



## SOLAR LIGHT REFLECTIVITY ANALYSIS

### V BY CROWN, PARRAMATTA

WB714-10F04(REV0)- SR REPORT

14 AUGUST 2012

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## DOCUMENT CONTROL

Date	Revision History	Non-Issued Revision	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
14/08/2012	Initial	-	0	AL	TR	KP

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## EXECUTIVE SUMMARY

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This report presents the results of a detailed study for the effect of potential solar glare from the proposed development known V by Crown, located at 45 Macquarie Street, Parramatta. The analysis has been undertaken based on architectural drawings prepared by the project architect Allen Jack + Cottier, received June 2012.

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;

- New buildings and facades should not result in glare that causes discomfort or threatens safety of pedestrians or drivers
- Visible light reflectivity from building materials used on the façades of new buildings should not exceed 20%

A site survey has been undertaken to obtain photographs of the critical sightlines of drivers on the 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 drivers and pedestrians on the surrounding streets and occupants of neighbouring buildings, and to comply with the abovementioned planning control requirements, either of the following additional recommendations should be taken into consideration:

- The façade on the 015° aspect of the proposed development between Levels 3 and 8 should have a normal spectral reflectivity of light no greater than 10%, 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 an external depth of at least 70mm.

With the above recommendations incorporated into the final design, the subject development will not cause adverse solar glare to pedestrians or motorists in the surrounding area, or to occupants of neighbouring buildings.

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## 1 DESCRIPTION OF THE PROPOSED DEVELOPMENT AND SURROUNDS

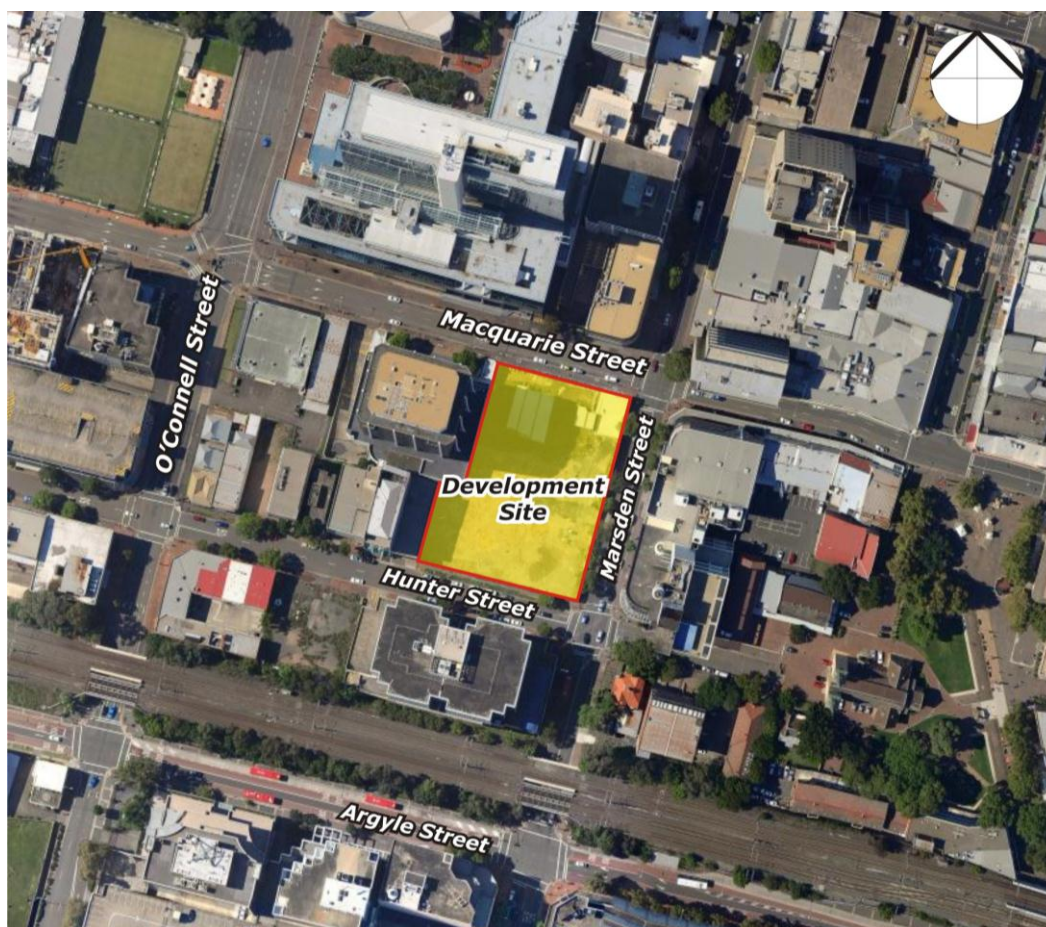
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The proposed development site consists of a 30 level residential development. 504 residential dwellings are proposed, spanning across 28 levels of the building. Ground floor consists of retail spaces and facilities associated with the archaeological site. Six basement levels dedicated to car-parking are also proposed. Openings to the residential apartments are proposed on all aspects of the subject development.

The subject site is located at 45 Macquarie Street, Parramatta and is bounded by Macquarie Street to the north, Marsden Street to the east and Hunter Street to the south. On the adjacent site to the west is a 12 storey office building, while to the north-west is the Jessie Street Centre. East of the subject site are a number of commercial buildings with heights up to six storeys above ground. To the south-east of the site is the St John's Cathedral, with Westfield Parramatta further beyond this.

There is a general rise towards the south-west in the local land topography around the subject site. An aerial image of the site is shown in the Figure 1 below.

The building façade is made from a mixture of metal, glass and stone cladding elements. There are two curved aspects associated with the development with titanium cladding.



**Figure 1 Aerial Image of the Site Location**

## 2 METHODOLOGY

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The reflectivity analysis of the subject development has been carried out using the technique published by Mr David N. H. Hassall (1991)<sup>1</sup>. The limiting veiling luminance of 500 candelas per square metre for the comfort of vehicle drivers, 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 drivers, conditions will also be satisfactory for pedestrians. The glare impact onto occupants of neighbouring buildings is also discussed in this assessment.

The various critical aspects were determined for the proposed development and are shown in Figure 2. Solar charts for each of these critical aspects is presented in Appendix B, and these are used to derive the check zones which are shown in Figure 3. The check zones highlight the zones that can be potentially affected by solar reflections from each critical aspect. It should be noted that the check zones shown 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. The effects of these components are examined in the detailed analysis described in Section 3 of this report.

