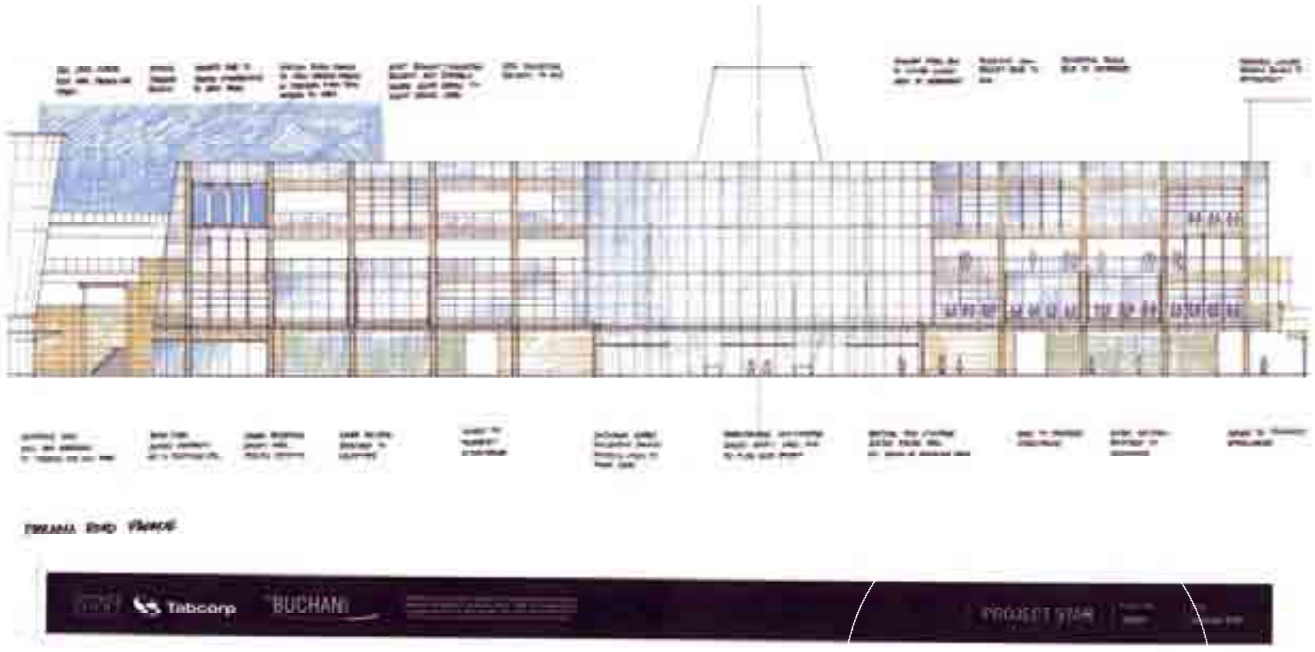



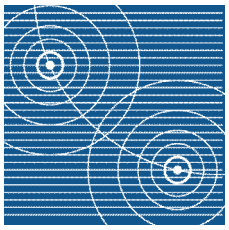
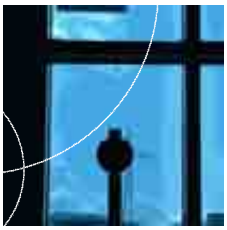

Project STAR

Assessment of Reflected Solar Glare from Glazed Facade Pirrama Road

Tabcorp

12 December 2008

Assessment of Reflected Solar Glare from Glazed Facade Pirrama Road

Prepared for

Tabcorp

Prepared by

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			Name/Position	Signature
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Table of Contents

Executive Summary

Bassett Consulting Engineers have been engaged by Tabcorp to undertake an assessment of the potential for reflected solar glare from Project STAR. Project STAR proposes vertical plane glass façade and canopy facing Pirrama Road, Pyrmont.

The LEP limits reflectance of glass to 20 percent and on this project the reflectance's proposed are much less: the variety of glasses proposed vary from 9 percent reflectance down to 5 percent reflectance. The adjacent Darling Walk Project (Google Building) utilises vertical glazing with glazing reflectance varying from 15 percent to 14 percent reflectance.

