Reflectivity Report

ATP

Mirvac

Prepared for
Mirvac

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Surface Design

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Contents

Executive Summary

The development consists of three buildings of various size that are to be constructed at the Australian Technology Park.

This reflectivity study has been carried out in order to verify that the façade of the proposed project at the Australian Technology Park will not cause an unacceptable risk of solar reflections causing disability glare to drivers and pedestrians. The City of Sydney requirements are for the external reflectivity of façade elements to be limited to 20%, and this study has been carried out to determine if there are areas of the façade with a requirement for a lower external reflectivity of elements.

The project has been assessed from twenty-four viewpoint from drivers and pedestrians in order to determine areas where there is a risk of a reflected image of the sun being formed. The methodology proposed by David Hassall has been used to assess where there is a risk of disability glare as calculated by the Holladay formula.

The analysis has been carried out based on the architectural drawings for DA.

Based on the assessment carried out it has been determined that there is a requirement to manage the reflectivity, beyond the City of Sydney minimum requirements of 20% external reflectivity, on the following elevations:

- Façade Aspect 260 of Building 1
- Façade Aspect 342 of Building 1
- Façade Aspect 253 of the Community Building
- Façade Aspect 163 of Building 2
- Façade Aspect 343 of Building 2

Mitigation of rogue reflections will be controlled through the selection of low reflectivity surfaces and the use of glare amelioration devices such as vertical or horizontal fin features. This will require further review and detailed design with the design team.

All viewpoints considered have been analysed and it has been determined that the risk of rogue reflections causing disability glare are limited and acceptable.

1. Introduction

1.1 Background

This report supports a State Significant Development Application (SSDA) submitted to the Department of Planning and Environment pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Mirvac Projects Pty Ltd (Mirvac) is seeking to secure approval for the urban regeneration of the Australian Technology Park (ATP), including the redevelopment of three car parking lots within ATP for the purposes of commercial, retail and community purposes, along with an extensive upgrade to the existing public domain within ATP. Building heights of 4, 7 and 9 storeys are proposed across the 3 development lots.

Australian Technology Park (ATP) has been continuously developed since its establishment in 1996, but has been underutilised as a technology and business precinct for quite some time. UrbanGrowth NSW Development Corporation (UGDC) has actively encouraged new development and employment opportunities at the Park for the past 15 years, and Mirvac intends to continue upon this and deliver upon the precinct's full potential, with the development of circa 107,400sqm for employment uses, which will facilitate the employment homes of an extra 10,000 staff everyday within ATP by development completion.

Mirvac has been announced by UrbanGrowth NSW as the successful party in securing ownership and redevelopment rights for the ATP precinct, following an Expression of Interest (EOI) and an Invitation to Tender (ITT) process which commenced in 2014. Mirvac has also secured the Commonwealth Bank of Australia (CBA) as an anchor tenant for the development and intends to immediately commence the urban regeneration of this precinct through the lodgement of this SSDA. CBA's commitment to the precinct is in the form of one of the largest commercial leasing pre-commitments in Australian history, occupying circa 95,000 square metres of commercial, retail, community and childcare NLA, which will house circa 10,000 technology focused staff by 2019 and 2020. Mirvac's redevelopment goes well beyond the development on the 3 development lots, as it includes the regeneration of the public domain within ATP, the addition of retail to activate the precinct and also the provision of community facilities such as a community centre, a gym and 2 x 90 child childcare facilities.

1.2 Purpose of the Report

This report details the results of a reflectivity study that aims to identify the potential for adverse reflected solar glare that may affect drivers and pedestrians within the proximity of the proposed project. This is a safety issue and is required under the City of Sydney requirements for design of new buildings. The City of Sydney has a requirement that the external reflectivity of materials used on the facades of new buildings does not exceed 20%. The proposed building is to comply with this requirement.

This report should be read in conjunction with the DA Architectural documents prepared by JPW and referenced in Section 1.6.

1.3 Project Description

The ATP site is strategically located approximately 5km south of the Sydney CBD, 8km north of Sydney airport and within 200m of Redfern Railway Station. The site, with an overall area of some 13.2 hectares, is located within the City of Sydney local government area (LGA). Refer to Figure 1 below for a graphic representation of the site location and context.

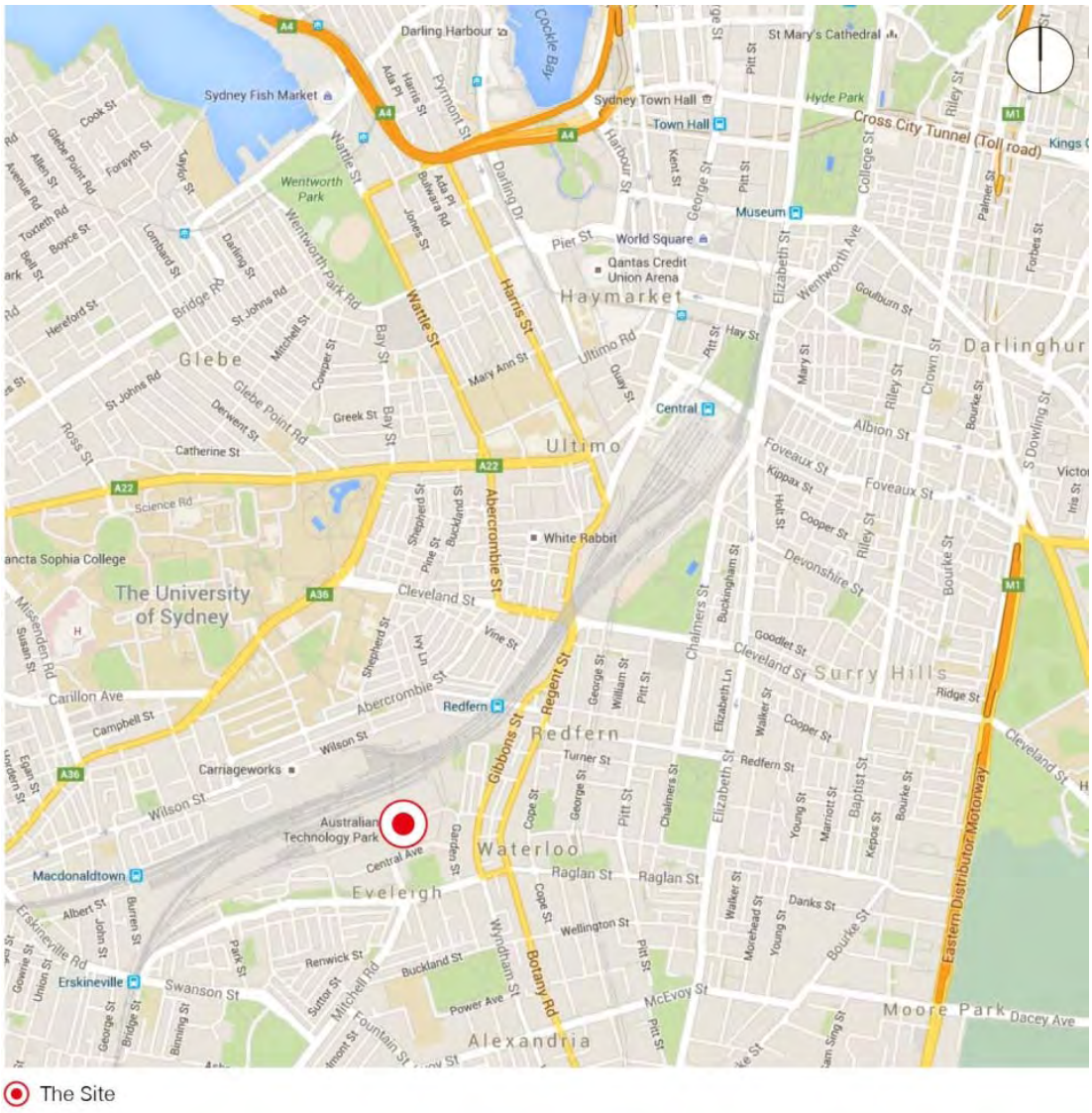


Figure 1 - Site Location and Context

Three key sites remain undeveloped within the ATP site and are presently used for at-grade worker and special event car parking. These sites are:

- Lot 8 in DP 1136859 – site area circa 1,937m^2;
- Lot 9 in DP 1136859 – site area circa 8,299m^2; and
- Lot 12 in DP 1136859 – site area circa 11,850m^2.

Figure 2 provides an aerial image of the ATP site along with identifying the three development sites.

The SSDA works boundary excludes the Locomotive Workshop. Future development associated with the adaptive re-use of the Locomotive Workshop will be the subject of separate future applications.

Figure 2 - Aerial Image of ATP Site

Overview of Proposed Development

The development application seeks approval for the following components of the development:

- Site preparation works, including demolition and clearance of the existing car parking areas/ancillary facilities and excavation;
- Construction and use of a 9 storey building within Lot 9 (Building 1), comprising of parking, retail, commercial and childcare uses;
- Construction and use of a 7 storey building within Lot 12 (Building 2) comprising of parking, retail and commercial uses;
- Construction and use of a 4 storey community building within Lot 8 (Community Building) comprising of gym, retail, community, commercial and childcare uses;
- Extensive landscaping and public domain improvements throughout the precinct for the benefit of the local community; and
- Extension and augmentation of physical infrastructure/utilities as required.

A more detailed and comprehensive description of the proposal is contained in the Environmental Impact Statement (EIS) prepared by JBA.

1.4 Site Location

The site has been assessed to determine appropriate viewpoints where drivers (red), and pedestrians when they are crossing the road (blue), are able to see the building façade in their direct line of vision.

It has been assessed that the building is visible to drivers from the following locations:

- Travelling west on Locomotive Street entering the site (VP1)
- Travelling west on Central Avenue entering the site (VP2)
- Travelling west on Henderson Road (VP3)
- Travelling north on Davy Road entering the site (VP4)
- Travelling east on Henderson Road at a near and far distance (VP5 and VP6)
- Travelling east on Rowley Street (VP7)
- Travelling east on Central Avenue (VP8 and VP9)
- Travelling west on Central Avenue (VP10)
- Travelling east on Locomotive Street (VP11)

It is also directly visible to pedestrians crossing roads at pedestrian crossings at the the following locations:

- Crossing south at Locomotive Street (VPA and VPL)
- Crossing north at Central Avenue (VPB, VPJ and VPM)
- Crossing at the pedestrian crossings at Henderson and Davy Road (VPC, VPD, VPE and VPF)
- Crossing east at Alexander Street (VPG)
- Crossing south at Central Avenue (VPH, VPI and VPK)

Figure 3 - Satellite Image with Viewpoints[1]

[1] Image from Google Maps

1.4.1 Site Orientation

There are three separate building on the site that have been considered in this report. The buildings have had façade aspects calculated relative to map north (true north). The façade aspects for the three building are shown in Figure 4, Figure 5 and Figure 6 below

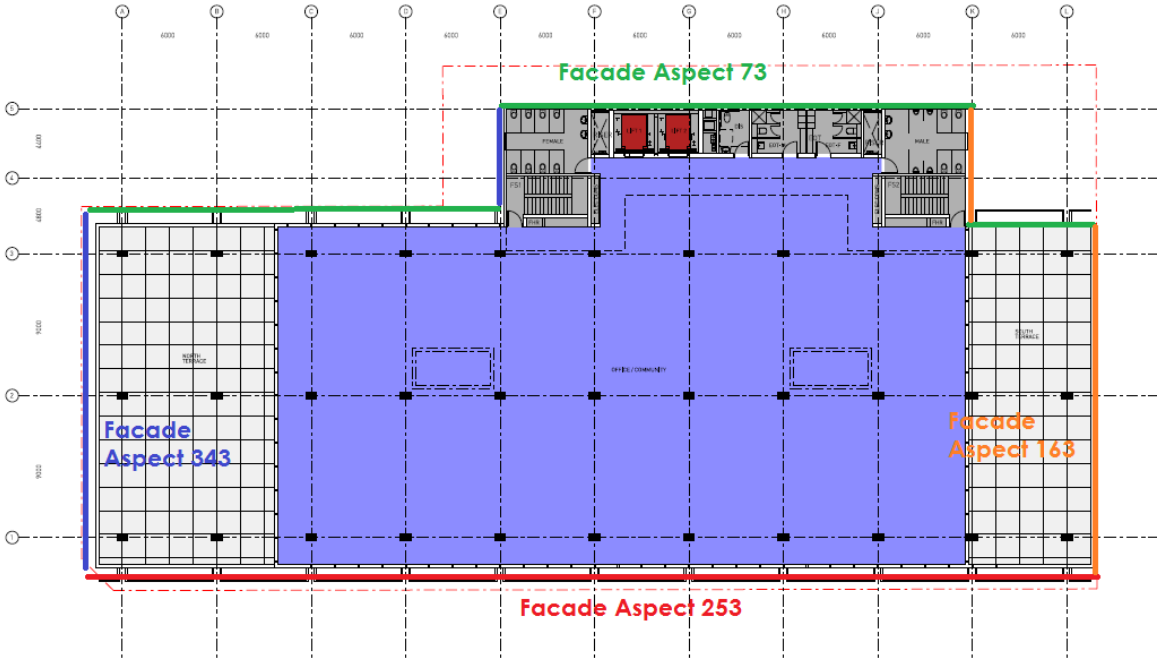


Figure 4 – Community Building with Façade Aspects

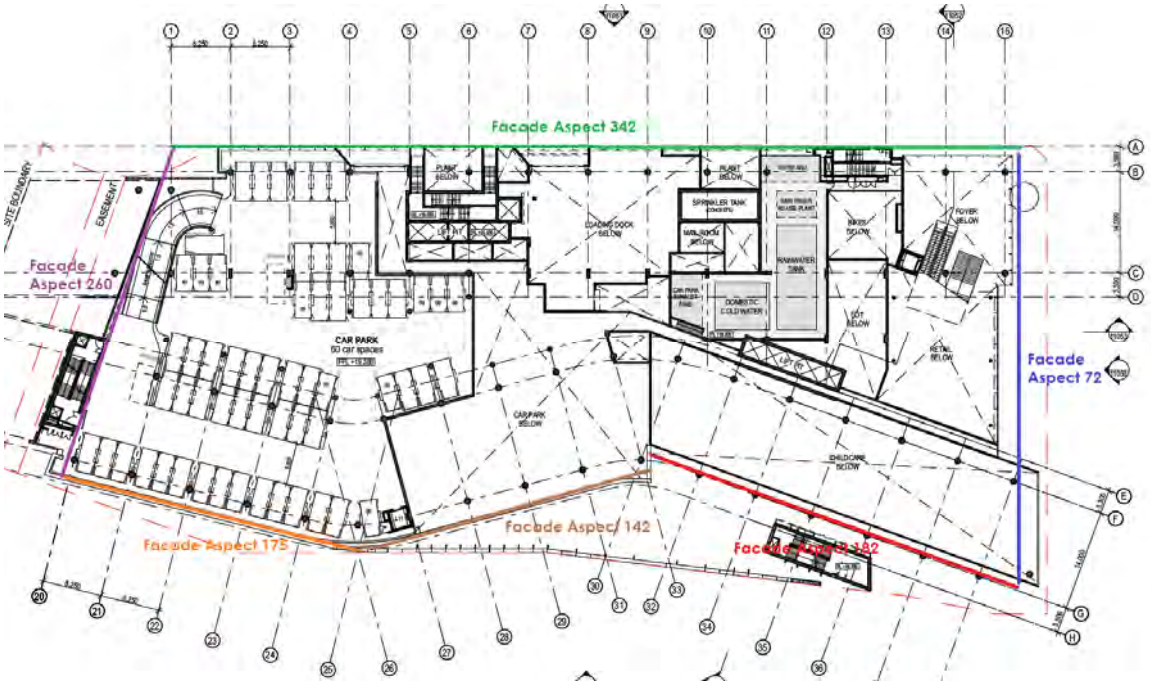


Figure 5 – Building 1 with Façade Aspects

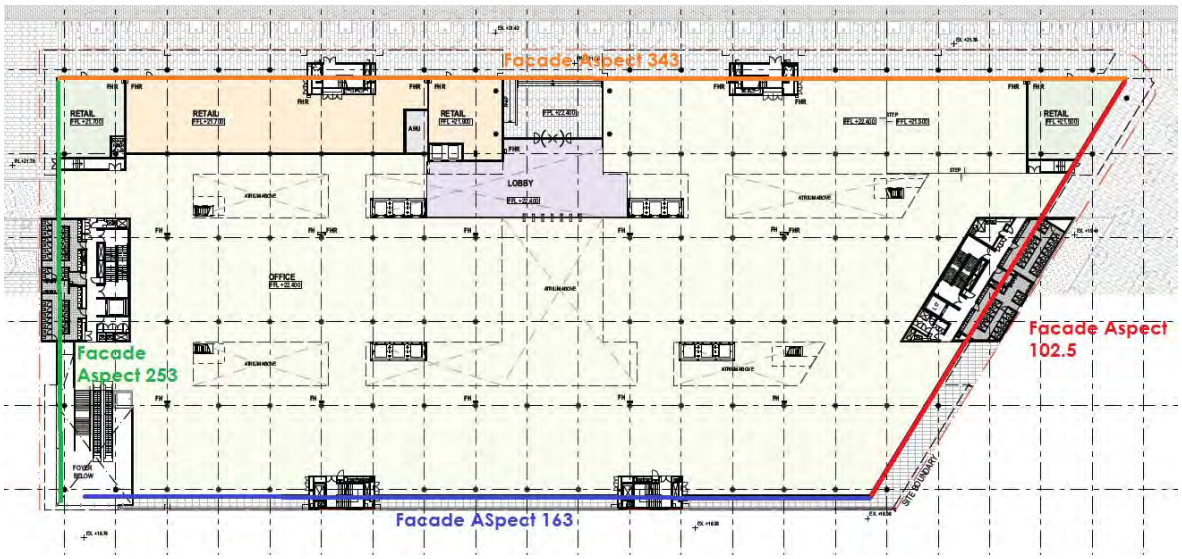


Figure 6 – Building 2 Façade Aspects

1.5 Stereographic Sun Chart

The position of the sun in the sky throughout the year varies depending on the latitude of the location of assessment. A stereographic sun chart is a two dimensional representation of this path of the sun for a particular line of latitude.

This chart is used in order to determine the location of a virtual reflected sun in accordance with the Hassall methodology in order to assess the potential for glare. Refer to Section 2 of this report for more detailed information on the assessment methodology

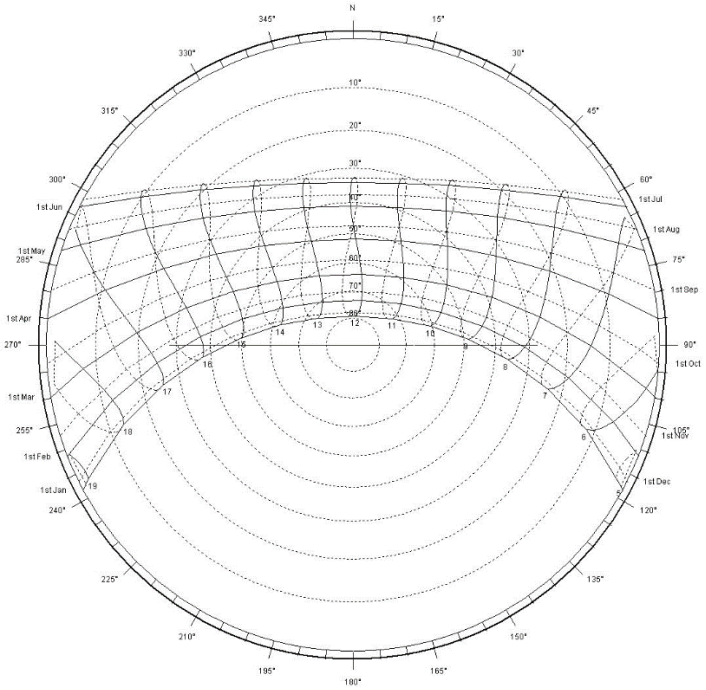


Figure 7 – Stereographic Sun Chart for Sydney (34 degree latitude)

1.6 Referenced Documents

1.6.1 General

Drawing Number	Revision	Authoring Company	Status
fjmt-AR-DWG-1000	DA0	FJMT	DA Submission
fjmt-AR-DWG-1001	DA0	FJM	DA Submission
fjmt-AR-DWG-1002	DA0	FJMT	DA Submission
fjmt-AR-DWG-1003	DA0	FJMT	DA Submission

1.6.2 Building 1

Drawing Number	Revision	Authoring Company	Status
fjmt-AR-DWG-1100L	DA0	FJMT	DA Submission
fjmt-AR-DWG-1100M	DA0	FJM	DA Submission
fjmt-AR-DWG-1100U	DA0	FJMT	DA Submission
fjmt-AR-DWG-11001	DA0	FJMT	DA Submission
fjmt-AR-DWG-11002	DA0	FJMT	DA Submission
fjmt-AR-DWG-11003	DA0	FJM	DA Submission
fjmt-AR-DWG-11004	DA0	FJMT	DA Submission
fjmt-AR-DWG-11005	DA0	FJMT	DA Submission
fjmt-AR-DWG-11006	DA0	FJMT	DA Submission
fjmt-AR-DWG-11007	DA0	FJM	DA Submission
fjmt-AR-DWG-11008	DA0	FJMT	DA Submission
fjmt-AR-DWG-11009	DA0	FJMT	DA Submission
fjmt-AR-DWG-11050	DA0	FJMT	DA Submission
fjmt-AR-DWG-11051	DA0	FJM	DA Submission
fjmt-AR-DWG-11052	DA0	FJMT	DA Submission
fjmt-AR-DWG-11053	DA0	FJMT	DA Submission

1.6.3 Building 2

Drawing Number	Revision	Authoring Company	Status
fjmt-AR-DWG-2100L	DA0	FJMT	DA Submission
fjmt-AR-DWG-2100M	DA0	FJM	DA Submission
fjmt-AR-DWG-2100U	DA0	FJMT	DA Submission
fjmt-AR-DWG-21001	DA0	FJMT	DA Submission
fjmt-AR-DWG-21002	DA0	FJMT	DA Submission
fjmt-AR-DWG-21003	DA0	FJM	DA Submission
fjmt-AR-DWG-21004	DA0	FJMT	DA Submission
fjmt-AR-DWG-21005	DA0	FJMT	DA Submission
fjmt-AR-DWG-21006	DA0	FJMT	DA Submission
fjmt-AR-DWG-21007	DA0	FJM	DA Submission

fjmt-AR-DWG-21050	DA0	FJMT	DA Submission
fjmt-AR-DWG-21051	DA0	FJMT	DA Submission
fjmt-AR-DWG-21052	DA0	FJMT	DA Submission
fjmt-AR-DWG-21053	DA0	FJMT	DA Submission
fjmt-AR-DWG-21054	DA0	FJMT	DA Submission

1.6.4 Community Building

Drawing Number	Revision	Authoring Company	Status
SisArch-AR-DWG-3100B	DA0	Sissons	DA Submission
SisArch-AR-DWG-3100G	DA0	Sissons	DA Submission
SisArch-AR-DWG-31001	DA0	Sissons	DA Submission
SisArch-AR-DWG-31002	DA0	Sissons	DA Submission
SisArch-AR-DWG-31003	DA0	Sissons	DA Submission
SisArch-AR-DWG-31004	DA0	Sissons	DA Submission
SisArch-AR-DWG-31005	DA0	Sissons	DA Submission
SisArch-AR-DWG-31050	DA0	Sissons	DA Submission
SisArch-AR-DWG-31060	DA0	Sissons	DA Submission

2. Assessment Methodology

2.1 Analysis Philosophy

The glare assessment has been carried out as per the methodology outlined in the technical bulletin "Reflectivity: Dealing with Rogue Solar Reflections" written by David Hassall from the Faculty of Architecture at the University of New South Wales.

This methodology defines a glare (I_v) limit of 500 candelas/m^2, calculated to the Holladay formula, to which a driver can be exposed without causing disability.

Viewpoints have been defined from which it is expected that either drivers or pedestrians where they are crossing the road, are able to see the building. A stereographic sun path diagram and the building geometry are then used to determine whether a viewpoint will be subject to the reflected sun during the year.

A glare protractor, oriented in the direction of drivers or pedestrians as appropriate, is used to determine the glare based on the reflectivity of the surface and the apparent angle of viewing.

2.2 Virtual Sun Location

The virtual suns location is determined with the stereographic sun chart for the project location.

This is completed by plotting the virtual sin on the stereographic sun chart based on the orientation of the façade. The apparent reflective surface of the façade is plotted based on the bounding horizontal and vertical angles from the viewpoint.

2.3 Glare Assessment

In order to allow assessment of buildings for glare David Hassall has developed a glare protractor that provides a diagrammatic limit of 500 candelas/m^2 based on viewing angle and inclination and reflectivity of the viewing surface. This glare protractor is shown in Figure 9 and is used where the stereographic sun path indicates that there is glare to a particular viewpoint.

A brief description of the calculation of the glare (equivalent veiling luminance) is provided below for reference. The glare protractor has thereafter been used in this assessment.

The equivalent veiling luminance (I_v) is calculated based on the Holladay formula (1), which defines the illumination of a viewer's eye based on a calculated illuminance perpendicular to the surface (EG) and a factor based on the angle of viewing (Θ).

$$I_v = 10 \times EG \div \Theta^2 \quad (1)$$

The angle of viewing (Θ) is based on the angle between the direct line of sight and the glare source (α) and the inclination between a viewing normal and the glare source (β). This is calculated with trigonometry based on Equation 2 below and is shown diagrammatically in Figure 8.

$$\Theta = ATAN \times [\sqrt{\{\tan^2(\beta) + \sin^2(\alpha)\}} \div \cos(\alpha)] \quad (2)$$

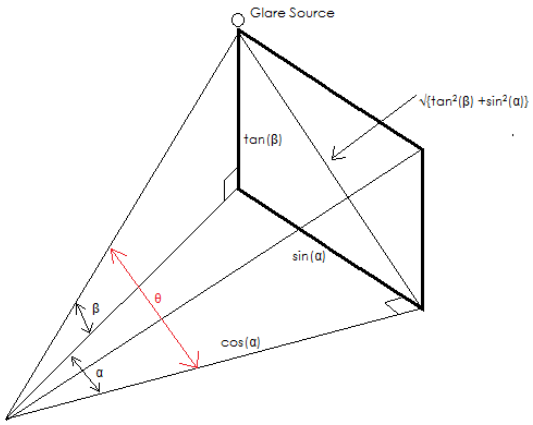


Figure 8 – Diagrammatic Angle of Viewing Calculation

The illumination of the viewer's eye normal to the light source (EG) is calculated based on the solar illumination (E), the reflectivity of the surface (R) and the angle of viewing (Θ) calculated in Equation

2. The solar illumination is calculated in Equation 4 based on the solar power (W), which is dependent on the inclination of the virtual sun (β) and the luminance efficacy (l_e).

$$EG = E \times R \times \cos(\theta) \quad (3)$$

$$E = W \times l_e \quad (4)$$

The solar power is determined as 50 watts per degree up to 10 degrees and 15 watts per degree thereafter.

The luminance efficacy is 90 lumens/watt at 7.5° and 117 lumens/watt at 25° and is interpolated for other angles.

The glare protractor by Hassall joins points at incremental reflectivity (iso-glare loops) with varying α and β values in order to set a limit where the equivalent veiling luminance is limited to 500 candelas/m^2.

By overlaying the glare protractor on a photo or computer generated image in the direction of viewing and aligning the verticals with the building it is possible to graphically determine the maximum reflectivity to not cause disability glare.

