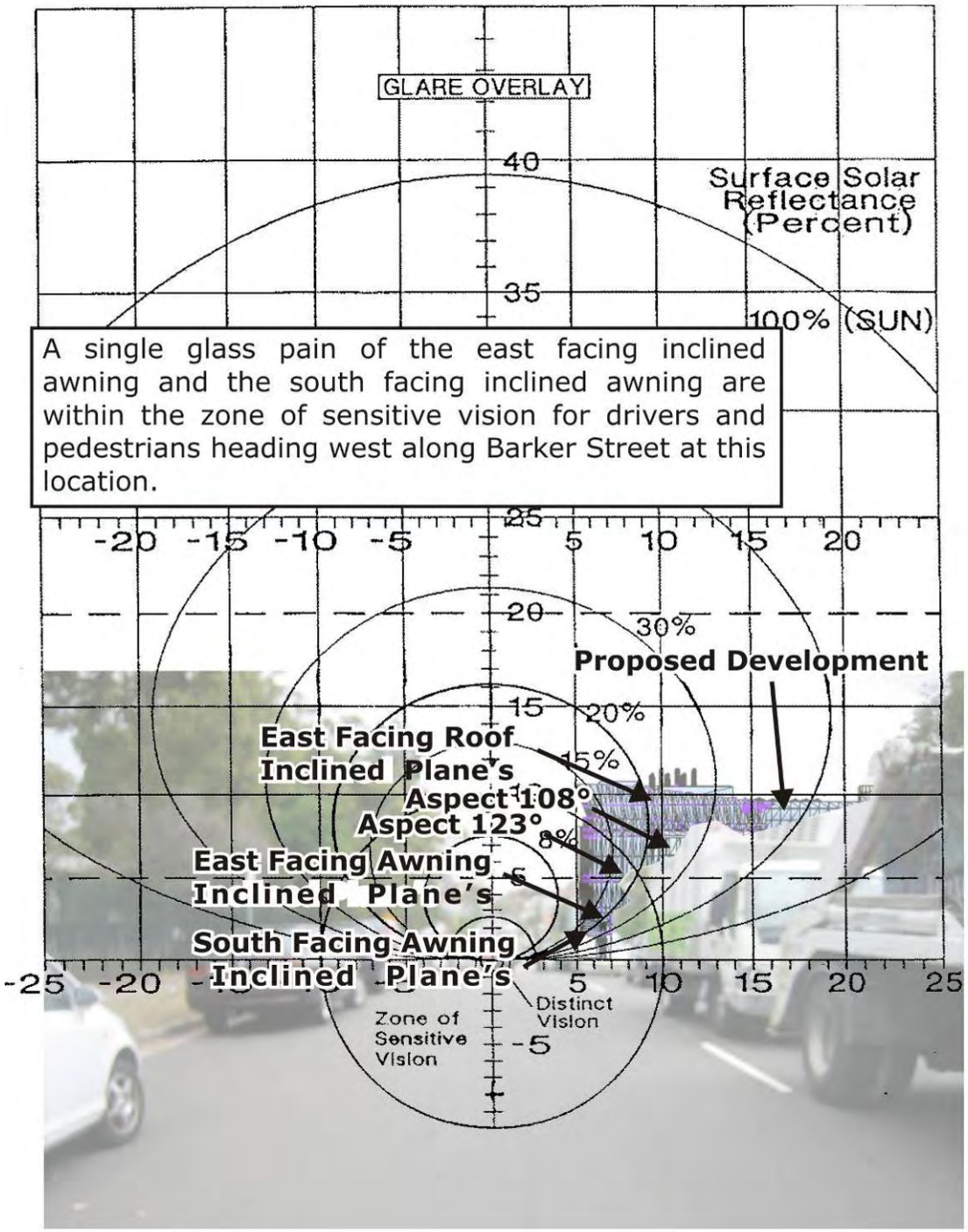

Figure A5: Glare Overlay for Point 5

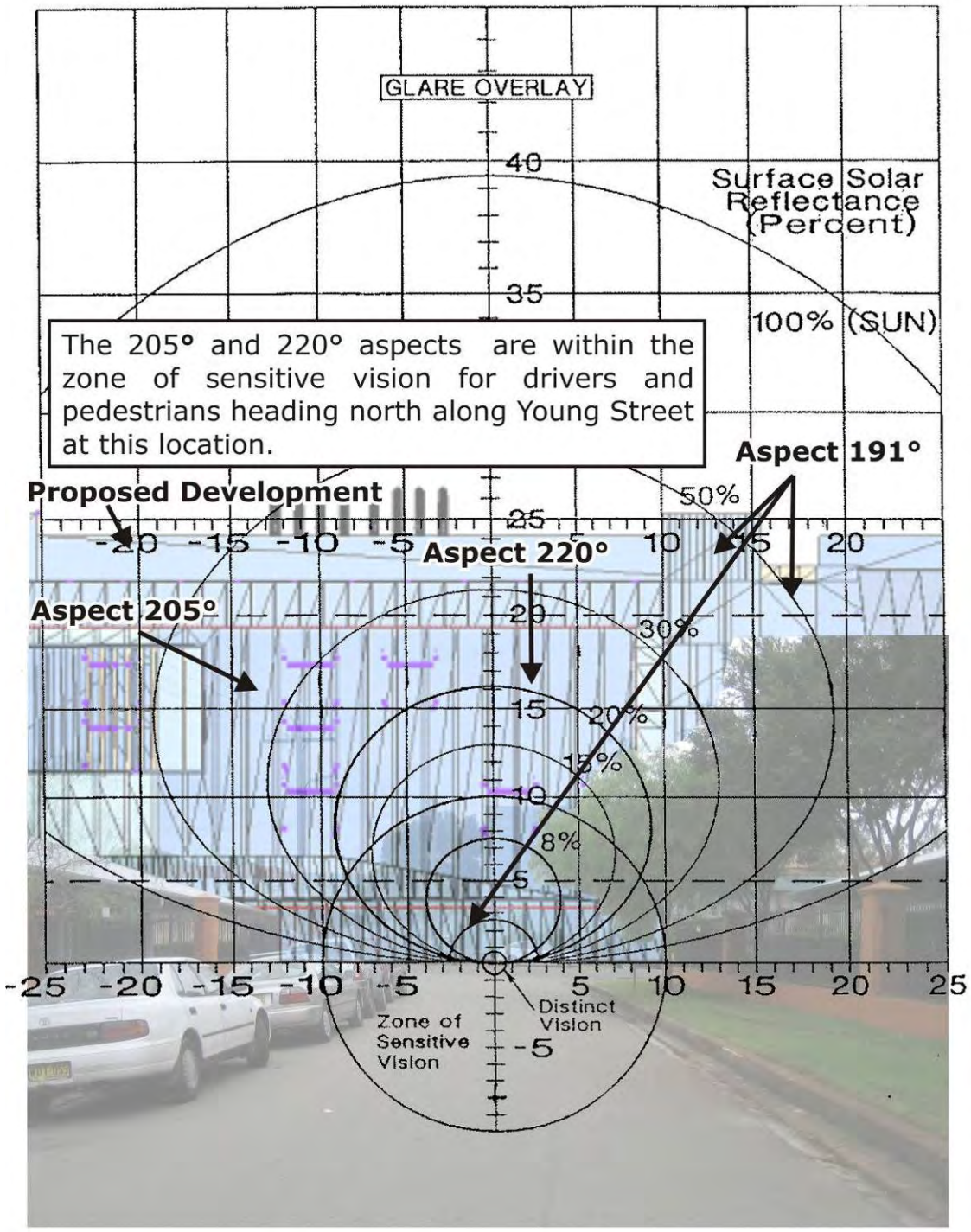

Figure A6: Glare Overlay for Point 6