This preliminary analysis shows that with the current façade design shown in section 1 of this report that there is no sunlight reflection towards driver location OP2. Likewise, for vertical glass, there is no sunlight reflection towards pedestrians at OP3.

There will be no reflection towards a pedestrian at position OP4 from the curved canopy aspect 48 degrees or from the south end of the façade which also has an aspect of 48 degrees. From the 63.5 degrees aspect of the canopy and from most of the main façade there is no reflection. There is a minor potential for reflection from the southern end of the main façade for that part that is visible above the dense trees shortly after sunrise for a short period of time bearing in mind that during early morning sunlight is not at full strength and that the angle at which any sunlight strikes the glazing will be well within 60 degrees of normal to the glass and therefore if the recommended glass selection is used any reflection will be 9 percent or less depending in which part of the façade the reflection is apparent to the observer.

For residential position OP5 the surface which has an aspect (ASP) of 63.5 degrees has potential for solar reflection only at sunrise March/April and August/September, however, the city skyline will obscure most of the direct sun at this time eliminating this potential.

There are no views of Project STAR from observer positions OP6 and OP8. Also, there will be no reflection from the glazed façade towards OP7 with vertical glazing.

Boat operator position OP9 is based on an assumption that a ferry or water taxis operator approaches the location in a direct line from the East. If the ferry or water taxis approaches this point in any different way such as in a wider arc and ultimately facing east, then none of the information in or associated with Figures 20 and 21 is relevant. From mid May to mid July there is a maximum of a 5 to 10 minute period following sunrise after the sun clears the top of the multistorey buildings of the CBD when there is potential for sunlight reflection from the top part of the canopy and the south end of the façade top edge that has an aspect of 48 degrees. From the main façade and from the front of the canopy where the aspect is 63.5 degrees and the surfaces are vertical, there is potential for sunlight reflection early in the morning from the top edge of the façade for a 5 to 10 minute period. During early morning sunlight is not at full strength. Also, the angle at which any sunlight strikes the glazing will be well within 60 degrees of normal to the glass and therefore if the recommended glass is used the reflection will be 5 to 9 percent (depending on which part of the façade the sun is being reflected from) of the incident radiation and of low impact.

Any impacts from the curved canopy glazing will be less than indicated in the report because of the assumptions shown in Figure 6 where the curved shape is approximated to 3 flat planes. In reality the curve will consist of a series of smaller flat planes and hence the reflected sun image towards any one point at any one time will be much smaller and have lower impact.

1.0 Description

Project STAR proposes an inclined plane glass façade and canopy facing Pirrama Road, Pyrmont. The new proposed façade is shown below in Figure 1