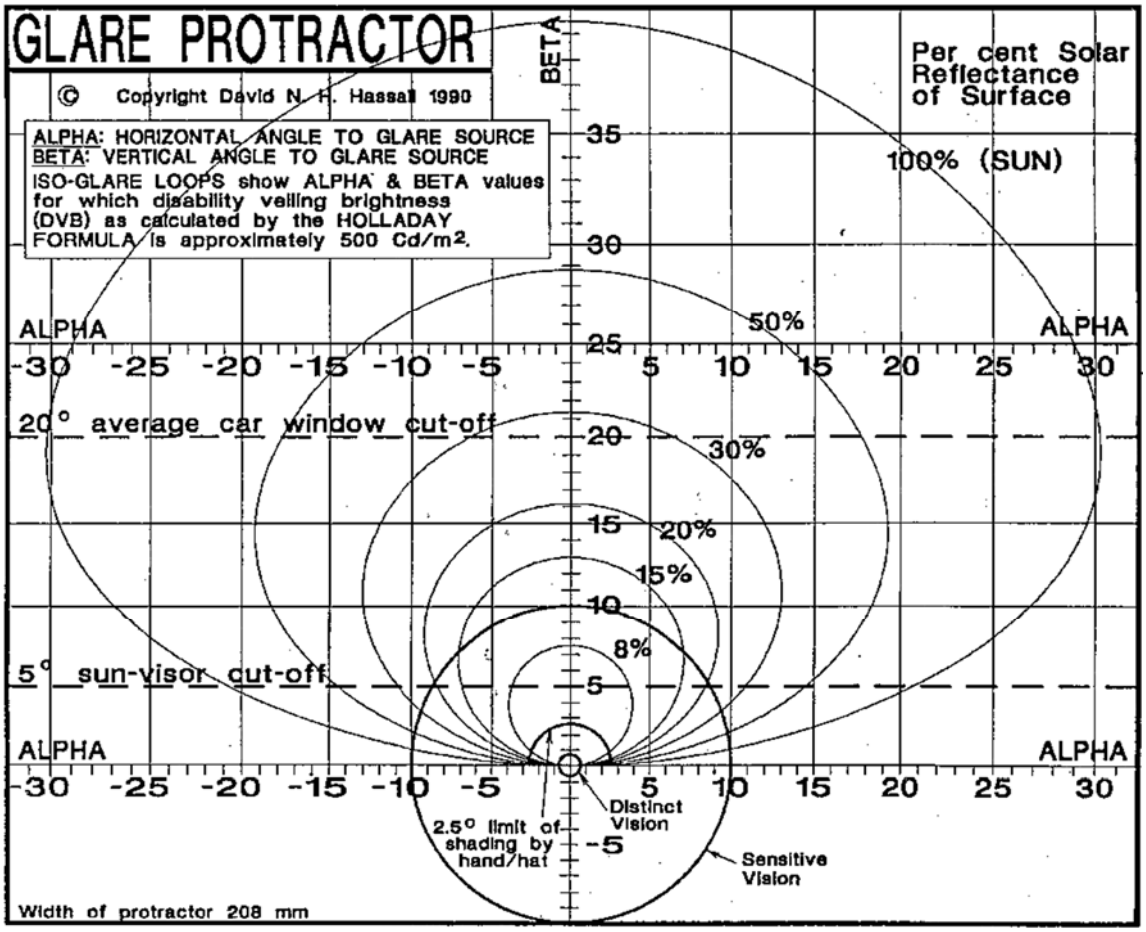


Figure 9 – Glare Protractor[2]

[2] "Reflectivity: Dealing with Rogue Solar Reflections" – David Hassall

3. Results

3.1 General

The façade has been assessed from each viewpoint identified in Section 1 of the report.

For determining the vertical bearing angle the height of each building is:

- Building 1: 31.6m
- Building 2: 33.7m
- Community Building: 16m

Where it is identified that there is reflected image the glare protractor is applied in order to determine the maximum reflectivity allowable on the façade surface to achieve a maximum equivalent veiling luminance of 500 candelas/m^2.

Detailed results have been included as part of Appendix A. A summary of these results is provided in this section.

3.2 Viewpoint 1

Viewpoint 1 has been taken at a distance of 37m from the north-east apex of Building 2. It has been taken from the viewpoint of a driver travelling south-west on the site.

The path of the reflected sun has been plotted for the 102.5 façade aspect of Building 2 that is visible from this viewpoint, refer to Appendix A.

There is no reflected image of the sun that forms from this viewpoint. No further studies are required.

3.3 Viewpoint 2

Viewpoint 2 has been taken at a distance of 33m from the south-east apex of Building 2. It has been is taken from the viewpoint of a driver travelling west on the site.

The path of the reflected sun has been plotted for the 102.5° and 163° façade aspects of Building 2 that are visible from this viewpoint, refer to Appendix A.

A reflected image forms from the 102.5° façade aspect however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

There is no reflected image on façade aspect 163° from this viewpoint. No further studies are required.

3.4 Viewpoint 3

Viewpoint 3 has been taken at a distance of 76m from the south-west apex of the Community Building and 105m from the south-east apex of Building 1. It has been taken from the viewpoint of a driver travelling west on Henderson Road.

The path of the reflected sun has been plotted for the 163° façade aspect of the Community Building and the 182°, 142° and 172° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 163° of the Community Building from this viewpoint. No further studies are required.

A reflected image forms from the 182° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

There is no reflected image on façade aspect 142° from this viewpoint. No further studies are required.

A reflected image forms from the 175° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.5 Viewpoint 4

Viewpoint 4 has been taken at a distance of 52m from the south-west apex of the Community Building and 65m from the south-east apex of Building 1.

The path of the reflected sun has been plotted for the 163° and 253° façade aspects of the Community Building and the 102.5°, 182° and 142° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 163° of the Community Building from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 253° of the Community Building from this viewpoint. No further studies are required.

A reflected image forms from the 102.5° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

A reflected image forms from the 182° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

There is no reflected image on façade aspect 142° of Building 1 from this viewpoint. No further studies are required.

3.6 Viewpoint 5

Viewpoint 5 has been taken at a distance of 77m from the south-west apex of the Community Building and 60m from the south-east apex of Building 1.

The path of the reflected sun has been plotted for the 163° and 253° façade aspects of the Community Building and the 182° façade aspect of Building 1 that is visible from this viewpoint, refer to Appendix A.

A reflected image forms from the 163° façade aspect of the Community Building however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

There is no reflected image on façade aspect 253° of the Community Building from this viewpoint. No further studies are required.

A reflected image forms from the 182° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.7 Viewpoint 6

Viewpoint 6 has been taken at a distance of 95m from the south-west apex of Building 1. It has been taken from the viewpoint of a driver travelling east on Henderson Road.

The path of the reflected sun has been plotted for the 175° and 260° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

A reflected image forms from the 175° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

A reflected image forms from the 260° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.8 Viewpoint 7

Viewpoint 7 has been taken at a distance of 93m from the north-west apex of Building 1. It has been taken from the viewpoint of a driver travelling east on Rowley Street.

The path of the reflected sun has been plotted for the 260° and 342° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There are potential reflections from Building 1 on the 260° façade aspect and the viewpoint has been assessed with the Hassall glazing protractor overlaid on a photo in Appendix A. Further assessment and treatment of the façade to manage reflections is required.

There are potential reflections from Building 1 on the 342° façade aspect and the viewpoint has been assessed with the Hassall glazing protractor overlaid on a photo in Appendix A. Further assessment and treatment of the façade to manage reflections is required.

3.9 Viewpoint 8

Viewpoint 8 has been taken at a distance of 30m from the north-west apex of Building 1 and 175m from the north-west apex of the Community Building. It has been taken from the viewpoint of a driver turning at the roundabout between Building 1 and the Channel 7 building.

The path of the reflected sun has been plotted for the 253° façade aspect of the Community Building and the 260° and 342° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There are potential reflections from the Community Building on the 253° façade aspect and the viewpoint has been assessed with the Hassall glazing protractor overlaid on a photo in Appendix A. Further assessment and treatment of the façade to manage reflections is required.

There is no reflected image on façade aspect 260° of the Community Building from this viewpoint. No further studies are required.

There are potential reflections from Building 1 on the 342° façade aspect and the viewpoint has been assessed with the Hassall glazing protractor overlaid on a photo in Appendix A. Further assessment and treatment of the façade to manage reflections is required.

3.10 Viewpoint 9

Viewpoint 9 has been taken at a distance of 50m from the north-west apex of the Community Building and 65m from the south-west apex of Building 2.

The path of the reflected sun has been plotted for the 253° and 343° façade aspects of the Community Building and the 163° and 253° façade aspects of Building 2 that are visible from this viewpoint, refer to Appendix A.

There are potential reflections from Building 2 on the 163° façade aspect and the viewpoint has been assessed with the Hassall glazing protractor overlaid on a photo in Appendix A. Further assessment and treatment of the façade to manage reflections is required.

A reflected image forms from the 253° façade aspect of Building 2 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

There is no reflected image on façade aspect 253° of the Community Building from this viewpoint. No further studies are required.

A reflected image forms from the 343° façade aspect of the Community Building however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.11 Viewpoint 10

Viewpoint 10 has been taken at a distance of 45m from the north-west apex of the Community Building, a distance of 70m from the north-east apex of Building 1, and a distance of 30m from the south-west apex of Building 2.

The path of the reflected sun has been plotted for the 73° and 343° façade aspects of the Community Building, 342° façade aspect of Building 1 and the 163° façade aspect of Building 2 that are visible from this viewpoint, refer to Appendix A.

A reflected image of façade aspect 73° of the Community Building would form however it is obstructed by an existing building. No further studies required.

A reflected image of façade aspect 343° of the Community Building and Building 1 would form however it is anticipated that the existing Channel 7 building obstructs the sun during this time and provides over shadowing to the façade, and that the external screen will provide glare amelioration.

There is no reflected image on façade aspect 163° of Building 2 from this viewpoint. No further studies are required.

3.12 Viewpoint 11

Viewpoint 11 has been taken at a distance of 85m from the north-west apex of Building 2. It has been taken from the viewpoint of a driver travelling north-east on Locomotive Street.

The path of the reflected sun has been plotted for the 253° and 343° façade aspects of Building 2 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 253° of Building 2 from this viewpoint. No further studies are required.

There are potential reflections from Building 2 on the 343° façade aspect. A shading study has been completed by FJMT at 7am in June, which shows that the north elevation of Building 2 is shaded by adjacent buildings during the times that would cause glare. No further studies are required.

3.13 Viewpoint A

Viewpoint A has been taken at a distance of 58m from the north-west apex of Building 2. It has been taken from the viewpoint of a pedestrian crossing Locomotive Street.

The path of the reflected sun has been plotted for the 102.5° and 343° façade aspects of Building 2 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 102.5° of Building 2 from this viewpoint. No further studies are required.

There are potential reflections from Building 2 on the 343° façade aspect and the viewpoint has been assessed with the Hassall glazing protractor overlaid on a photo in Appendix A. Further assessment and treatment of the façade to manage reflections is required.

3.14 Viewpoint B

Viewpoint B has been taken at a distance of 25m from the south-west apex of Building 2. It has been taken from the viewpoint of a pedestrian crossing Central Avenue.

The path of the reflected sun has been plotted for the 102.5° and 163° façade aspects of Building 2 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 102.5° of Building 2 from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 163° of Building 2 from this viewpoint. No further studies are required.

3.15 Viewpoint C

Viewpoint C has been taken at a distance of 70m from the south-west apex of the Community Building and a distance of 90m from the south-east apex of Building 1. It has been taken from the viewpoint of a pedestrian crossing Henderson Road.

The path of the reflected sun has been plotted for the 163° and 253° façade aspects of the Community Building and the 142°, 175° and 182° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 163° of the Community Building from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 253° of the Community Building from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 142° of Building 1 from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 175° of Building 1 from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 182° of Building 1 from this viewpoint. No further studies are required.

3.16 Viewpoint D

Viewpoint D has been taken at a distance of 70m from the south-west apex of the Community Building and a distance of 90m from the south-east apex of Building 1.

The path of the reflected sun has been plotted for the 163° and 253° façade aspects of the Community Building and the 142°, 175° and 182° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 163° of the Community Building from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 253° of the Community Building from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 142° of Building 1 from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 175° of Building 1 from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 182° of Building 1 from this viewpoint. No further studies are required.

3.17 Viewpoint E

Viewpoint E has been taken at a distance of 90m from the south-east apex of Building 1. It has been taken from the viewpoint of a pedestrian crossing west on Davy Road.

The path of the reflected sun has been plotted for the 142° and 182° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 142° of Building 1 from this viewpoint. No further studies are required.

A reflected image forms from the 182° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.18 Viewpoint F

Viewpoint F has been taken at a distance of 70m from the south-west apex of the Community Building and a distance of 90m from the south-east apex of Building 1.

The path of the reflected sun has been plotted for the 163° and 253° façade aspects of the Community Building that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 163° of the Community Building from this viewpoint. No further studies are required.

There is no reflected image on façade aspect 253° of the Community Building from this viewpoint. No further studies are required.

3.19 Viewpoint G

Viewpoint G has been taken at a distance of 95m from the south-west apex of Building 1. It has been taken from the viewpoint of a pedestrian crossing Alexander Street at the daycare.

The path of the reflected sun has been plotted for the 260° façade aspect of Building 1 that is visible from this viewpoint, refer to Appendix A.

A reflected image forms from the 260° façade aspect of Building 1. From the image taken at site it can be seen that the elevation falls within the 20% iso-loop but outside the 15% isoloop. The west elevation of Building 1 has solid cladding which will be limited to an external reflectivity of 15%.

3.20 Viewpoint H

Viewpoint H has been taken at a distance of 130m from the north-west apex of the Community Building and a distance of 28m from the north-west apex of Building 1. It has been taken from the viewpoint of a pedestrian crossing south on Central Avenue.

The path of the reflected sun has been plotted for the 253° façade aspects of the Community Building and the 342° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

A reflected image forms from the 253° façade aspect of the Community Building however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

A reflected image forms from the 342° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.21 Viewpoint I

Viewpoint I has been taken at a distance of 70m from the north-west apex of the Community Building and a distance of 20m perpendicular to Façade Aspect 342 of Building 1. It has been taken from the viewpoint of a pedestrian crossing south on Central Avenue.

The path of the reflected sun has been plotted for the 253° and 342° façade aspects of the Community Building and the 342° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 253° of the Community Building from this viewpoint. No further studies are required.

A reflected image forms from the 342° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.22 Viewpoint J

V Viewpoint J has been taken at a distance of 27m from the south-west apex of Building 2. It has been taken from the viewpoint of a pedestrian north on Central Avenue.

The path of the reflected sun has been plotted for the 163° and 253° façade aspects of Building 2 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 163° of Building 2 from this viewpoint. No further studies are required.

There are potential reflections from Building 2 on the 253° façade aspect and the viewpoint has been assessed with the Hassall glazing protractor overlaid on a photo in Appendix A. Further assessment and treatment of the façade to manage reflections is required.

3.23 Viewpoint K

Viewpoint H has been taken at a distance of 28m from the north-west apex of the Community Building and a distance of 41m to the north-east apex of Building 1. It has been taken from the viewpoint of a pedestrian crossing south on Central Avenue.

The path of the reflected sun has been plotted for the 342° façade aspect of the Community Building and the 72° and 342° façade aspects of Building 1 that are visible from this viewpoint, refer to Appendix A.

There is no reflected image on façade aspect 72° of Building 1 from this viewpoint. No further studies are required.

A reflected image forms from the 342° façade aspect of Building 1 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

There is no reflected image on façade aspect 343° of the Community Building from this viewpoint. No further studies are required.

3.24 Viewpoint L

Viewpoint L has been taken at a distance of 20m perpendicular from Building 2. It has been taken from the viewpoint of a pedestrian crossing south on Locomotive Street.

The path of the reflected sun has been plotted for the 343° façade aspects of Building 2 that is visible from this viewpoint, refer to Appendix A.

A reflected image forms from the 342° façade aspect of Building 2 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

3.25 Viewpoint M

Viewpoint M has been taken at a distance of 48m from the south-west apex of Building 2. It has been taken from the viewpoint of a pedestrian crossing east on Davy Road.

The path of the reflected sun has been plotted for the 163° and 253° façade aspects of Building 2 that are visible from this viewpoint, refer to Appendix A.

A reflected image forms from the 163° façade aspect of Building 2 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

A reflected image forms from the 253° façade aspect of Building 2 however it does not fall within the 20% reflectivity iso-loop. No further studies are required.

4. Conclusion

This reflectivity study has been carried out in order to address the potential for disability glare to pedestrians and drivers caused by this project. This report details additional requirements, beyond the City of Sydney requirement for the external reflectivity of all façade materials to be less than 20%, for the project façade in order to prevent the occurrence of disability glare.

The analysis has been completed based on the architectural drawings for DA.

The glare assessment has been carried out as per the methodology outlined in the technical bulletin "Reflectivity: Dealing with Rogue Solar Reflections" written by David Hassall.

The three new buildings that will form part of the project have been assessed.

A total of 24 viewpoints have been selected for this study to represent possible views from drivers and pedestrians of the proposed project.

Reflection of the sun will be controlled through the selection of low reflectivity surfaces and the use of glare amelioration devices. This will require further review and detailed design with the design team.

Based on the assessment carried out it has been determined that there is a requirement to manage the reflectivity, beyond the City of Sydney minimum requirements of 20% external reflectivity, on the following elevations:

- Façade Aspect 260 of Building 1
- Façade Aspect 342 of Building 1
- Façade Aspect 253 of the Community Building
- Façade Aspect 163 of Building 2
- Façade Aspect 343 of Building 2

Mitigation of rogue reflections will be controlled through the selection of low reflectivity surfaces and the use of glare amelioration devices such as vertical or horizontal fin features. This will require further review and detailed design with the design team.

All viewpoints considered have been analysed and it has been determined that the risk of rogue reflections causing disability glare are limited and acceptable.

Appendix A

Appendix A – Detailed Results

Viewpoint 1

Viewpoint 1 is taken from the viewpoint of a driver travelling south-west on the site. The viewing angle of the driver is 255°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 102.5

Viewpoint 1 has been taken at a distance of 37m from the north-east apex of Building 2.

On Figure 10 below yellow lines have been drawn to represent the bearing angles to the one visible façade aspect of the building. The red arrow indicated the direction of travel and viewing.

Figure 10 – Viewpoint 1 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 1.

$\beta_{Building\ 2}$ = $\tan^{-1}(30.7m \div 37m)$

= 39.7°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 2 – Façade Aspect 102.5	0°	39.7°	204°	245°

These bearing angles have been plotted on the reflected sun path diagram in Figure 11.

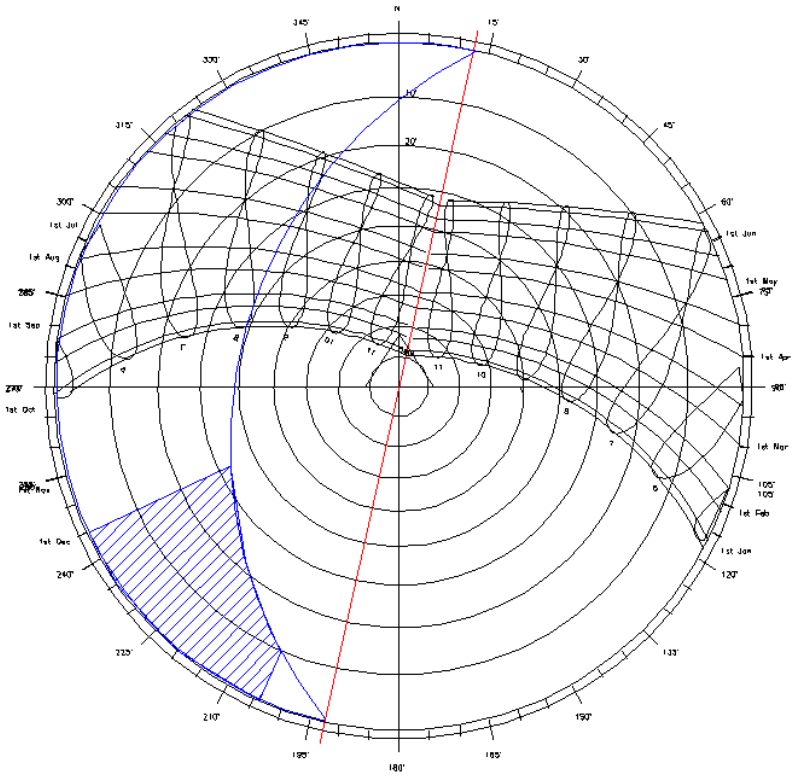


Figure 11 – 102.5° Façade Aspect Reflected Virtual Sun from Viewpoint 1

There is no reflected image of the sun that reaches Viewpoint 1 from Façade Aspect 102.5 of the building.

Viewpoint 2

Viewpoint 2 is taken from the viewpoint of a driver travelling west on the site. The viewing angle of the driver is 270°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 102.5
- Building 2 Façade Aspect 163

Viewpoint 2 has been taken at a distance of 33m from the south-east apex of Building 2.

On Figure 12 below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 12 – Viewpoint 2 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 2.

$\beta_{Building\ 2}$ = $\tan^{-1}(33.7m \div 33m)$

= 45.6°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 2 – Façade Aspect 102.5	0°	45.6°	322°	358°
Building 2 – Façade Aspect 163	0°	45.6°	261°	322°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 13 and Figure 14 below.

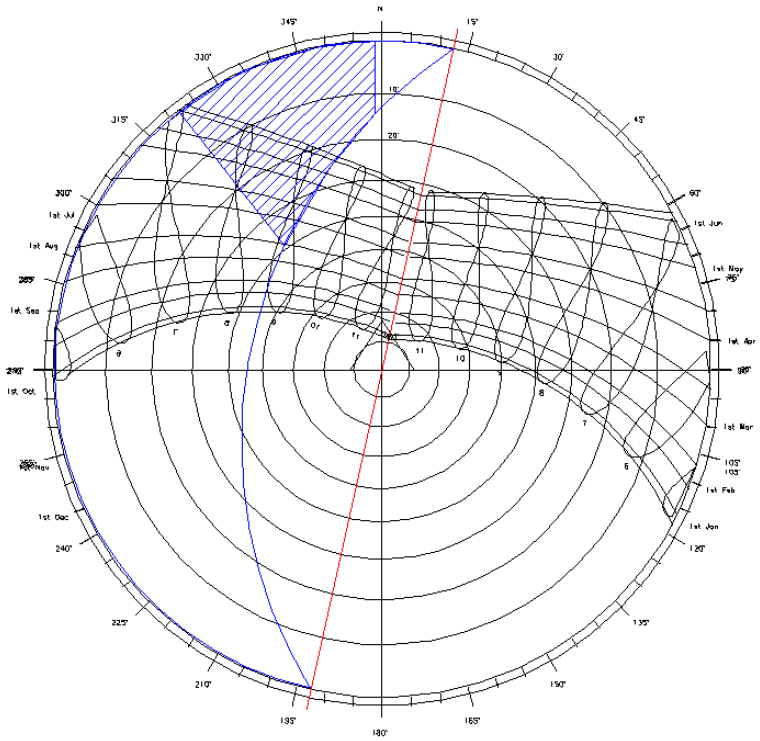
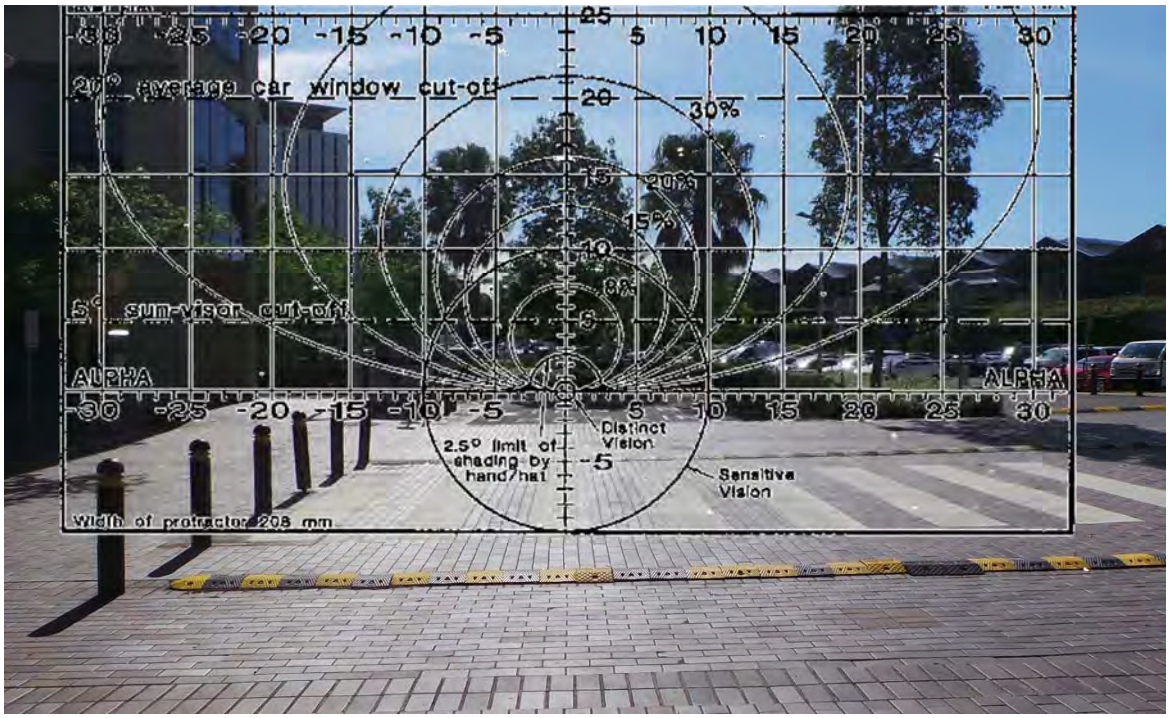


Figure 13 – 102.5° Façade Aspect Reflected Virtual Sun from Viewpoint 2

There is a reflected image of the sun that reaches Viewpoint 2 from Façade Aspect 102.5 of Building 2. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale.



From the image above it can be seen that Façade aspect 102.5 of building 2 is not within the 20% reflectivity iso-loop.

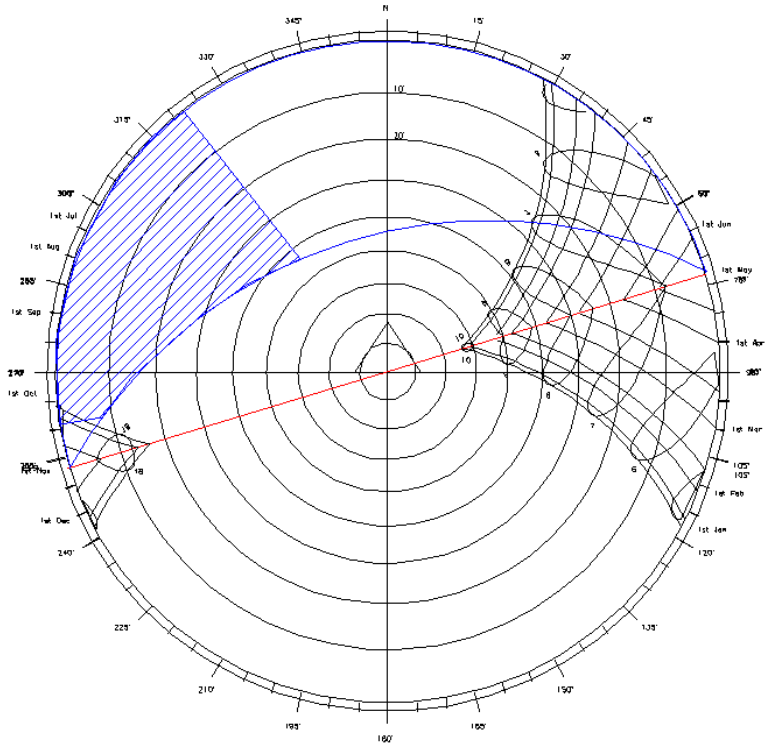


Figure 14 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint 2

There is no reflected image of the sun that reaches Viewpoint 2 from Façade Aspect 163 of building 2.

Viewpoint 3

Viewpoint 3 is taken from the viewpoint of a driver travelling west on Henderson Road. The viewing angle of the driver is 255°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 163
- Building 1 Façade Aspect 182
- Building 1 Façade Aspect 142
- Building 1 Façade Aspect 175

Viewpoint 3 has been taken at a distance of 76m from the south-west apex of the Community Building.

Viewpoint 3 has been taken at a distance of 105m from the south-east apex of Building 1.

On Figure 15 below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 15 – Viewpoint 3 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 3.

$\beta_{Community} = \tan^{-1}(16m \div 76m)$

$= 11.9°$

$\beta_{Building\ 1} = \tan^{-1}(31.6m \div 105m)$

$= 16.8°$

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 163	0°	11.9°	329°	346°
Building 1 – Façade Aspect 182	0°	16.8°	290°	312°
Building 1 – Façade Aspect 142	0°	16.8°	280°	290°
Building 1 – Façade Aspect 175	0°	16.8°	275°	280°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 16, Figure 17, Figure 18 and Figure 19 below.

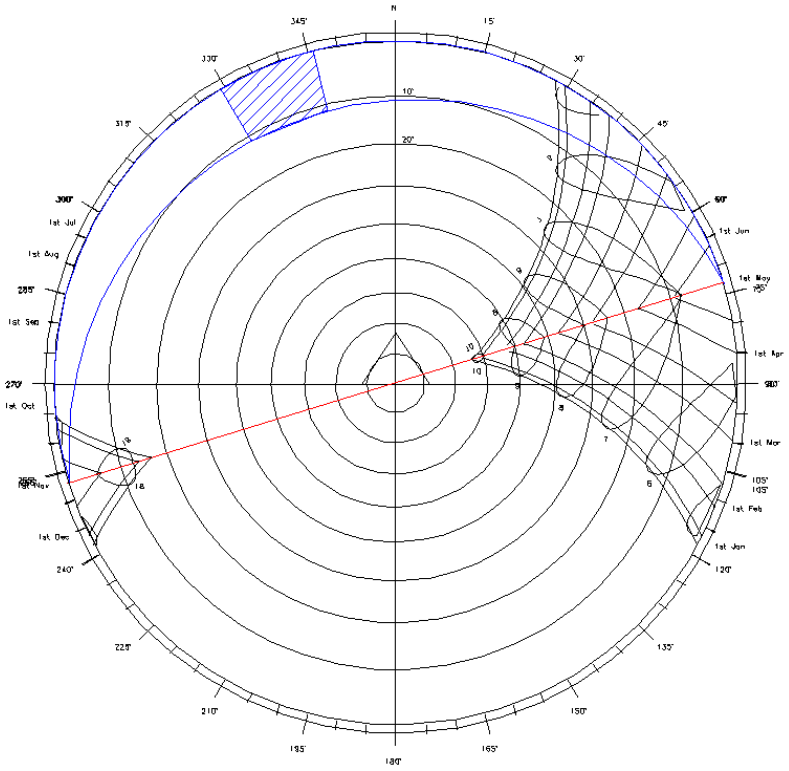


Figure 16 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint 3

There is no reflected image of the sun that reaches Viewpoint 3 from Façade Aspect 163 of the Community Building.