Appendix B

Solar Charts for the Various Aspects of the Proposal

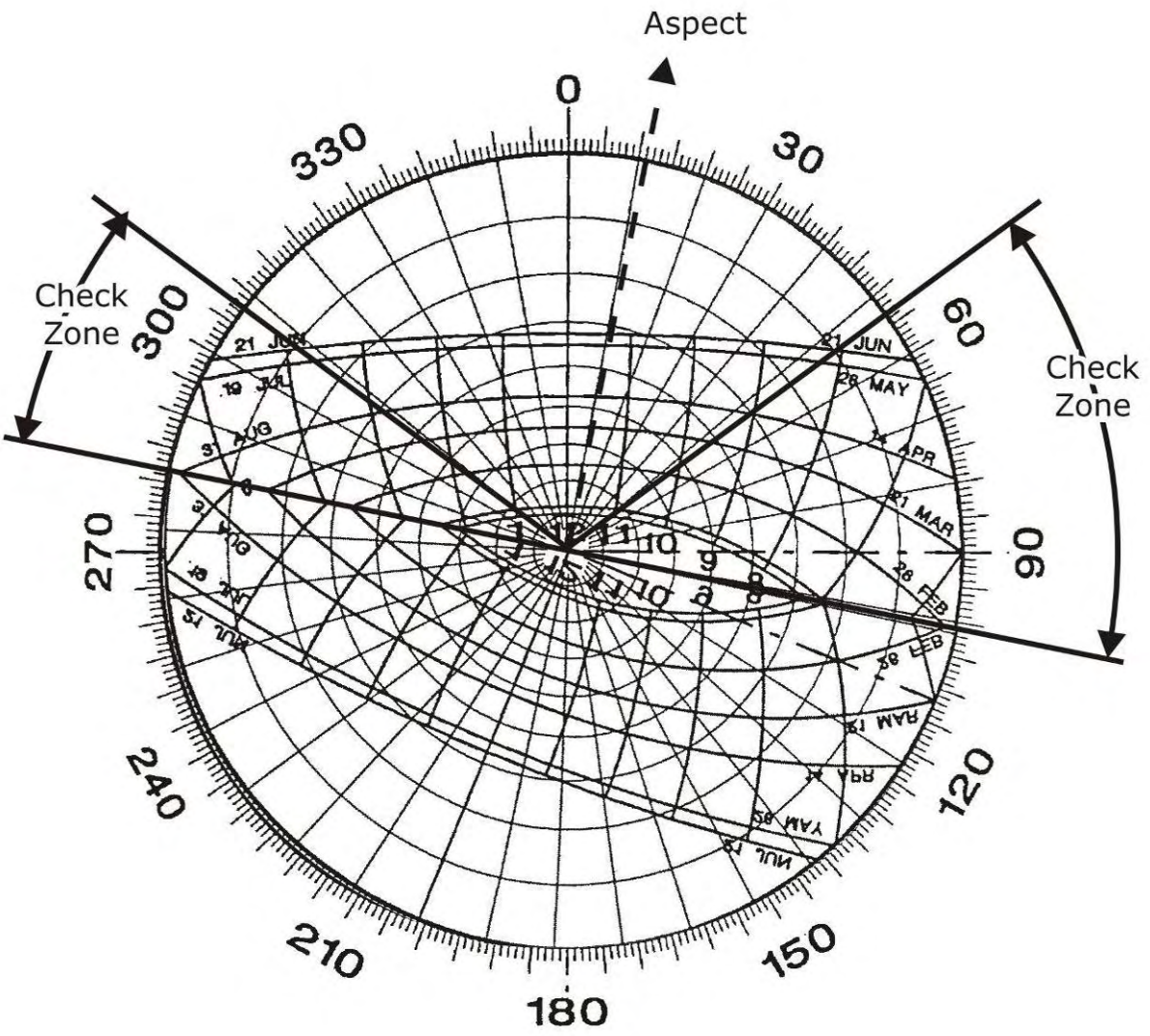

Figure B1: Sun Chart for Aspect 017°