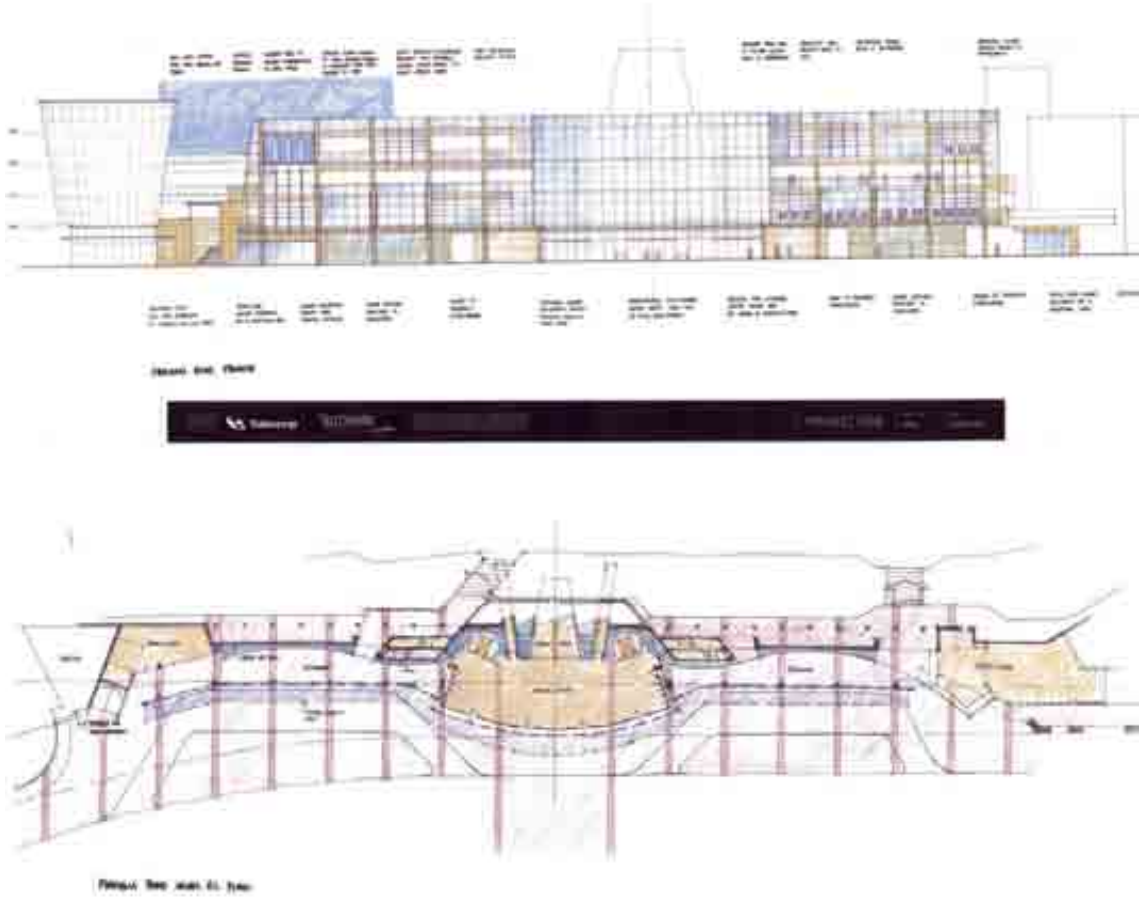

Figure 1 STAR project proposed new façade and canopy glazing facing Pirrama Road

Highly reflective glass will produce solar reflection problems. Glass generally has a low reflectance for incident radiation normal to the glass unless it has a surface treatment. However, as the angle of incidence changes, glass can become a mirror. Assuming only low reflectance glass is used than as the angle of incidence increases above 60 degrees the surface will still have mirror like properties, refer Figure 2.

The most important aspect is solar reflection and disability glare to drivers. Due to the complexity of analysis of a curved some approximations are required for the purpose of preliminary analysis. Some simplifications to approximate equivalent straight flat sections of façade are shown in Figure 6.

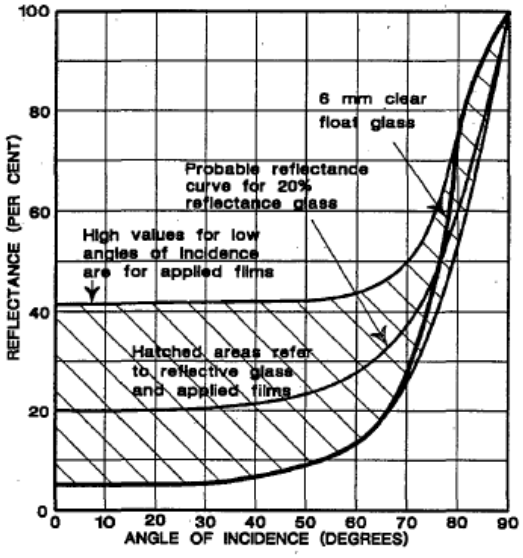

Figure 2 Reflection characteristics of glass (Hassall 1991)

Operable windows that have tilt adjustment are not included in this report as it is unknown at what angle any one window may be temporarily adjusted to. Also the size of any one window will not be large.

2.0 Surroundings

An inspection of the precinct, observation points OP1 to OP9 at pedestrian and driver height, Figure 3, revealed potential locations for views of Project STAR which are analysed in the report below.