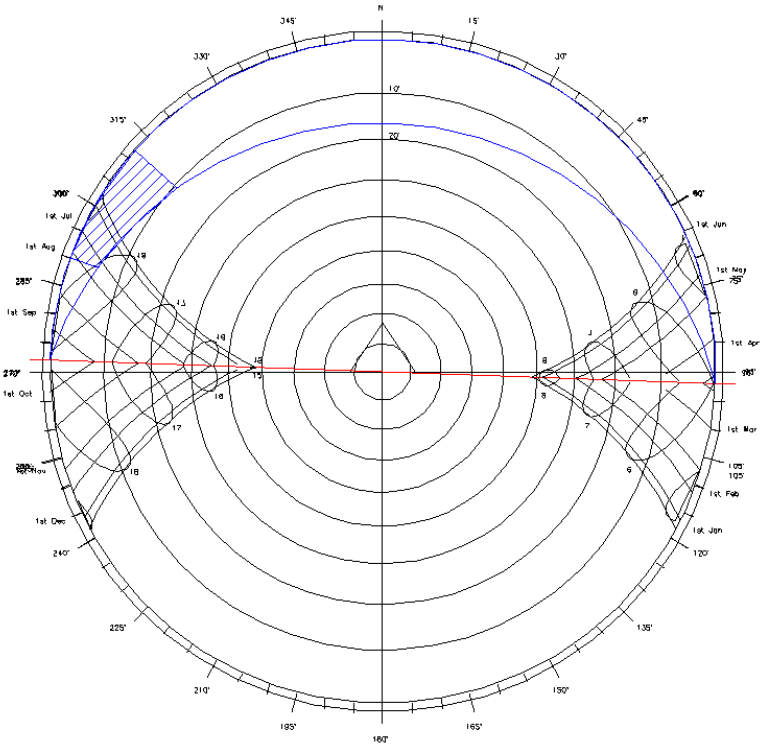
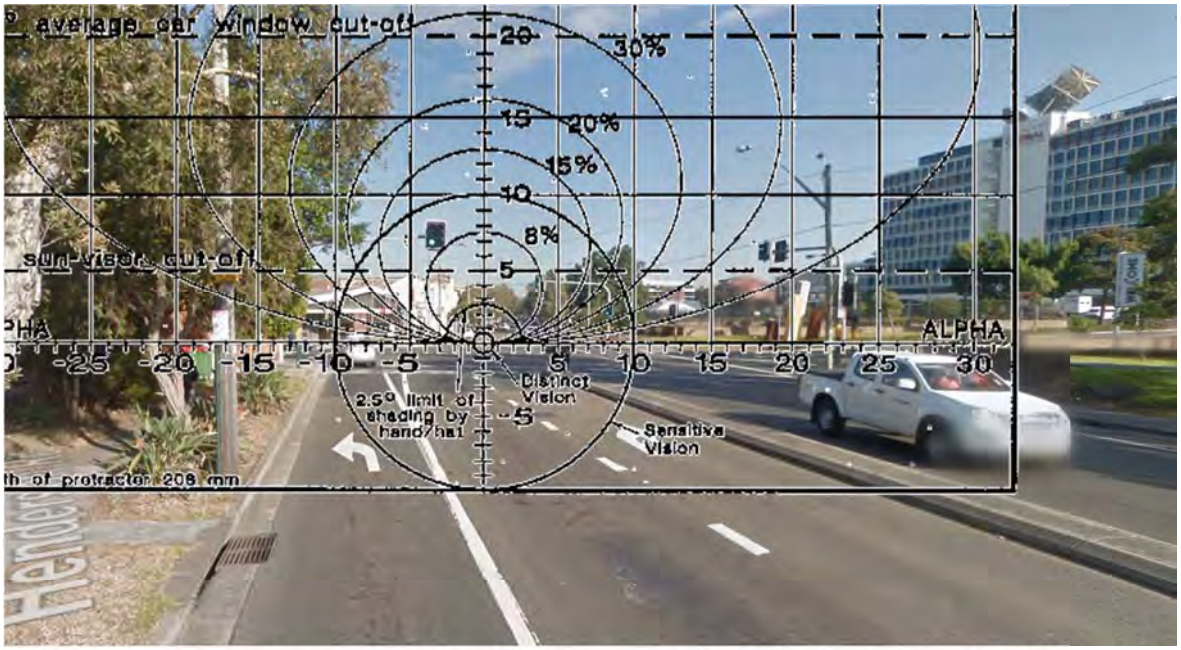


Figure 17 – 182° Façade Aspect Reflected Virtual Sun from Viewpoint 3

There is a reflected image of the sun that reaches Viewpoint 3 from Façade Aspect 182 of Building 1. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale. The south-west corner of the Channel 7 building is approximately 18° from the viewing angle of the driver.



From the image above it can be seen that the new building is outside the 20% iso-glare loop as it will be beyond the tree line. No further studies required.

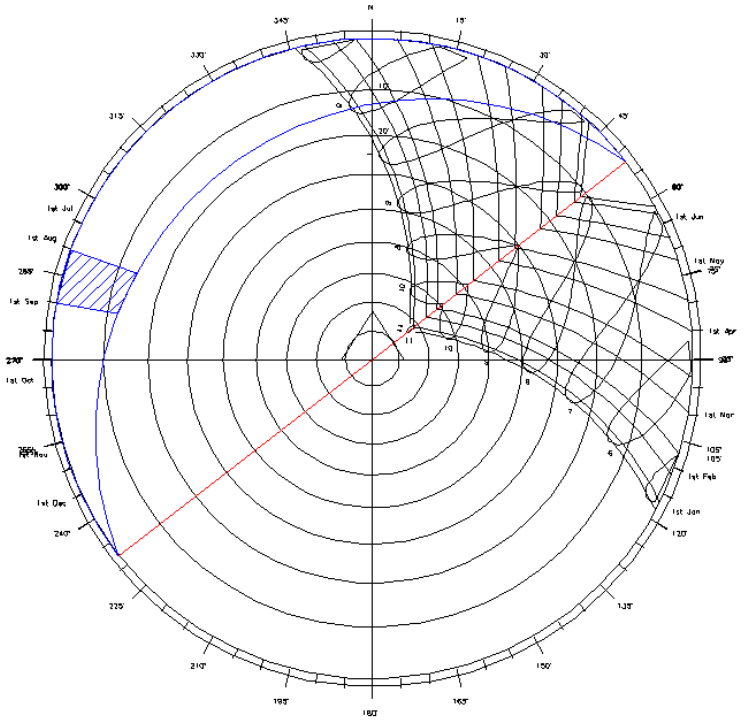


Figure 18 – 142° Façade Aspect Reflected Virtual Sun from Viewpoint 3

There is no reflected image of the sun that reaches Viewpoint 3 from Façade Aspect 142 of Building 1.

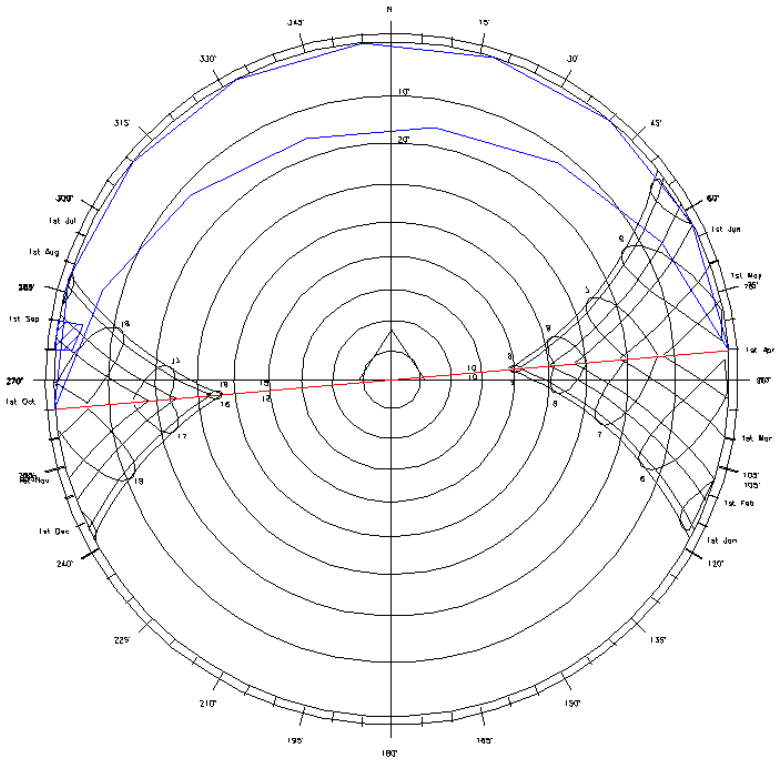
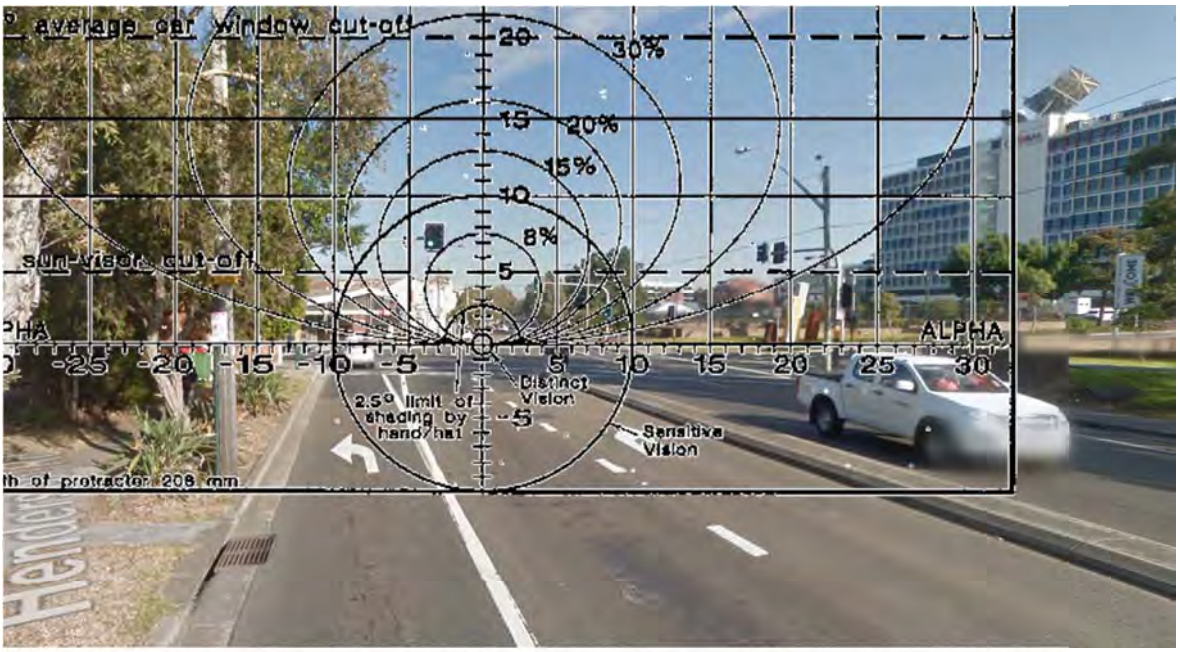


Figure 19 – 175° Façade Aspect Reflected Virtual Sun from Viewpoint 3

There is a reflected image of the sun that reaches Viewpoint 3 from Façade Aspect 182 of Building 1. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale. The south-west corner of the Channel 7 building is approximately 18° from the viewing angle of the driver.



From the image above it can be seen that the new building is outside the 20% iso-glare loop as it will be beyond the tree line. No further studies required.

Viewpoint 4

Viewpoint 4 is taken from the viewpoint of a driver travelling north-west on Davy Road. The viewing angle of the driver is 340°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 163
- Community Building Façade Aspect 253
- Building 1 Façade Aspect 102.5
- Building 1 Façade Aspect 182
- Building 1 Façade Aspect 142

Viewpoint 4 has been taken at a distance of 52m from the south-west apex of the Community Building.

Viewpoint 4 has been taken at a distance of 65m from the south-east apex of Building 1.

On Figure 20 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 20 – Viewpoint 4 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 4.

$\beta_{Community}$ = $\tan^{-1}(16m \div 52m)$

= 17.1°

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 65m)$

= 25.5°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building - Façade Aspect 163	0°	17.1°	5°	29°
Community Building - Façade Aspect 253	0°	17.1°	349°	5°
Building 1 – Façade Aspect 102.5	0°	25.5°	326°	333°
Building 1 – Façade Aspect 182	0°	25.5°	290°	326°
Building 1 – Façade Aspect 142	0°	25.5°	275°	290°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 21, Figure 22, Figure 22, Figure 23, Figure 24 and Figure 25 below.

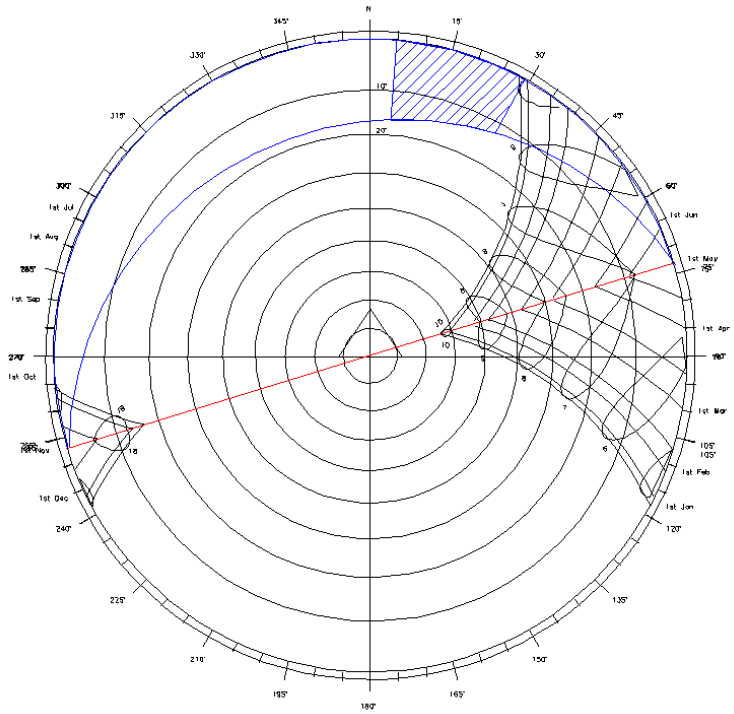


Figure 21 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint 4

There is no reflected image of the sun that reaches Viewpoint 4 from Façade Aspect 163 of the Community Building.

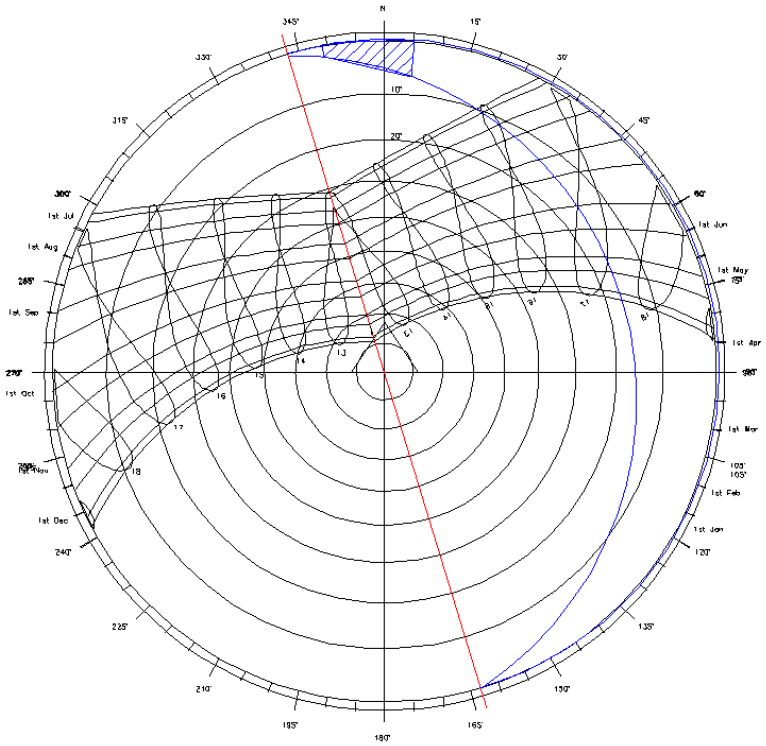


Figure 22 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint 4

There is no reflected image of the sun that reaches Viewpoint 4 from Façade Aspect 253 of the Community Building.

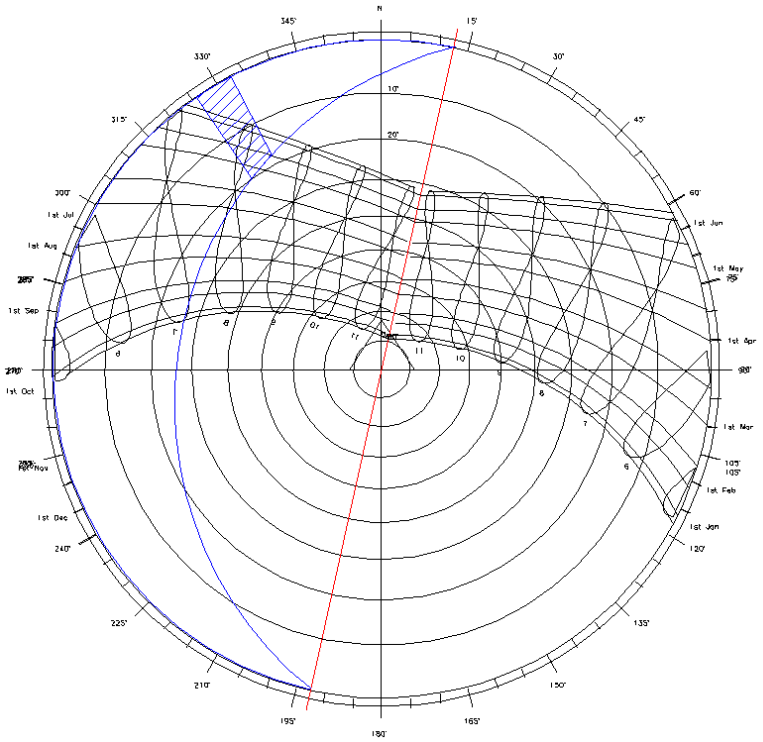
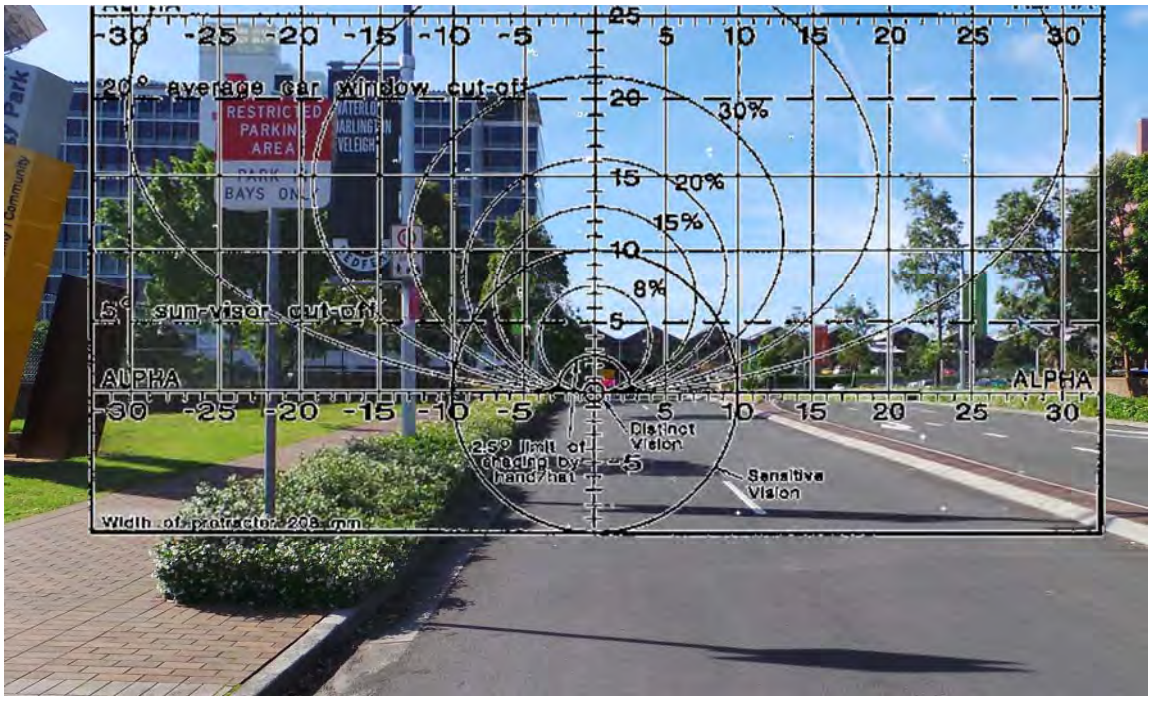


Figure 23 – 102.5° Façade Aspect Reflected Virtual Sun from Viewpoint 4

There is a reflected image of the sun that reaches Viewpoint 4 from Façade Aspect 182 of Building 1. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale. The Channel 7 building is approximately 52m in height and is at a distance of 135m; the top of the building has been aligned at 21° for scale.



From the image above it can be seen that the new building, which will be beyond the footpath, is outside the 20% iso-glare loop. No further studies required.

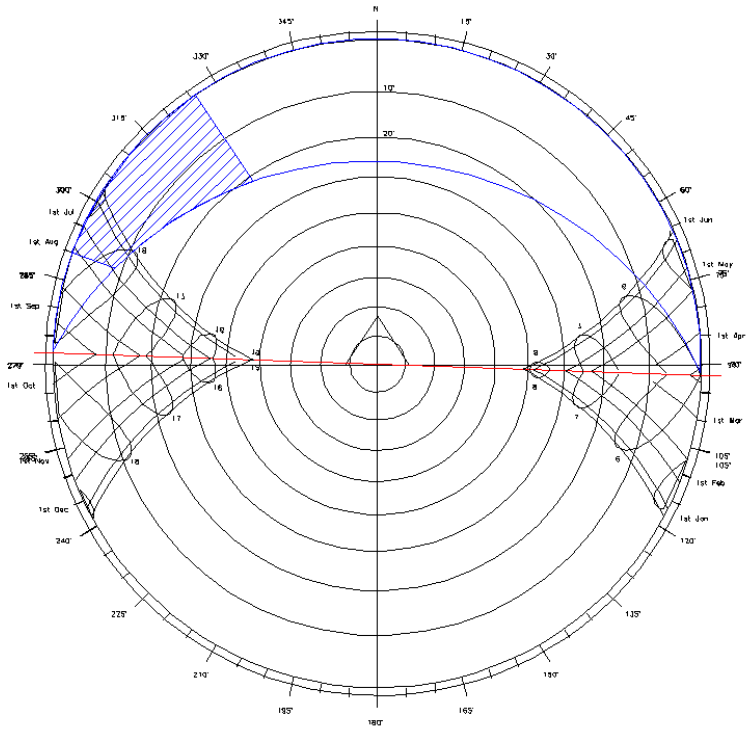
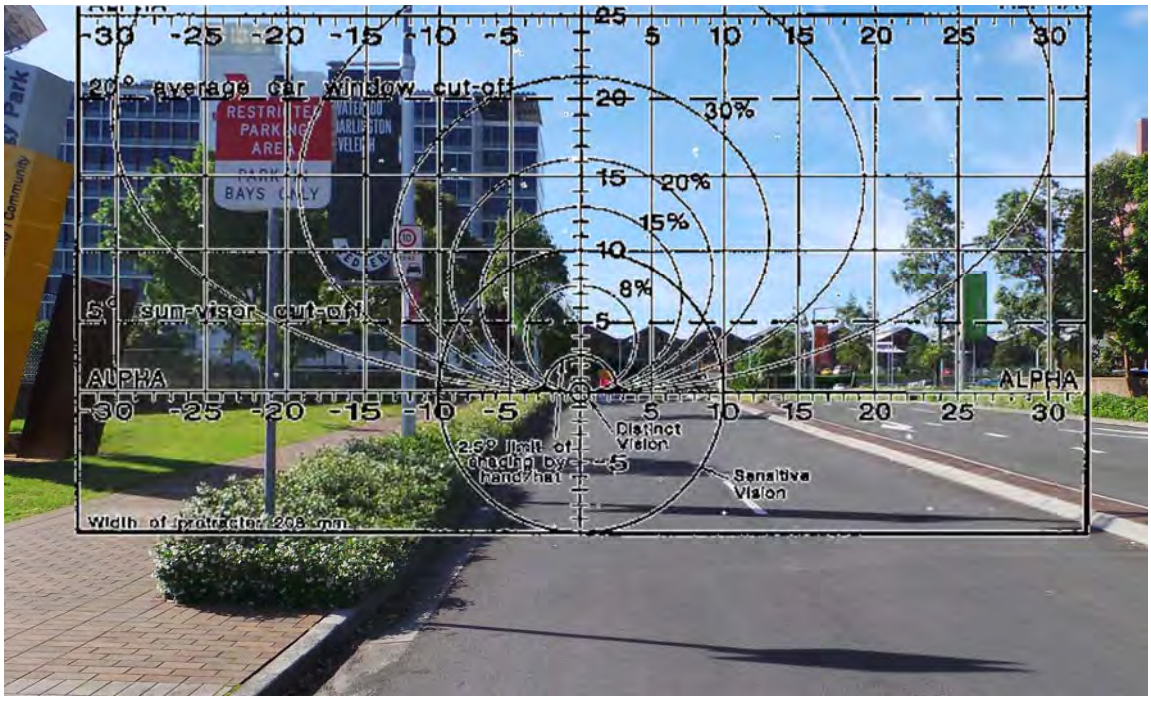


Figure 24 – 182° Façade Aspect Reflected Virtual Sun from Viewpoint 4

There is a reflected image of the sun that reaches Viewpoint 4 from Façade Aspect 182 of Building 1. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale. The Channel 7 building is approximately 52m in height and is at a distance of 135m; the top of the building has been aligned at 21° for scale.



From the image above it can be seen that the new building, which will be beyond the footpath, is outside the 20% iso-glare loop. No further studies required.

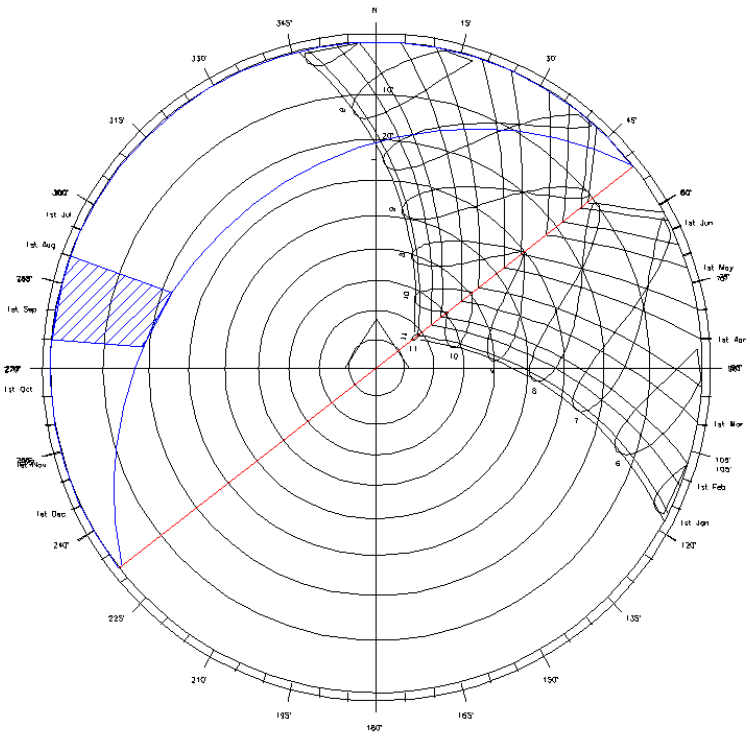


Figure 25 – 142° Façade Aspect Reflected Virtual Sun from Viewpoint 4

There is no reflected image of the sun that reaches Viewpoint 4 from Façade Aspect 142 of Building 1.

Viewpoint 5

Viewpoint 5 is taken from the viewpoint of a driver travelling east on Henderson Road. The viewing angle of the driver is 90°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 163
- Community Building Façade Aspect 253 (Cut off in part by Building 1)
- Building 1 Façade Aspect 182 (Limited by the viewing angle)

Viewpoint 5 has been taken at a distance of 77m from the south-west apex of the Community Building.

Viewpoint 5 has been taken at a distance of 60m from the south-east apex of Building 1.

On Figure 26 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 26 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community} = \tan^{-1}(16m \div 60m)$

$= 14.9°$

$\beta_{Building\ 1} = \tan^{-1}(31.6m \div 77m)$

$= 22.3°$

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 163	0°	14.9°	40°	46°
Community Building – Façade Aspect 253	0°	14.9°	25°	40°
Building 2 – Façade Aspect 182	0°	22.3°	0°	25°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 27, Figure 28 and Figure 29 below.

