Solar Light Reflectivity Analysis

for the proposed development known as

Macquarie Place, Parramatta

January 28, 2010

Report Reference No. WA714-01F04(rev0)- SR Report

Sydney • Melbourne • Singapore • Dubai www.windtech.com.au
WINDTECH Consultants Pty Ltd: 19 Willis St, Wolli Creek NSW 2205 Australia ABN 72 050 574 037
T: (61.2) 9567 0722 **F:** (61.2) 9567 0733 **E:** reception@windtech.com.au

Document Control

Revision Number	Date	Revision History	Prepared By (initials)	Initial Review By (initials)	Reviewed & Authorised By (initials)
0	28/1/2010	Initial	AL		TR

The work presented in this document was carried out in accordance with the Windtech Consultants Pty Ltd Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for our Client's particular requirements which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Windtech Consultants Pty Ltd. This report should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

The information contained herein is for the purpose of wind, thermal and or solar effects only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the scope of this report.

Table of Contents

1.0 Introduction

This study is to investigate the potential impact of solar glare from the proposed development known as Macquarie Place, Parramatta. The analysis takes into consideration potential reflectivity to street level locations and to the surrounding buildings. The site is bounded by Macquarie Street to the north, Marsden Street to the East, Hunter Street to the South and adjacent buildings to the west. An analysis has been undertaken based on architectural drawings prepared by Bates Smart, received January 11, 2010.

With regards to solar reflectivity, this study addresses the requirement of the Parramatta City Centre DCP 2007, Section 5.3: *Reflectivity*, which states the following;

> *Reflective materials used on the exterior of buildings can result in undesirable glare for pedestrians and potentially hazardous glare for motorists. Reflective materials can also impose additional heat load on other buildings. The excessive use of highly reflective glass should be discouraged. Buildings with a glazed roof, facade or awning should be designed to minimise hazardous or uncomfortable glare arising from reflected sunlight.*
>
> *Objective:*
>
> > *To restrict the reflection of sunlight from buildings to surrounding areas and buildings.*
>
> *Control:*
>
> > *a) New buildings and facades should not result in glare that causes discomfort or threatens safety of pedestrians or drivers*
> >
> > *b) Visible light reflectivity from building materials used on the façades of new buildings should not exceed 20%*

A 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 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

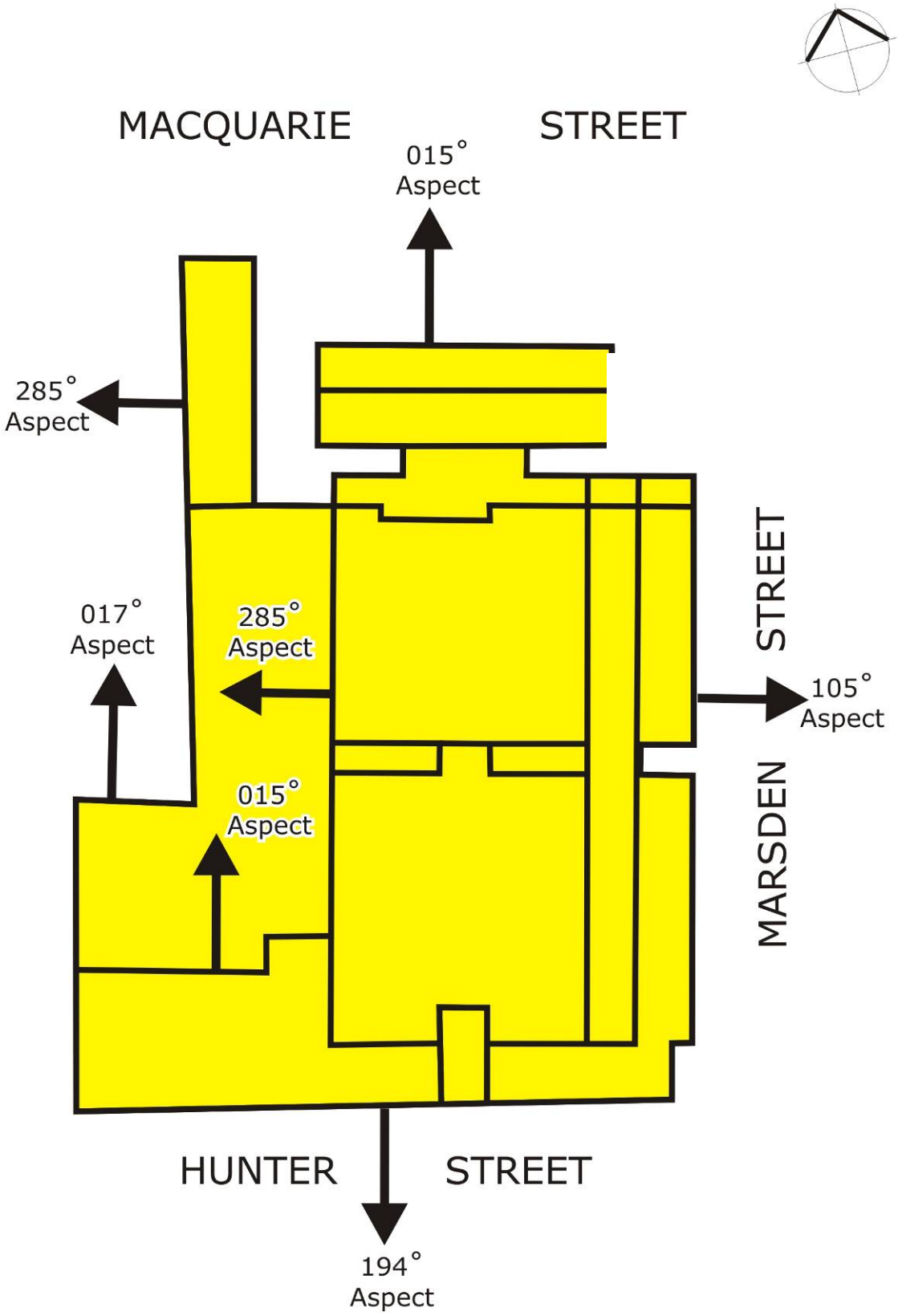

Figure 2: The Critical Aspects of the Development

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, 7 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	015˚&017˚ and 105˚ aspects
Point 2	015˚&017˚ aspect
Point 3	015˚&017˚ aspect
Point 4	015˚&017˚ and 285˚ aspects
Point 5	194˚ and 285˚ aspects
Point 6	194˚ aspect
Point 7	005˚ and 194˚ aspects

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.