Figure 3 Project STAR and location of observer points OP1 to OP9

3.0 Analysis

3.1 Observation Point 1 (OP1)

Figure 4 Driver view at OP1

As drivers head north-west round the bend in Pirrama Road adjacent Pier 7, the view of the new proposed glass façade will be obscured by the dense foliage as seen in Figure 4

Figure 5 Driver view at OP2

3.2 Observation Point 2 (OP2)

A critical point for drivers will be the approach to the junction of Pirrama Road and Edward Street, designated as observer point OP2 and shown in Figure 5.

The simplifications shown in Figure 6 indicate the aspect of the glazing facing the driver to be 79 degrees.

Plotting this information on a reflection protractor copied from Hassall 1991, Figure 7 indicates that there will be solar reflections from late April to end of July between 1030 and 1130 hours. The angle of incident radiation will not be in the critical 60 degrees and over zone which means the glass will reflect some light but not be as dazzling as a mirror surface. Curvature of the glass will have the advantage of reducing the overall size of the reflected sun image but it will also mean whilst driving toward Project STAR the glare will continue for a longer period than if it was a flat plane.

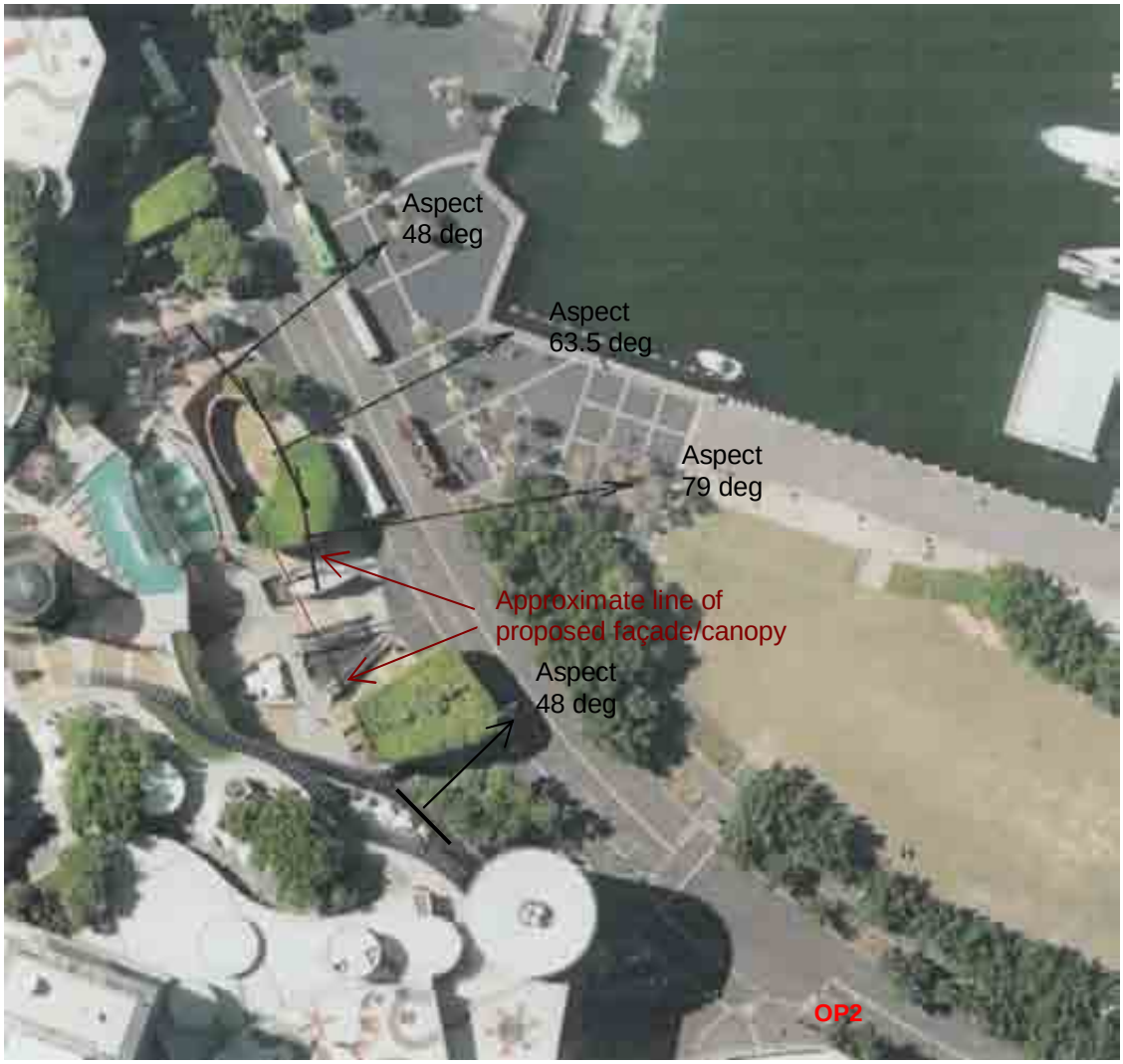

Figure 6 Observer point OP2 relative to Project STAR new proposed glass facade

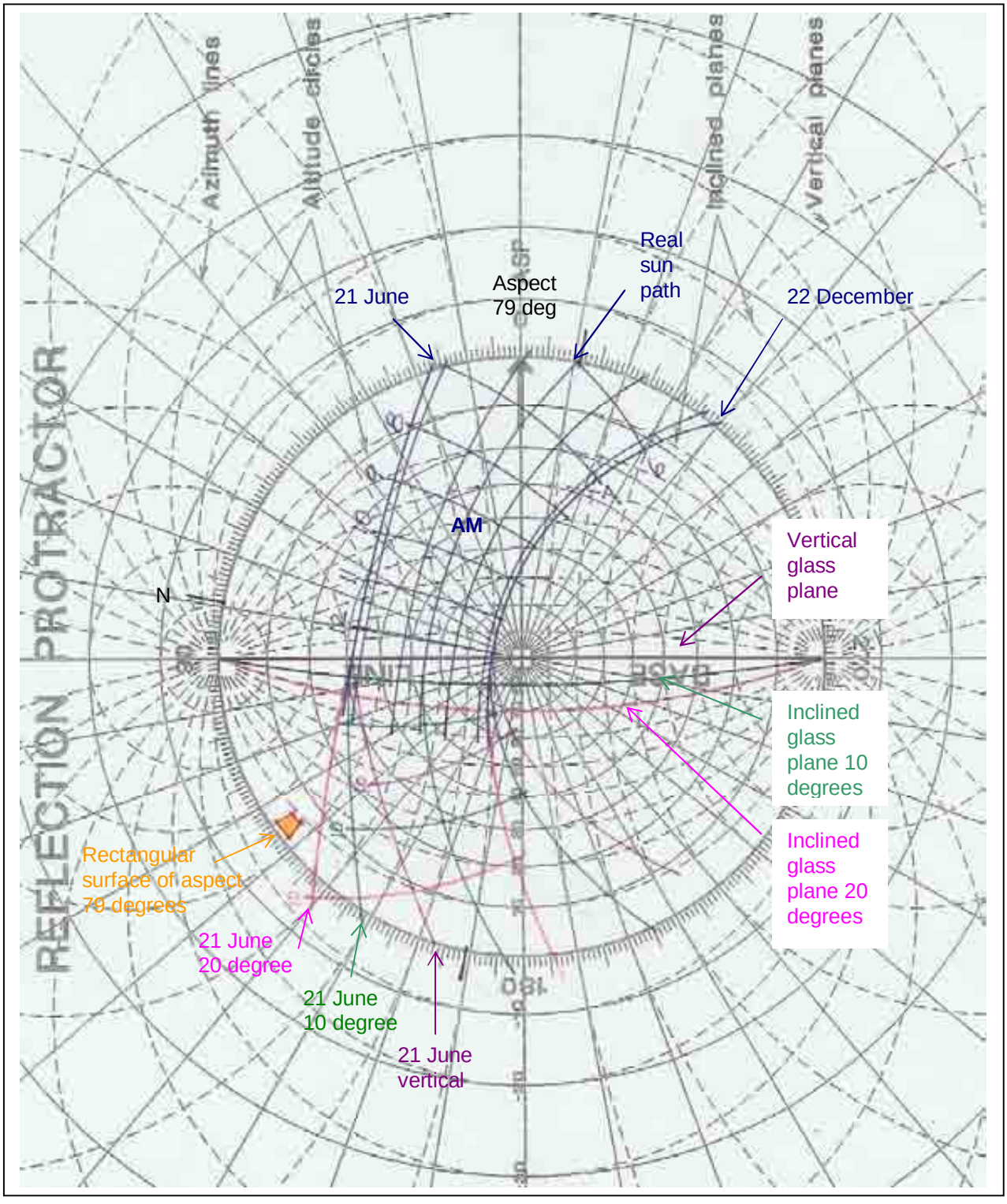

Figure 7 Solar reflection from a surface – from glass canopy towards driver at location OP2. The figure shows that the surface which has an aspect (ASP) of 79 degrees, that regardless of whether that aspect is vertical (in purple) or tilted back to upwards of 20 degrees (in pink) there will be no reflection towards a driver at position OP2 as the rectangular surface never intersects the reflected sun paths..

3.3 Observation Point 3 (OP3)

Figure 8 shows that there will be no reflections from the curved canopy towards this point if the glazing is vertical as the rectangle representing the surface does not intersect with the reflected sun path