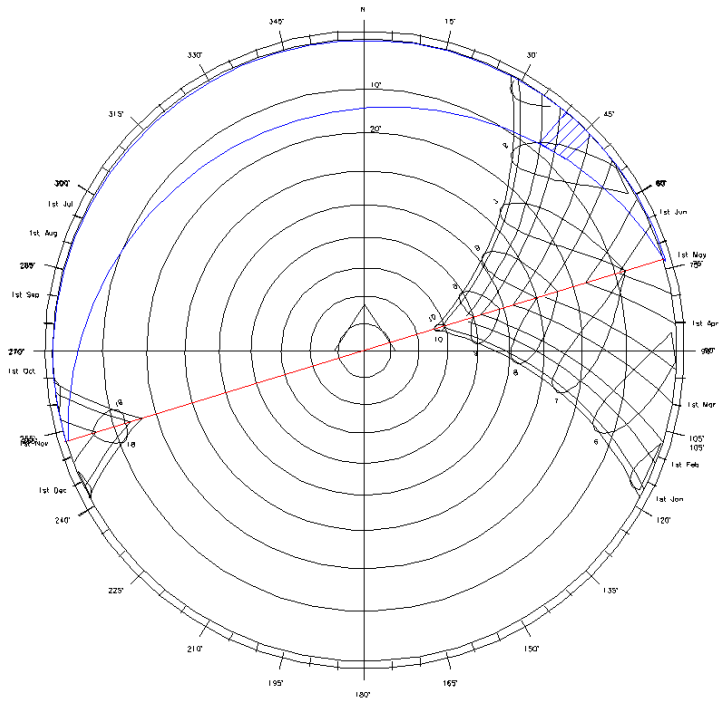
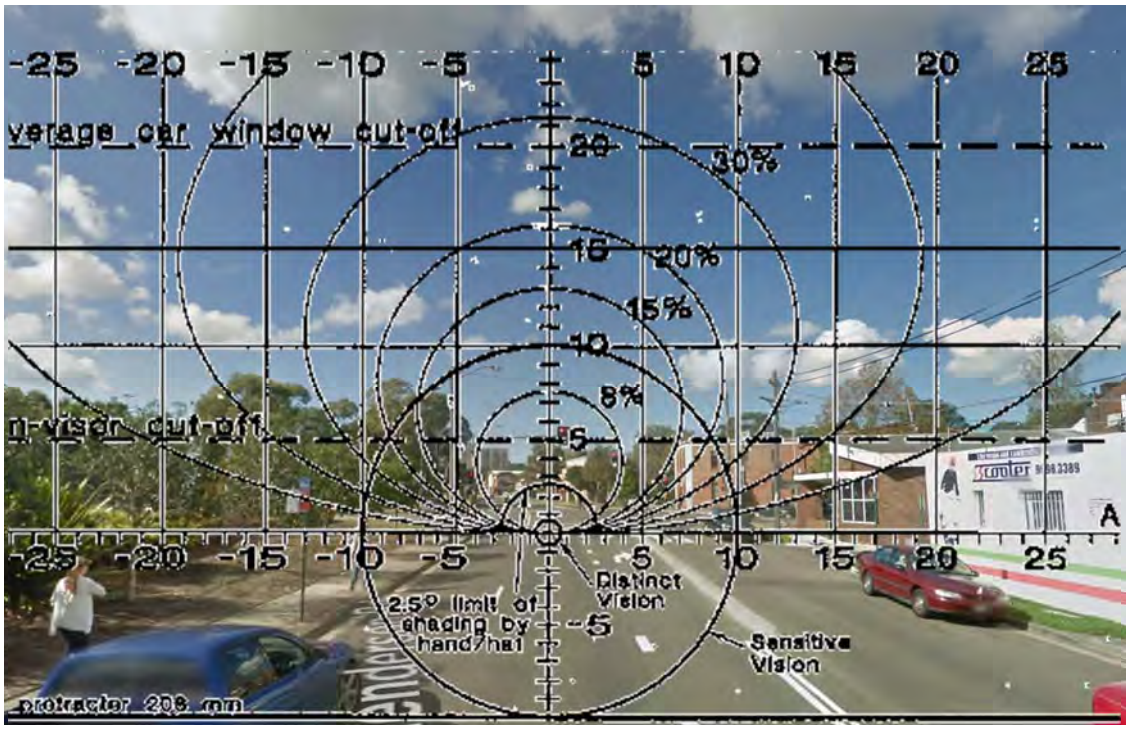


Figure 27 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint 5

There is a reflected image of the sun that reaches Viewpoint 5 from Façade Aspect 163 of the Community Building. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale.



From the image above it can be seen that the new buildings, are outside the 20% iso-glare loop (are to the left of image). No further studies required.

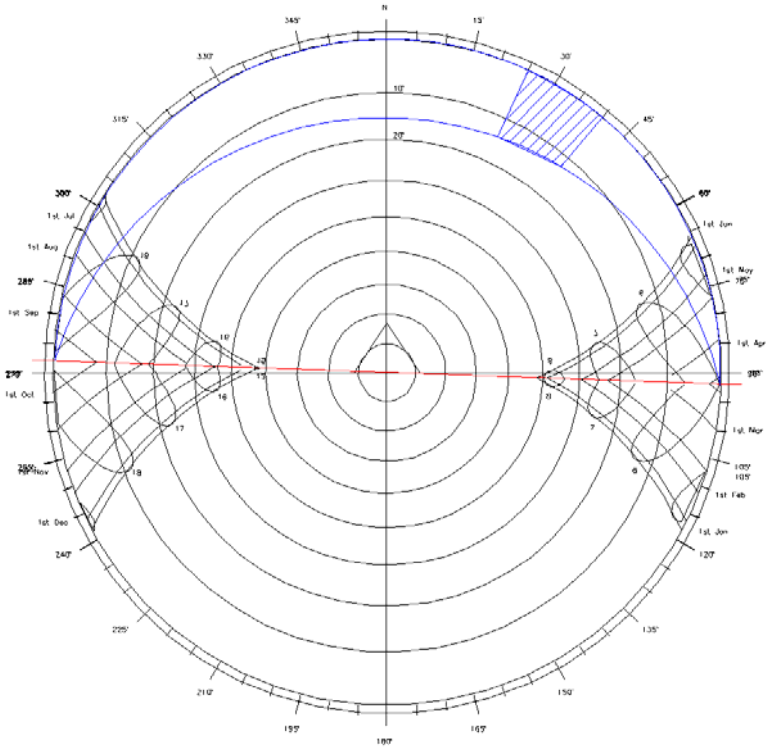


Figure 28 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint 5

There is no reflected image of the sun that reaches Viewpoint 5 from Façade Aspect 253 of Community Building.

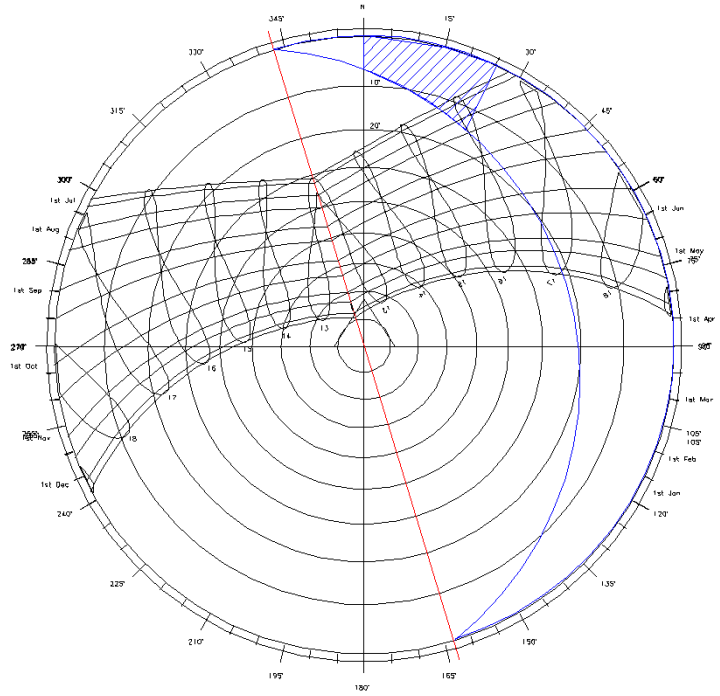
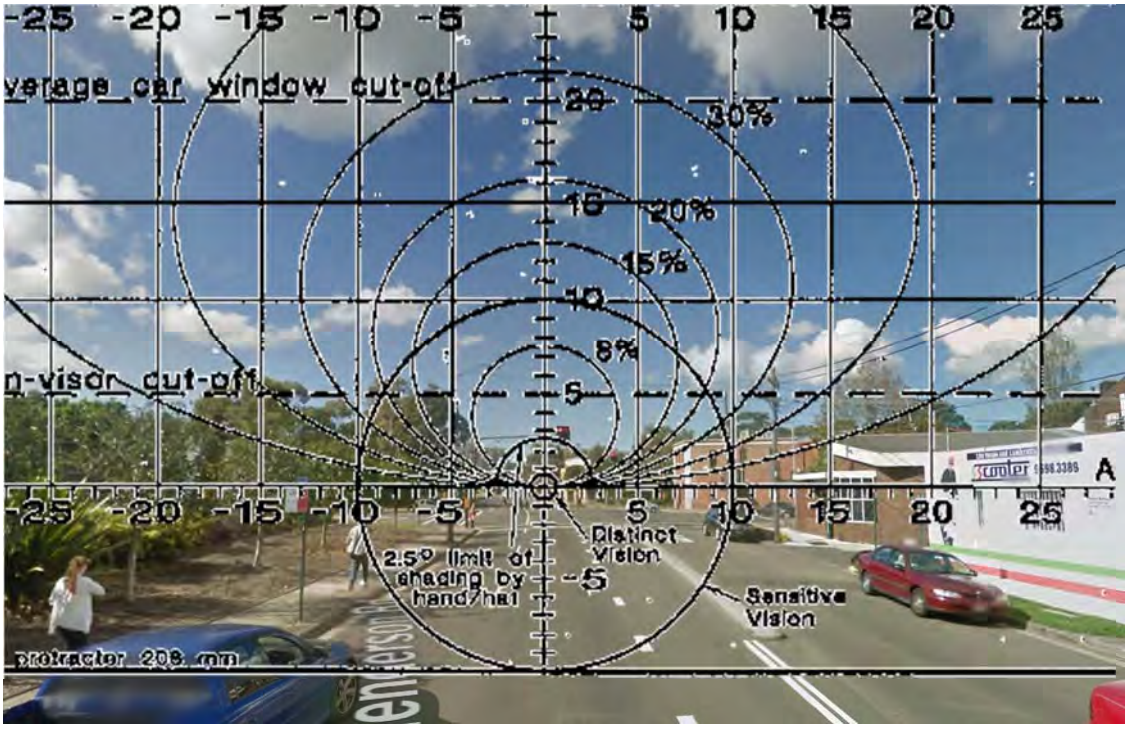


Figure 29 – 182° Façade Aspect Reflected Virtual Sun from Viewpoint 5

There is a reflected image of the sun that reaches Viewpoint 5 from Façade Aspect 182 of the Building 1. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale.



From the image above it can be seen that the new buildings, are outside the 20% iso-glare loop (are to the left of image). No further studies required.

Viewpoint 6

Viewpoint 6 is taken from the viewpoint of a driver travelling east on Henderson Road. The viewing angle of the driver is 90°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 1 Façade Aspect 175
- Building 1 Façade Aspect 260

Viewpoint 6 has been taken at a distance of 95m from the south-west apex of Building 1.

On Figure 30 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 30 – Viewpoint 6 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 95m)$

= 18.4°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 1 – Façade Aspect 175	0°	18.4°	70°	76°
Building 1 – Façade Aspect 260	0°	18.4°	50°	70°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 31 and Figure 32 below.

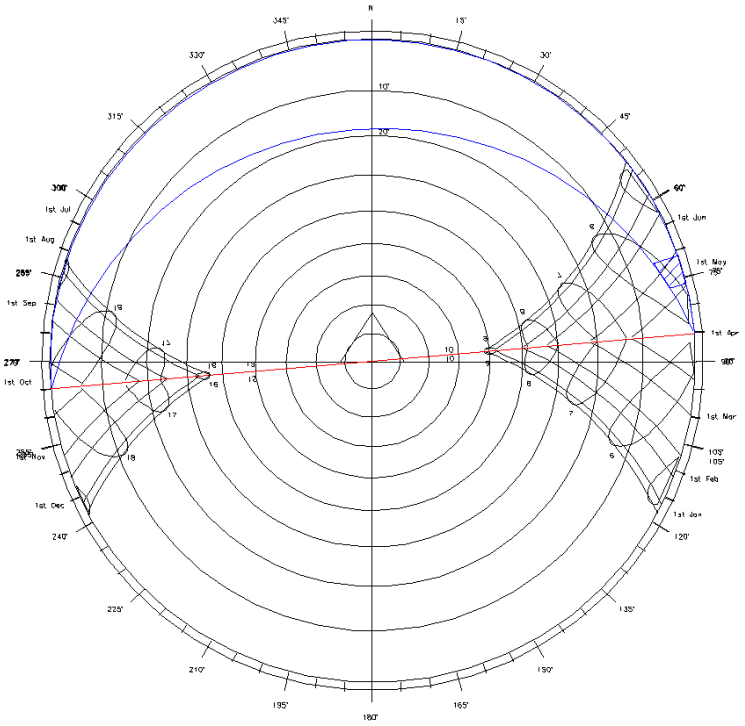
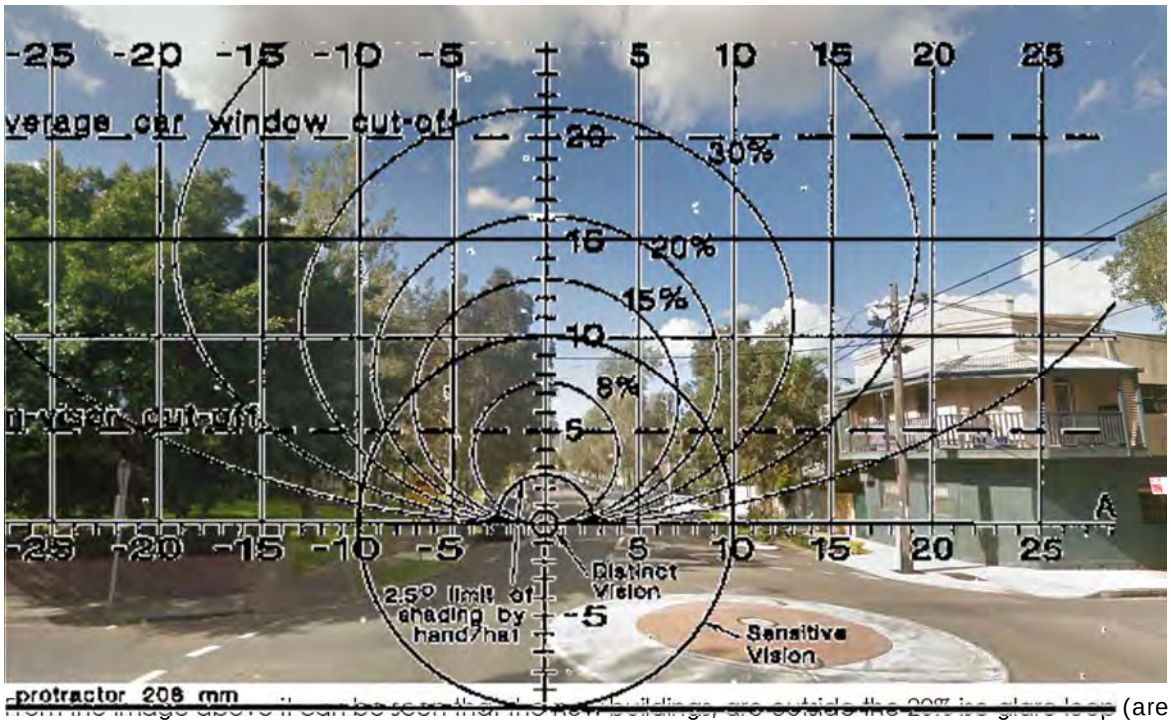


Figure 31 – 175° Façade Aspect Reflected Virtual Sun from Viewpoint 6

There is a reflected image of the sun that reaches Viewpoint 6 from Façade Aspect 175 of the Building 2. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale.



from the image above it can be seen that the new buildings are outside the 20% ice glare loop (are to the left of image). No further studies required.

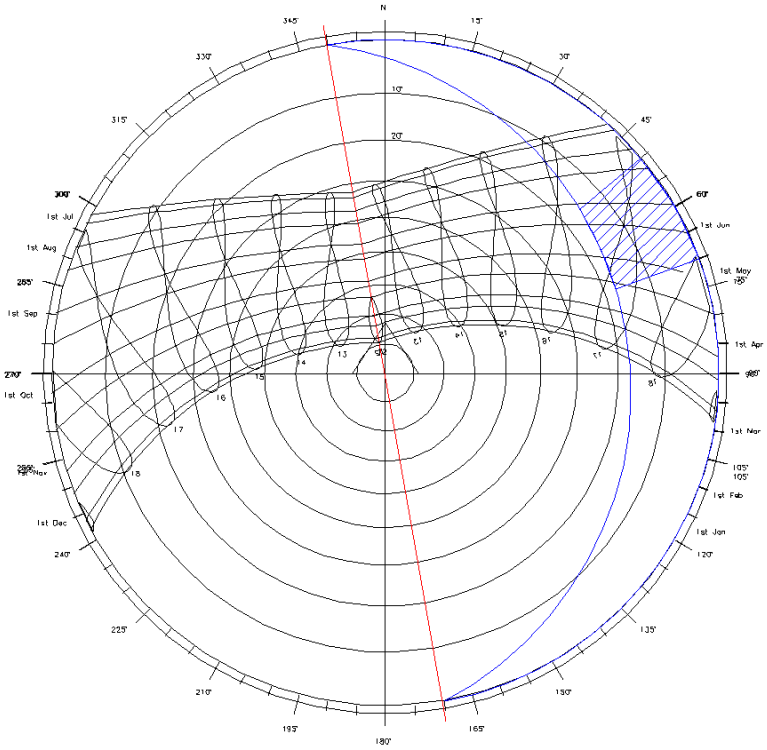
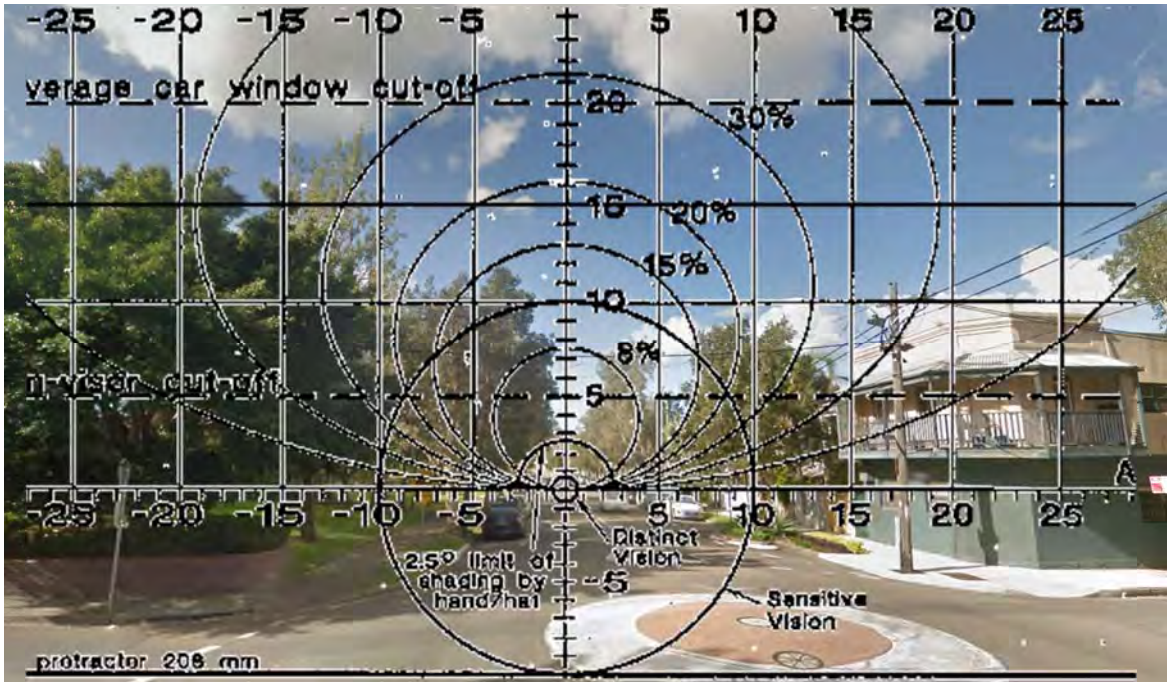


Figure 32 – 260° Façade Aspect Reflected Virtual Sun from Viewpoint 6

There is a reflected image of the sun that reaches Viewpoint 6 from Façade Aspect 260 of the Building 2. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale.



From the image above it can be seen that the new buildings, are outside the 20% iso-glare loop (are to the left of image). No further studies required.

Viewpoint 7

Viewpoint 7 is taken from the viewpoint of a driver travelling east on Rowley Street. The viewing angle of the driver is 90°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 1 Façade Aspect 260
- Building 1 Façade Aspect 342

Viewpoint 7 has been taken at a distance of 93m from the north-west apex of Building 1.

On Figure 33 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 33 – Viewpoint 7 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 93m)$

= 18.8°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 1 – Façade Aspect 260	0°	18.8°	90°	112°
Building 1 – Façade Aspect 342	0°	18.8°	79°	90°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 34 and Figure 35 below

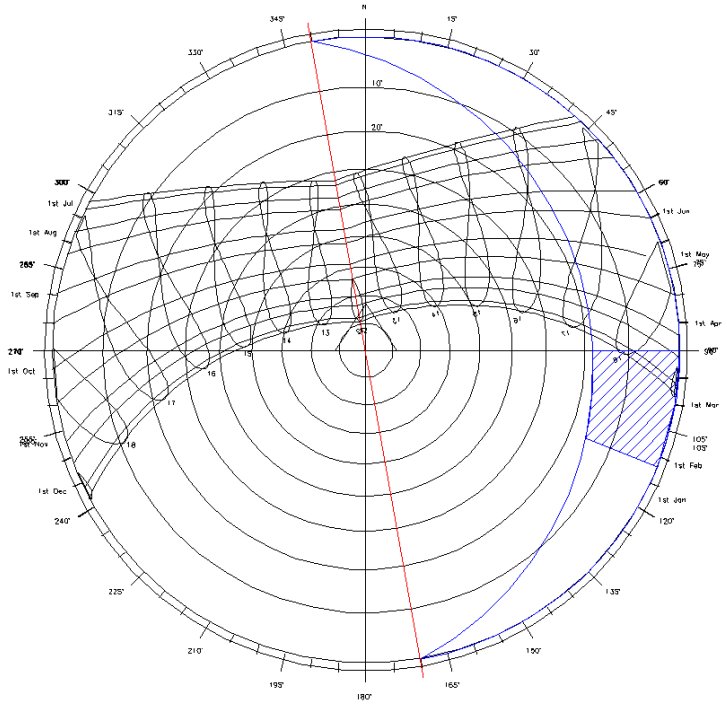
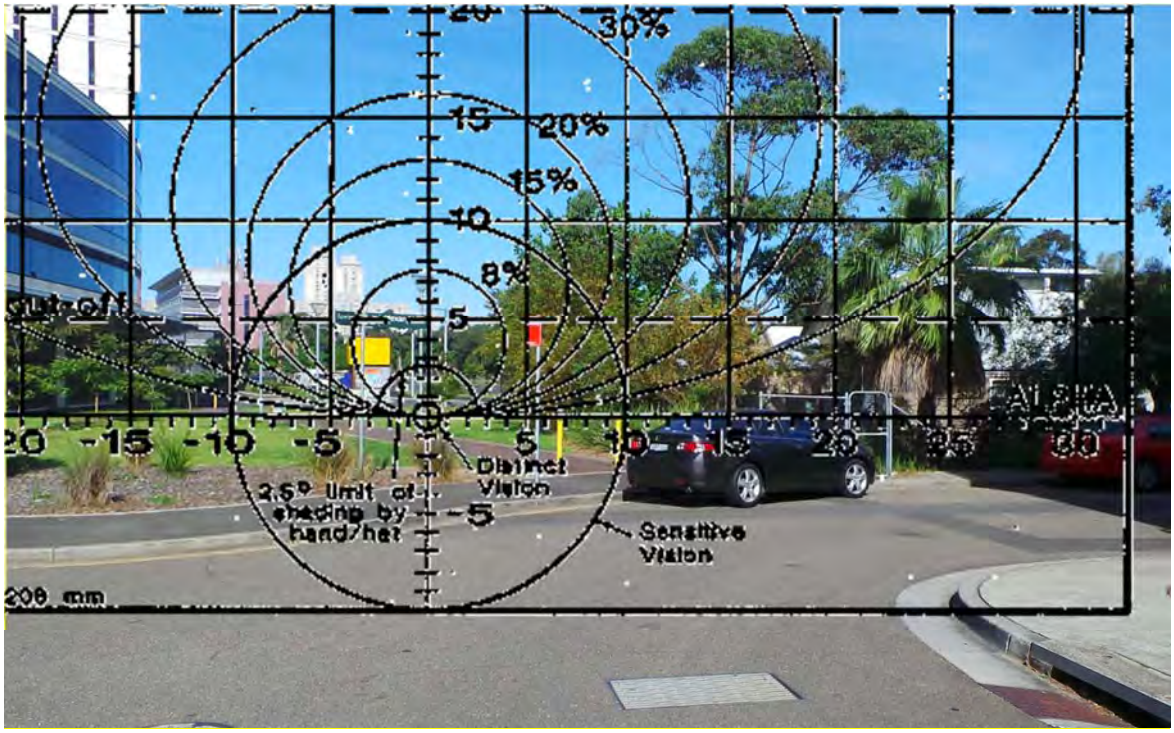


Figure 34 – 260° Façade Aspect Reflected Virtual Sun from Viewpoint 7

There is a reflected image of the sun that reaches Viewpoint 7 from Façade Aspect 342 of the Building 2. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 275m distant.



There is a reflected image of the eastern half of the façade that forms between 6 and 630pm during December and January. Further assessment and treatment of the façade to manage reflections is required.

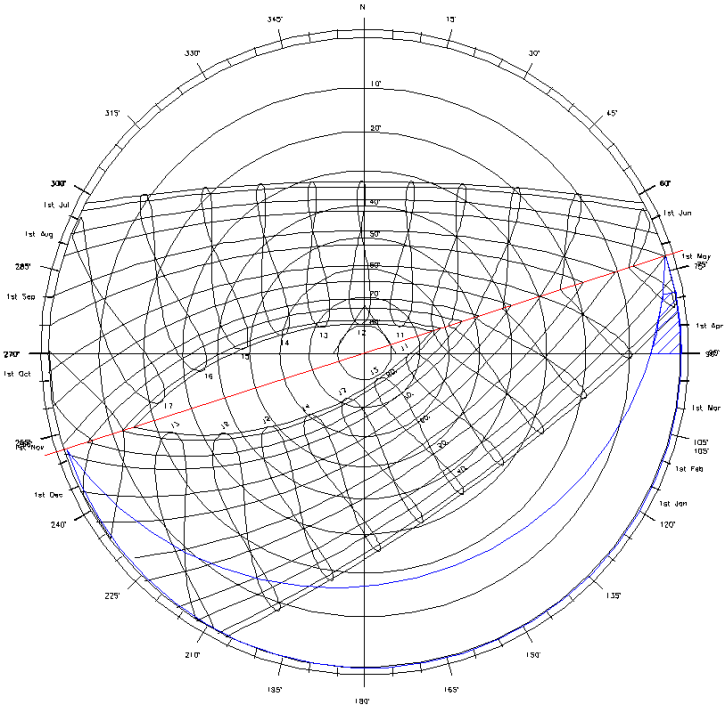
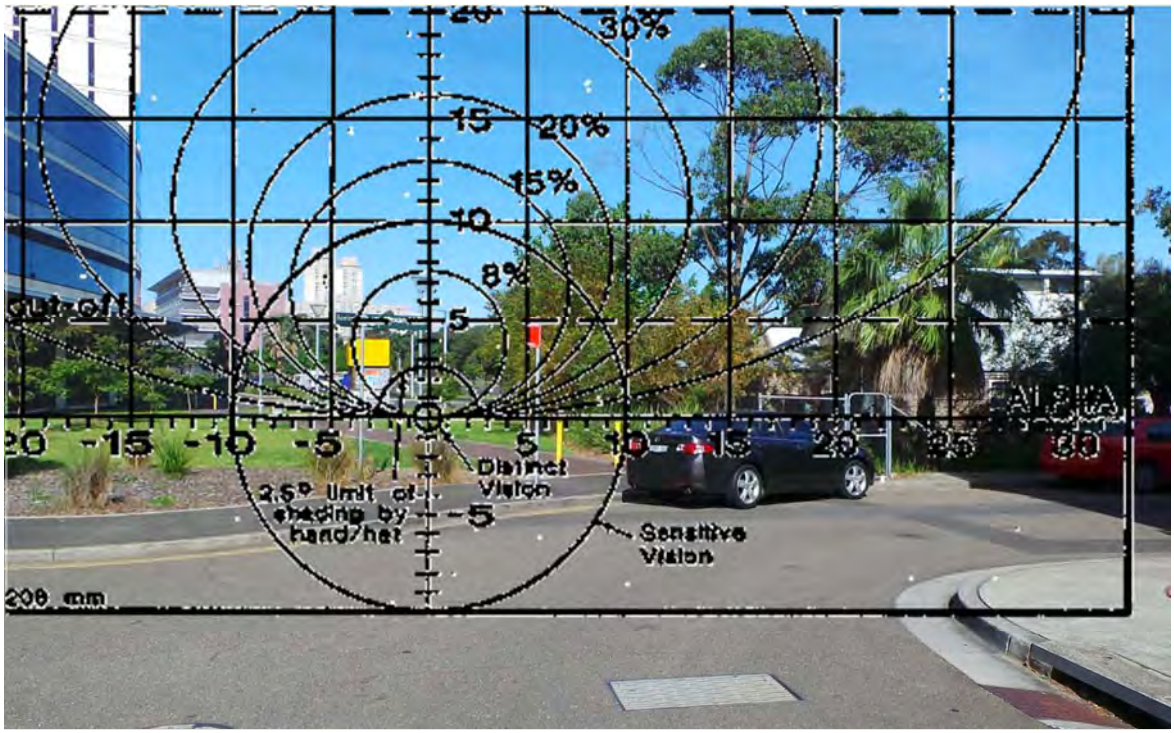


Figure 35 – 342° Façade Aspect Reflected Virtual Sun from Viewpoint 7

There is a reflected image of the sun that reaches Viewpoint 7 from Façade Aspect 342 of the Building 2. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 275m distant.