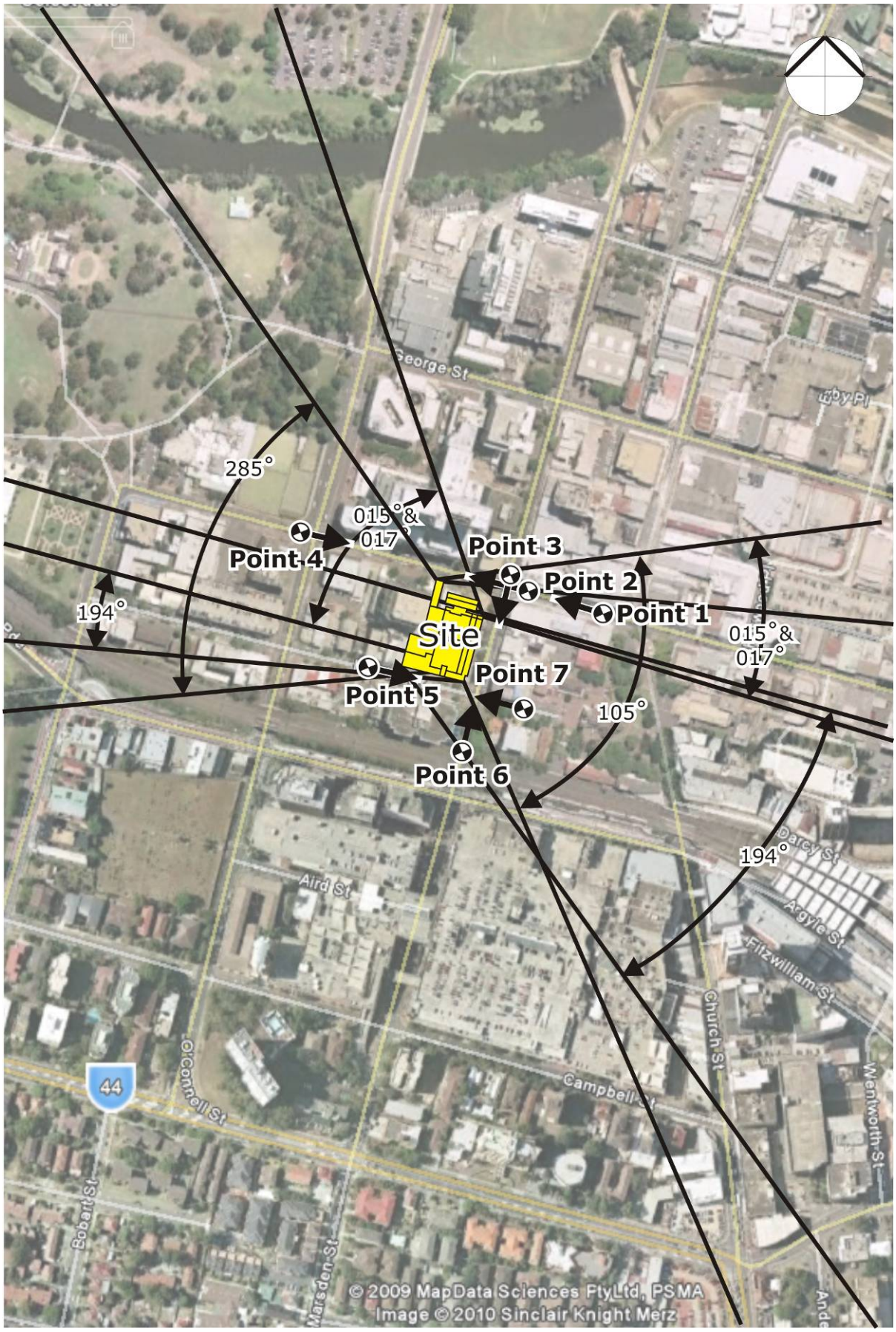

Figure 3: Check Zones and Layout of Study Points

Point 1

Point 1 is located north-east of the proposed development on Macquarie Street. This point represents a critical sightline of drivers heading west along Macquarie Street. This point is located within the check zones for the 015˚&017˚ and 105˚ aspects of the proposed development.

The analysis of Point 1, shown in Figure A1 of Appendix A, indicates that the proposed development is obscured by the existing surrounding buildings to the east of the proposed development.

Hence there will be no adverse glare from the 015˚&017˚ and 105˚ aspects of the proposed development to drivers and pedestrians facing west along Macquarie Street at Point 1.

Points 2

Point 2 is located north-east of the proposed development on Macquarie Street. This point represents a critical sightline of drivers heading west along Macquarie Street. This point is located within the check zones for the 015˚&017˚ aspect of the proposed development.

The analysis of Point 2, shown in Figure A2 of Appendix A, indicates that the 015˚ aspect of the north-east most café/retail area of the proposed development up to an including level 1 falls within the zone of sensitive vision for drivers and pedestrians heading west at this location. It is therefore recommended that one of the two measures be implemented for this section of glazing:

- the reflectivity of glass in this location be minimised, and not exceed a normal spectral reflectivity of light value of 15%; OR
- Install vertical mullions external to the glass-line that can block solar reflections up to 8degrees from the centre of the glass. For example for a glass panel of 1000mm width, the mullions will need to have a external depth of at least 70mm.

With the inclusion of the above-mentioned recommendations, there will be no adverse glare from the 015˚&017˚ aspects of the proposed development to drivers and pedestrians facing west along Macquarie Street at Point 2.

Points 3

Point 3 is located north-east of the proposed development on Marsden Street. This point represents a critical sightline of drivers heading south along Marsden Street. This point is located within the check zones for the 015˚&017˚ aspect of the proposed development.

The analysis of Point 3, shown in Figure A3 of Appendix A, indicates that no part of the proposed development falls within the zone of sensitive vision for drivers and pedestrians heading south at this location.

Hence there will be no adverse glare from the 015˚&017˚ aspect of the proposed development to drivers and pedestrians facing south along Marsden Street at Point 3.

Point 4

Point 4 is located north-west of the proposed development on Macquarie Street. This point represents a critical sightline of drivers heading east along Macquarie Street. This point is located within the check zones for the 015˚&017˚ and 285˚ aspects of the proposed development.

The analysis of Point 4, shown in Figure A4 of Appendix A, indicates that the 015˚ aspect of the proposed development up to an including level 4 falls within the zone of sensitive vision for drivers and pedestrians heading east at this location. It is noted that the glass balustrades are the only reflective elements along the edge of this aspect. Our calculation of the angle subtended by each balustrade panel indicates that only 71% of the sun can reflect from these balustrades. Hence even if the glass had the maximum permissible reflectivity of 20%, this is effectively equivalent to 14%. An inspection of the glare overlay shows that the reflectivity of glass in the abovementioned location will not care glare discomfort provided that it does not exceed a normal spectral reflectivity of light value of 14%.

Hence there will be no adverse glare from the 015˚&017˚ aspects of the proposed development to drivers and pedestrians facing east along Macquarie Street at Point 2.

Point 5

Point 5 is located south-west of the proposed development on Hunter Street. This point represents a critical sightline of drivers heading east along Hunter Street. This point is located within the check zones for the 194˚, and 285˚ aspects of the proposed development.

The analysis of Point 5, shown in Figure A5 of Appendix A, indicates that the 194˚ aspect of the proposed development up to an including level 6 falls within the zone of sensitive vision for drivers and pedestrians heading east at this location. For the sun to reflect from the 194˚ aspect to this location, and be within the zone of sensitive vision, it will need to reflect at an angle of less than 8-degrees to the glass alignment. On close inspection is was confirmed that the sun cannot reflect from a glass surface on this aspect within a range of 8-degres from the glass alignment due to the various recesses and blade walls proposed.

Hence there will be no adverse glare from the 194˚ and 285˚ aspects of the proposed development to drivers and pedestrians facing east along Hunter Street at Point 5.

Points 6

Point 6 is located south-east of the proposed development on Marsden Street. This point represents a critical sightline of drivers heading north along Marsden Street. This point is located within the check zones for the 194˚ aspect of the proposed development.

The analysis of Point 6, shown in Figure A6 of Appendix A, indicates that the proposed development is obscured by the existing densely foliating trees lining the east side of Marsden Street south of the proposed development.

Hence there will be no adverse glare from the 194˚ aspect of the proposed development to drivers and pedestrians facing north along Marsden Street at Point 6.

Point 7

Point 7 is located south-east of the proposed development on Hunter Street. This point represents a critical sightline of drivers heading west along Hunter Street. This point is located within the check zones for the 005˚ and 194˚ aspects of the proposed development.

The analysis of Point 7, shown in Figure A2 of Appendix A, indicates that the 194˚ aspect of the proposed development up to an including level 4 falls within the zone of sensitive vision for drivers and pedestrians heading west at this location. For the sun to reflect from the 194˚ aspect to this location, and be within the zone of sensitive vision, it will need to reflect at an angle of less than 8-degrees to the glass alignment. On close inspection is was confirmed that the sun cannot reflect from a glass surface on this aspect within a range of 8-degres from the glass alignment due to the various recesses and blade walls proposed.

Hence there will be no adverse glare from the 194˚ and 285˚ aspects of the proposed development to drivers and pedestrians facing east along Hunter Street at Point 7.

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

---

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

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.