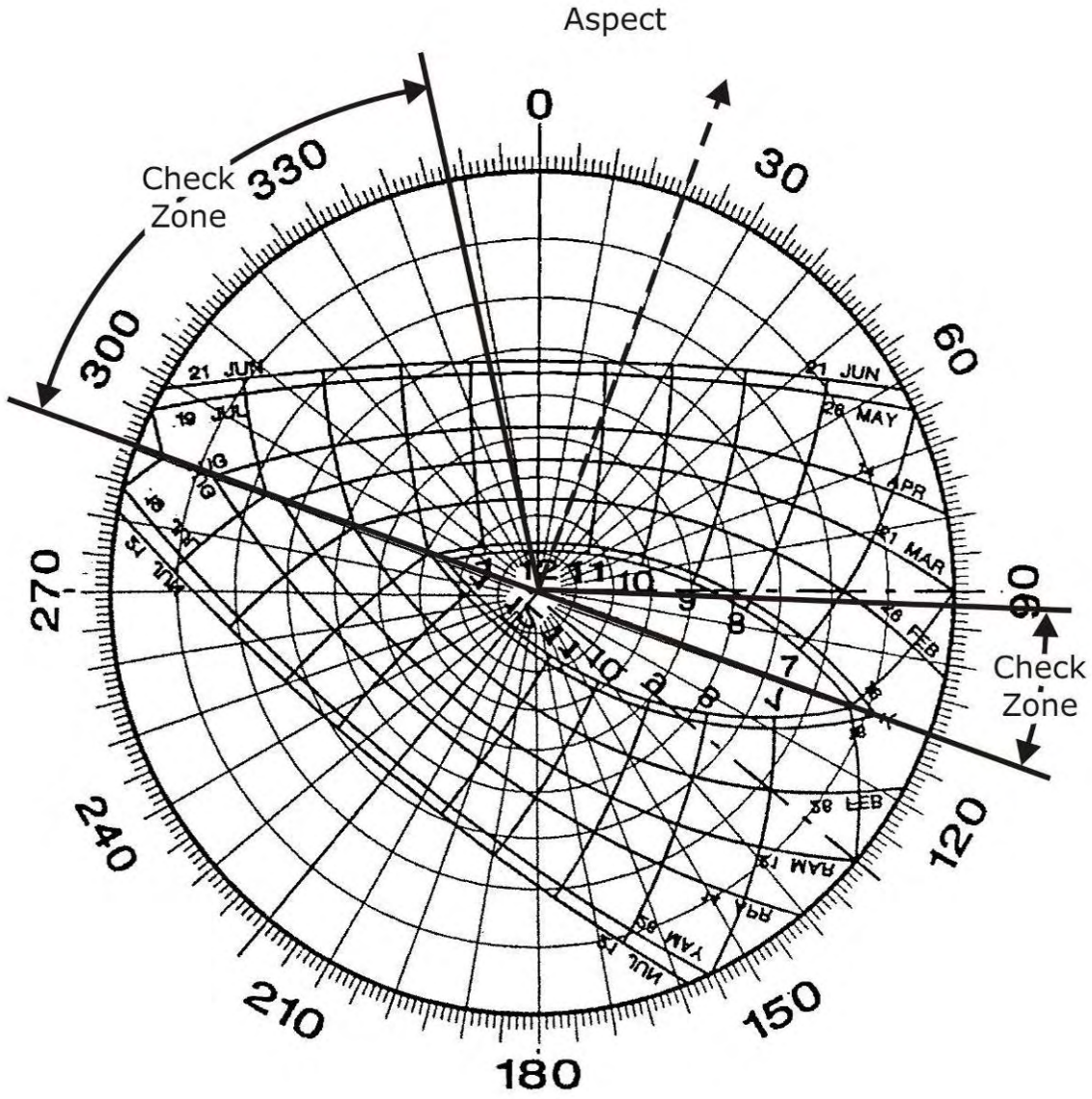

Figure B2: Sun Chart for Aspect 020°

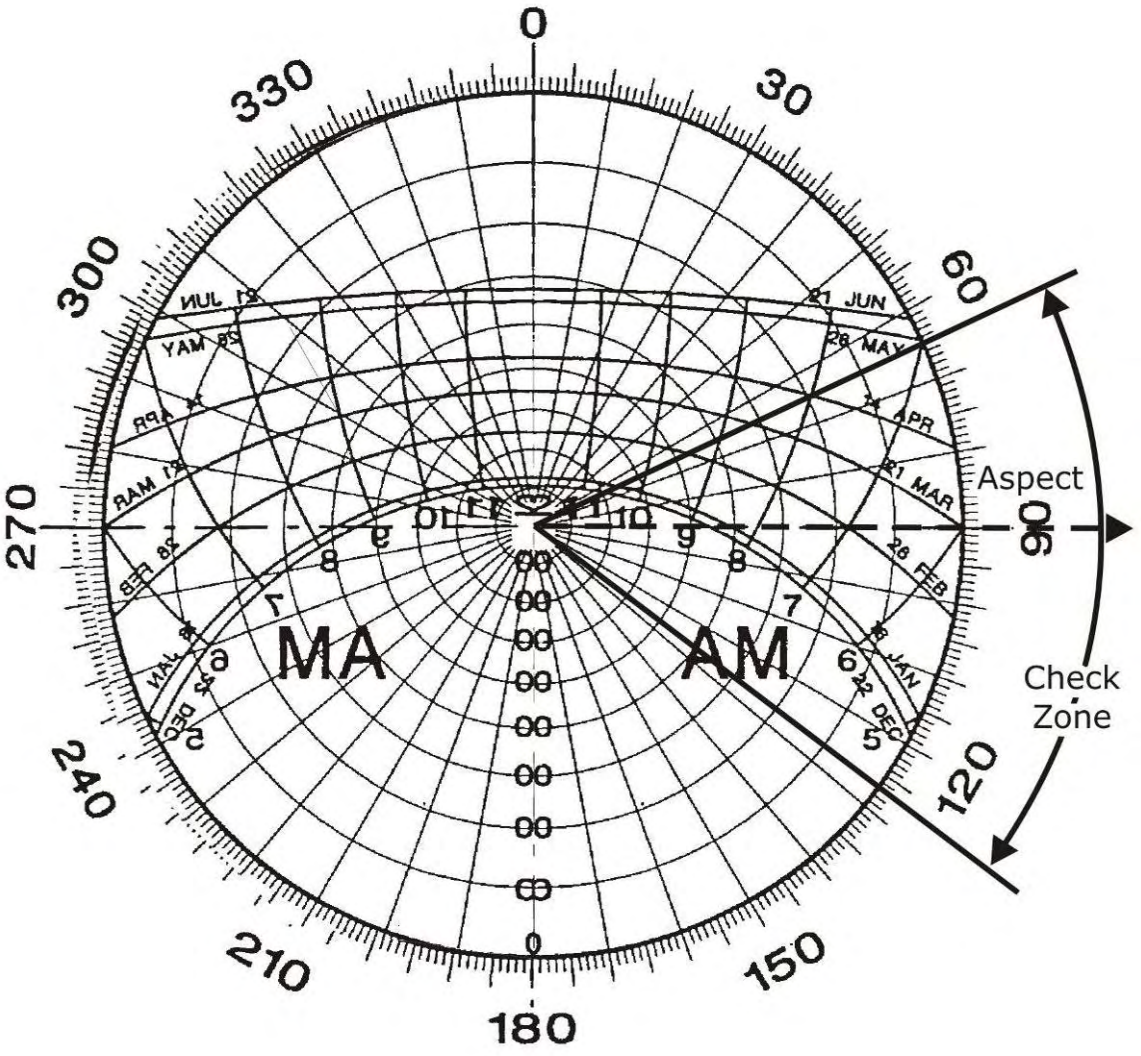

Figure B3: Sun Chart for Aspect 090°