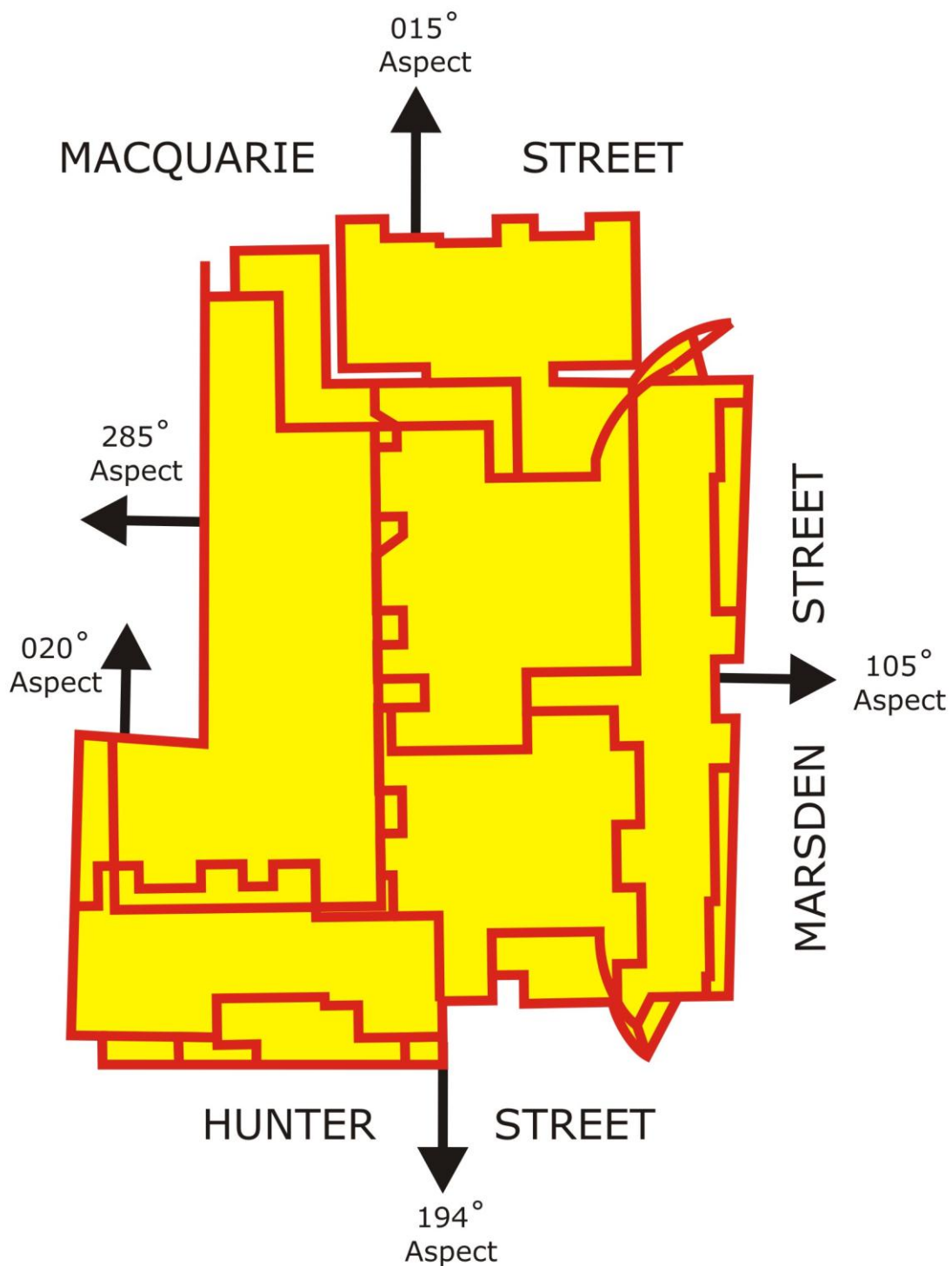
Study point locations have been selected within the check zone areas where motorists will be facing the general direction of the subject development. These locations are also shown in Figure 3. For each of the study point locations, photographs have been taken from the viewpoint of drivers and pedestrians 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 as part of the analysis process.

The glare protractor is used to assess the amount of glare likely to be caused by the façade of the building 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<sup>2</sup>.

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. This allows the subject development to comply with the relevant planning control requirements.

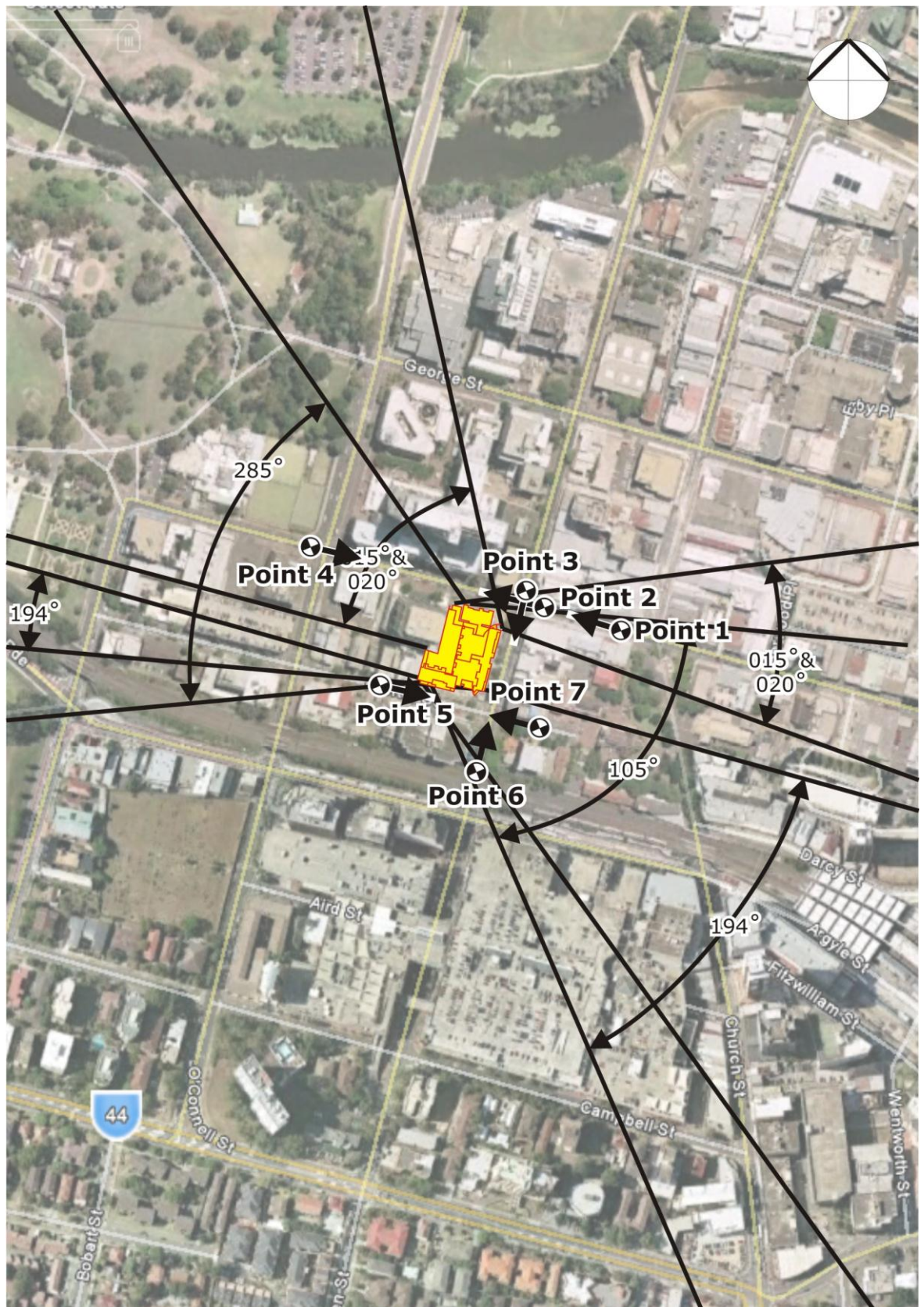
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<sup>1</sup> D.N. Hassall, 1991, Reflectivity, Dealing with Rogue Solar Reflections (published by author)



**Figure 2: Critical Aspects of the Proposed Development**





**Figure 3: Check Zones and Layout of Study Points**



## 3 ANALYSIS

### 3.1 Impact onto Drivers and Pedestrians

From the study of the check zones shown in Figure 3, a total of 7 street level locations have been identified for detailed analysis. These locations are also indicated in Figure 3. A summary of which 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 2, the check zones shown 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 described in the following sub-sections.

**Table 1: Aspects of the development that could reflect solar glare to each Study Point**

Study Points	Aspect(s) of the Development
1	015° - 020° and 105° aspects
2	015° - 020° and 105° aspects
3	015° - 020° aspects
4	015° - 020° and 285° aspects
5	194° and 285° aspects
6	105° and 194° aspects
7	105° and 194° aspects

#### 3.1.1 Drivers Heading West along Macquarie Street

Points 1 and 2 are located along Macquarie Street, to the east of the proposed development site. These points represent the critical sightlines of drivers heading west along Macquarie Street. Points 1 and 2 are located within the check zones for the 015° - 020° and 105° aspects of the proposed development.

A site survey of these points has been undertaken, and photographs showing the viewpoints of drivers heading west along the Macquarie Street at these locations 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 A2 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Points 1 indicates that the view of the proposed development will be obscured by the existing local surrounding buildings east of the site. Hence there will be no adverse solar glare reflected from the proposed development to drivers and pedestrians facing west along the Macquarie Street at Point 1.