There is a reflected image of the eastern half of the façade that forms between 7 and 730am during June and July. Further assessment and treatment of the façade to manage reflections is required.

Viewpoint 8

Viewpoint 8 is taken from the viewpoint of a driver turning at the roundabout between Building 1 and the Channel 7 building. The viewing angle of the driver is 72°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 253 (Cut off in part by Building 1)
- Building 1 Façade Aspect 260
- Building 1 Façade Aspect 342

Viewpoint 8 has been taken at a distance of 30m from the north-west apex of Building 1.

Viewpoint 8 has been taken at a distance of 175m from the north-west apex of the Community Building.

On Figure 36 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 36 – Viewpoint 8 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community} = \tan^{-1}(16m \div 175m)$

$= 5.2°$

$\beta_{Building\ 1} = \tan^{-1}(31.6m \div 30m)$

$= 46.5°$

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 253	0°	5.2°	73°	77°
Building 1 – Façade Aspect 260	0°	46.5°	116°	157°
Building 1 – Façade Aspect 342	0°	46.5°	77°	116°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 37, Figure 38 and Figure 39 below.

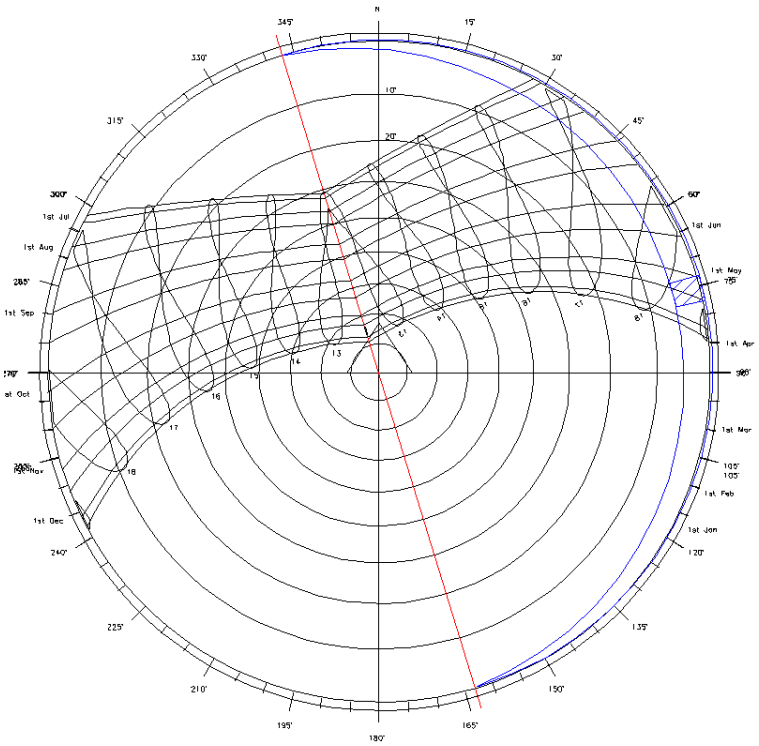


Figure 37 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint 8

There is a reflected image from the northern end of façade aspect 253 of the Community Building between 6pm and 7pm from November to February. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 200m distant.

Further assessment and treatment of the façade to manage reflections is required.

It is anticipated that Building 1 will provide shadowing to the Community building during these times; this can be confirmed with a sun study.

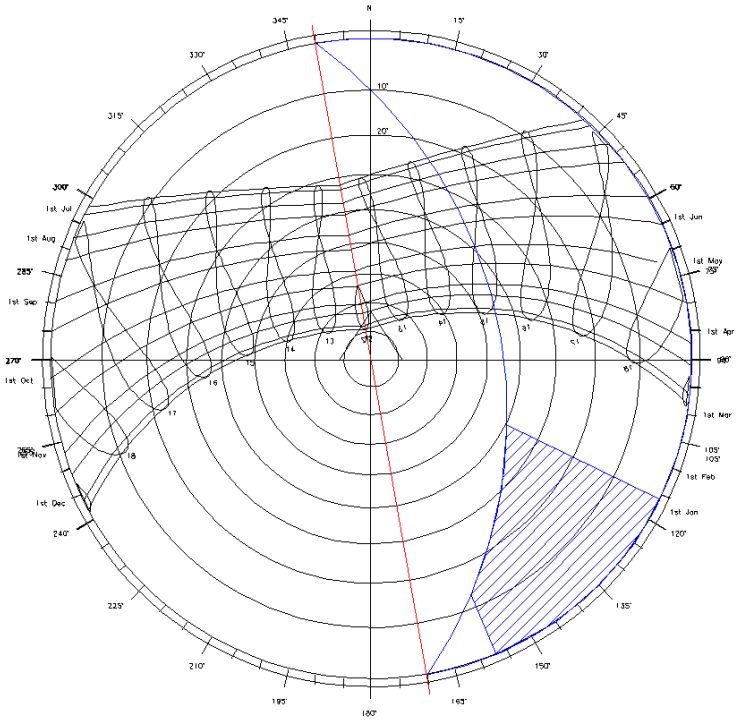


Figure 38 – 260° Façade Aspect Reflected Virtual Sun from Viewpoint 8

There is no reflected image of the sun that reaches Viewpoint 8 from Façade Aspect 260 of Community Building.

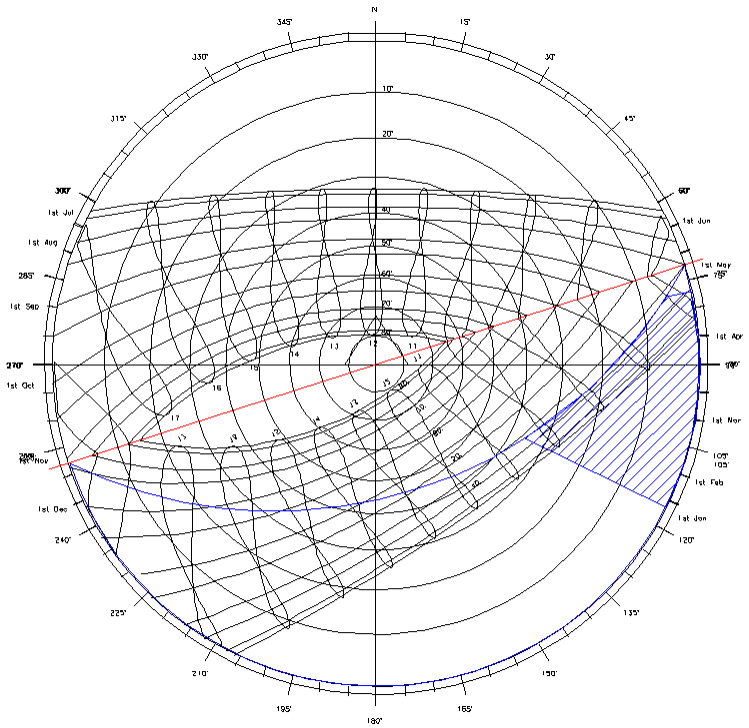
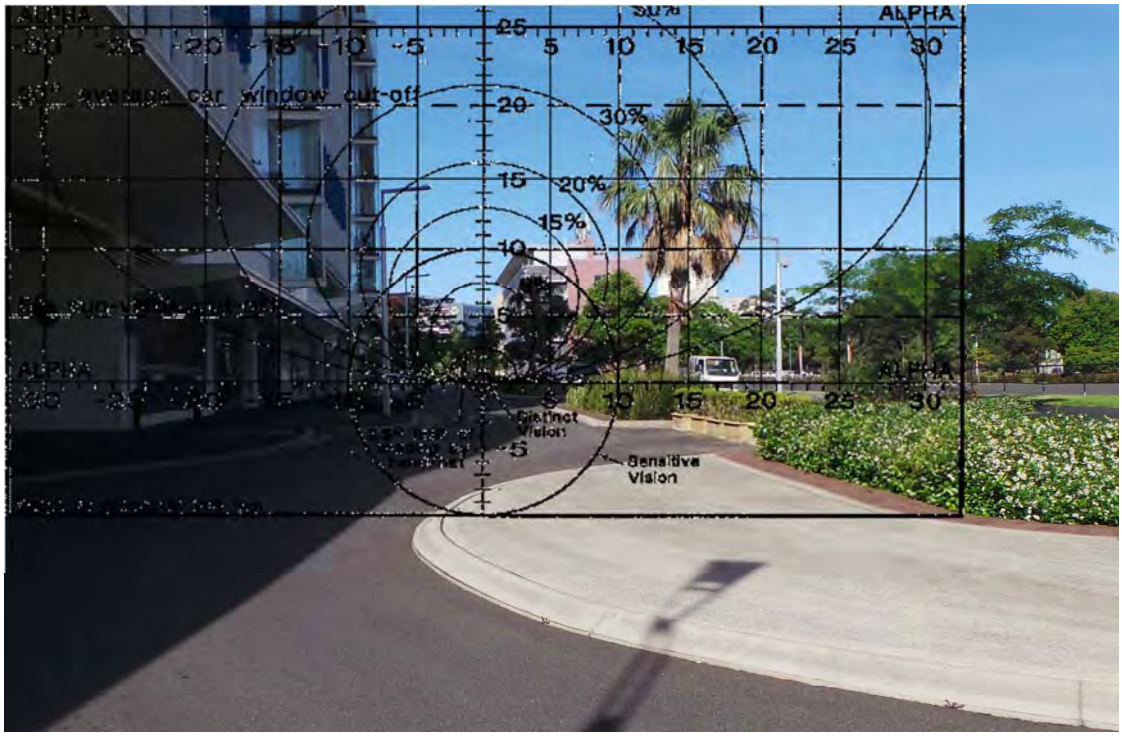


Figure 39 – 342° Façade Aspect Reflected Virtual Sun from Viewpoint 8

There is a reflected image of the sun that reaches Viewpoint 8 from Façade Aspect 342 of Building 1 until 10am from May to August. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 200m distant.



Further assessment and treatment of the façade to manage reflections is required.

Viewpoint 9

Viewpoint 9 is taken from the viewpoint of a driver travelling north-east on Central Avenue. The viewing angle of the driver is 70°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 253
- Community Building Façade Aspect 343
- Building 2 Façade Aspect 163
- Building 2 Façade Aspect 253

Viewpoint 9 has been taken at a distance of 50m from the north-west apex of the Community Building.

Viewpoint 9 has been taken at a distance of 65m from the south-west apex of Building 2.

On Figure 40below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 40 – Viewpoint 9 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community}$ = $\tan^{-1}(16m \div 50m)$

= 17.75°

$\beta_{Building\ 2}$ = $\tan^{-1}(33.7m \div 65m)$

= 27.4°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 253	0°	17.8°	91°	131°
Community Building – Façade Aspect 343	0°	17.8°	83	91
Building 1 – Façade Aspect 163	0°	27.4°	61°	66°
Building 1 – Façade Aspect 253	0°	27.4°	11°	61°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 41, Figure 42 and Figure 43 below.

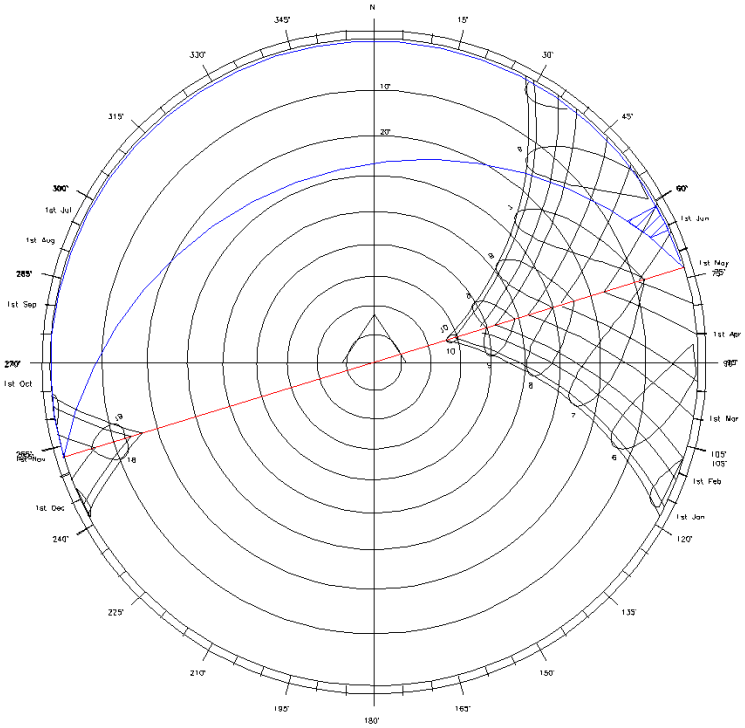
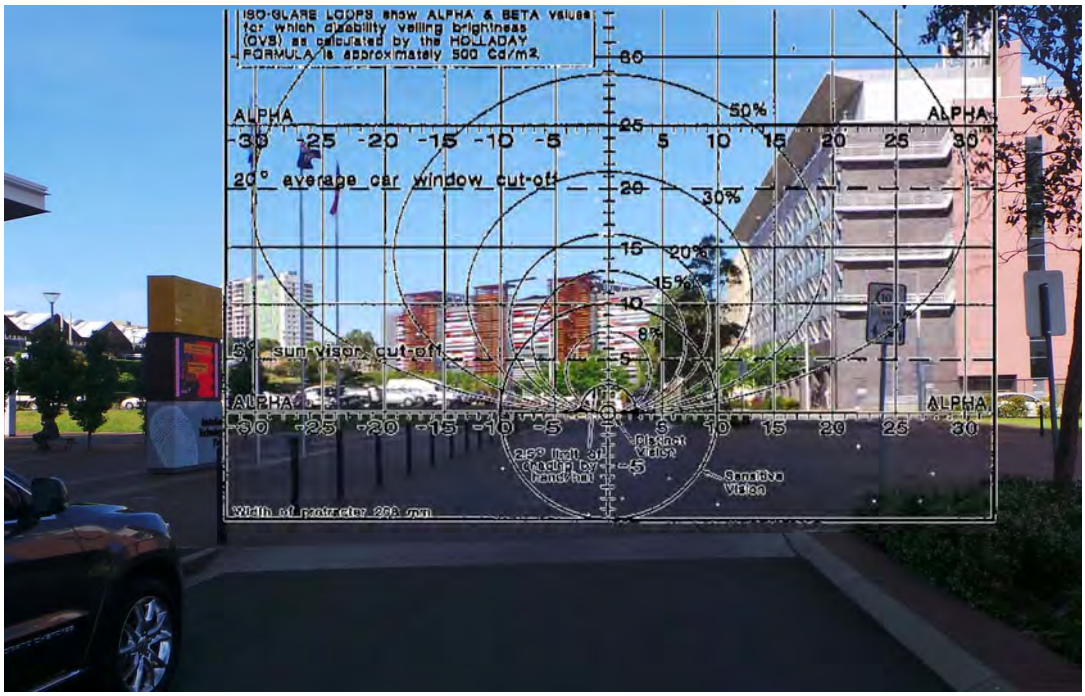


Figure 41 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint 9

There is a reflected image of the sun that reaches Viewpoint 9 from Façade Aspect 163 of Building 1 from 6 to 630am from April to May. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 70m distant.



Further assessment and treatment of the façade to manage reflections is required.

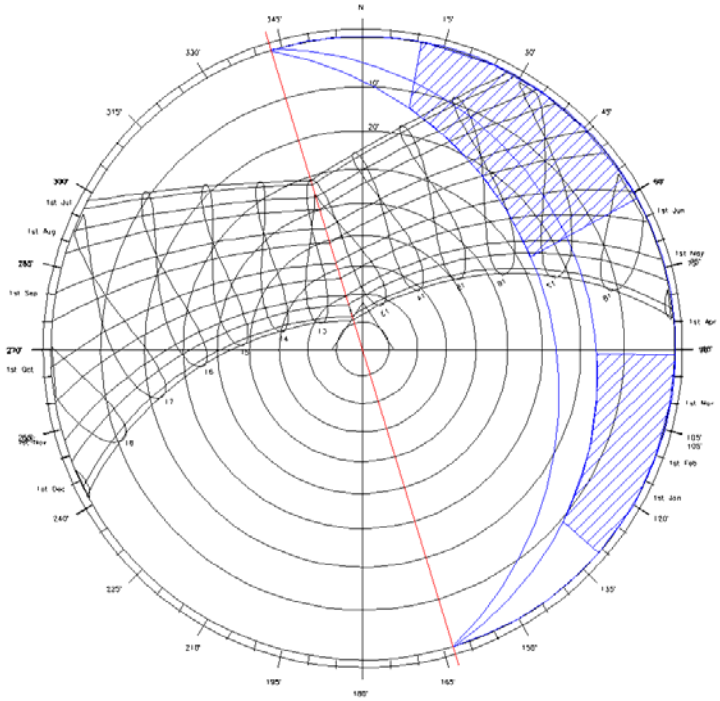
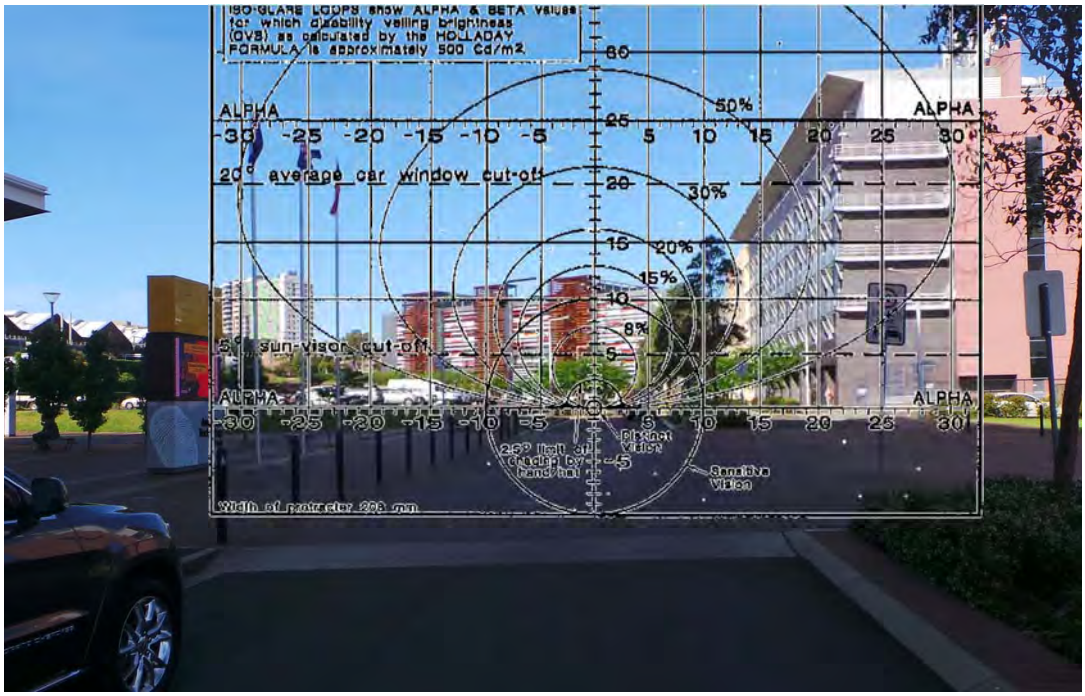


Figure 42 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint 9

There is no reflected image of the sun that reaches Viewpoint 9 from Façade Aspect 253 of Building 1 after 330pm throughout the year. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 70m distant.



Façade aspect 253 of Building 2 is outside the 20% iso-loop and therefore no further studies are required.

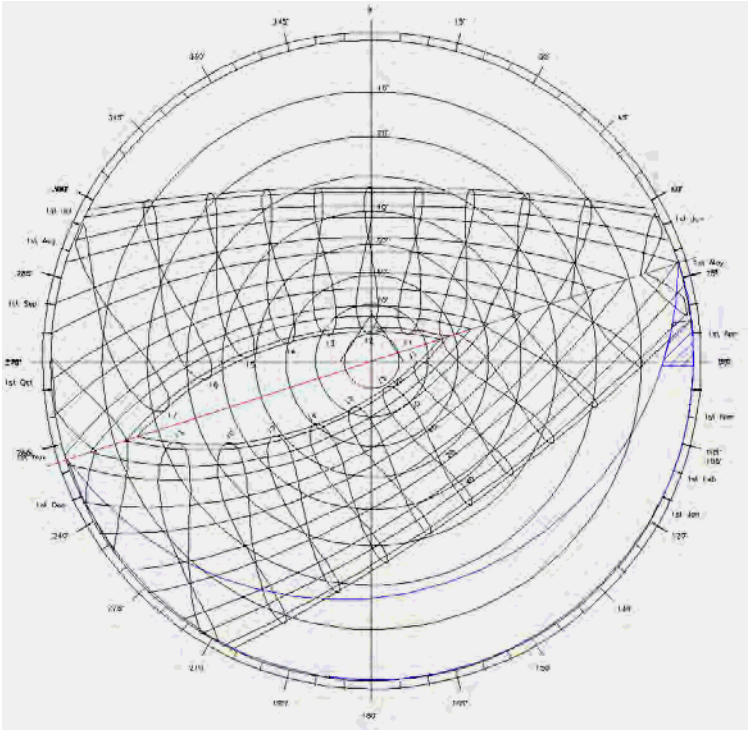
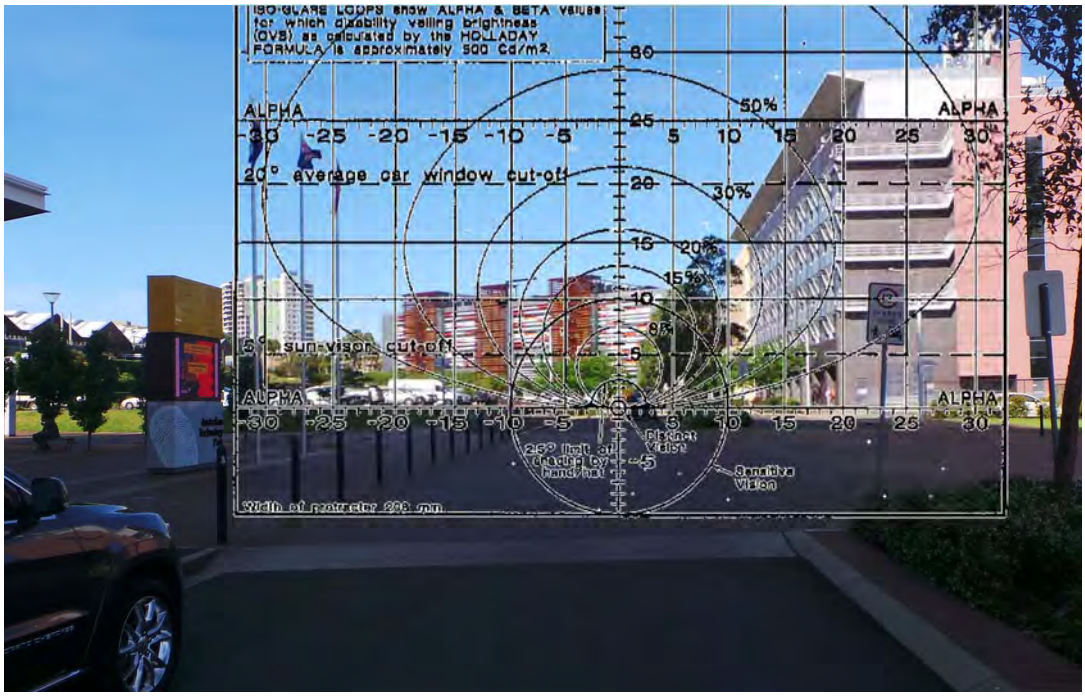


Figure 43 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint 9

There is a reflected image of the sun that reaches Viewpoint 9 from Façade Aspect 343 of the Community Building. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 70m distant.



Façade aspect 343 of the Community Building is outside the 20% iso-loop and therefore no further studies are required.

Viewpoint 10

Viewpoint 10 is taken from the viewpoint of a driver travelling east on Henderson Road. The viewing angle of the driver is 250°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 73
- Community Building Façade Aspect 343
- Building 1 Façade Aspect 342
- Building 2 Façade Aspect 163 (Limited by the viewing angle)

Viewpoint 10 has been taken at a distance of 45m from the north-west apex of the Community Building.

Viewpoint 10 has been taken at a distance of 70m from the north-east apex of Building 1.

Viewpoint 10 has been taken at a distance of 30m from the south-west apex of Building 2.

On Figure 44 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 44 – Viewpoint 10 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 10.

$\beta_{Community} = \tan^{-1}(16m \div 45m)$

$= 19.6°$

$\beta_{Building\ 1} = \tan^{-1}(31.6m \div 70m)$

$= 24.3°$

$\beta_{Building\ 2} = \tan^{-1}(33.7m \div 30m)$

$= 48.3°$

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 73	0°	19.9°	170°	225°
Community Building – Façade Aspect 343	0°	19.6°	225°	240°
Building 1 – Façade Aspect 342	0°	24.3°	240°	245°
Building 2 – Façade Aspect 163	0°	48.3°	275°	326°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 45, Figure 46 and Figure 48 below.

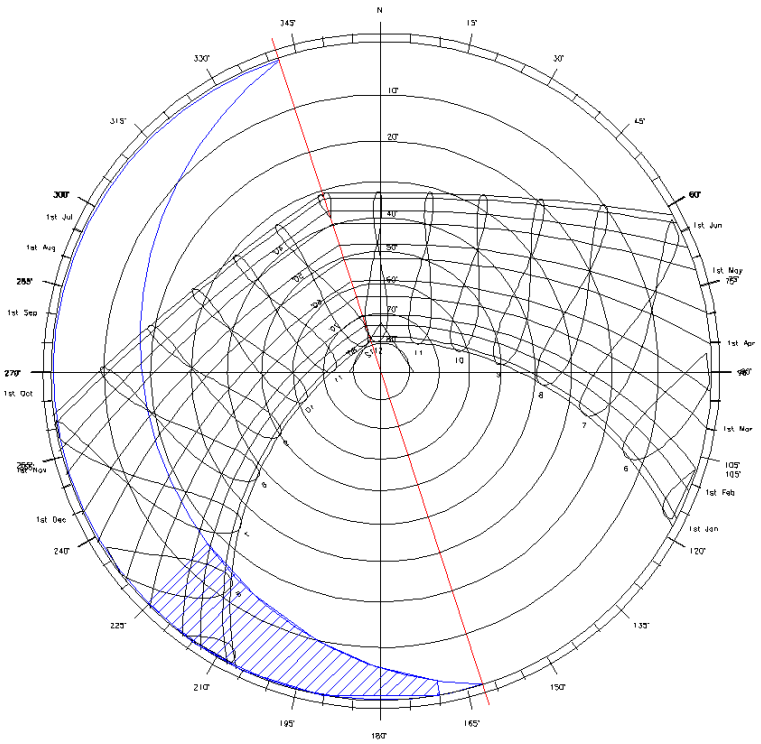


Figure 45 – 73° Façade Aspect Reflected Virtual Sun from Viewpoint 10

Façade aspect 73 is obstructed by the existing TOP Education Institute Building; therefore no further studies are required.