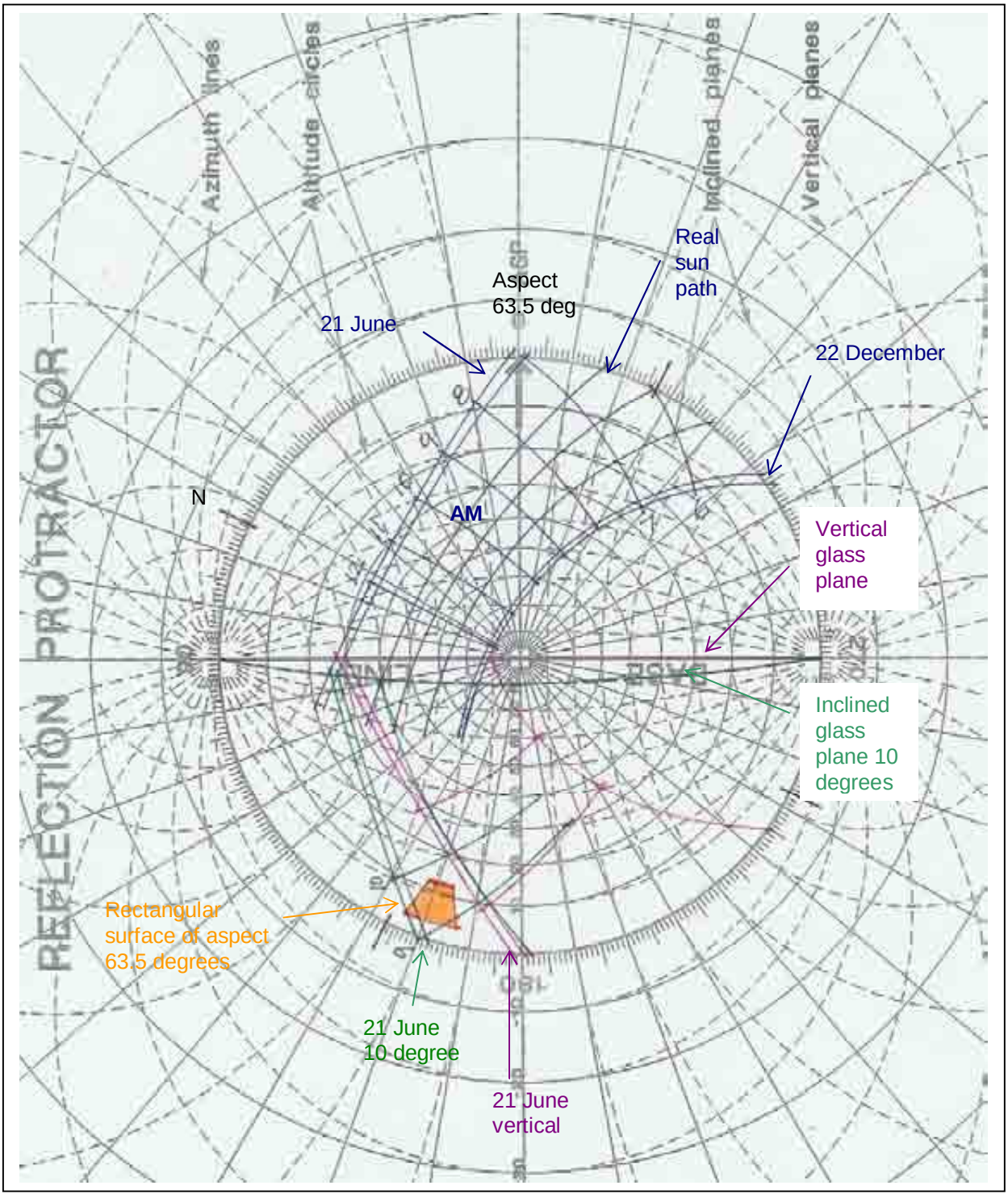

Figure 8 Solar reflection from a surface – from glass façade/canopy towards a pedestrian at location OP3. The figure shows that the surface which has an aspect (ASP) of 63.5 degrees, that if the surface is vertical (in purple) there will be no reflection towards a pedestrian at position OP3 from the curved canopy as the rectangular surface never intersects the reflected sun paths. If the surface is tilted back 10 degrees there will be some reflected sun from late April to the end of July.

(purple). There will be no reflection from the majority of the vertical façade behind, however, towards the south end there will be some reflection early in the morning during winter which will be screened by the dense foliage more or less depending on where the pedestrian is standing. If the curved canopy surface was to be tilted 10 degrees then there would be some reflection from late April through to end of July from 