An analysis of the glare meter overlaid onto the viewpoint at Point 2 indicates that a portion of the 015° aspect up to and including Level 3 and a portion of the 105° aspect up to and including Level 1 upper of the proposed development fall within the zone of sensitive vision of drivers heading west at this location. For solar glare to be reflected off the 015° aspect of the proposed development to Point 2, the sun would need to have an angle of inclination between

0° and 9° and azimuth between 293° and 297°. According to the standard sun chart for the Sydney region as shown in Figure C1 of Appendix C, the sun does pass through these ranges of inclination and azimuth, hence either of the following is recommended:

- The portion of façade on the 015° aspect up to and including Level 3 which is inside the zone of sensitive vision have a normal spectral reflectivity of light no greater than 10%.
- Install vertical mullions external to the glass-line that can block solar reflections up to 8° from the centre of the glass. For example for a glass panel of 1000mm width, the mullions will need to have an external depth of at least 70mm.

For solar glare to be reflected from the 105° aspect of the proposed development to Point 2, the sun would need to have an angle of inclination between 0° and 10° and azimuth between 121° and 124°. According to the standard sun chart for the Sydney region as shown in Figure C1 of Appendix C, the sun does not pass through these ranges of inclination and azimuth, hence solar glare cannot be reflected from the 105° aspect of the proposed development to drivers and pedestrians facing west at Point 2.

With either of the two abovementioned recommendations incorporated in the final design, there will be no adverse solar glare reflected from the proposed development to drivers and pedestrians facing west along Macquarie Street at Points 1 and 2.

### 3.1.2 Drivers Heading South along Marsden Street

Point 3 is located along Marsden Street and represents a critical sightline of drivers heading south along Marsden Street. Point 3 is located within the check zones for the 015° - 020° aspects of the proposed development.

A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers heading south along Marsden Street at this location was obtained using a calibrated camera. The photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figure A3 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 3 indicates that no part of the development falls within the zone of sensitive vision, hence there will be no adverse solar glare reflected from the proposed development to drivers and pedestrians facing south along Marsden Street at Point 3.

### 3.1.3 Drivers Heading East along Macquarie Street

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° - 020° and 285° aspects of the proposed development.

A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers heading east along Macquarie Street at this location was obtained using a calibrated

camera. The photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figure A4 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 4 indicates that a portion of the 015° aspect between Levels 4 and 8, and a portion of the 285° aspect between Levels 4 and 6 of the proposed development fall within the zone of sensitive vision for drivers heading east in this location. For solar glare to be reflected off the 015° aspect of the proposed development to Point 4, the sun would need to have an angle of inclination between 5° and 9° and azimuth between 95° and 97°. According to the standard sun chart for the Sydney region as shown in Figure C1 of Appendix C, the sun does pass through these ranges of inclination and azimuth, hence either of the following is recommended:

- The portion of façade on the 015° aspect between Levels 4 and 8 which is inside the zone of sensitive vision have a normal spectral reflectivity of light no greater than 10%.
- Install vertical mullions external to the glass-line that can block solar reflections up to 8° from the centre of the glass. For example for a glass panel of 1000mm width, the mullions will need to have an external depth of at least 70mm.

For solar glare to be reflected off the 285° aspect of the proposed development to Point 4, the sun would need to have an angle of inclination between 6° and 9° and azimuth between 270° and 195°. According to the standard sun chart for the Sydney region as shown in Figure C1 of Appendix C, the sun does pass through these ranges of inclination and azimuth, however incident solar glare would be overshadowed by the existing high-rise office building west of the site, hence solar glare would not be reflected off the 285° aspect of the proposed development to drivers and pedestrians travelling east at Point 4.

With either of the two abovementioned recommendations incorporated in the final design, there will be no adverse solar glare reflected from the proposed development to drivers and pedestrians travelling east along Macquarie Street at Point 4.

#### 3.1.4 Drivers Heading East along Hunter Street

Point 5 is located along Hunter Street and represents a critical sightline of drivers heading east along Hunter Street. Point 5 is located within the check zones for the 194° and 285° aspects of the proposed development.

A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers heading east along Hunter Street at this location was obtained using a calibrated camera. The photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figure A5 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 3 indicates a portion of the 194° falls within the zone of sensitive vision for drivers and pedestrians heading east at this location, however adverse reflected solar glare will not reach Point 5 since the majority of the cladding which is within the zone of sensitive vision is stone, which has a poor normal spectral

reflectivity of light. For the areas of this façade which are glazed and within the zone of sensitive vision for Point 5, the proposed vertical mullions are expected to block any adverse glare being reflected to Point 5.

Hence there will be no adverse solar glare reflected from the proposed development to drivers and pedestrians travelling east along Hunter Street at Point 5.

#### 3.1.5 Drivers Heading North along Marsden Street

Point 6 is located along Marsden Street and represents a critical sightline of drivers heading north along Marsden Street. Point 6 is located within the check zones for the 105° and 194° aspects of the proposed development.

A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers heading north along Marsden Street at this location was obtained using a calibrated camera. The photograph has been scaled to enable the glare meter to be overlaid onto the image, as shown in Figure A6 of Appendix A.

An analysis of the glare meter overlaid onto the viewpoint at Point 6 indicates that the proposed development is blocked by the existing densely foliating trees south of the site, hence there will be no adverse solar glare reflected from the proposed development to drivers and pedestrians travelling north along Marsden Street at Point 6.

#### 3.1.6 Drivers Heading West along Hunter Street

Point 7 is located along Hunter Street and represents a critical sightline of drivers heading west along Hunter Street. Point 7 is located within the check zones for the 105° and 194° aspects of the proposed development.

A site survey of this point has been undertaken, and a photograph showing the viewpoint of drivers heading west along Hunter Street at this location was obtained using a calibrated camera. The 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 a negligible portion of the proposed development falls within the zone of sensitive, hence there will be no adverse solar glare reflected from the proposed development to drivers and pedestrians travelling west along Hunter Street at Point 7.

### **3.2 Occupants of Neighbouring Buildings**

Our past experience involving more than 200 projects, and also research by Rofail and Dowdle (2004)<sup>2</sup>, 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.

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



## 4 CONCLUSION

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An analysis has been undertaken to assess the potential for solar glare from the proposed development known V by Crown, located at 45 Macquarie Street, Parramatta. The analysis has been undertaken based on architectural drawings prepared by the project architect Allen Jack + Cottier, received June 2012.

The results of the study indicate that, to avoid any adverse glare to drivers and pedestrians on the surrounding streets and occupants of neighbouring buildings, and to comply with the relevant planning control requirements, either of the following additional recommendations should be taken into consideration:

- The façade on the 015° aspect of the proposed development between Levels 3 and 8 should have a normal spectral reflectivity of light no greater than 10%, 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 an external depth of at least 70mm.

With the abovementioned recommendations incorporated into the final design, the subject development will not cause adverse solar glare to pedestrians or motorists in the surrounding area, or to occupants of neighbouring buildings.