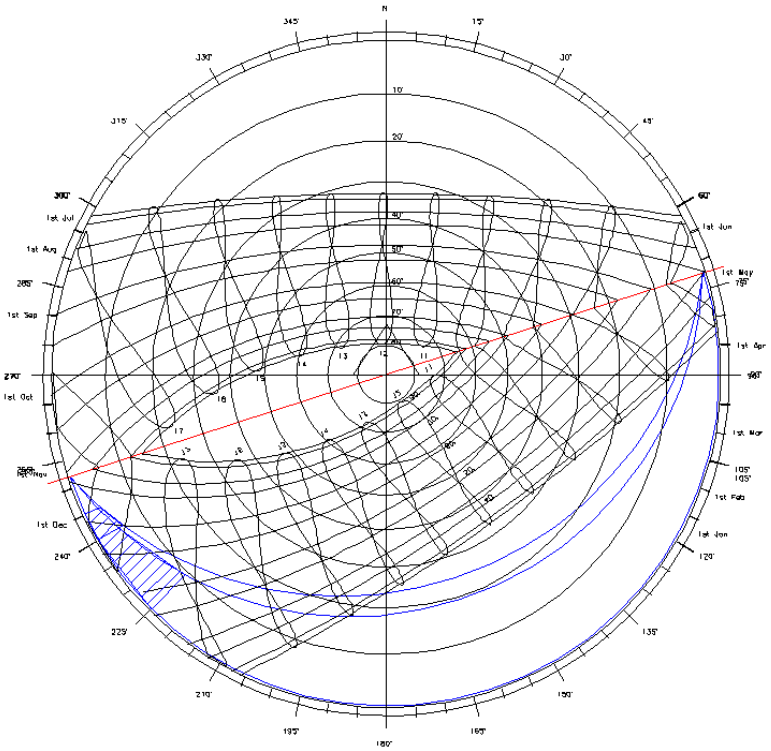


Figure 46 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint 10

There is no reflected image of the sun that reaches Viewpoint 10 from Façade Aspect 343 of Community Building.

It is anticipated that the existing Channel 7 building obstructs the sun during this time and provides over shadowing to the façade, and that the external screen will provide glare amelioration

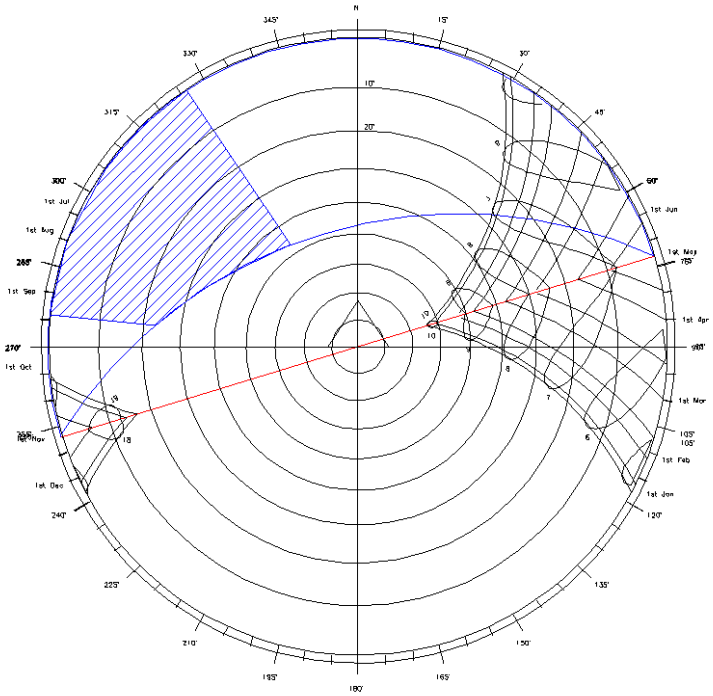


Figure 47 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint 10

There is no reflected image of the sun that reaches Viewpoint 10 from Façade Aspect 163 of Building 2.

Viewpoint 11

Viewpoint 11 is taken from the viewpoint of a driver travelling north-east on Locomotive Street. The viewing angle of the driver is 70°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 253
- Building 2 Façade Aspect 343

Viewpoint 11 has been taken at a distance of 85m from the north-west apex of Building 2.

On Figure 48 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The red arrow indicated the direction of travel and viewing.

Figure 48 – Viewpoint 11 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 2}$ = $\tan^{-1}(30.7m \div 85m)$

= 19.9°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 1 – Façade Aspect 253	0°	19.9°	81°	122°
Building 1 – Façade Aspect 343	0°	19.9°	72°	81°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 49 and Figure 50 below.

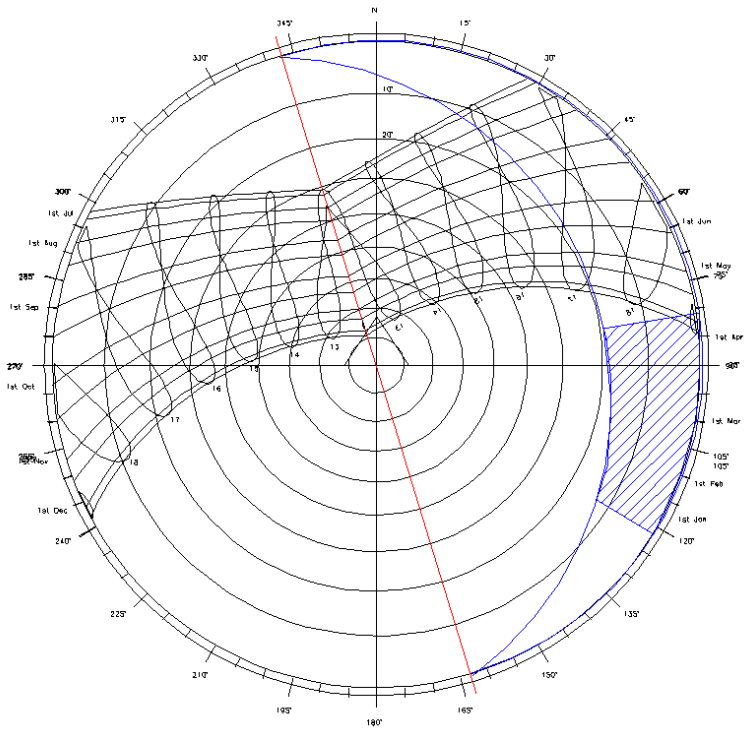


Figure 49 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint 11

There is no reflected image of the sun that reaches Viewpoint 11 from Façade Aspect 253 of Building 1

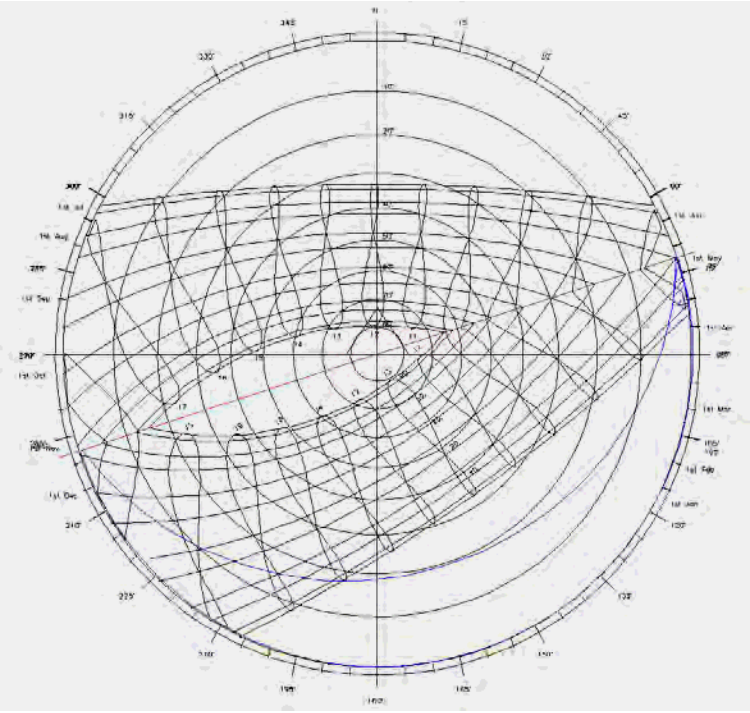
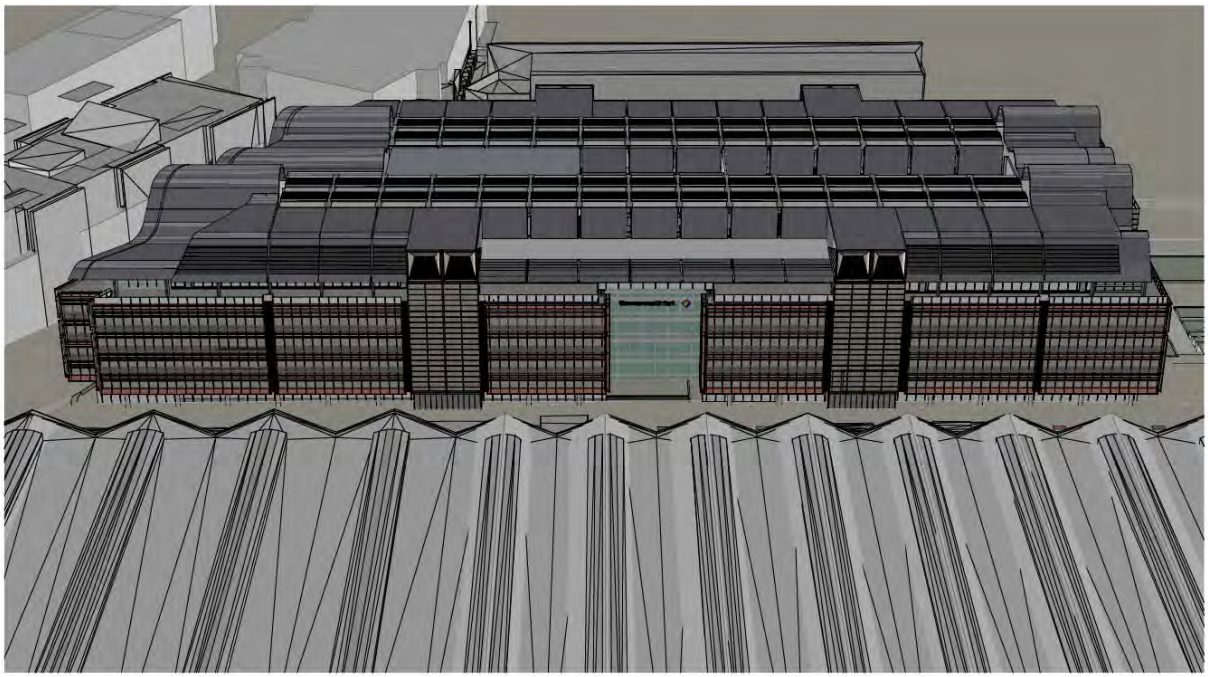


Figure 50 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint 11

There is a reflected image of the sun that reaches Viewpoint 11 from Façade Aspect 343 of Building 2 before 7am from May to August. A shading study has been completed for June at 7am (when the sun is in the worst case position relative to the building façade that shows that the façade is in shade from surrounding buildings at times that may cause glare. A screenshot of this study is shown below.



NORTH ELEVATION - JUNE 7AM

In the event that the surrounding buildings are not there in the future, there are vertical fins on this elevation that provide glare amelioration from the low angle early morning sun.

Viewpoint A

Viewpoint A is taken from the viewpoint of a pedestrian crossing Locomotive Street. The viewing angle of the pedestrian is 200°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 102.5
- Building 2 Façade Aspect 343

Viewpoint A has been taken at a distance of 58m from the north-west apex of Building 2.

On Figure 51 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 51 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint A.

$\beta_{Building\ 2}$ = $\tan^{-1}(33.7m \div 58m)$

= 30.2°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 2 – Façade Aspect 102.5	0°	30.2°	199°	218°
Building 2 – Façade Aspect 343	0°	30.2°	218°	242°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 52 and Figure 53 below.

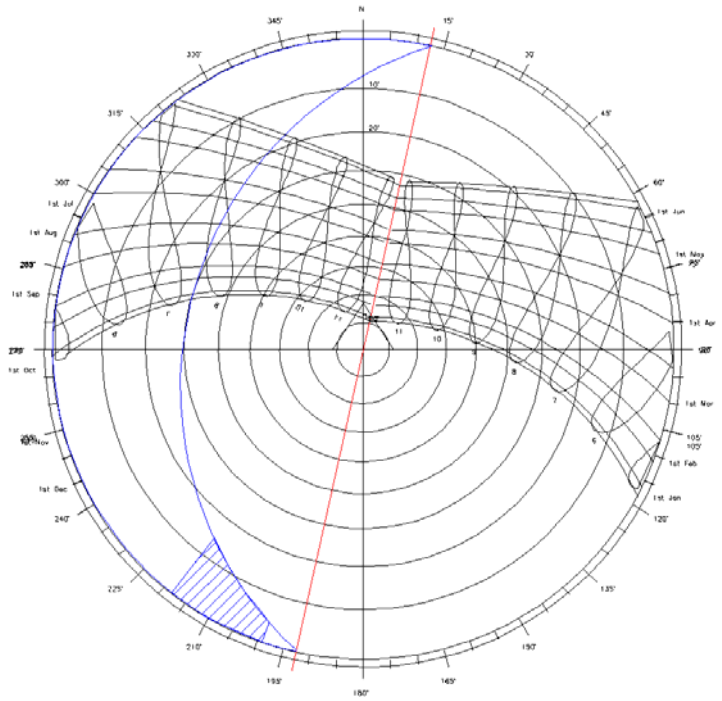


Figure 52 – 102.5° Façade Aspect Reflected Virtual Sun from Viewpoint A

There is no reflected image of the sun that reaches Viewpoint A from Façade Aspect 102.5 of Building 2. Therefore no further studies are required

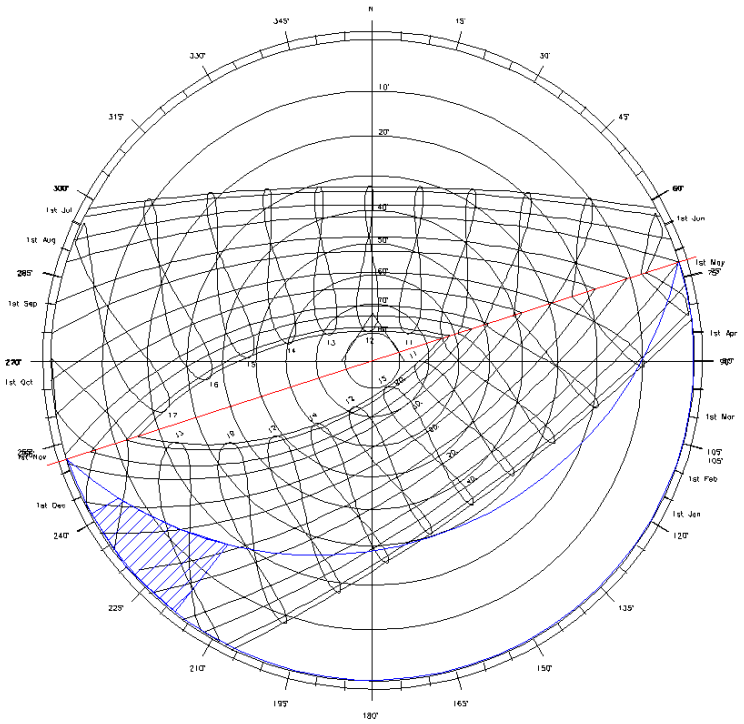
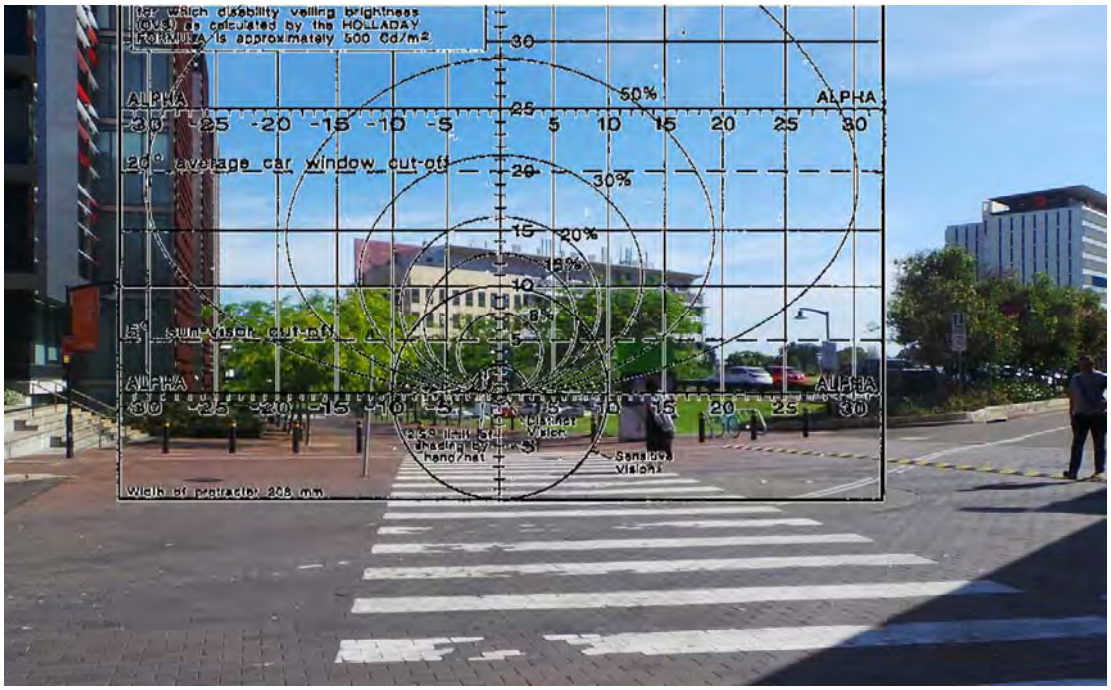


Figure 53 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint A

There is a reflected image of the sun that reaches Viewpoint A from Façade Aspect 343 of Building 2 after 6pm from April to May and August to October. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale; where the 40m high TOP Education Institute building is 160m distant.



Further assessment and treatment of the façade to manage reflections is required.

Viewpoint B

Viewpoint B is taken from the viewpoint of a pedestrian crossing Central Avenue. The viewing angle of the pedestrian is 10°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 102.5
- Building 2 Façade Aspect 163

Viewpoint B has been taken at a distance of 25m from the south-west apex of Building 2.

On Figure 54 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 54 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 2}$ = $\tan^{-1}(33.7m \div 25m)$

= 53.4°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 2 – Façade Aspect 102.5	0°	53.4°	349°	10°
Building 2 – Façade Aspect 163	0°	53.4°	264°	349°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 55 and Figure 56 below.

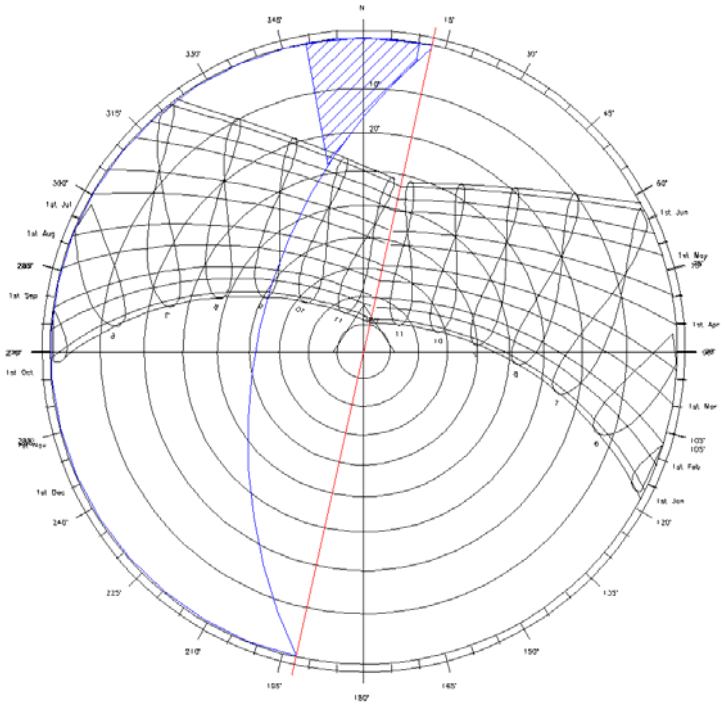


Figure 55 – 102.5° Façade Aspect Reflected Virtual Sun from Viewpoint B

There is no reflected image of the sun that reaches Viewpoint B from Façade Aspect 102.5 of Building 2. Therefore no further studies are required.

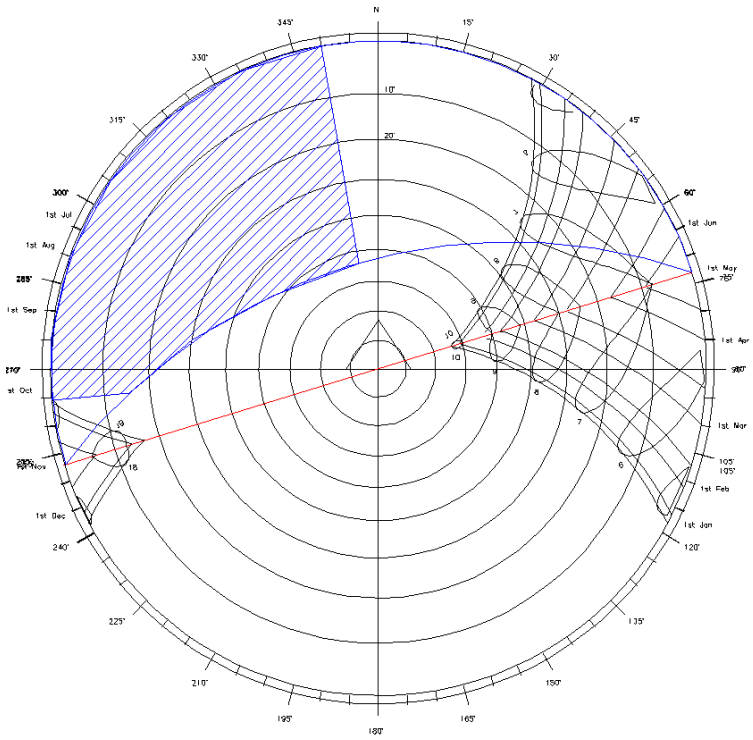


Figure 56 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint B

There is no reflected image of the sun that reaches Viewpoint B from Façade Aspect 163 of Building 2. Therefore no further studies are required.

Viewpoint C

Viewpoint C is taken from the viewpoint of a pedestrian crossing Henderson Road. The viewing angle of the pedestrian is 90°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 163
- Community Building Façade Aspect 253
- Building 1 Façade Aspect 142
- Building 1 Façade Aspect 175
- Building 1 Façade Aspect 182

Viewpoint C has been taken at a distance of 70m from the south-west apex of the Community Building.

Viewpoint C has been taken at a distance of 90m from the south-east apex of Building 1.

On Figure 57 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 57 – Viewpoint C horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community}$ = $\tan^{-1}(16m \div 70m)$

= 12.9°

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 90m)$

= 19.3°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building - Façade Aspect 163	0°	12.9°	345°	3°
Community Building - Façade Aspect 253	0°	12.9°	341°	345°
Building 1 – Façade Aspect 142	0°	19.3°	289°	301°
Building 1 – Façade Aspect 175	0°	19.3°	283°	289°
Building 1 – Façade Aspect 182	0°	19.3°	301°	324°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 58, Figure 59, Figure 60, Figure 61 and Figure 62 below.

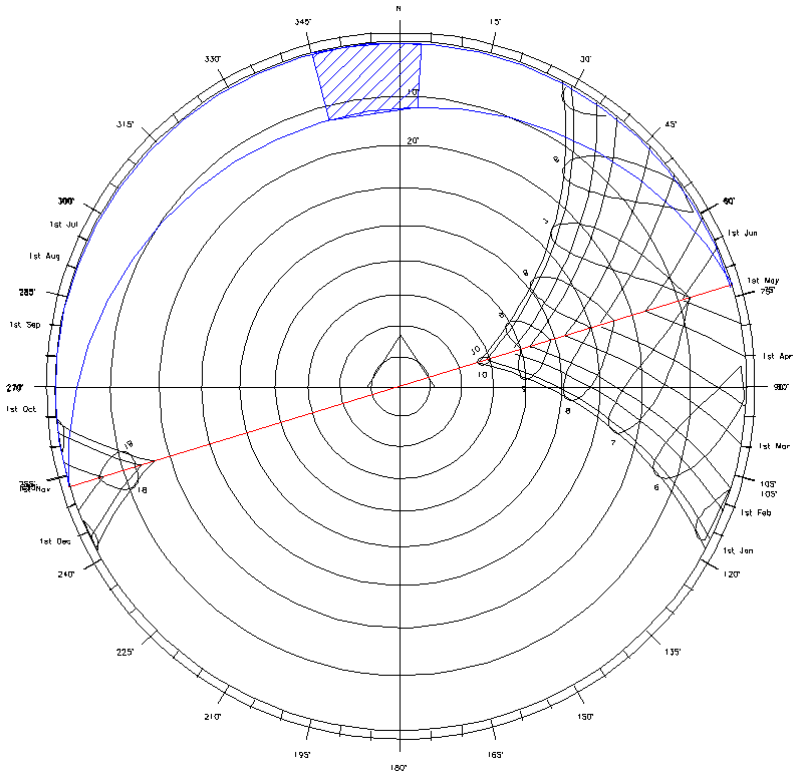


Figure 58 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint C

There is no reflected image of the sun that reaches Viewpoint C from Façade Aspect 163 of the Community Building. Therefore no further studies are required.

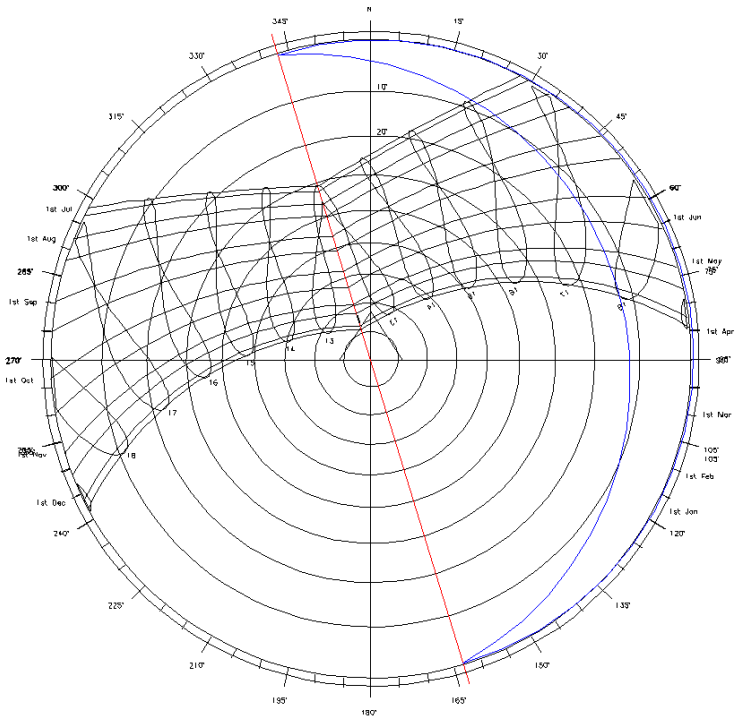


Figure 59 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint C

There is no reflected image of the sun that reaches Viewpoint C from Façade Aspect 253 of Community Building. Therefore no further studies are required.

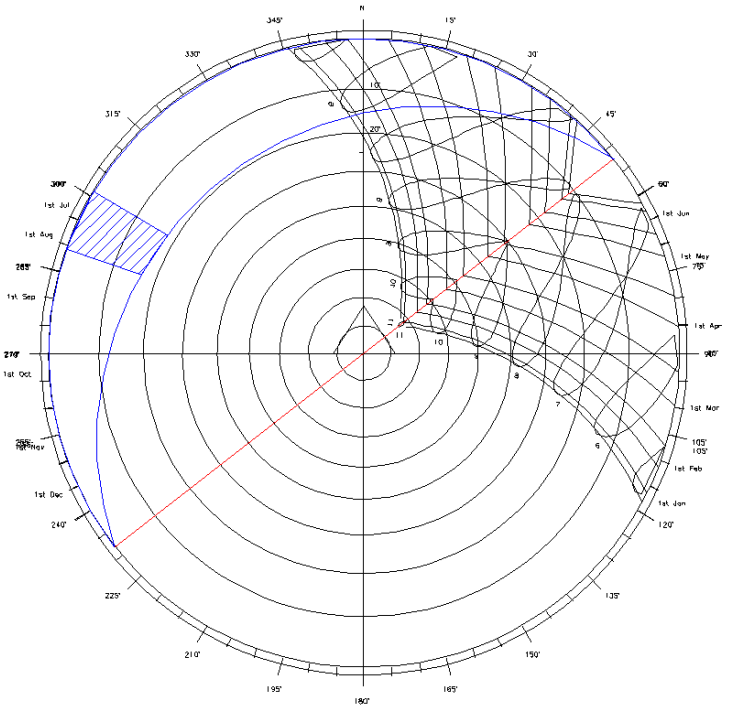


Figure 60 – 142° Façade Aspect Reflected Virtual Sun from Viewpoint C

There is no reflected image of the sun that reaches Viewpoint C from Façade Aspect 182 of Building 1. Therefore no further studies are required.