3.0 Conclusion

A reflectivity analysis of the proposed development known as Macquarie Place, Parramatta 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 the requirements of the Parramatta City Centre DCP 2007, Section 5.3: *Reflectivity* the following recommendation has been made on the reflectivity properties of the glazing to be used on the facade to satisfy minimum comfort levels for the occupants of the neighbouring buildings;

- The reflectivity of glass on the façade for the 015˚ aspect of the proposed development up to an including level 4, including 015˚ aspect of the north-east most café/retail area should not exceed a normal spectral reflectivity of light value of 15%; OR
- Install vertical mullions external to the glass-line of the 015˚ aspect that can block solar reflections up to 8degrees from the centre of the glass. For example for a glass panel of 1000mm width, the mullions will need to have a external depth of at least 70mm.
- All other areas of the façade of the proposed development should have a maximum normal specular reflectivity of visible light of 20 percent.

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, other outdoor areas and the surrounding buildings.

Appendix A

Analysis of Sight-Lines from the Various Study Locations

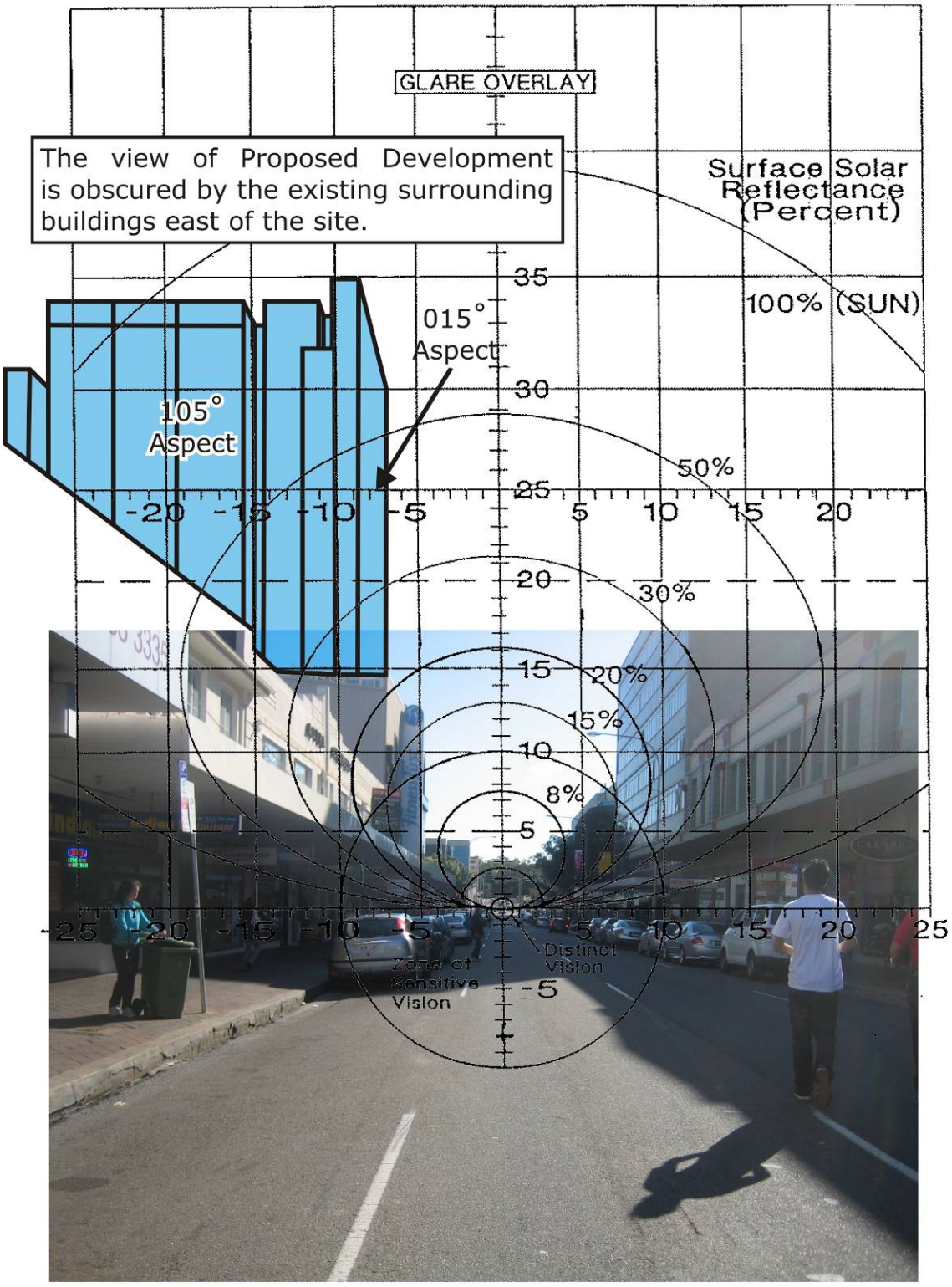

Figure A1: Glare Overlay for Point 1

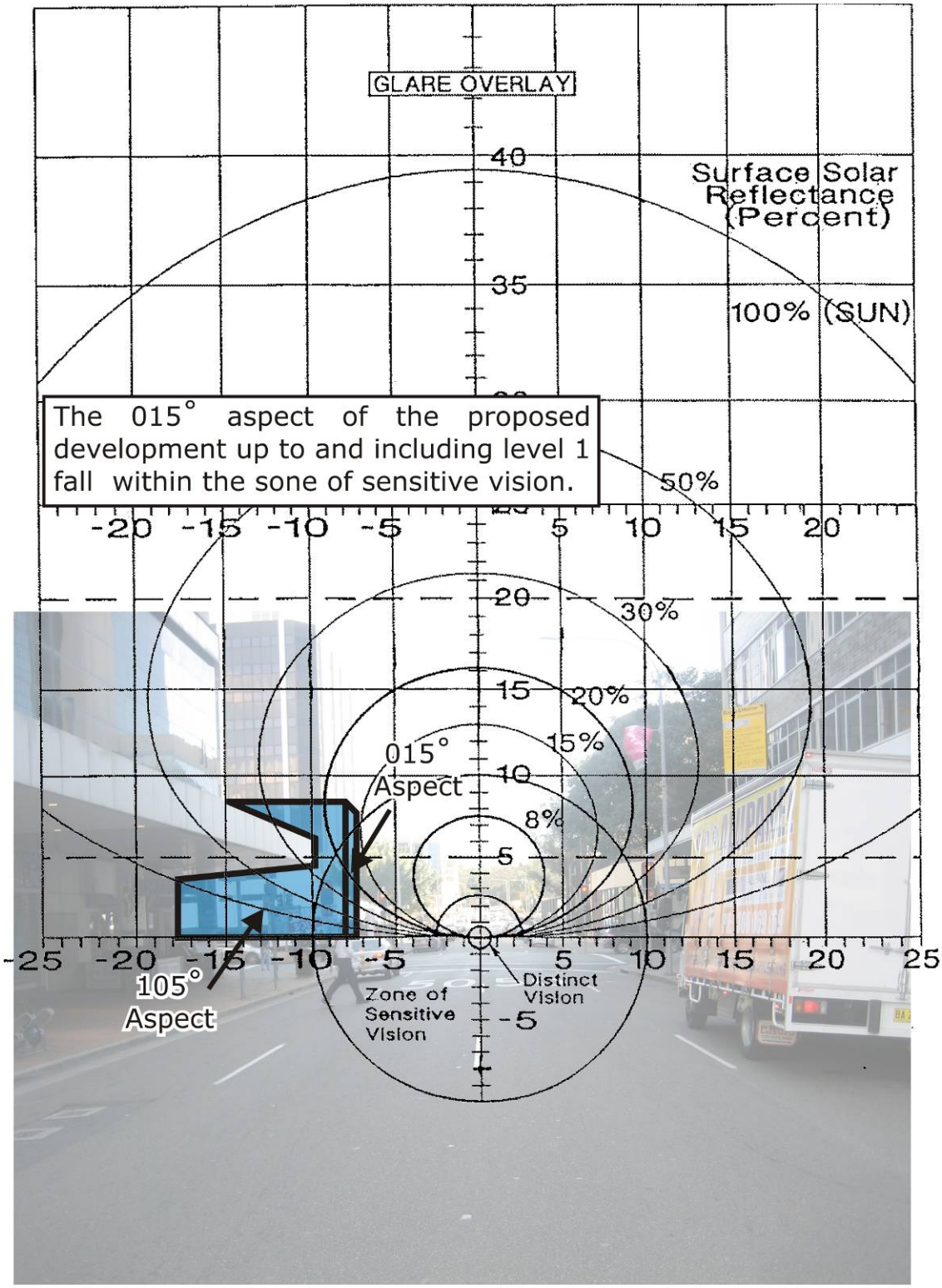

Figure A2: Glare Overlay for Point 2

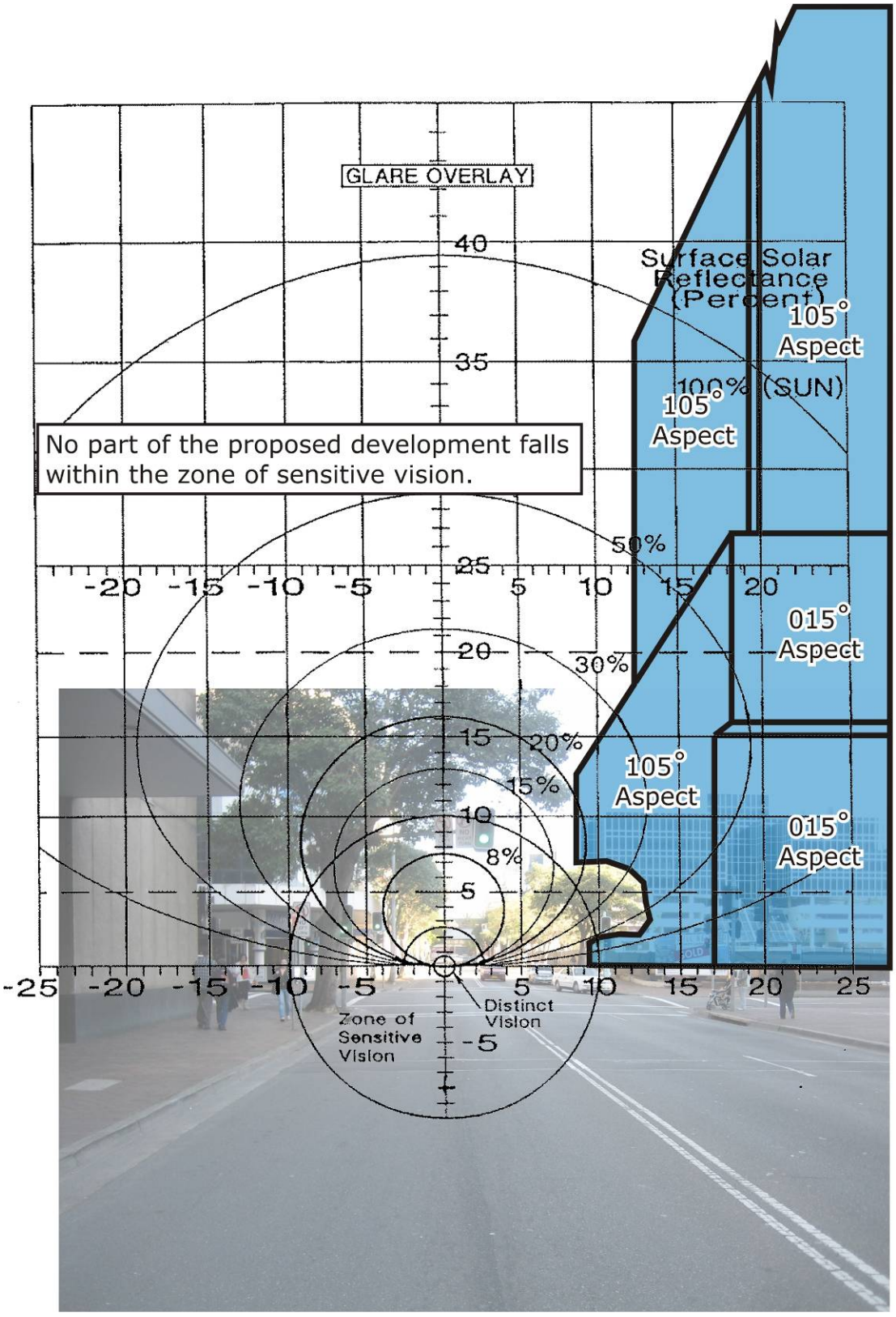

Figure A3: Glare Overlay for Point 3