## APPENDIX A - GLARE OVERLAYS FOR THE CRITICAL SIGHT-LINES

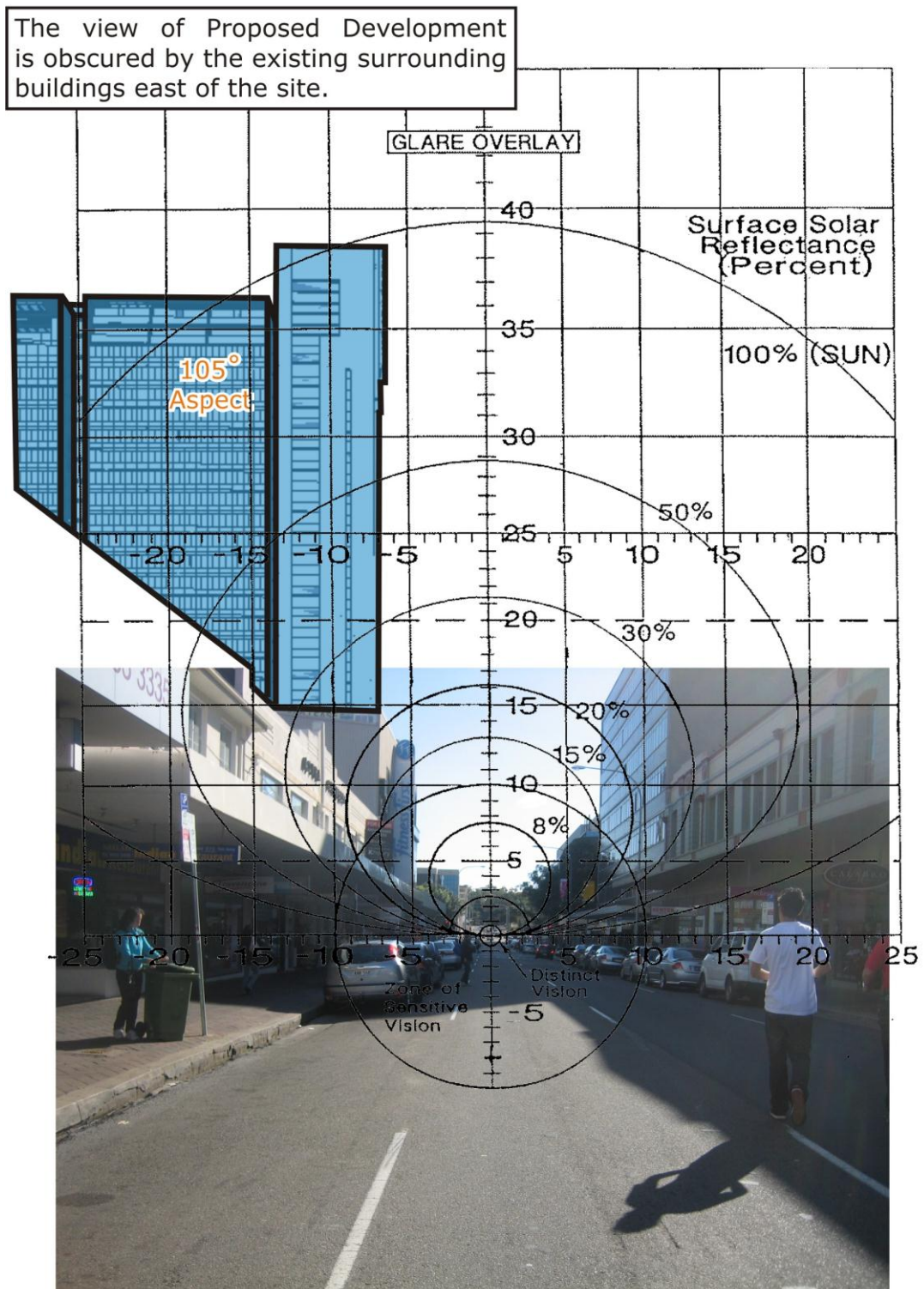
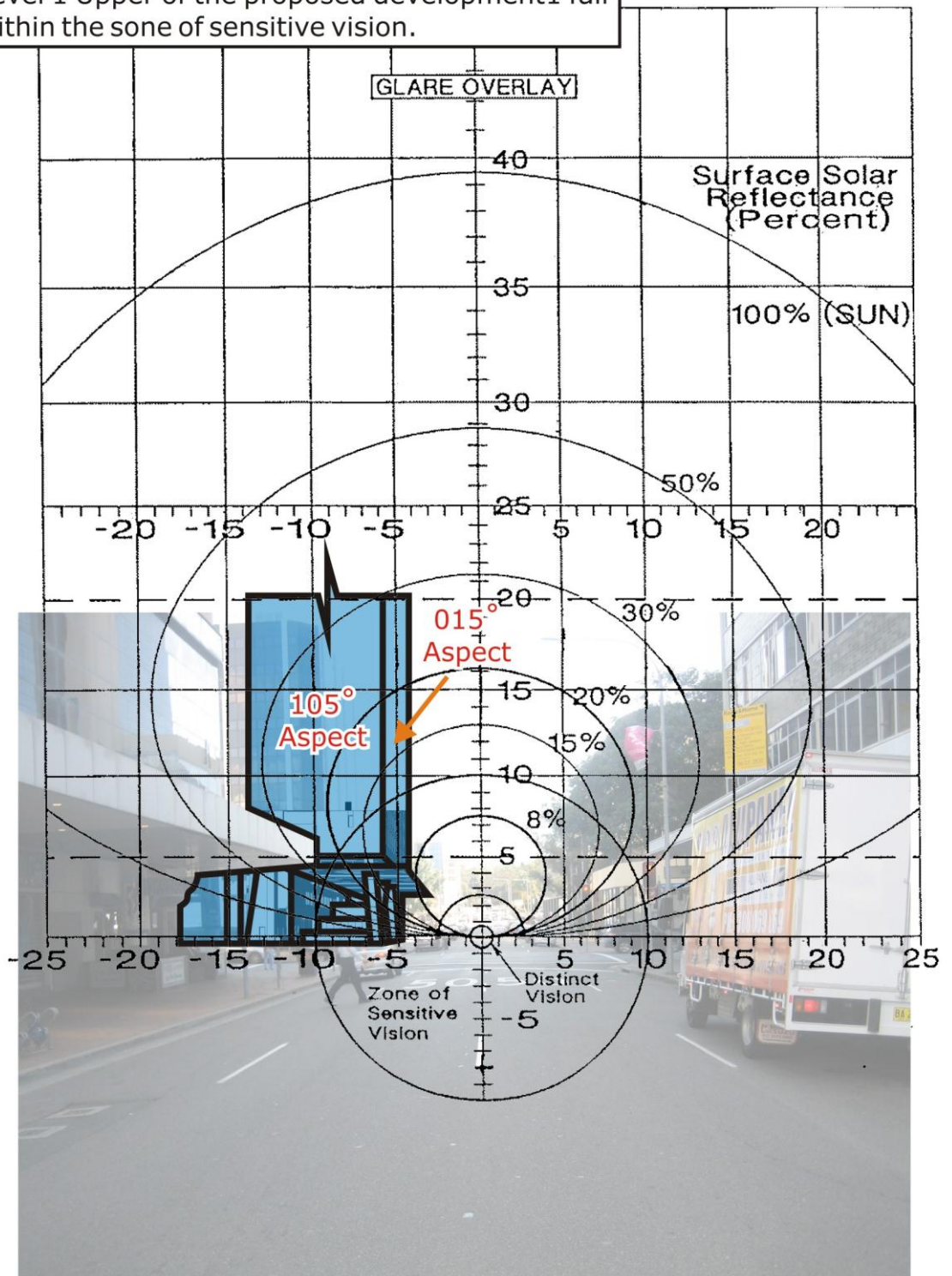