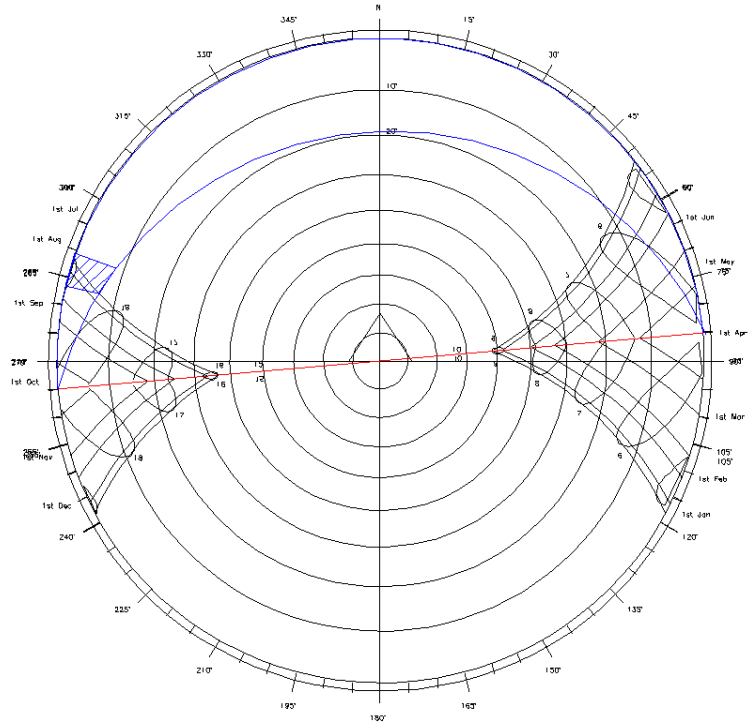


Figure 61 – 172° Façade Aspect Reflected Virtual Sun from Viewpoint C

There is no reflected image of the sun that reaches Viewpoint C from Façade Aspect 253 of Community Building. Therefore no further studies are required.

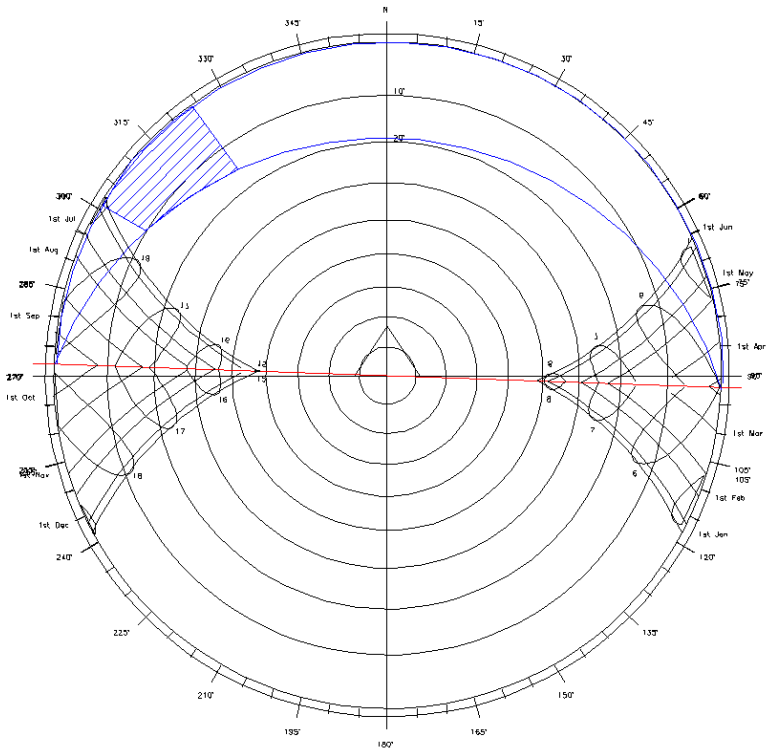


Figure 62 – 182° Façade Aspect Reflected Virtual Sun from Viewpoint C

There is no reflected image of the sun that reaches Viewpoint C from Façade Aspect 182 of Building 1. Therefore no further studies are required.

Viewpoint D

Viewpoint D is taken from the viewpoint of a pedestrian crossing Henderson Road. The viewing angle of the pedestrian is 90°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 163
- Community Building Façade Aspect 253
- Building 1 Façade Aspect 142
- Building 1 Façade Aspect 175
- Building 1 Façade Aspect 182

Viewpoint D has been taken at a distance of 70m from the south-west apex of the Community Building.

Viewpoint D has been taken at a distance of 90m from the south-east apex of Building 1.

On Figure 63 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 63 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community}$ = $\tan^{-1}(16m \div 70m)$

= 12.9°

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 90m)$

= 19.3°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building - Façade Aspect 163	0°	12.9°	5°	20°
Community Building - Façade Aspect 253	0°	12.9°	353°	5°
Building 1 – Façade Aspect 142	0°	19.3°	296°	311°
Building 1 – Façade Aspect 175	0°	19.3°	286°	296°
Building 1 – Façade Aspect 182	0°	19.3°	311°	341°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 64, Figure 65, Figure 66, Figure 67 and Figure 68 below.

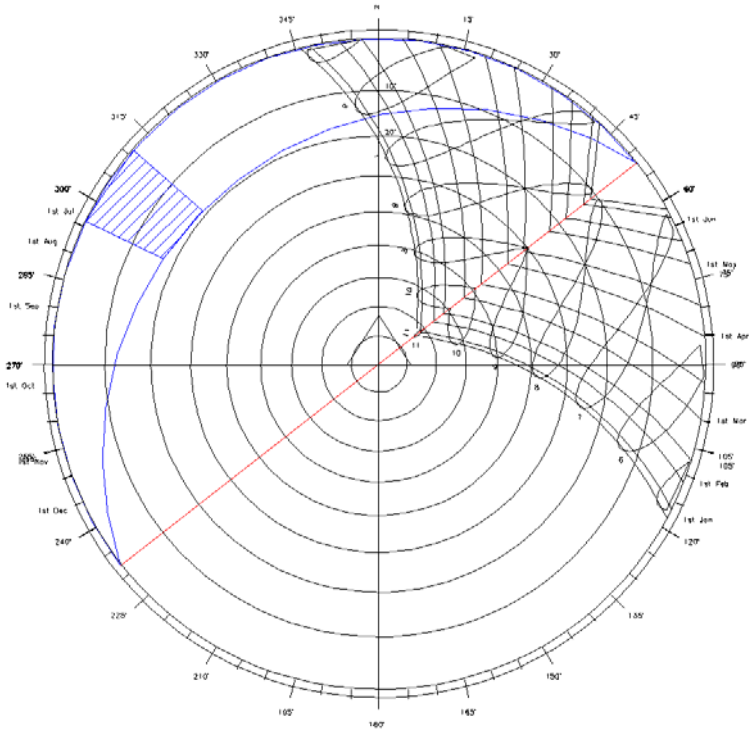


Figure 64 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint D

There is no reflected image of the sun that reaches Viewpoint D from Façade Aspect 163 of the Community Building. Therefore no further studies are required.

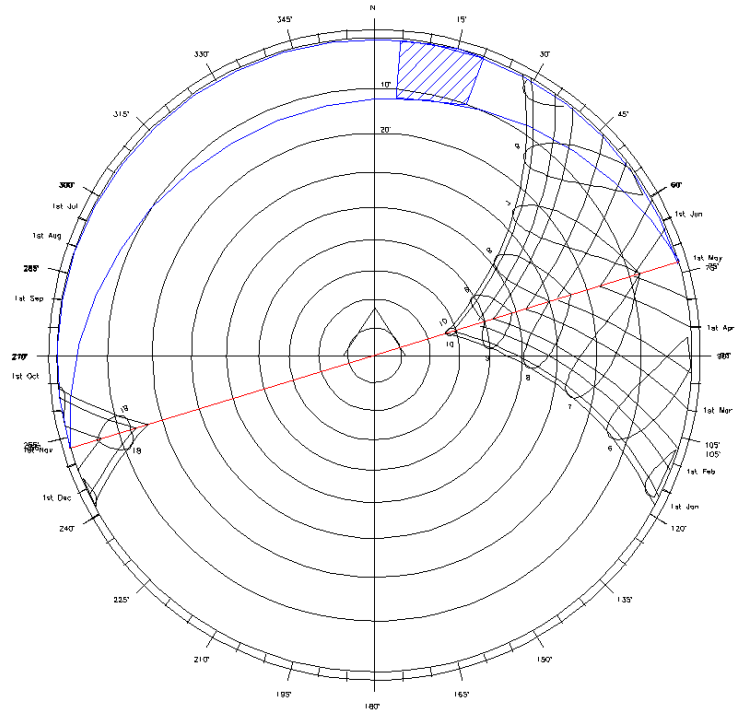


Figure 65 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint D

There is no reflected image of the sun that reaches Viewpoint D from Façade Aspect 253 of Community Building. Therefore no further studies are required.

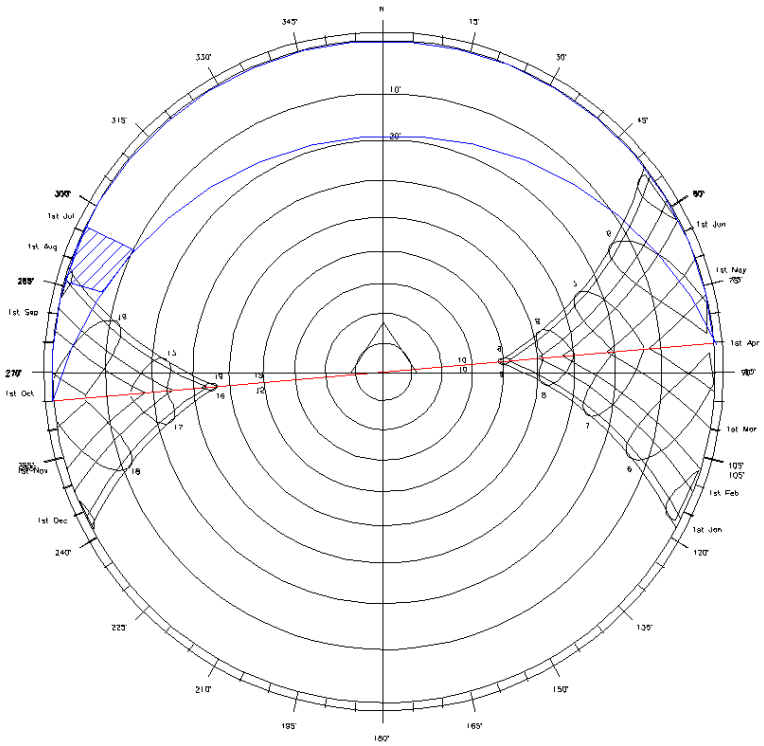


Figure 66 – 152° Façade Aspect Reflected Virtual Sun from Viewpoint D

There is no reflected image of the sun that reaches Viewpoint D from Façade Aspect 182 of Building 1. Therefore no further studies are required.

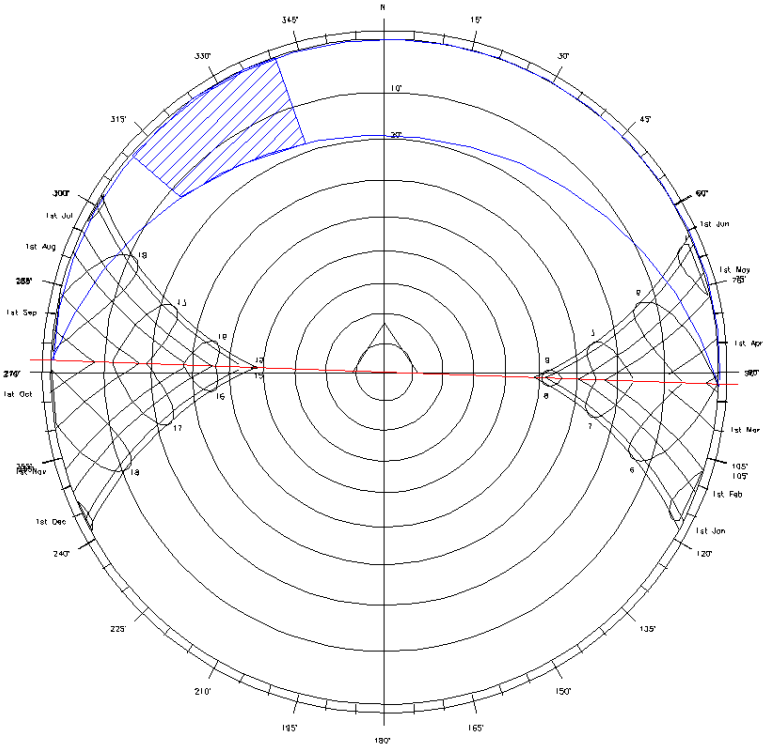


Figure 67 – 175° Façade Aspect Reflected Virtual Sun from Viewpoint D

There is no reflected image of the sun that reaches Viewpoint D from Façade Aspect 253 of Community Building. Therefore no further studies are required.

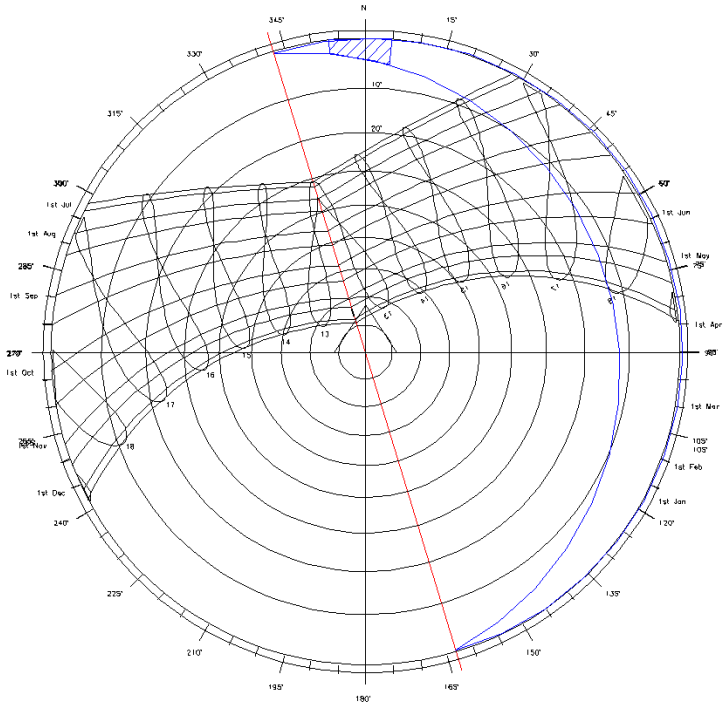


Figure 68 – 182° Façade Aspect Reflected Virtual Sun from Viewpoint D

There is no reflected image of the sun that reaches Viewpoint D from Façade Aspect 182 of Building 1. Therefore no further studies are required.

Viewpoint E

Viewpoint E is taken from the viewpoint of a pedestrian crossing west on Davy Road. The viewing angle of the pedestrian is 270°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 1 Façade Aspect 142
- Building 1 Façade Aspect 182

Viewpoint E has been taken at a distance of 90m from the south-east apex of Building 1.

On Figure 69 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 69 – Viewpoint E horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 1} = \tan^{-1}(31.6m \div 90m)$

$= 19.3°$

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 1 – Façade Aspect 142	0°	19.3°	280°	291°
Building 1 – Façade Aspect 182	0°	19.3°	293°	316°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 70 and Figure 71 below.

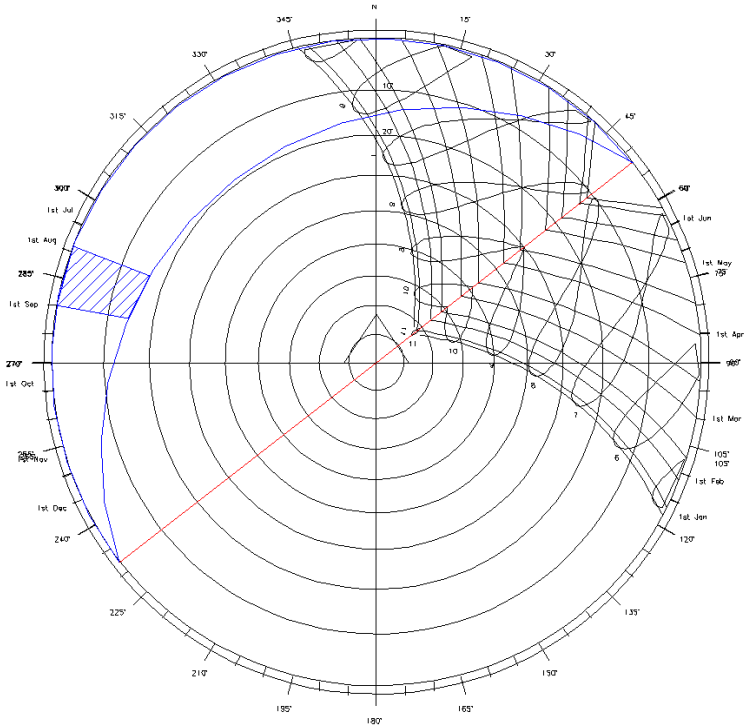


Figure 70 – 142° Façade Aspect Reflected Virtual Sun from Viewpoint E

There is no reflected image of the sun that reaches Viewpoint E from Façade Aspect 142 of the Community Building. Therefore no further studies are required.

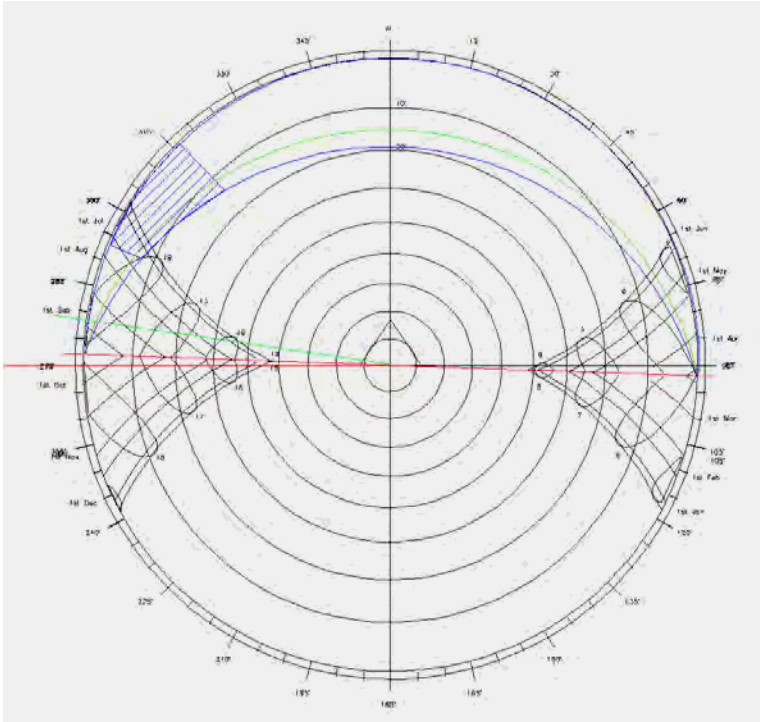


Figure 71 – 182° Façade Aspect Reflected Virtual Sun from Viewpoint E

There is a reflected image of the sun that reaches Viewpoint E from Façade Aspect 182 of Building 1 after 6pm during December and January.

The 20% reflectivity iso-loop is below a vertical bearing angle of 16° and +/- 9° horizontal bearing angle. The area of the façade that would cause disability of reflection is outside of the viewing cone of a pedestrian. This is shown diagrammatically above, where the red line represents the angle of viewing and the green lines represent the horizontal and vertical bearing angle limits.

Viewpoint F

Viewpoint F is taken from the viewpoint of a pedestrian crossing Henderson Road. The viewing angle of the pedestrian is 90°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 163
- Community Building Façade Aspect 253

Viewpoint F has been taken at a distance of 70m from the south-west apex of the Community Building.

Viewpoint F has been taken at a distance of 90m from the south-east apex of Building 1.

On Figure 72 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 72 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community} = \tan^{-1}(16m \div 70m)$

$= 12.9°$

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 163	0°	12.9°	7°	27°
Community Building – Façade Aspect 253	0°	12.9°	352°	7°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 73 and Figure 74 below.

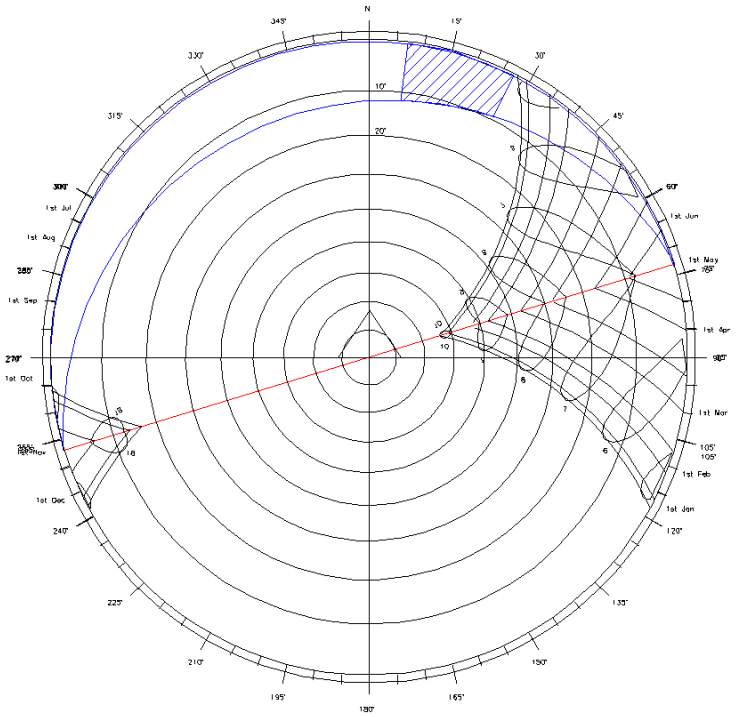


Figure 73 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint F

There is no reflected image of the sun that reaches Viewpoint F from Façade Aspect 163 of the Community Building. Therefore no further studies are required.

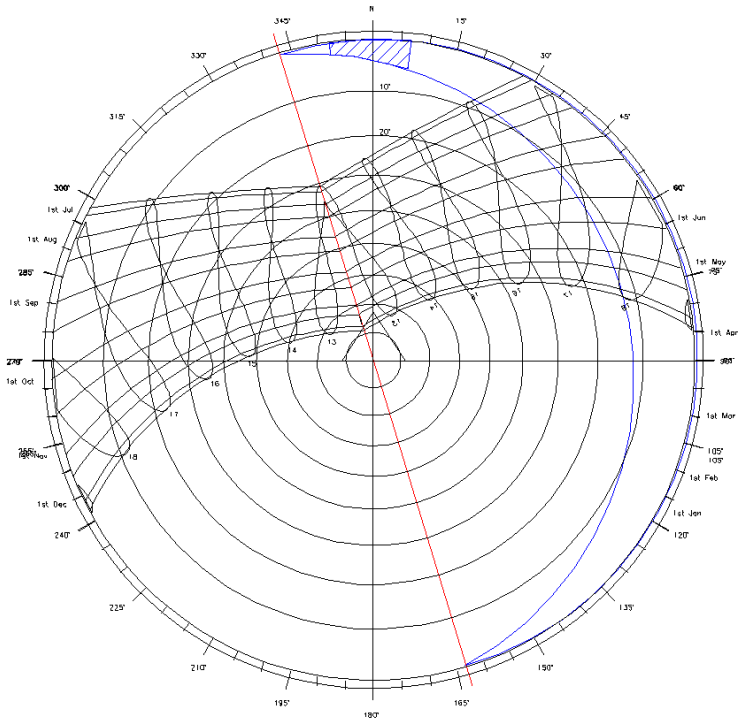


Figure 74 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint F

There is no reflected image of the sun that reaches Viewpoint F from Façade Aspect 253 of the Community Building. Therefore no further studies are required.

Viewpoint G

Viewpoint G is taken from the viewpoint of a pedestrian crossing Alexander Street at the daycare. The viewing angle of the pedestrian is 90°. The following façade aspect is visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 1 Façade Aspect 260

Viewpoint G has been taken at a distance of 95m from the south-west apex of Building 1.

On Figure 75 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 75 – Viewpoint G horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 95m)$

= 18.4°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 1 – Façade Aspect 260	0°	18.4°	65°	94°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 76 below.

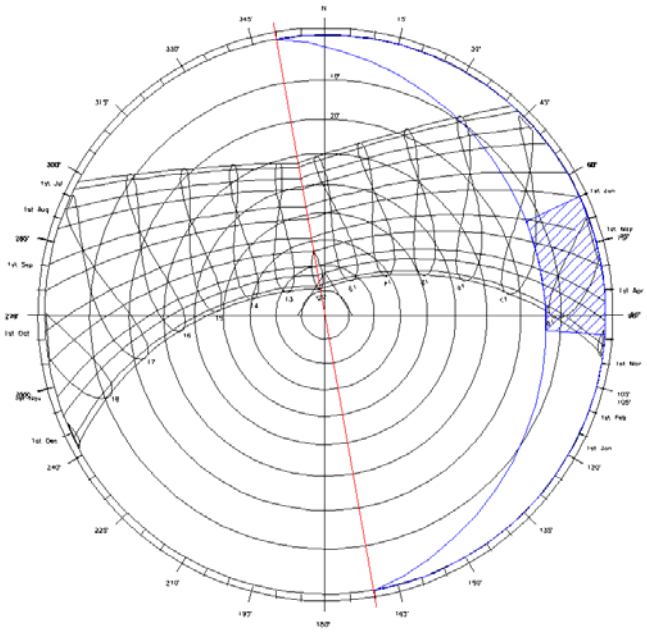
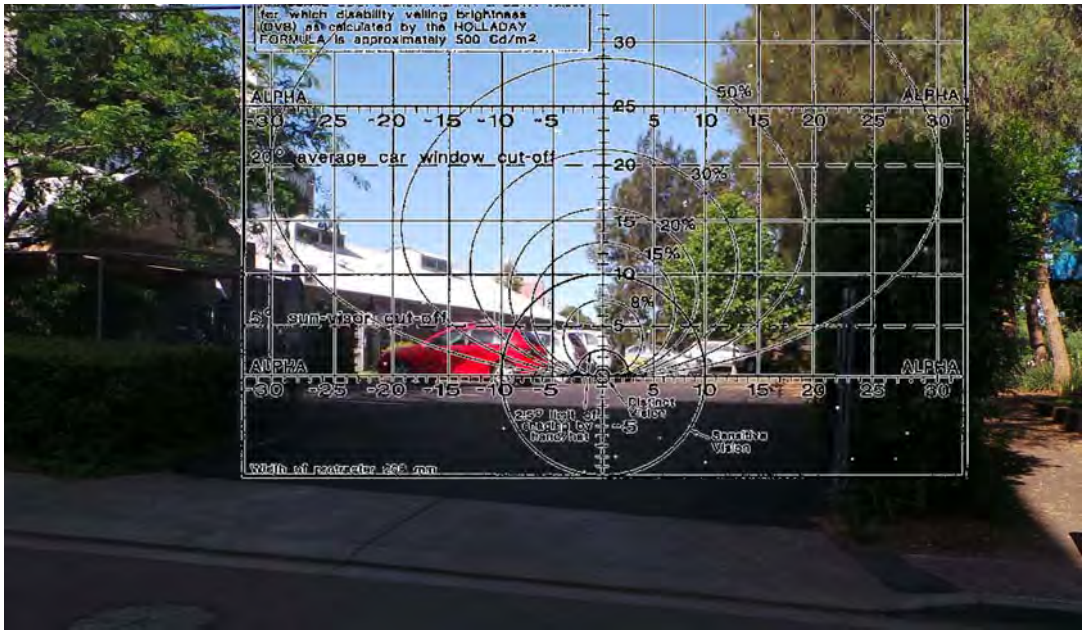


Figure 76 – 260° Façade Aspect Reflected Virtual Sun from Viewpoint G

There is a reflected image of the sun that reaches Viewpoint G from Façade Aspect 260 of Building 1 after 5pm from September to April.



From the image taken at site it can be seen that the elevation falls within the 20% iso-loop but outside the 15% isoloop. The west elevation of Building 1 has solid cladding which will be limited to an external reflectivity of 15%.

Viewpoint H

Viewpoint H is taken from the viewpoint of a pedestrian crossing south on Central Avenue. The viewing angle of the pedestrian ix 165°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 253 (Cut off in part by Building 1)
- Building 1 Façade Aspect 342

Viewpoint H has been taken at a distance of 130m from the north-west apex of the Community Building.

Viewpoint H has been taken at a distance of 28m from the north-west apex of Building 1.

On Figure 77 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 77 – Viewpoint H horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint H.

$\beta_{Community}$ = $\tan^{-1}(16m \div 130m)$

= 7.0°

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 28m)$

= 48.5°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 253	0°	7.0°	78°	85°
Building 1 – Façade Aspect 343	0°	48.5°	85°	200°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 78 and Figure 79 below.