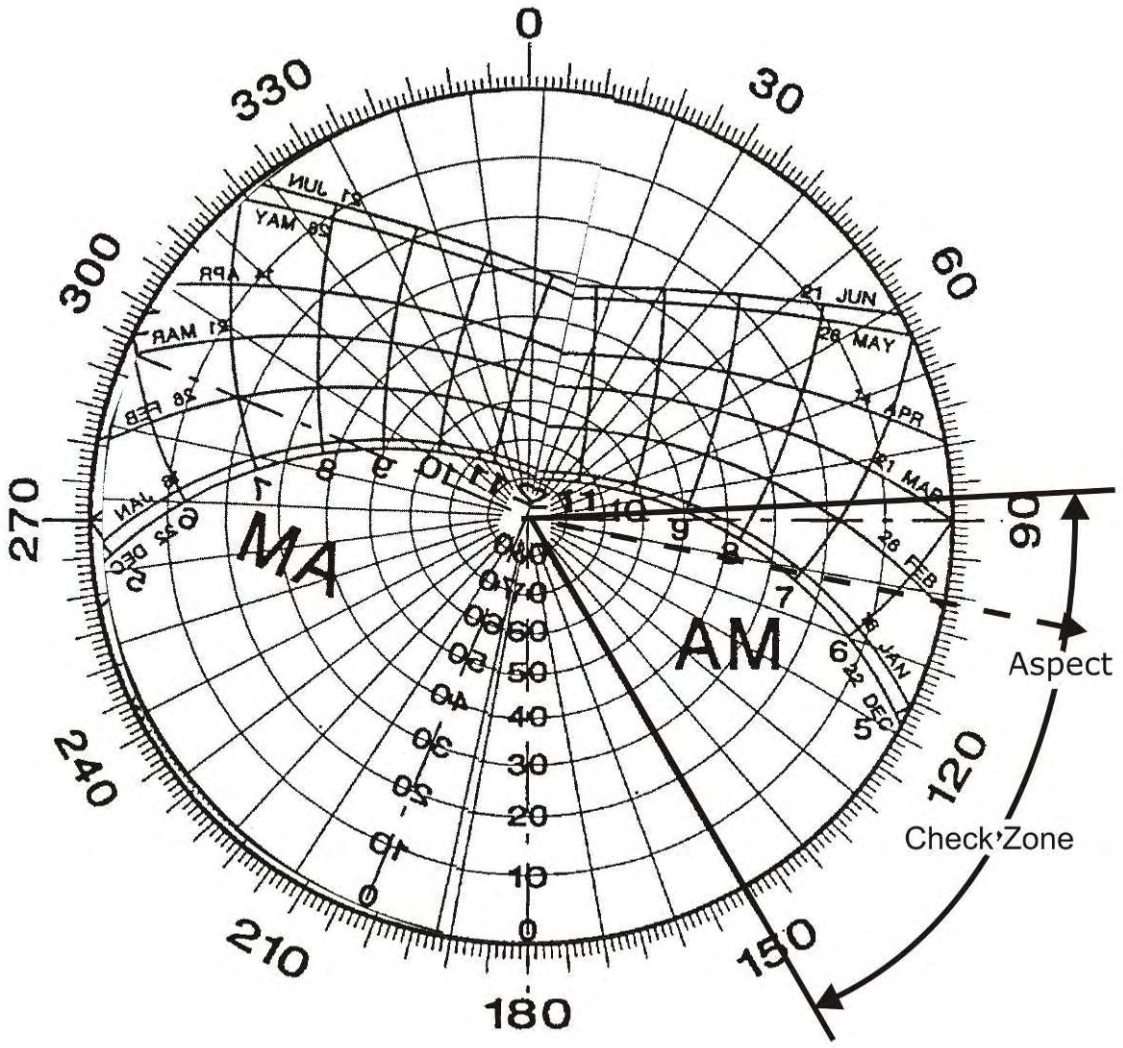

Figure B4: Sun Chart for Aspect 101°

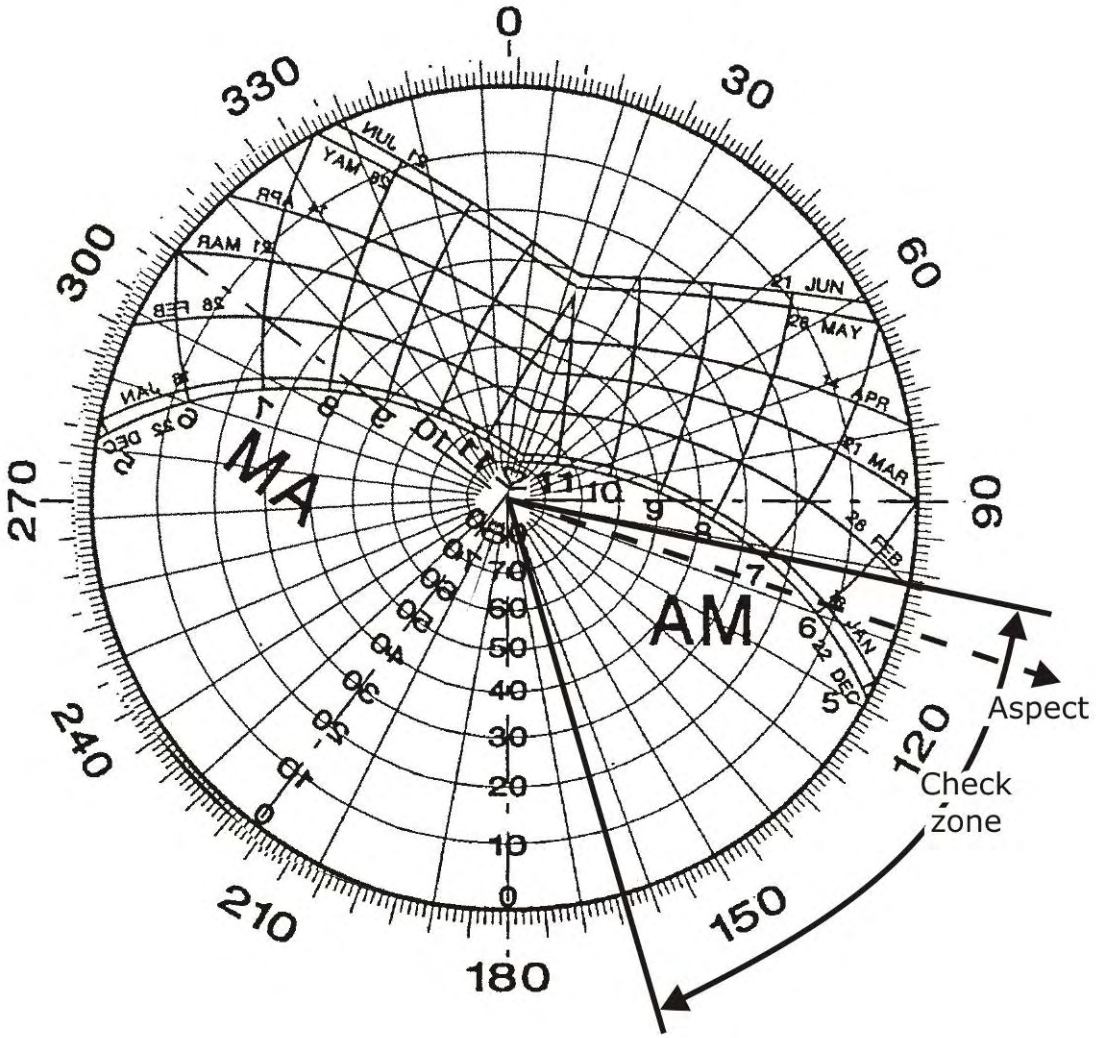

Figure B5: Sun Chart for Aspect 108°