Figure A1: Glare Overlay for Point 1

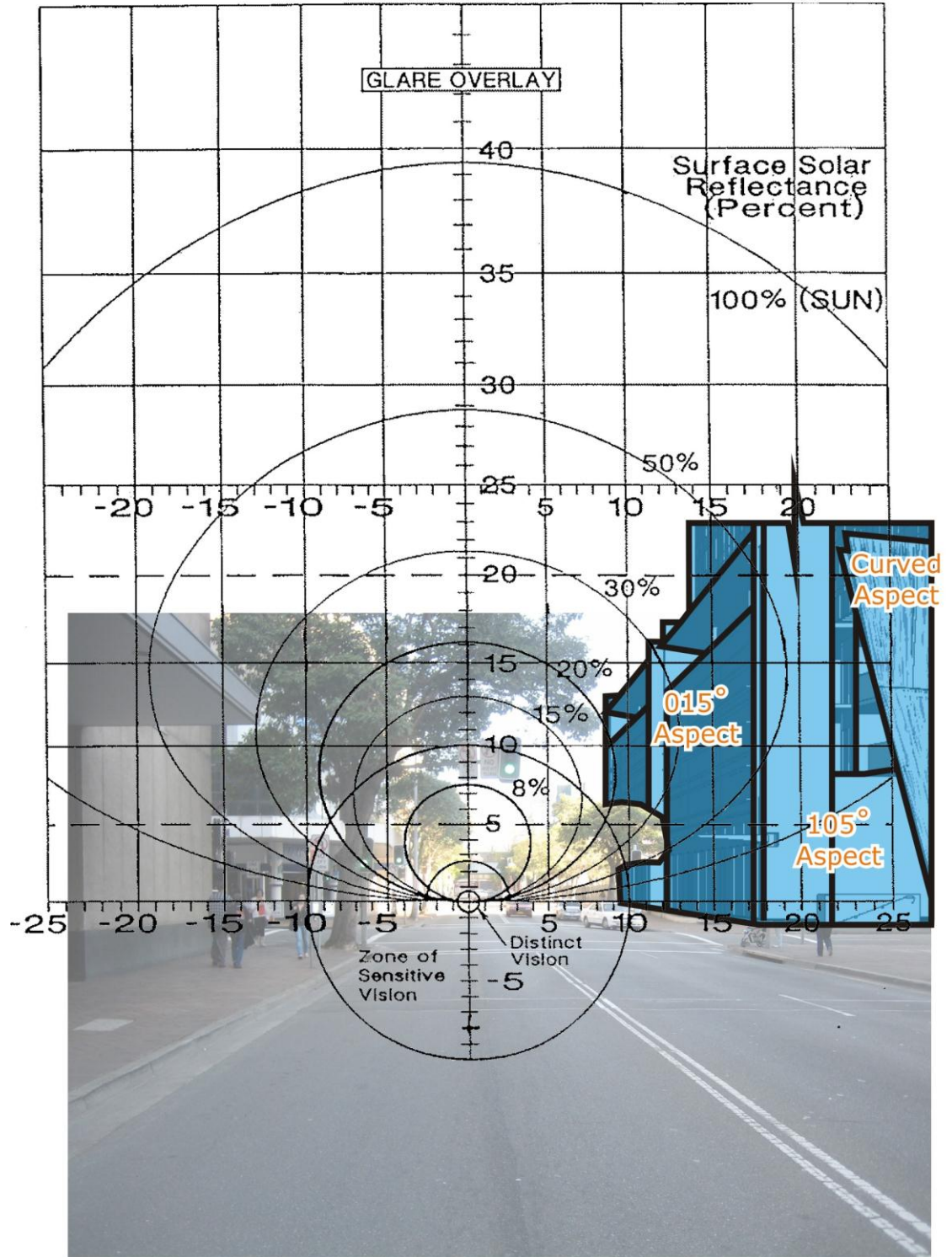
The 015° aspect up to and including Level 3 and a portion of the 105° aspects up to an including Level 1 Upper of the proposed development1 fall within the sone of sensitive vision.



**Figure A2: Glare Overlay for Point 2**

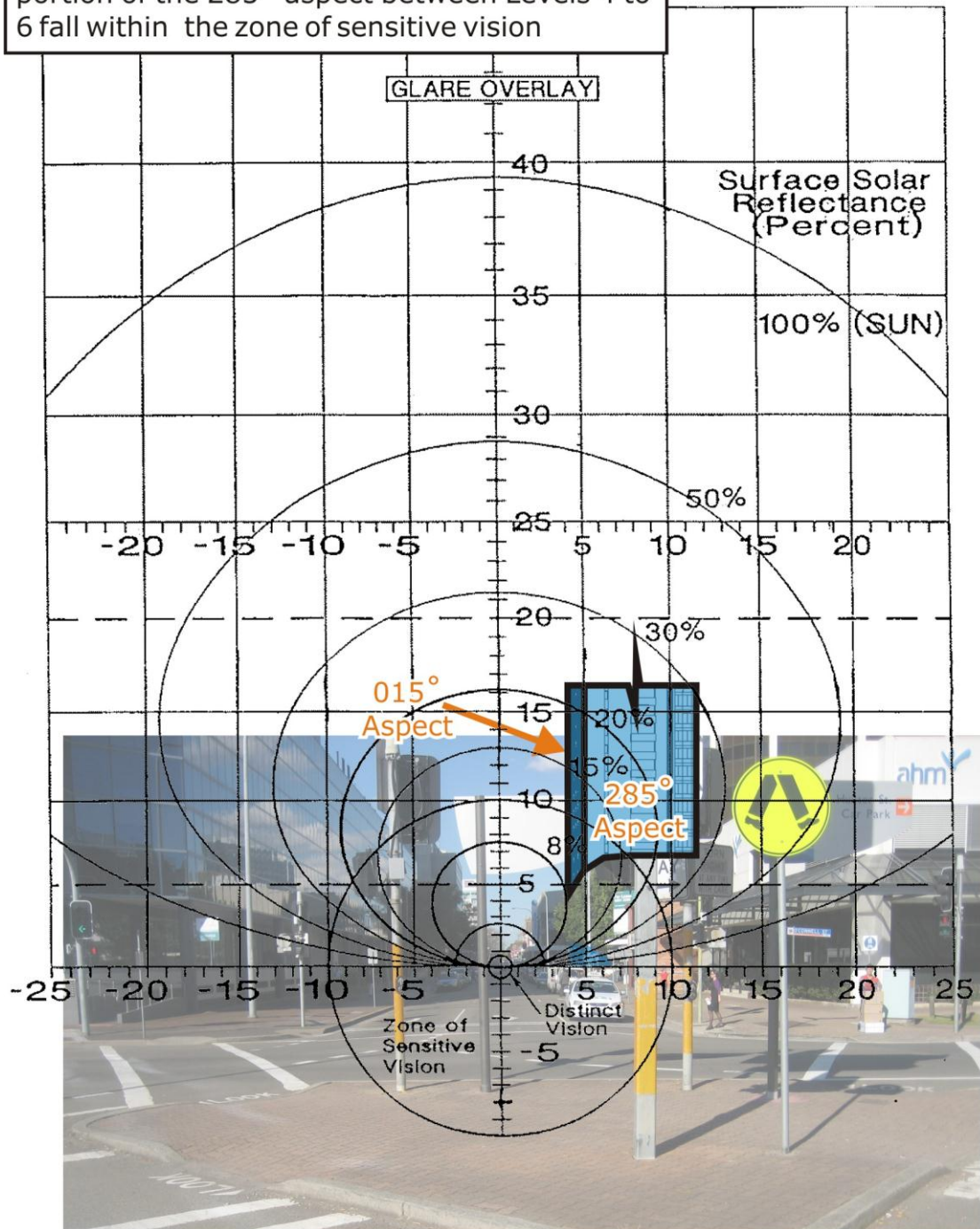


No part of the proposed development falls within the zone of sensitive vision.



**Figure A3: Glare Overlay for Point 3**

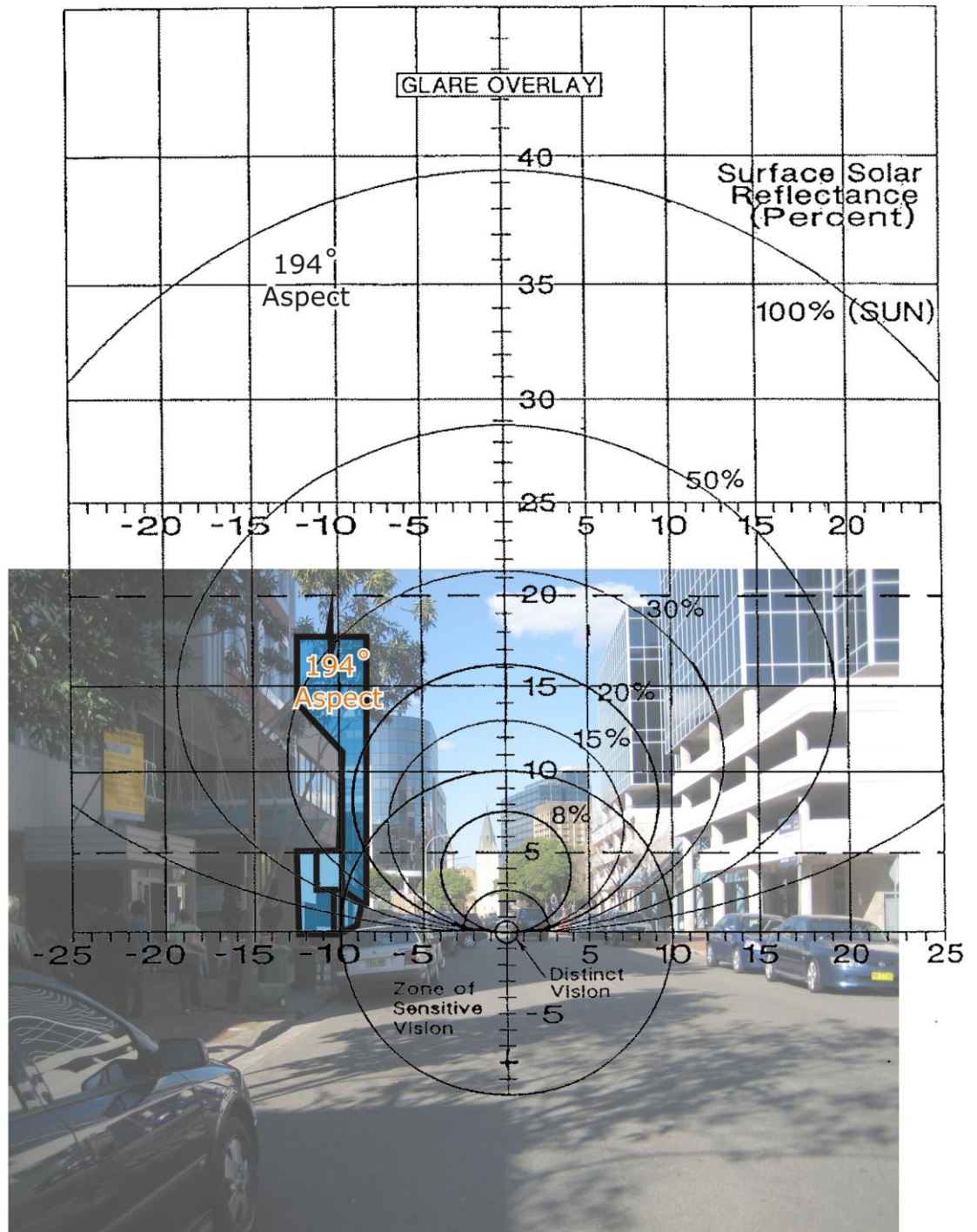
The 015° aspect between Levels 4 and 8 and a portion of the 285° aspect between Levels 4 to 6 fall within the zone of sensitive vision