0850 to 0940 hours. The assumption in this analysis is that the manicured trees in front of the casino, Figure 9, will be sacrificed as part of the new proposed facade/canopy arrangement.

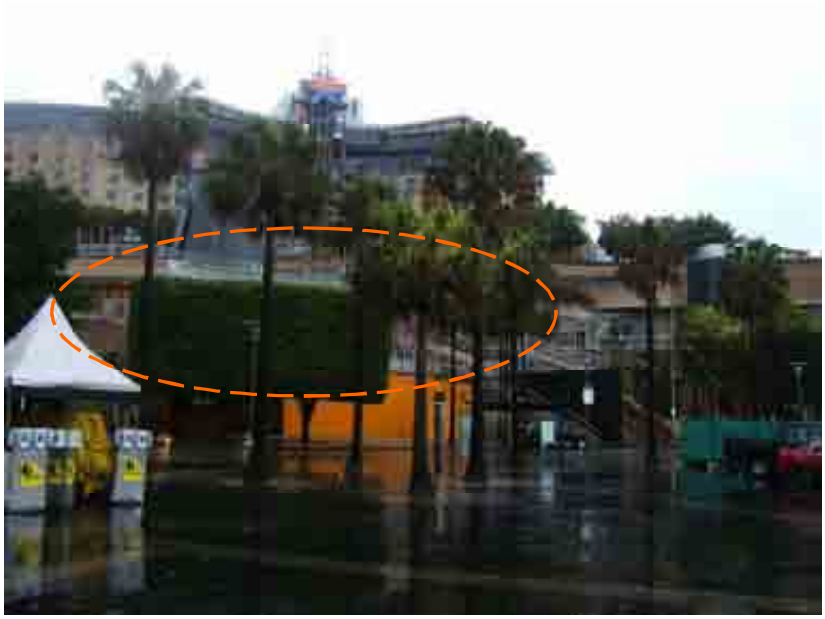

Figure 9 Casino from pedestrian observer position OP3

3.4 Observation Point 4 (OP4)

Towards pedestrian location OP4, Figure 10, there will be no reflected sunlight from the surface with an aspect of 48 degrees. some reflected sunlight from late September to late November and again early February to mid March between 1030 and 1130 hours , refer Figure 11, and during this period the angle of incident radiation will be in the critical 60 degrees and over zone which means the glass will act like a mirror. The curvature of the glass will reduce the overall size of the reflected sun image. As the distance from the reflecting surface increases the angular size appears less and is less disturbing than if the view was much closer.