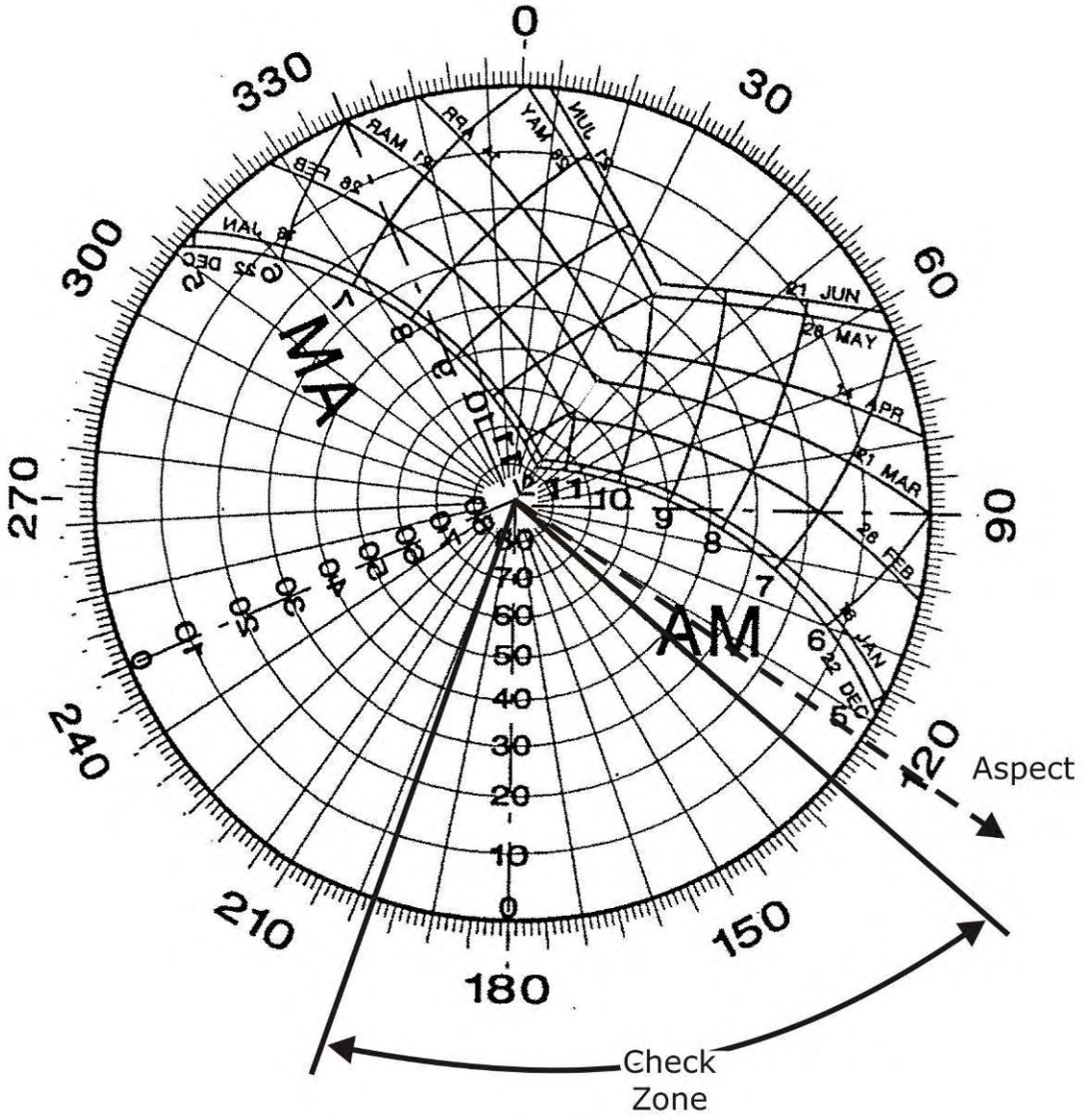

Figure B6: Sun Chart for Aspect 123°

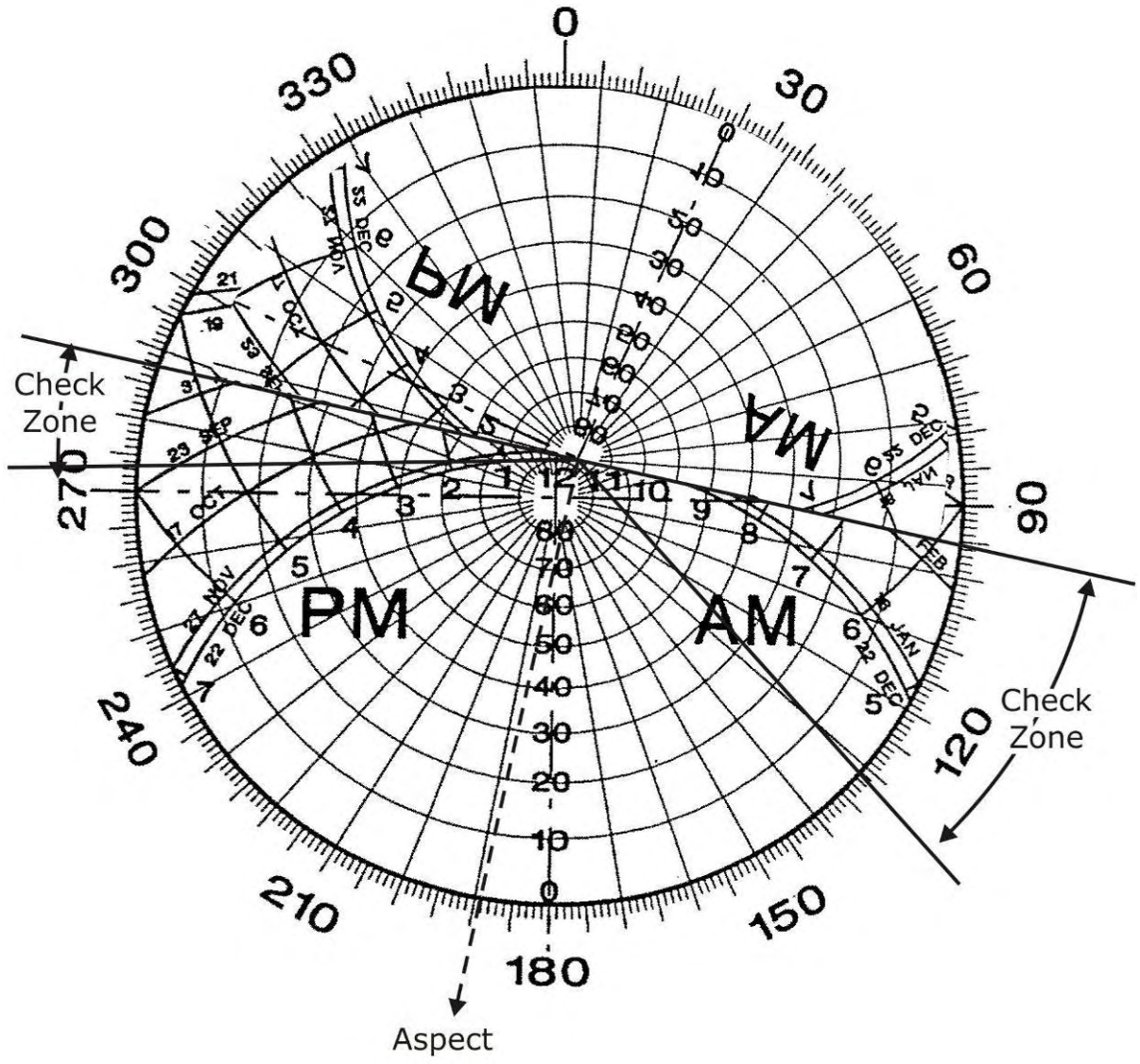

Figure B7: Sun Chart for Aspect 191°