**Figure A4: Glare Overlay for Point 4**

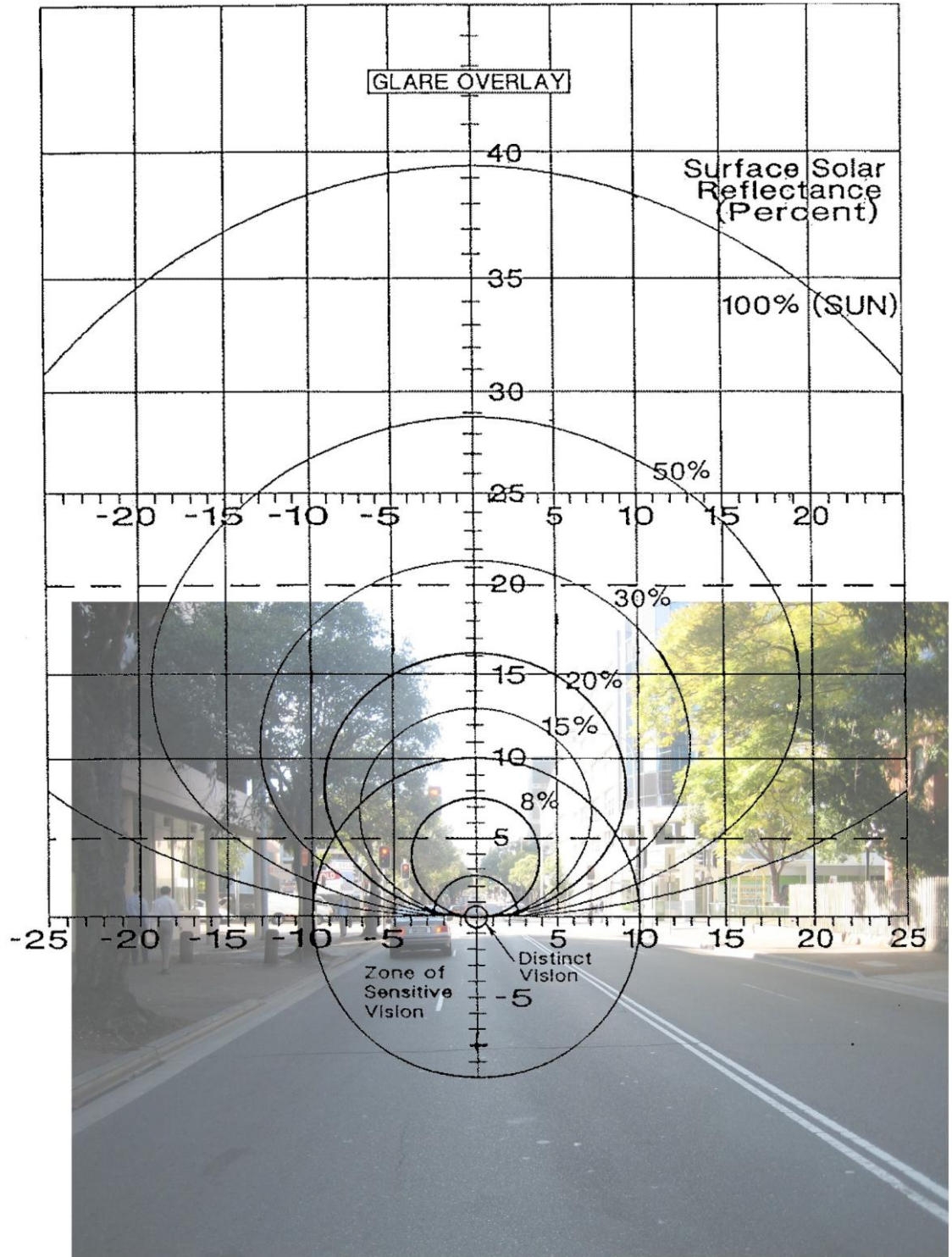


The 194° aspect of the proposed development up to and including Level 4 fall within the zone of sensitive vision.



**Figure A5: Glare Overlay for Point 5**

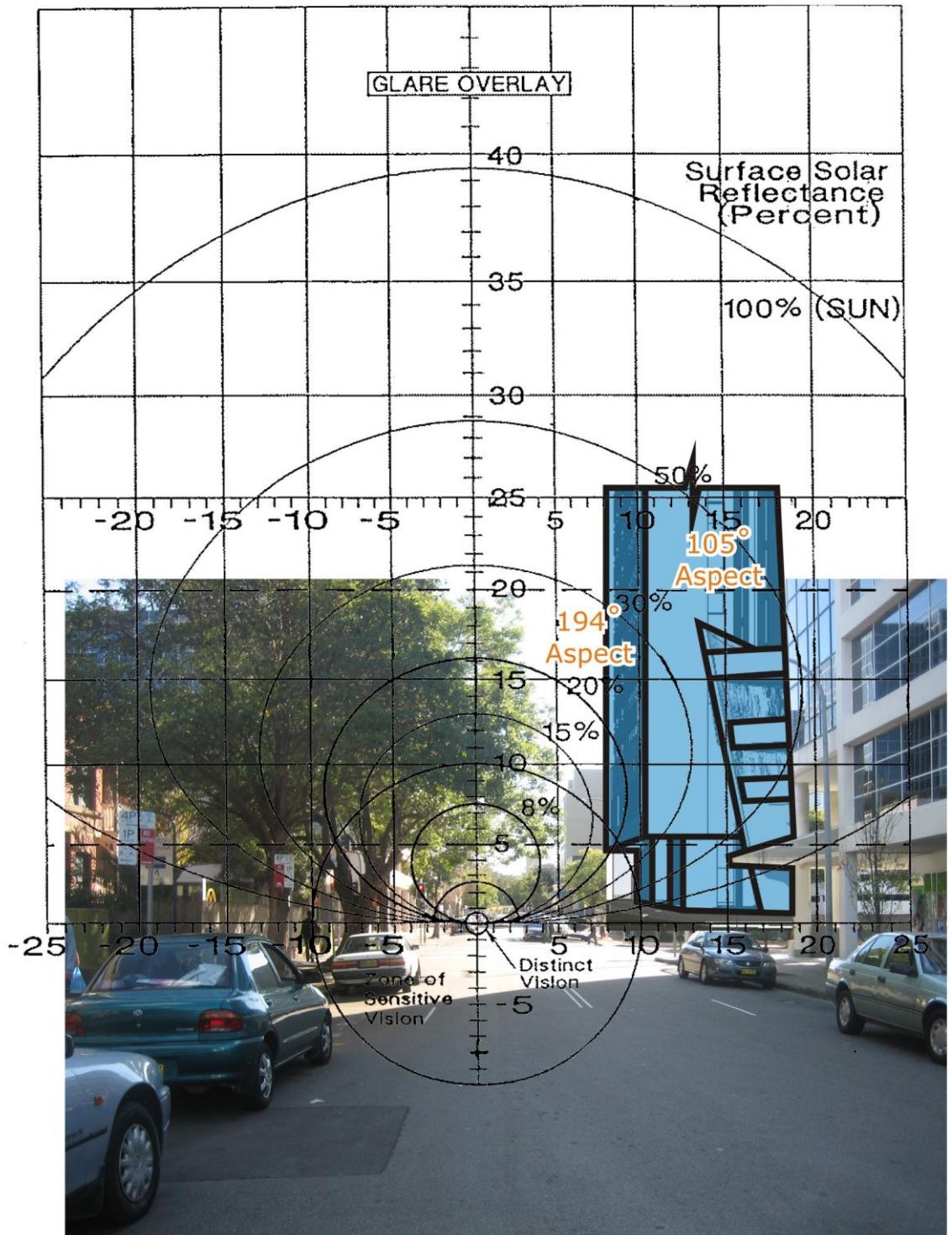
The proposed development is obscured by the existing densely foliating trees south of the site.