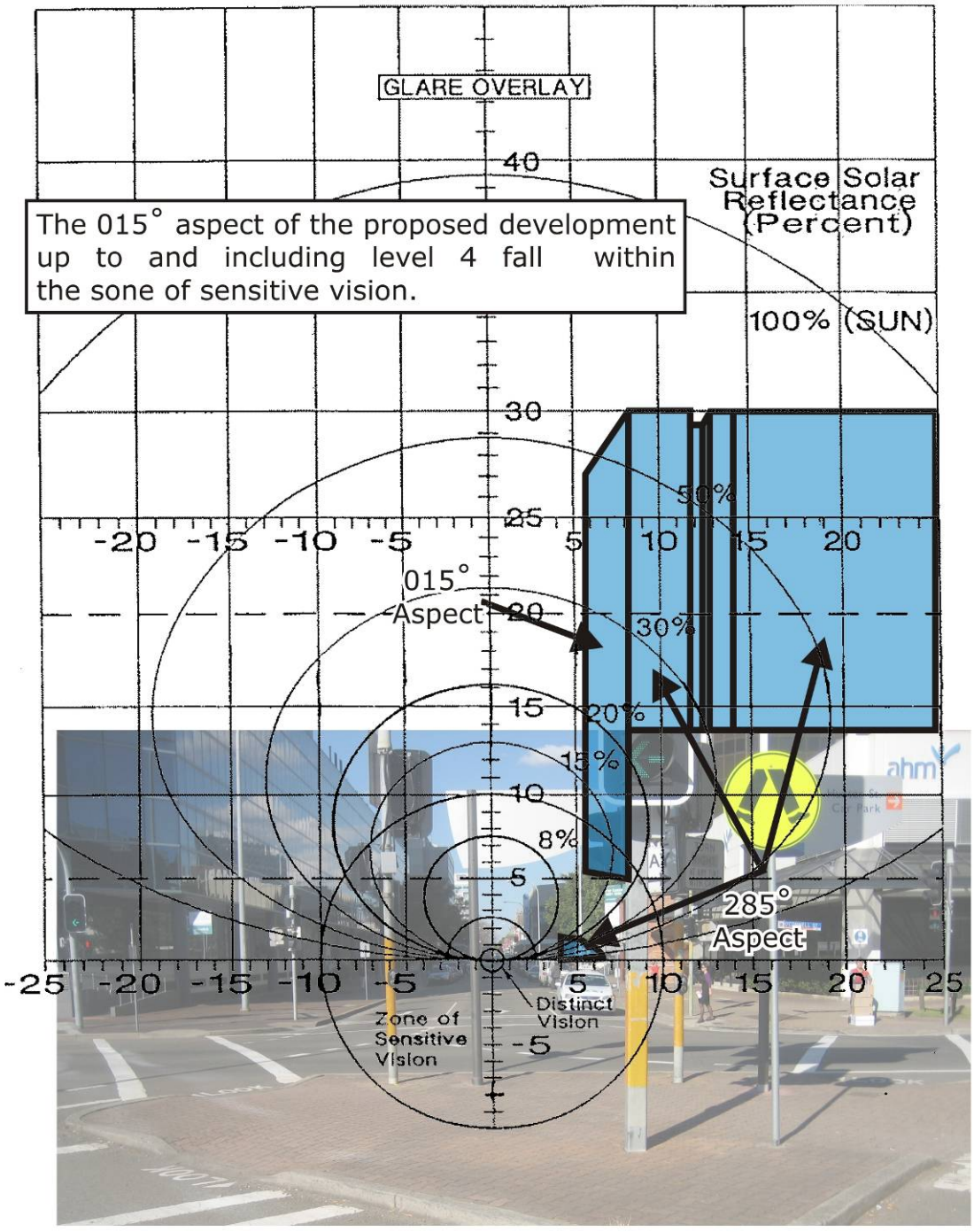

Figure A4: Glare Overlay for Point 4

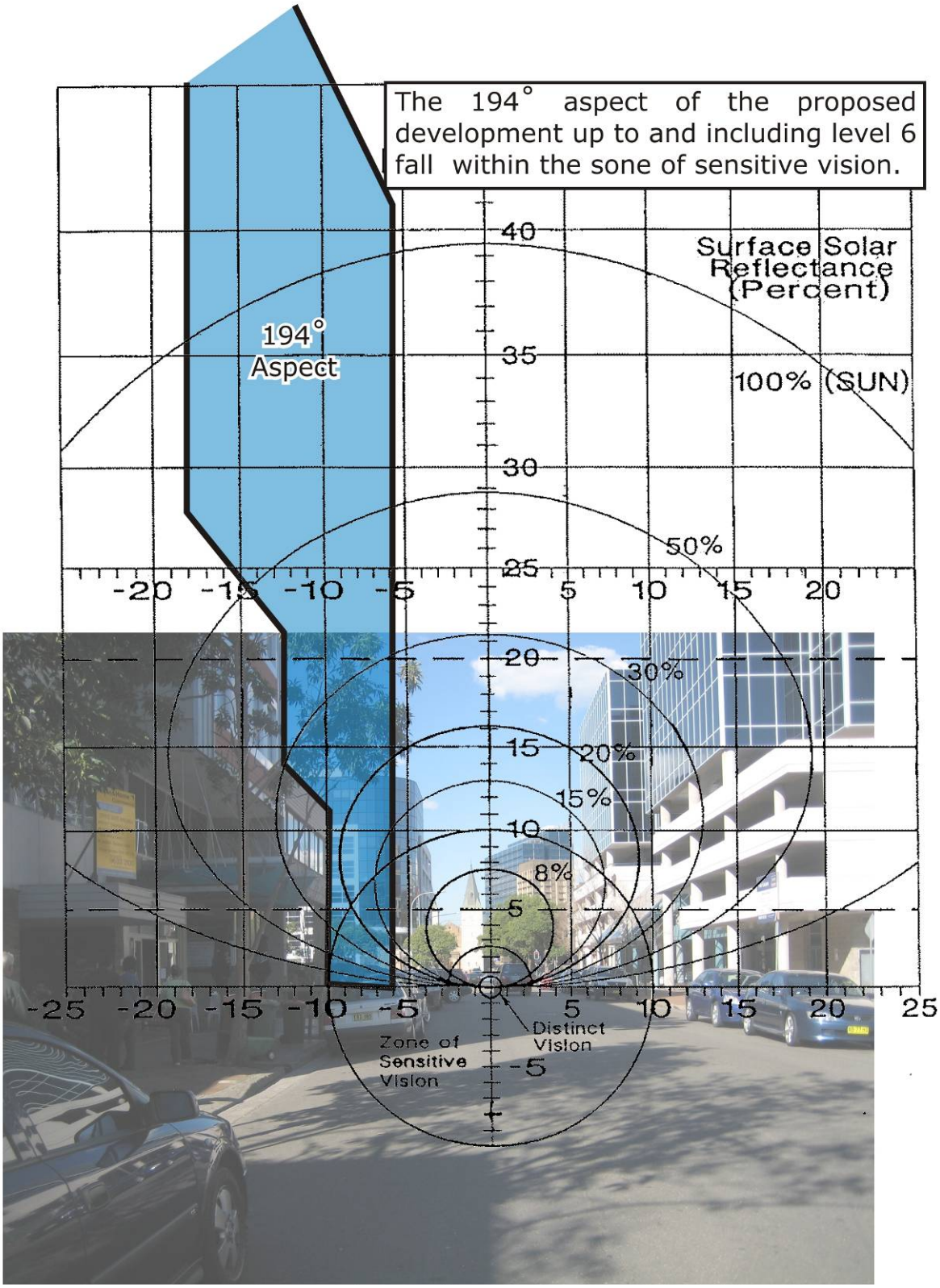

Figure A5: Glare Overlay for Point 5

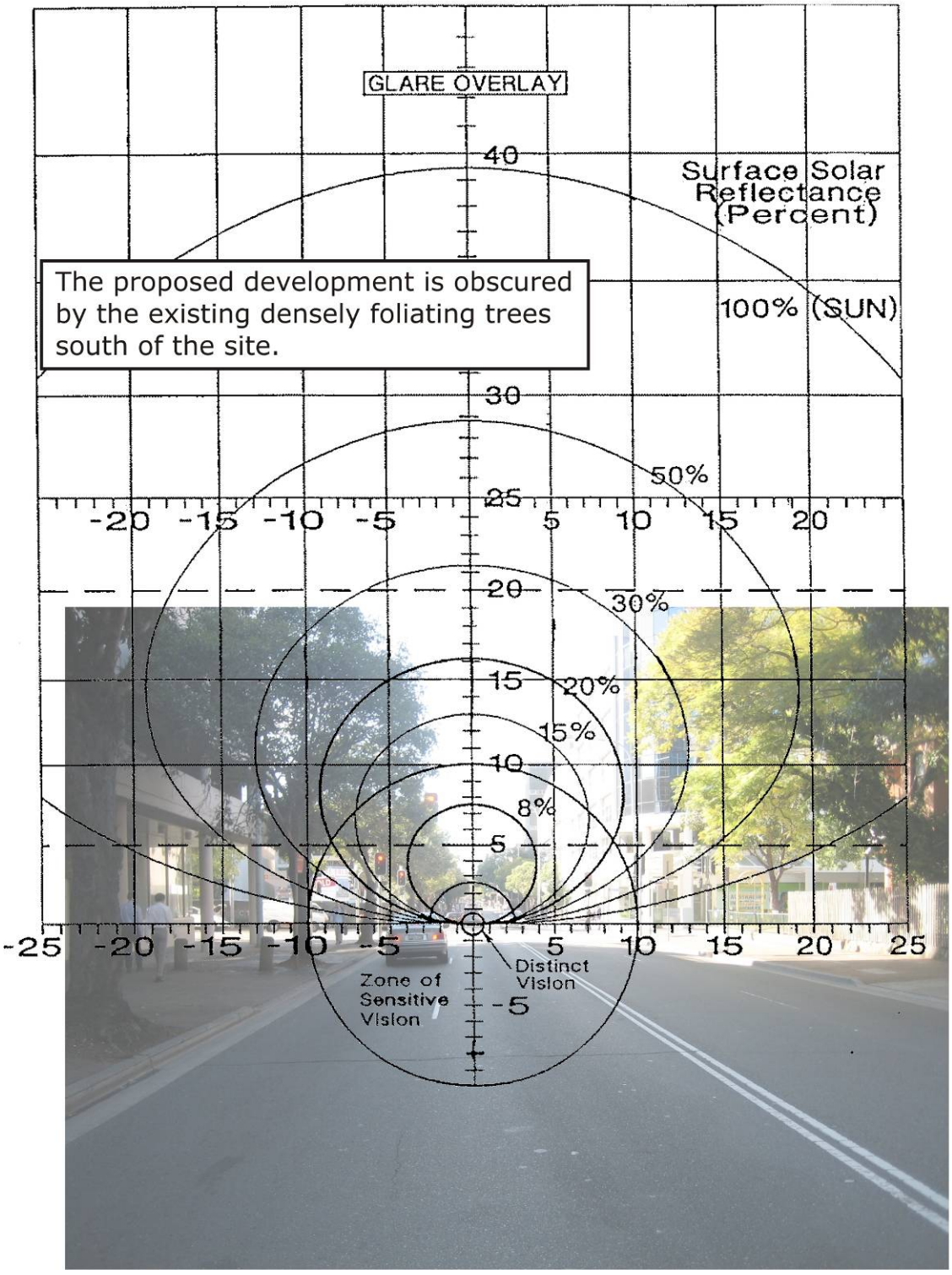

Figure A6: Glare Overlay for Point 6

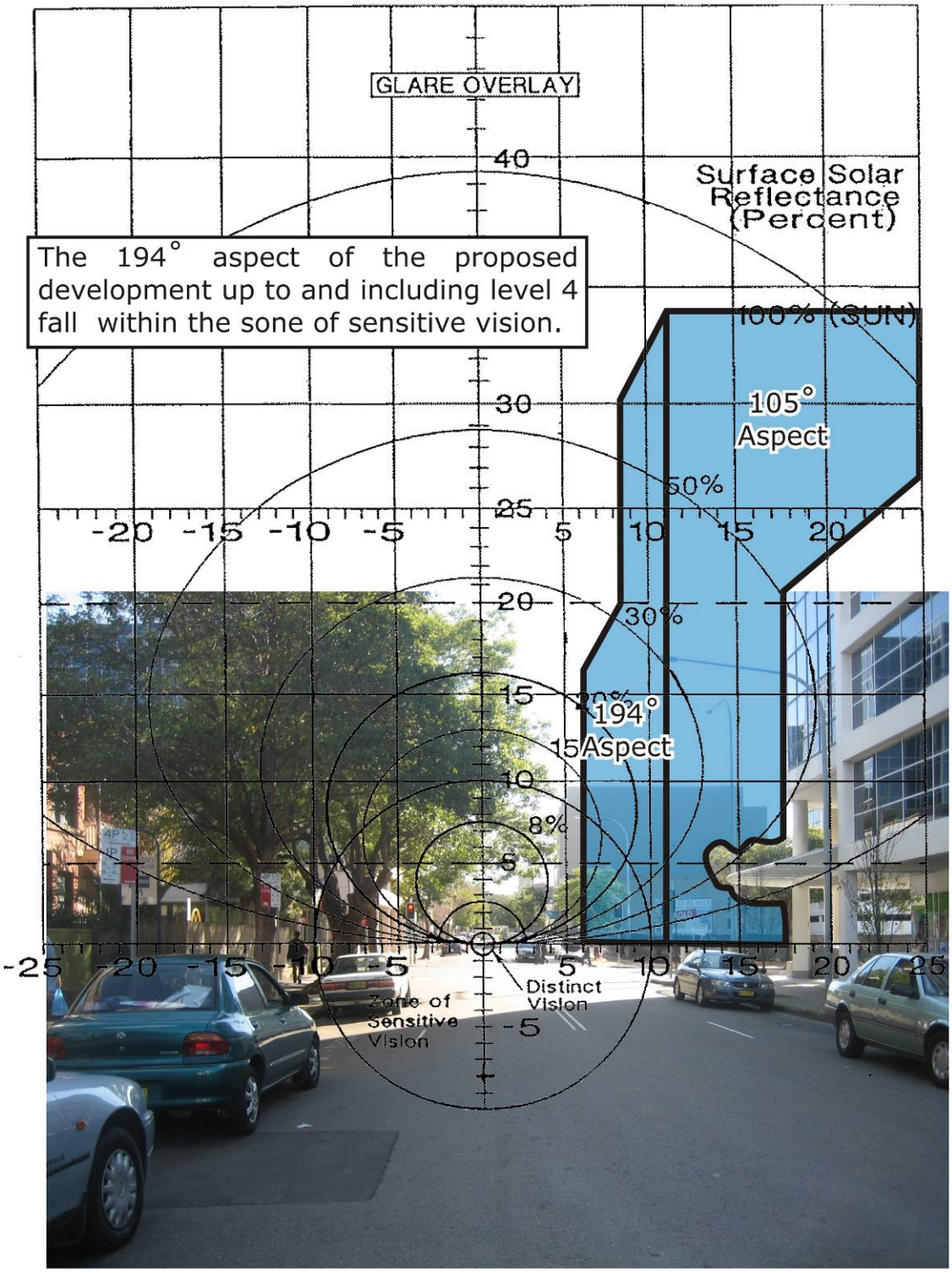

Figure A7: Glare Overlay for Point 7

Appendix B

Solar Charts for the Various Aspects of the Proposal