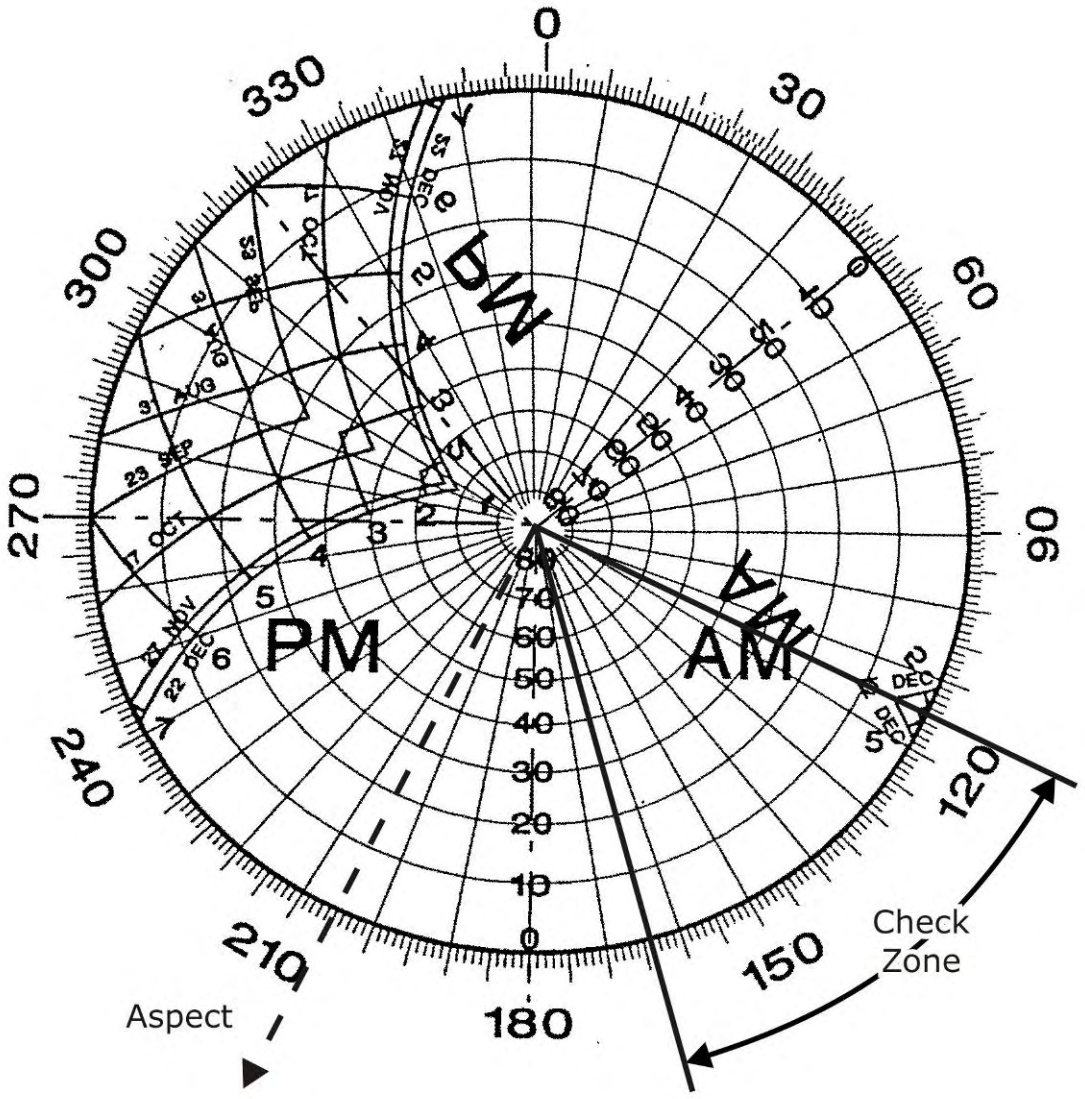

Figure B8: Sun Chart for Aspect 205°

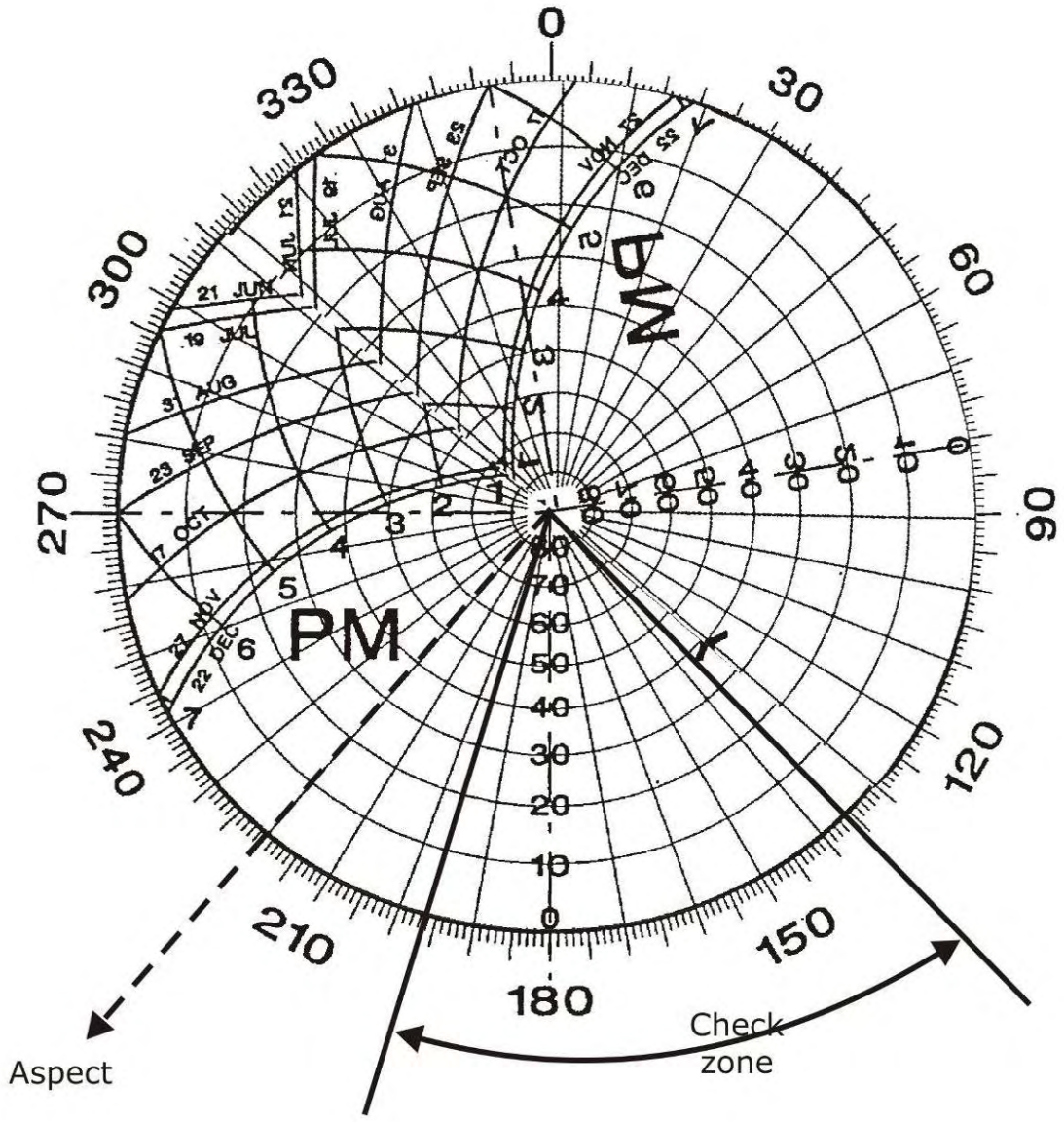

Figure B9: Sun Chart for Aspect 220°