**Figure A6: Glare Overlay for Point 6**



A negligible portion of the 194° aspect of the proposed development falls within the zone of sensitive vision.



**Figure A7: Glare Overlay for Point 7**

## APPENDIX B - SOLAR CHARTS FOR THE VARIOUS CRITICAL ASPECTS

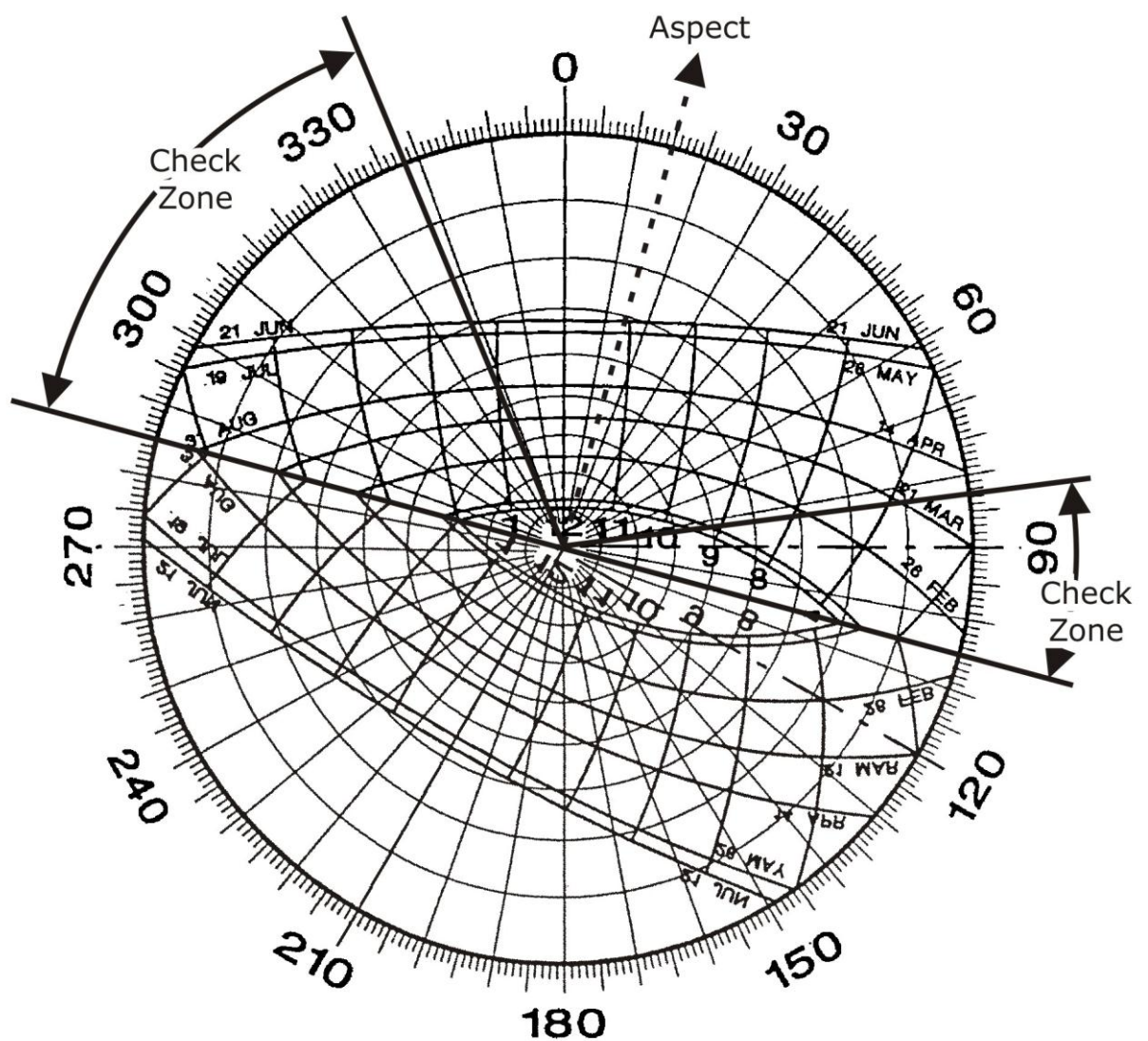
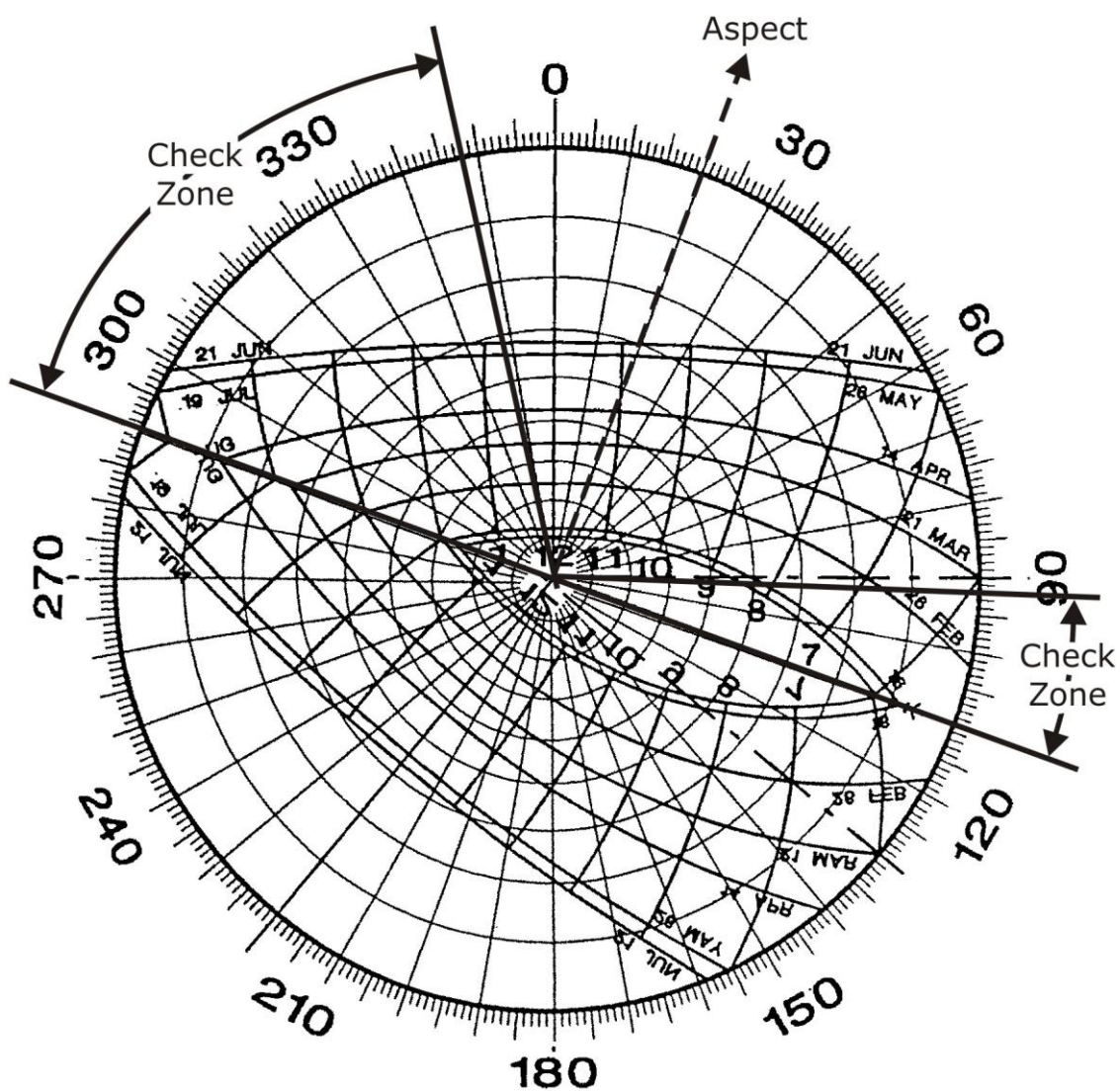
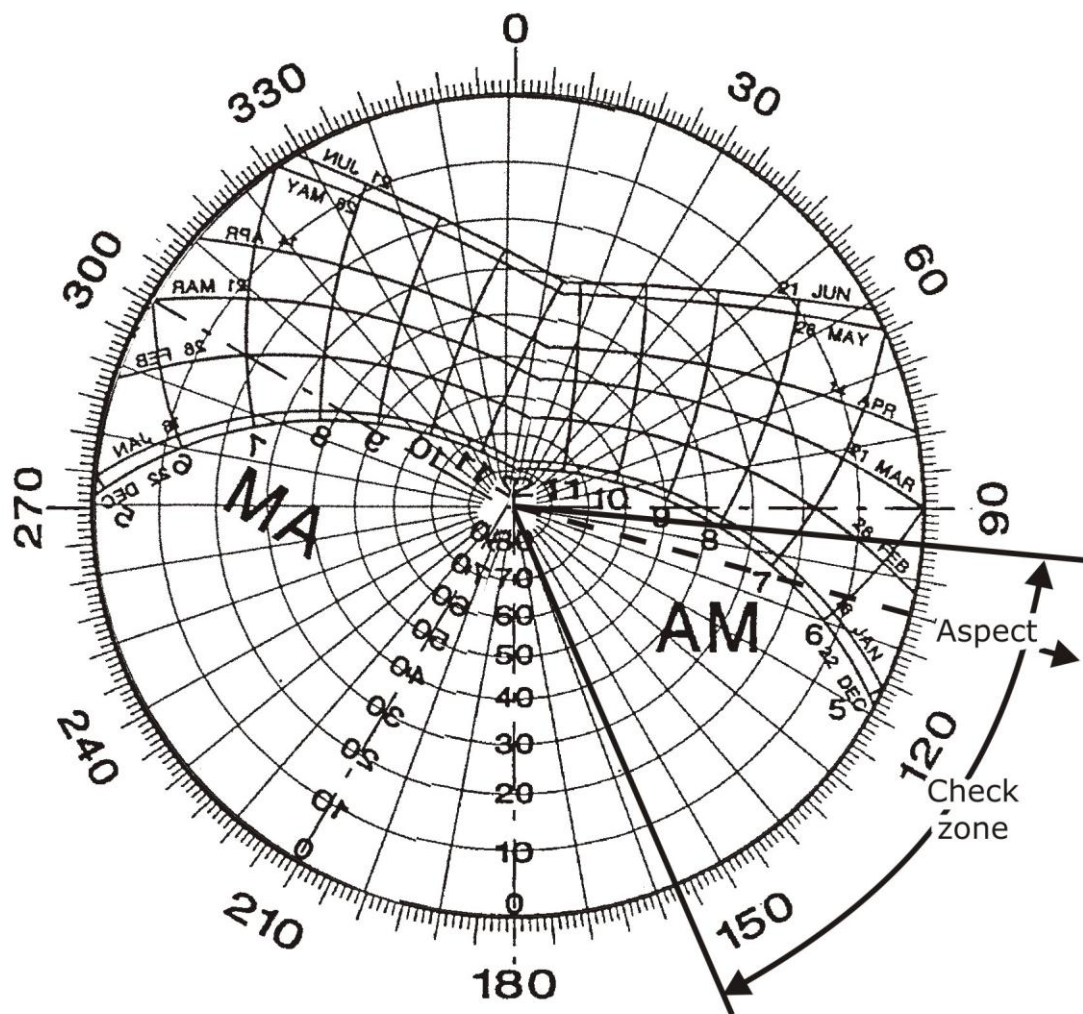