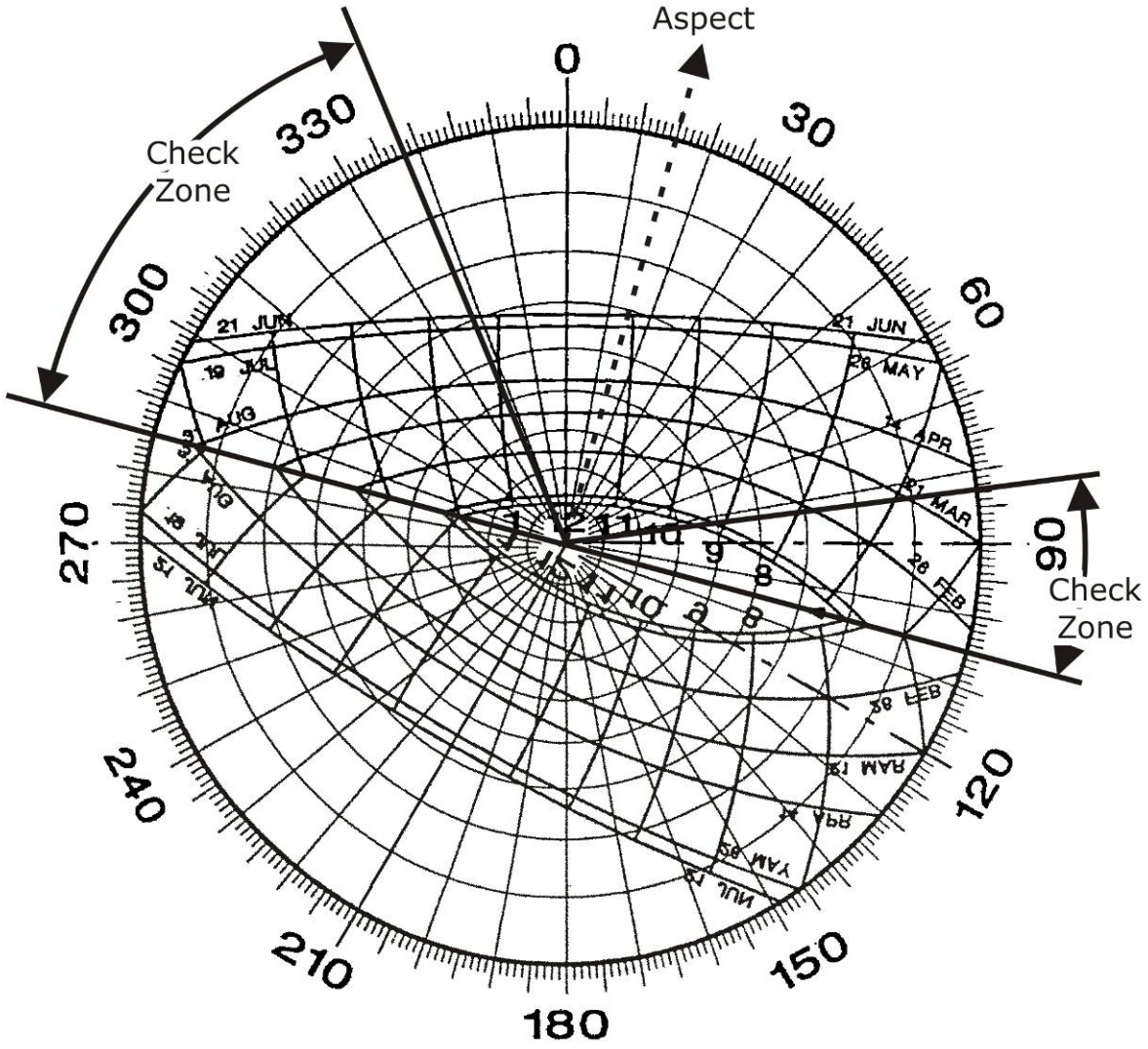

Figure B1: Sun Chart for Aspect 015°

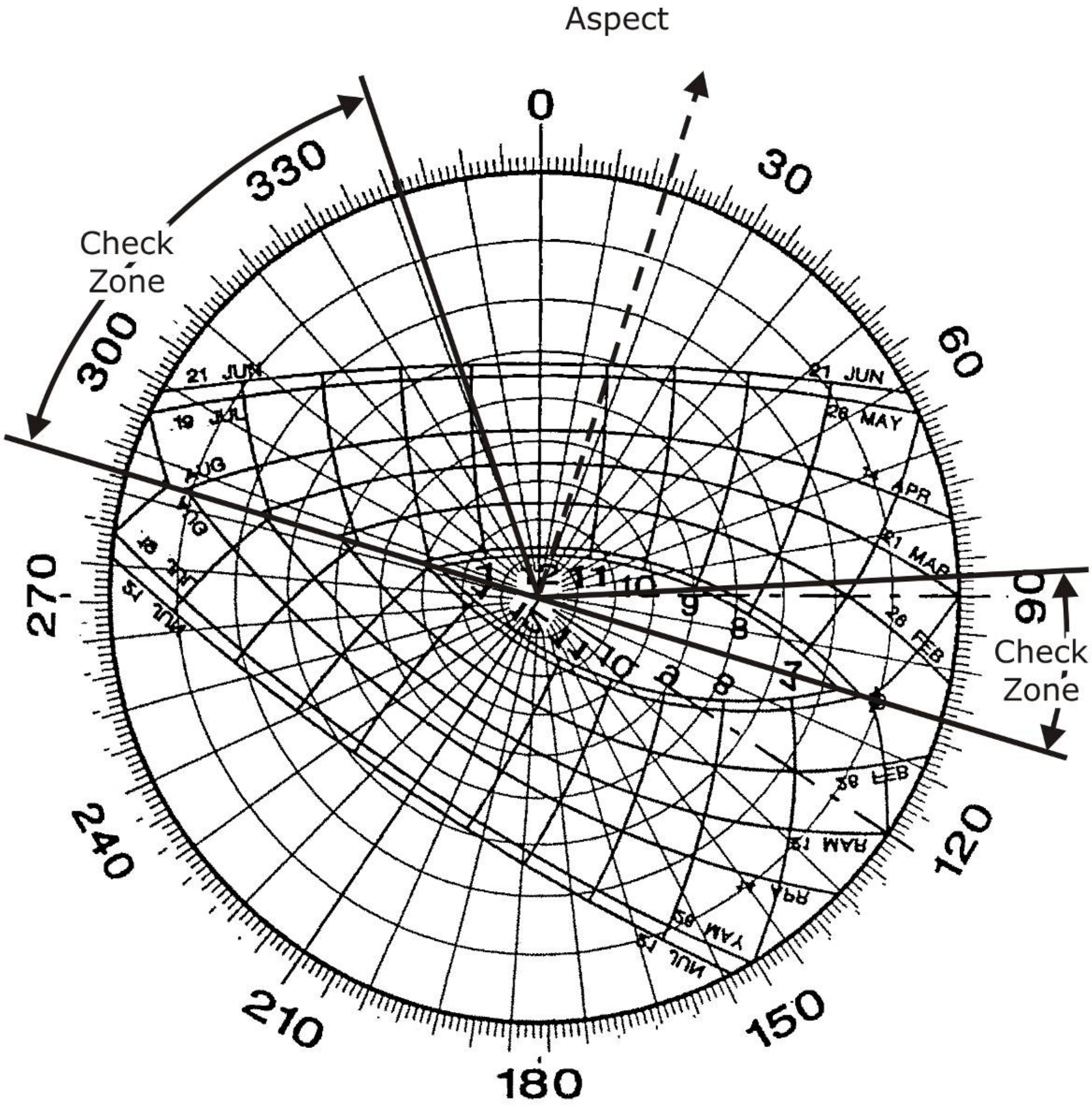

Figure B2: Sun Chart for Aspect 017°

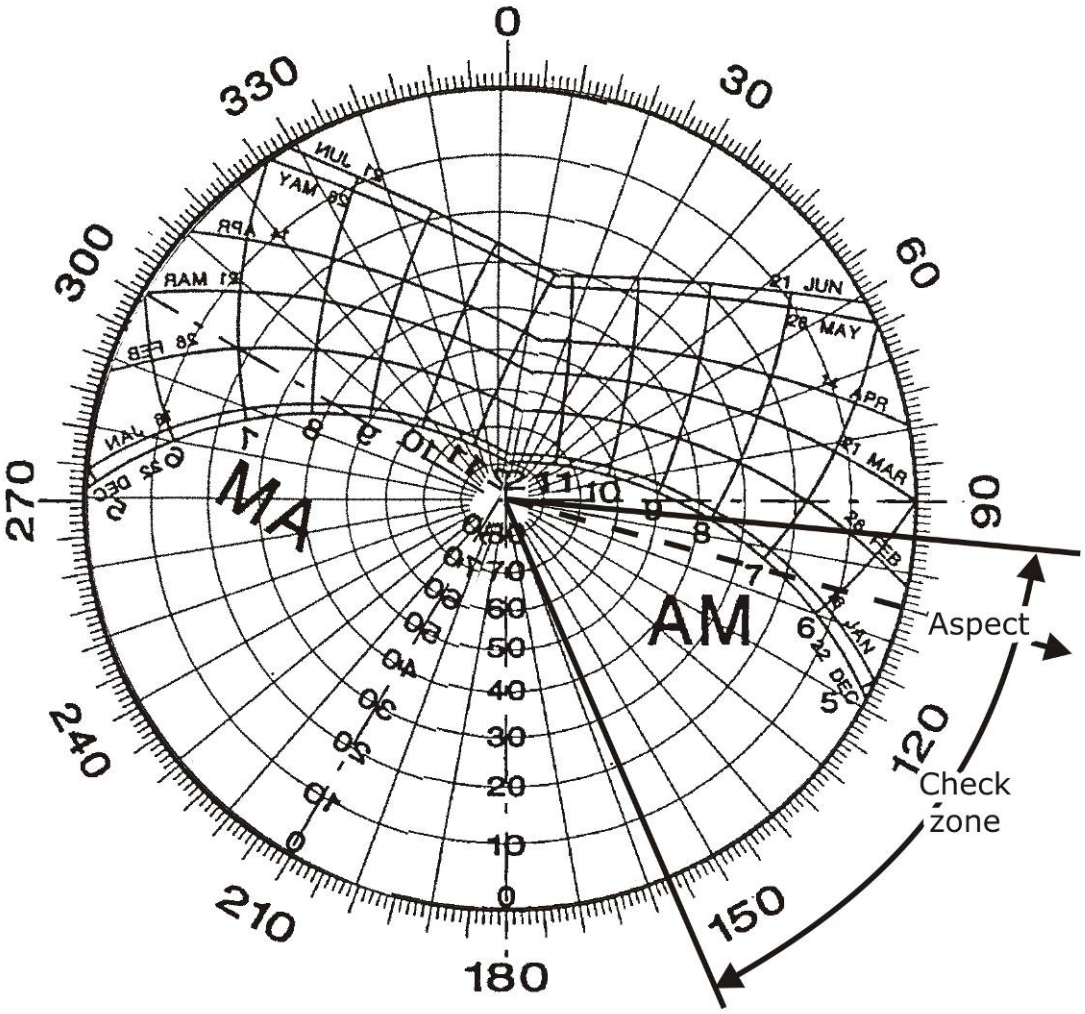

Figure B3: Sun Chart for Aspect 105°

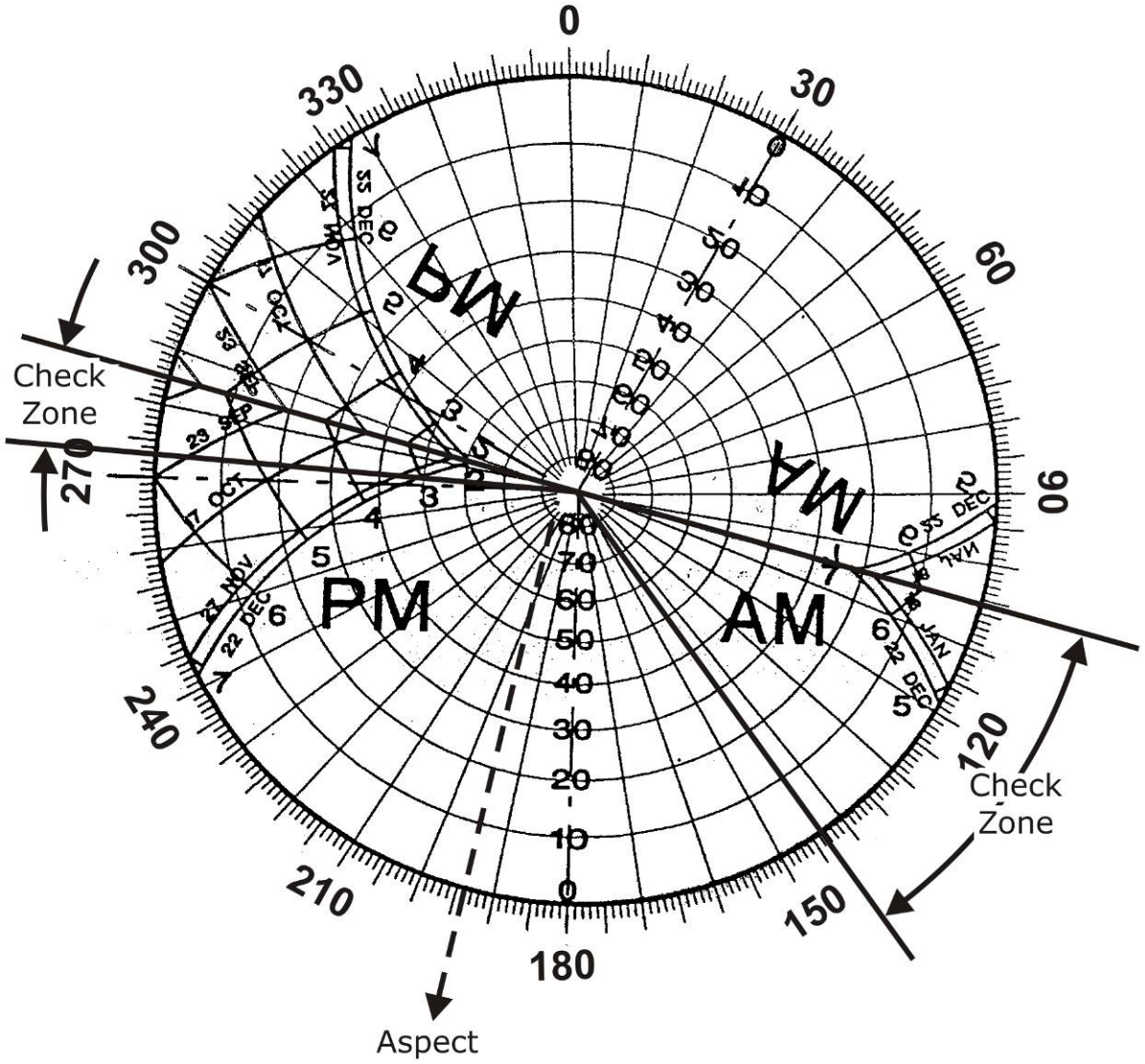

Figure B4: Sun Chart for Aspect 194°

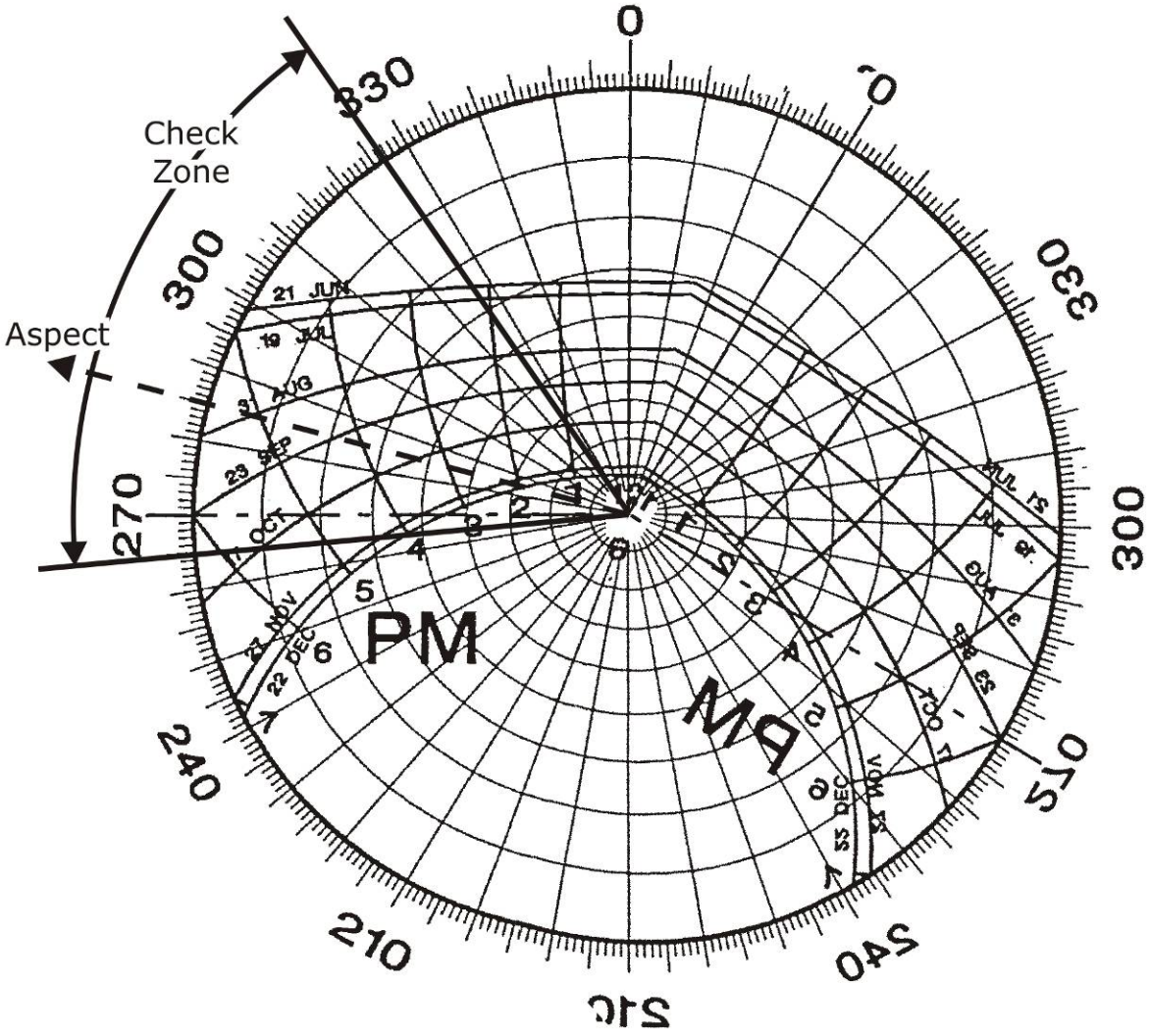

Figure B5: Sun Chart for Aspect 285°