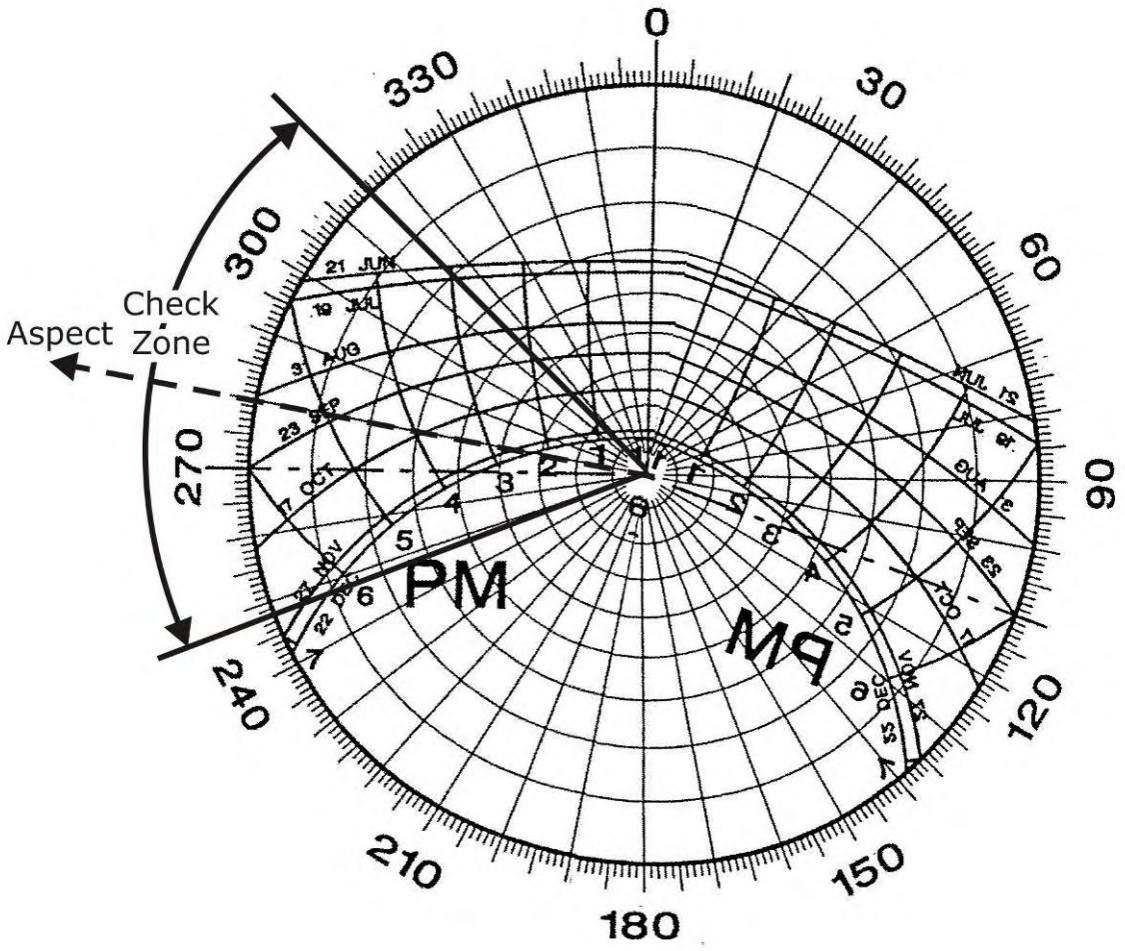

Figure B10: Sun Chart for Aspect 281°

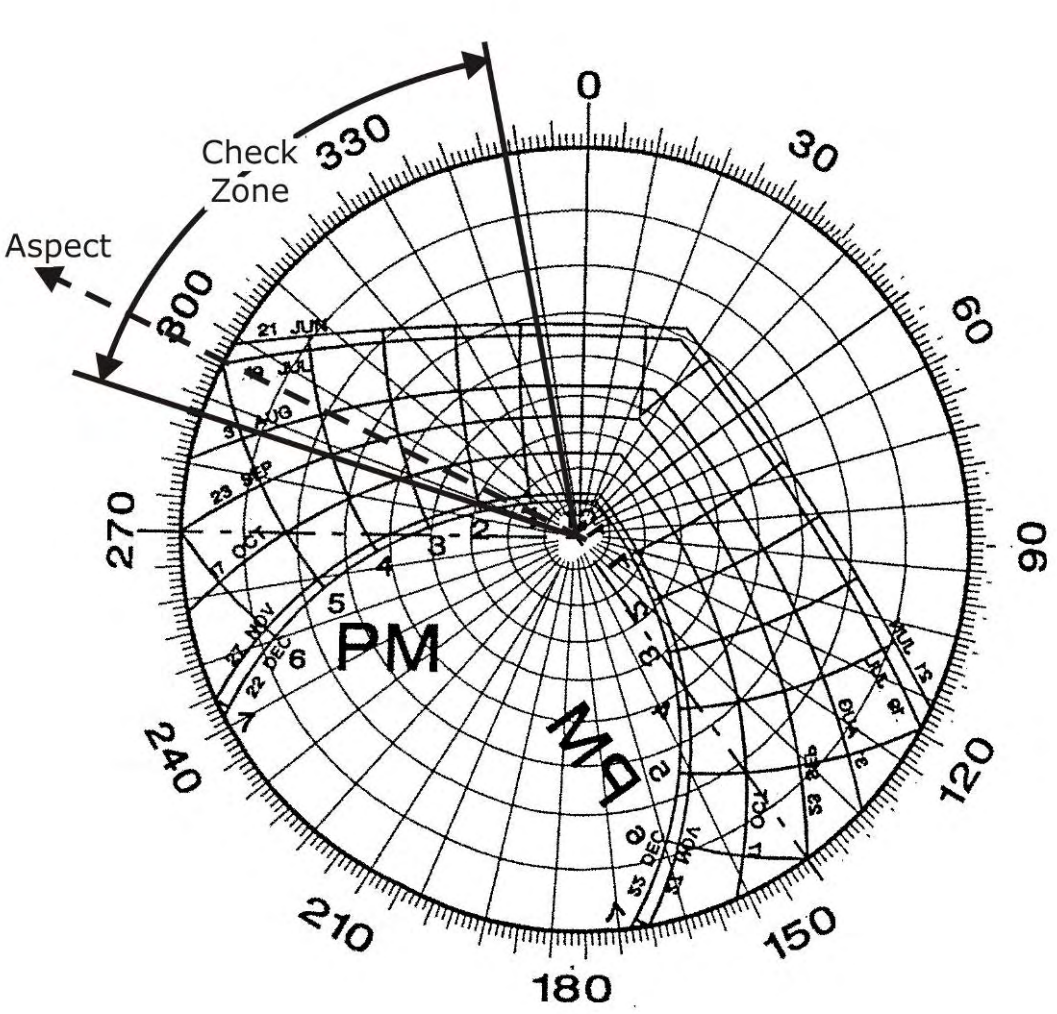

Figure B11: Sun Chart for Aspect 296°