Figure B1: Sun Chart for Aspect 015°



**Figure B2: Sun Chart for Aspect 020°**





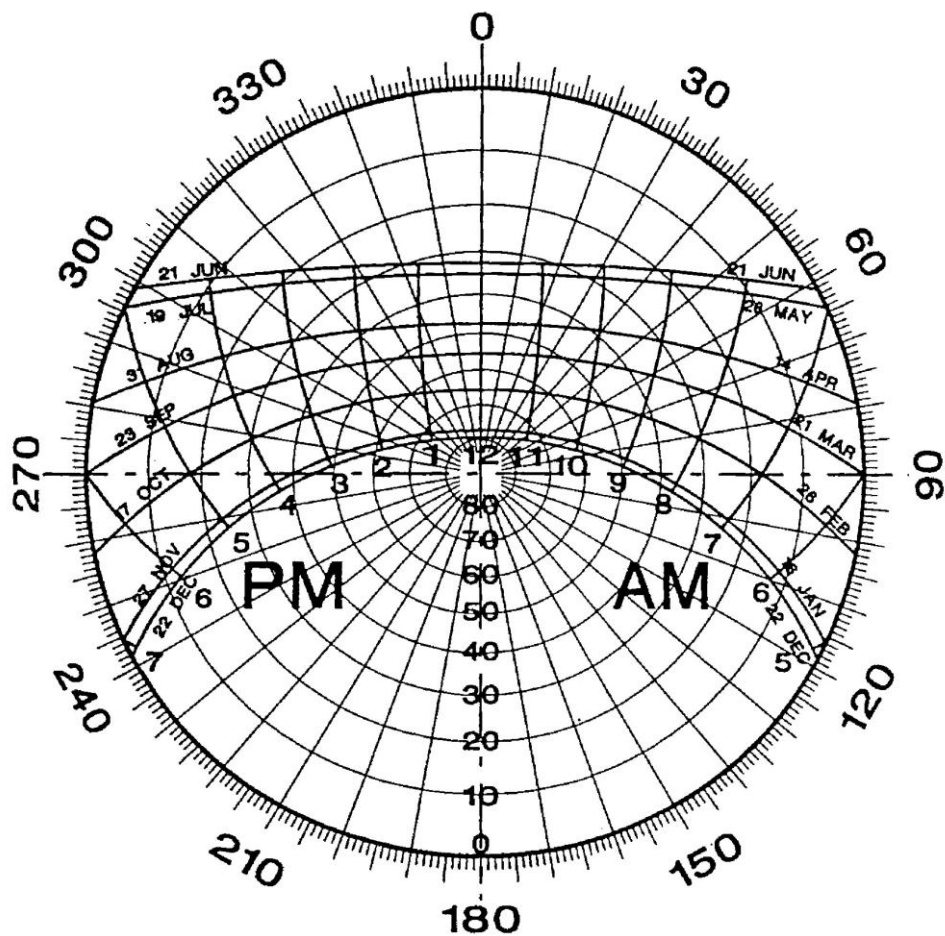
**Figure B3: Sun Chart for Aspect 105°**





## APPENDIX C - STANDARD SUN CHART FOR SYDNEY REGION

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**Figure C1: Standard Sun Chart for Sydney Region**