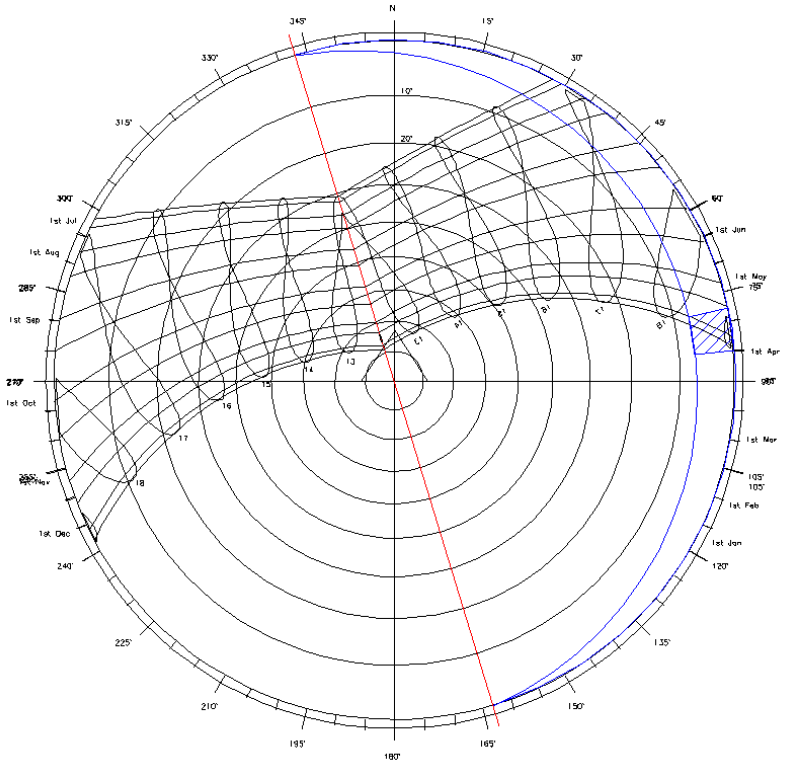


Figure 78 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint H

There is a reflected image of the sun that reaches Viewpoint H from Façade Aspect 253 of Community Building after 630 pm during December and January. The façade is outside the cone of viewing of a pedestrian crossing Central Avenue.

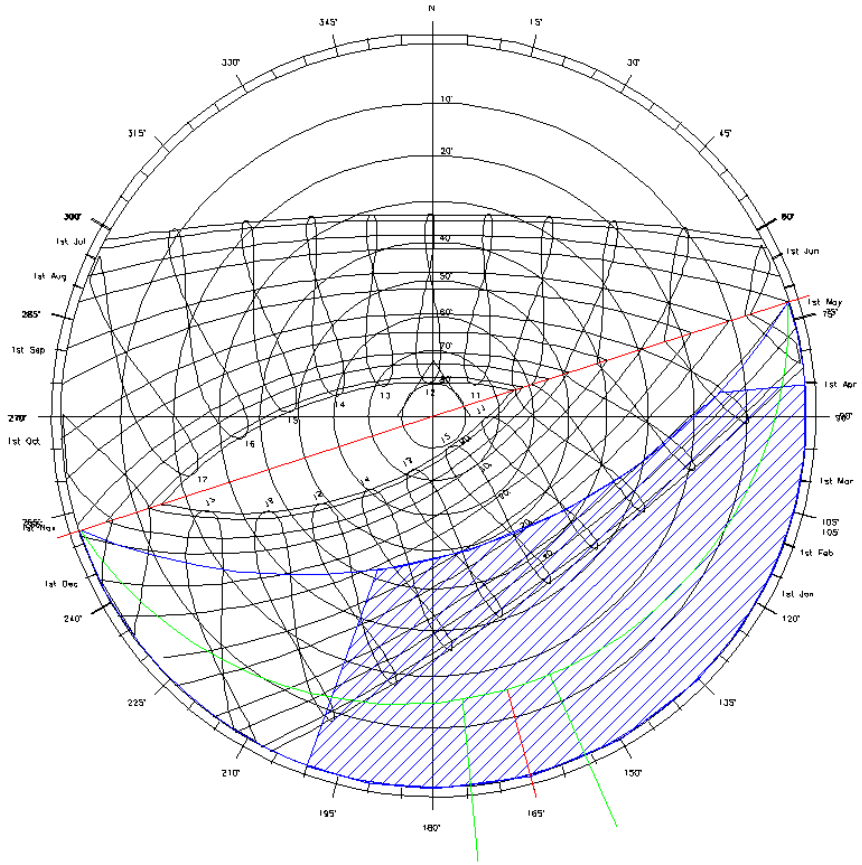


Figure 79 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint H

There is a reflected image of the sun that reaches Viewpoint H from Façade Aspect 343 of Building 1 throughout the day from April to September.

The 20% reflectivity iso-loop is below a vertical bearing angle of 16° and +/- 9° horizontal bearing angle. The area of the façade that would cause disability of reflection is outside of the viewing cone of a pedestrian. This is shown diagrammatically above, where the red line represents the angle of viewing and the green lines represent the horizontal and vertical bearing angle limits.

Viewpoint I

Viewpoint I is taken from the viewpoint of a pedestrian crossing south on Central Avenue. The viewing angle of the pedestrian ix 165°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 342
- Community Building Façade Aspect 253 (Cut off in part by Building 1)
- Building 1 Façade Aspect 342

Viewpoint I has been taken at a distance of 70m from the north-west apex of the Community Building.

Viewpoint I has been taken at a distance of 20m perpendicular to Façade Aspect 342 of Building 1.

On below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 80 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community}$ = $\tan^{-1}(16m \div 70m)$

= 12.9°

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 20m)$

= 57.7°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 343	0°	12.9°	80°	86°
Community Building – Façade Aspect 253	0°	12.9°	86°	105°
Building 1 – Façade Aspect 343	0°	57.7°	105°	236°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 81 and Figure 82 below.

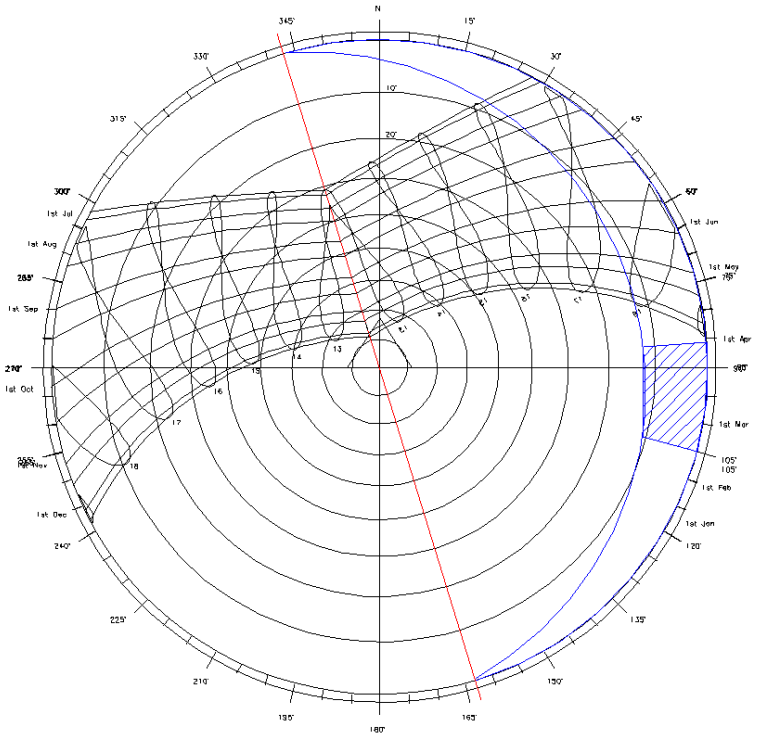


Figure 81 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint I

There is no reflected image of the sun that reaches Viewpoint I from Façade Aspect 253 of Community Building. Therefore no further studies are required.

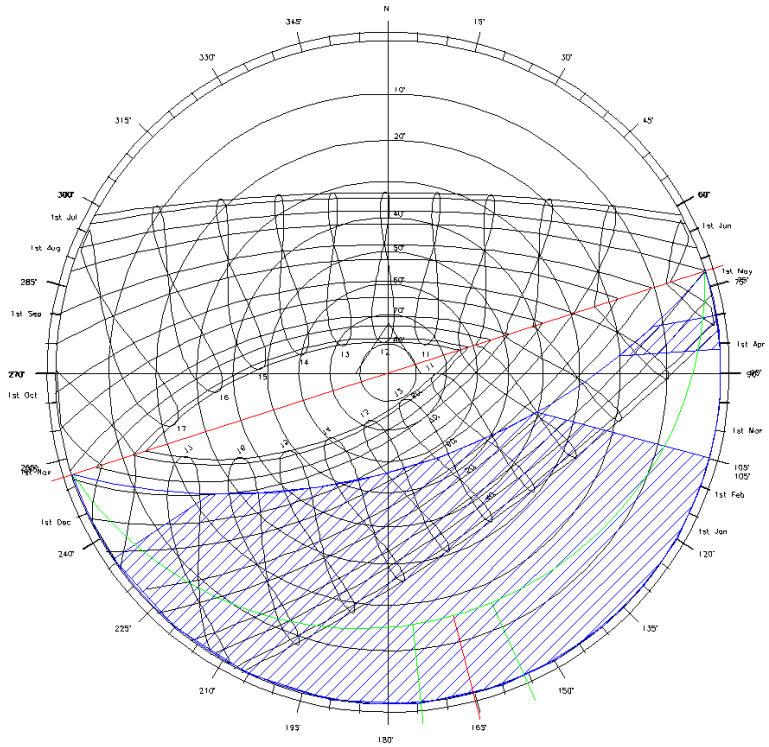


Figure 82 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint I

There is no reflected image of the sun that reaches Viewpoint I from Façade Aspect 182 of Building 1 throughout the day from April to September.

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The 20% reflectivity iso-loop is below a vertical bearing angle of 16° and +/- 9° horizontal bearing angle. The area of the façade that would cause disability of reflection is outside of the viewing cone of a pedestrian. This is shown diagrammatically above, where the red line represents the angle of viewing and the green lines represent the horizontal and vertical bearing angle limits.

Viewpoint J

Viewpoint J is taken from the viewpoint of a pedestrian north on Central Avenue. The viewing angle of the pedestrian is 340°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 163
- Building 2Façade Aspect 253

Viewpoint J has been taken at a distance of 27m from the south-west apex of Building 2.

On Figure 83 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 83 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 2}$ = $\tan^{-1}(33.7m \div 27m)$

= 51.3°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 2 – Façade Aspect 163	0°	51.3°	347°	10°
Building 2 – Façade Aspect 253	0°	51.3°	10°	61°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 84 and Figure 85 below.

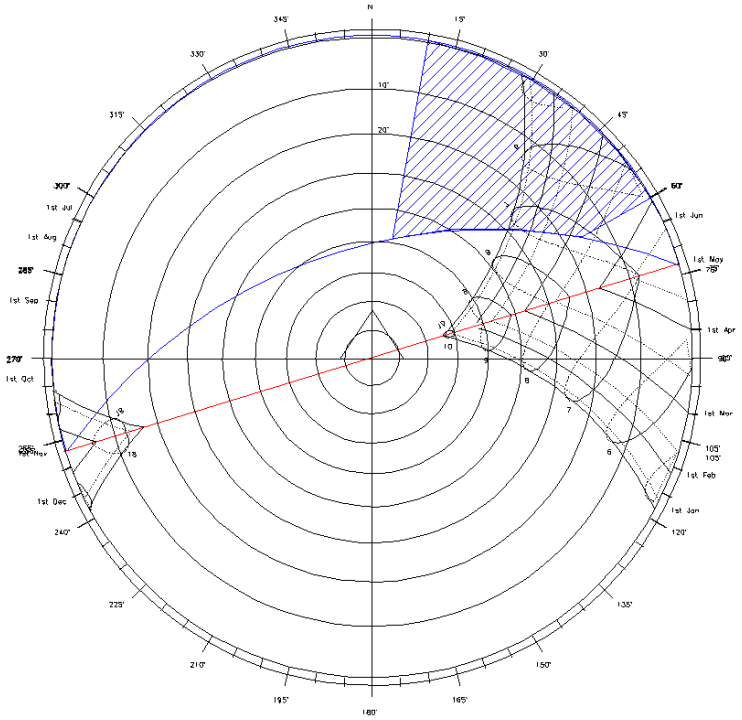
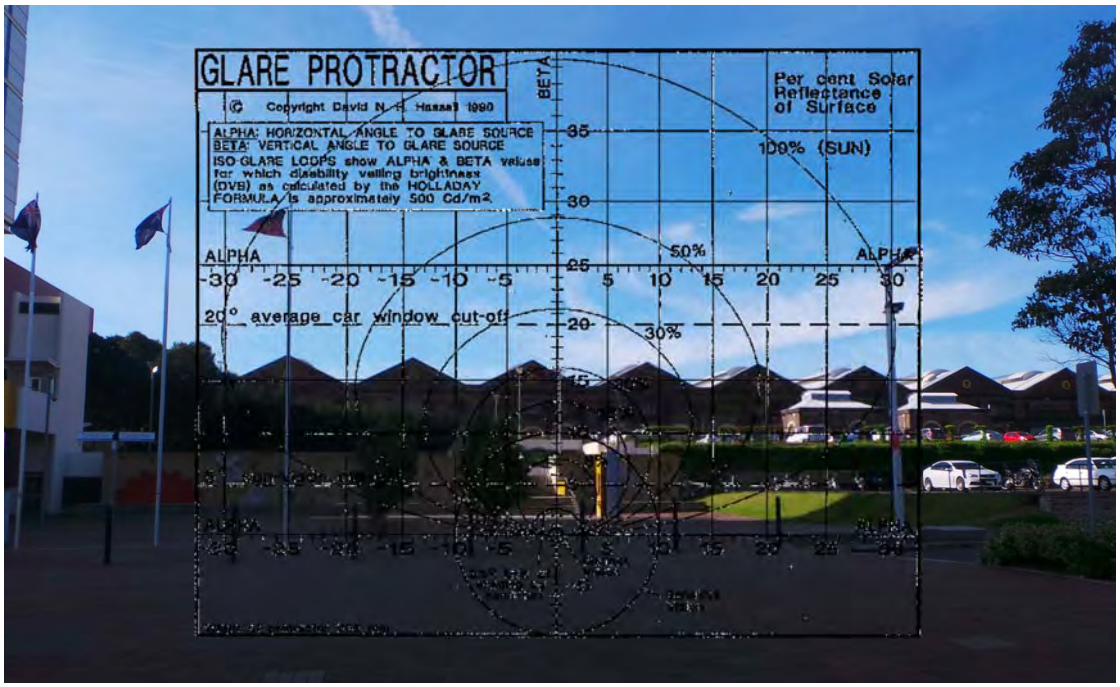


Figure 84 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint J

There is a reflected image of the sun that reaches Viewpoint J from Façade Aspect 163 of Building 2 before 7am from October to March. In order to assess the façade a photo has been taken and the glare protractor has been applied at scale.



From the image above it can be seen that the façade aspect will be outside the 20% iso-glare loop; no further studies required.

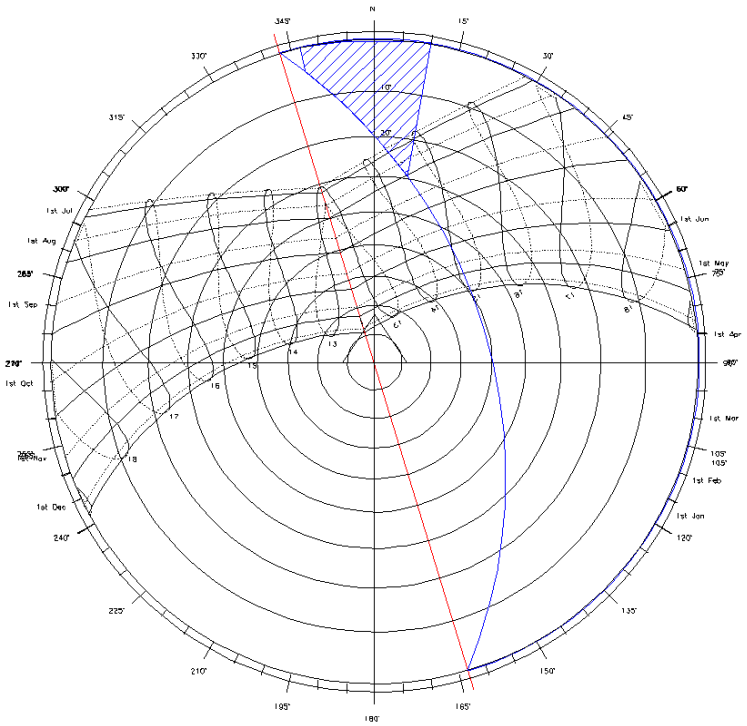


Figure 85 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint J

There is a reflected image of the sun that reaches Viewpoint J from Façade Aspect 343 of Building 2 between 1pm and 2pm in winter. The façade that causes reflections to Viewpoint J is above 20°

Viewpoint K

Viewpoint K is taken from the viewpoint of a pedestrian crossing south on Central Avenue. The viewing angle of the pedestrian ix 155°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Community Building Façade Aspect 342
- Building 1 Façade Aspect 72
- Building 1 Façade Aspect 342

Viewpoint H has been taken at a distance of 28m from the north-west apex of the Community Building.

Viewpoint H has been taken at a distance of 41m to the north-east apex of Building 1.

On Figure 86 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 86 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Community}$ = $\tan^{-1}(16m \div 28m)$

= 29.7°

$\beta_{Building\ 1}$ = $\tan^{-1}(31.6m \div 41m)$

= 37.6°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Community Building – Façade Aspect 342	0°	29.7°	108°	156°
Building 1 – Façade Aspect 72	0°	37.6°	179°	206°
Building 1 – Façade Aspect 343	0°	37.6°	206°	237°

These bearing angles have been plotted on the reflected sun path diagrams in **Error! Reference source not found.**, Figure 87 and Figure 88 below.

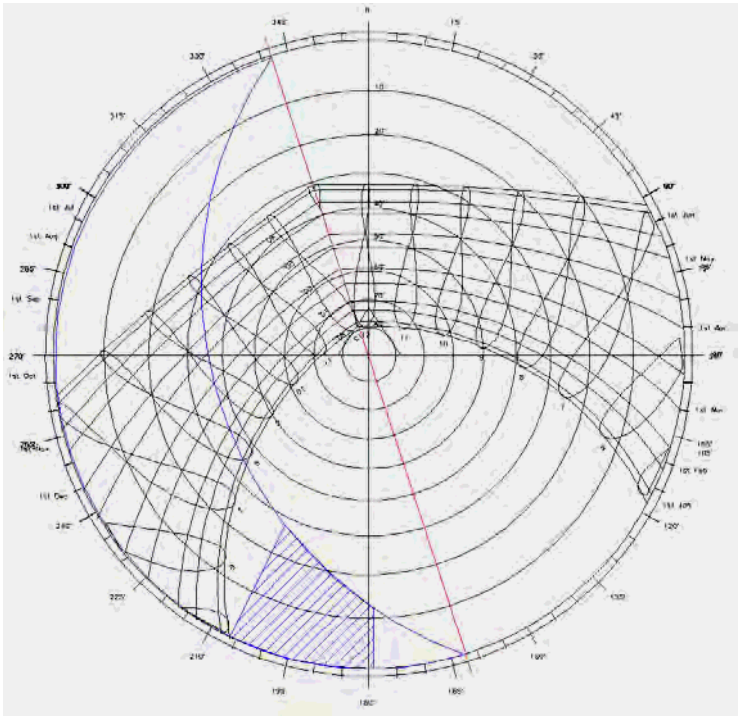


Figure 87 – 72° Façade Aspect Reflected Virtual Sun from Viewpoint K

There is no reflected image of the sun that reaches Viewpoint K from Façade Aspect 72 of Community Building. Therefore no further studies are required.

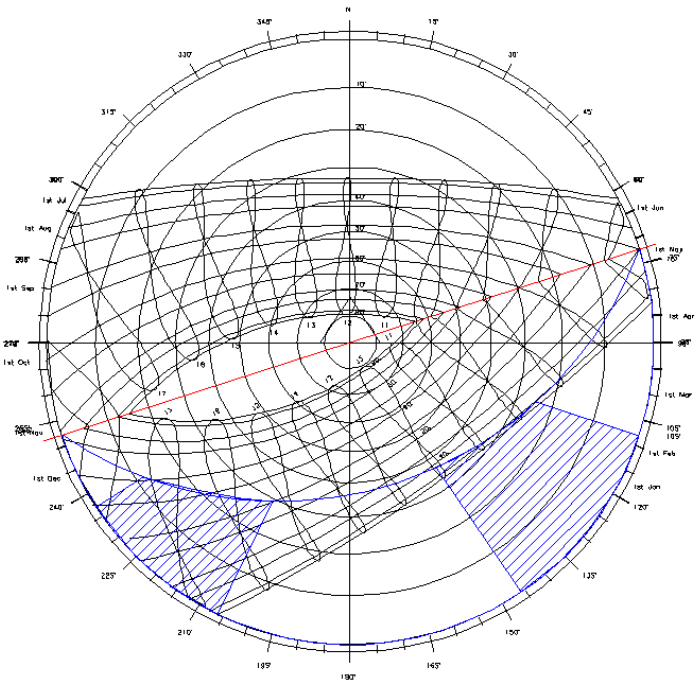


Figure 88 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint K

There is a reflected image of the sun that reaches Viewpoint K from Façade Aspect 182 of Building 1 after 3pm from March to October.

IMAGE NEEDED

The 20% reflectivity iso-loop is below a vertical bearing angle of 16° and +/- 9° horizontal bearing angle. The area of the façade that would cause disability of reflection is outside of the viewing cone of a pedestrian.

Viewpoint L

Viewpoint L is taken from the viewpoint of a pedestrian crossing south on Locomotive Street. The viewing angle of the pedestrian is 160°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 343

Viewpoint L has been taken at a distance of 20m perpendicular from Building 2.

On Figure 89 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 89 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 2}$ = $\tan^{-1}(33.7m \div 20m)$

= 59.3°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 2 – Façade Aspect 343	0°	59.3°	80°	233°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 90 below.

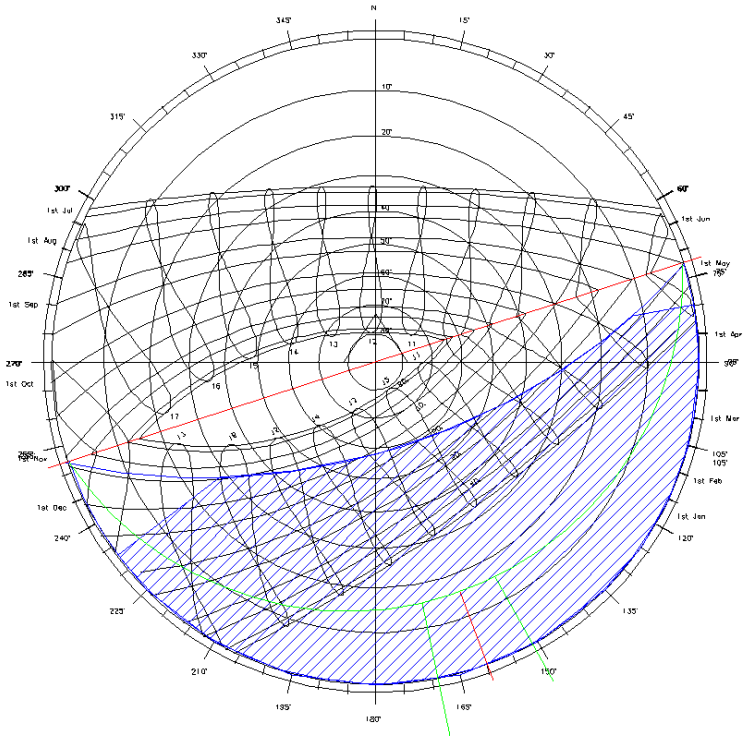


Figure 90 – 343° Façade Aspect Reflected Virtual Sun from Viewpoint L

There is a reflected image of the sun that reaches Viewpoint L from Façade Aspect 343 of Building 2 throughout the day from February to November.

IMAGE NEEDED

The 20% reflectivity iso-loop is below a vertical bearing angle of 16° and +/- 9° horizontal bearing angle. The area of the façade that would cause disability of reflection is outside of the viewing cone of a pedestrian. This is shown diagrammatically above, where the red line represents the angle of viewing and the green lines represent the horizontal and vertical bearing angle limits.

Viewpoint M

Viewpoint M is taken from the viewpoint of a pedestrian crossing east on Davy Road. The viewing angle of the pedestrian is 340°. The following façade aspects are visible from the Viewpoint (in a 180° segment oriented to the direction of viewing):

- Building 2 Façade Aspect 163
- Building 2 Façade Aspect 253

Viewpoint M has been taken at a distance of 48m from the south-west apex of Building 2.

On Figure 91 below below yellow lines have been drawn to represent the bearing angles to the two visible façade aspects of the building. The blue arrow indicated the direction of travel and viewing.

Figure 91 – Viewpoint 5 horizontal bearing angles

The vertical bearing angles have been calculated for each building that is visible from Viewpoint 5.

$\beta_{Building\ 2}$ = $\tan^{-1}(33.7m \div 48m)$

= 35.1°

	Vertical Bearing Angle		Horizontal Bearing Angle (0° at North)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Building 2 – Façade Aspect 253	0°	35.1°	0°	30°
Building 2 – Façade Aspect 163	0°	35.1°	30°	60°

These bearing angles have been plotted on the reflected sun path diagrams in Figure 92 and Figure 93 below.

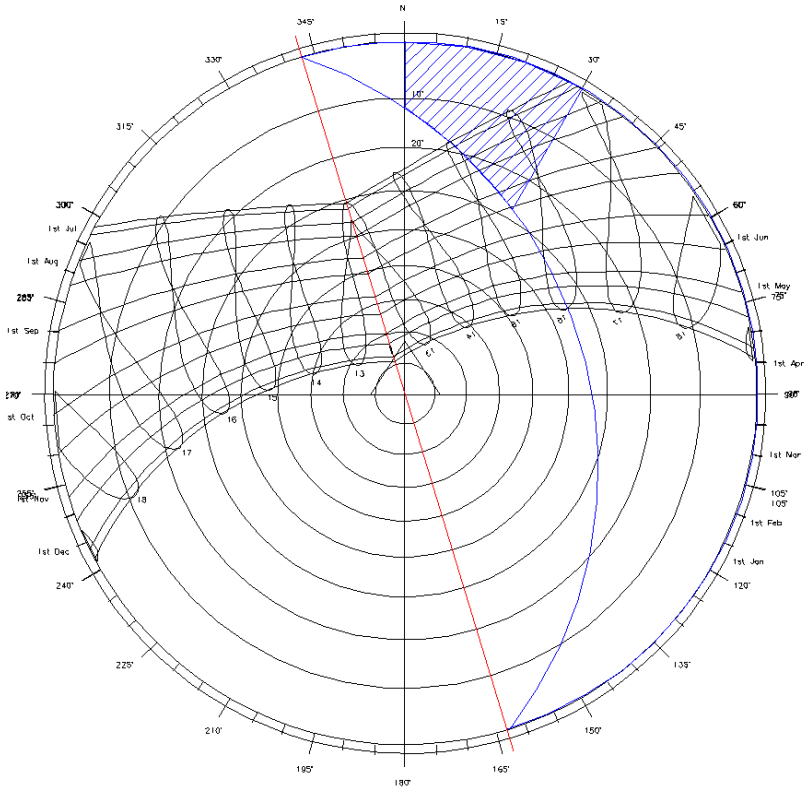


Figure 92 – 253° Façade Aspect Reflected Virtual Sun from Viewpoint M

There is a reflected image of the sun that reaches Viewpoint M from Façade Aspect 253 of Building 2 after 3pm from May to August.

The 20% reflectivity iso-loop is below a vertical bearing angle of 16° and +/- 9° horizontal bearing angle. The area of the façade that would cause disability of reflection is outside of the viewing cone of a pedestrian.

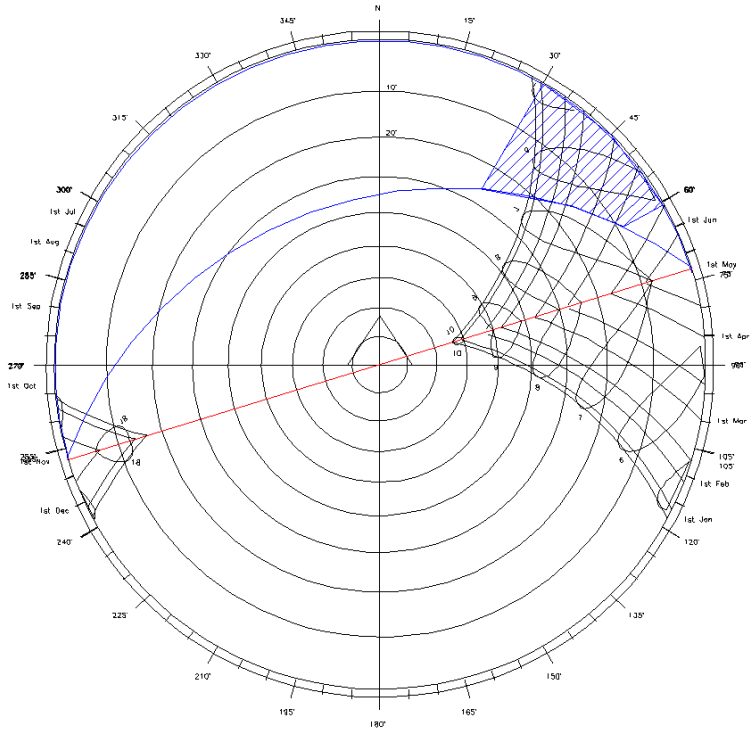


Figure 93 – 163° Façade Aspect Reflected Virtual Sun from Viewpoint M

There is a reflected image of the sun that reaches Viewpoint M from Façade Aspect 163 of Building 1 before 7am from September to April.

The 20% reflectivity iso-loop is below a vertical bearing angle of 16° and +/- 9° horizontal bearing angle. The area of the façade that would cause disability of reflection is outside of the viewing cone of a pedestrian.