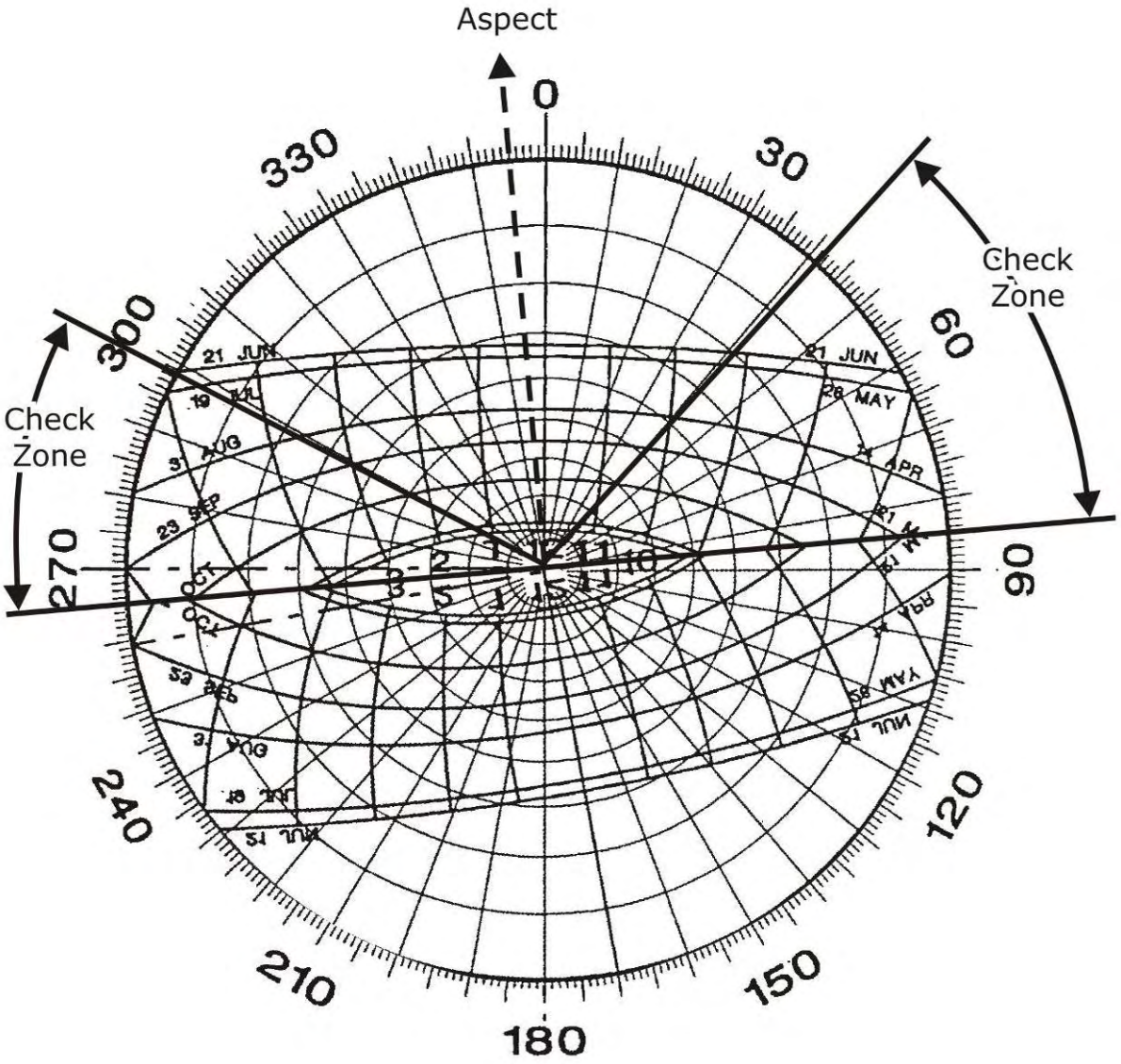

Figure B12: Sun Chart for Aspect 355°

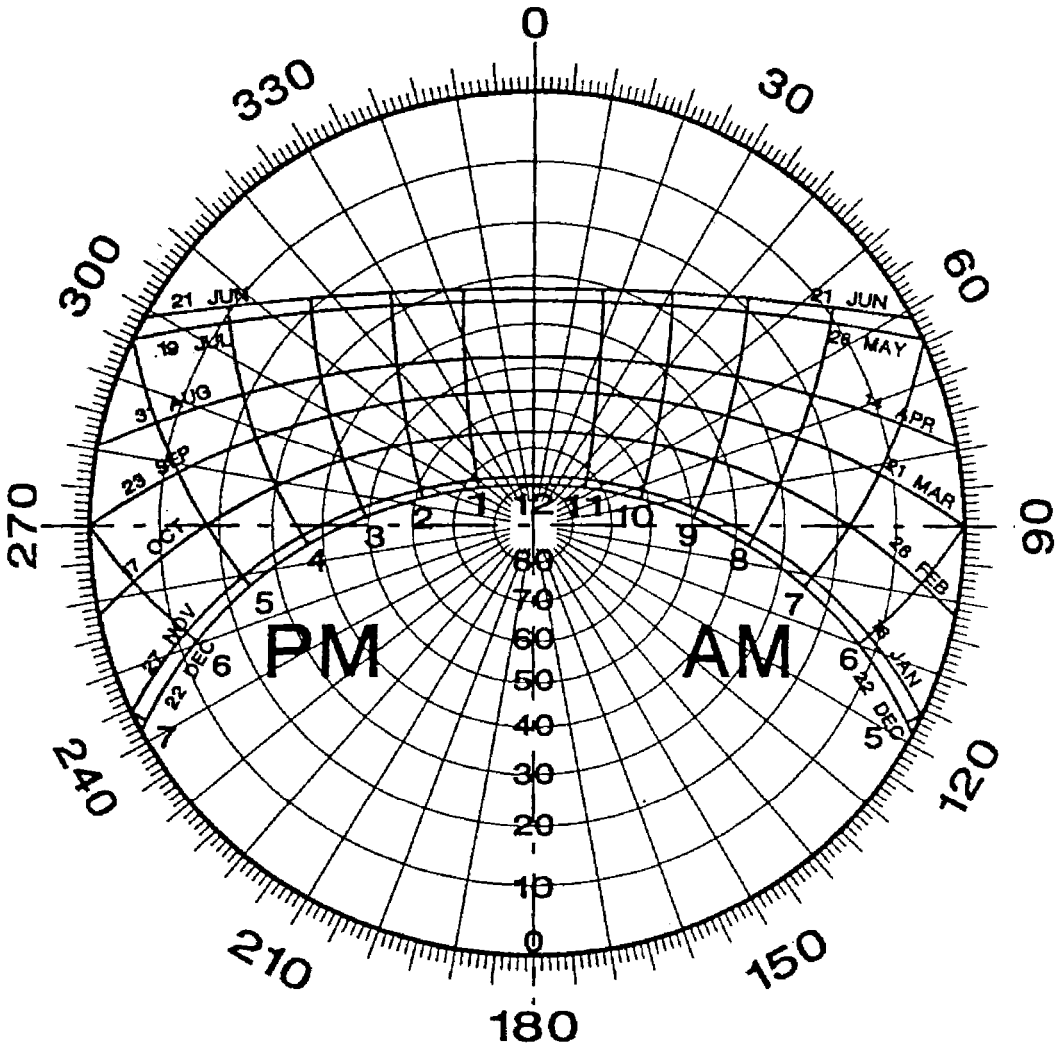

Figure B13: Sun Chart for Sydney