Figure 10 Pedestrian location OP4

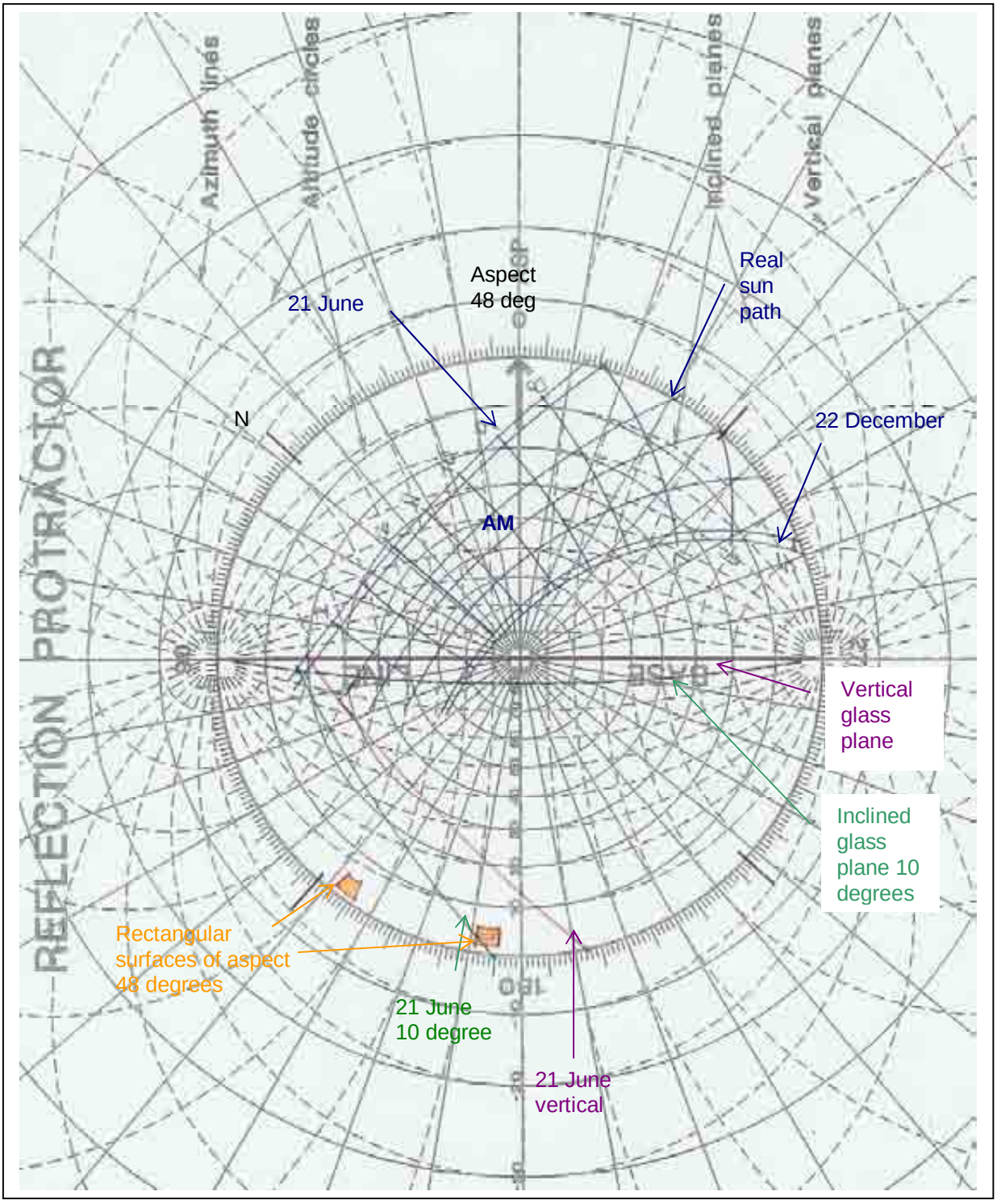

Figure 11 *Solar reflection from a surface – from glass canopy and the south end of the façade towards a pedestrian at location OP4. The figure shows that the surfaces which have an aspect (ASP) of 48 degrees, that, if the surfaces are vertical (in purple) there will be no reflection towards a pedestrian at position OP4 from the surfaces of aspect 48 degrees as the rectangular surface never intersects the reflected sun paths.*

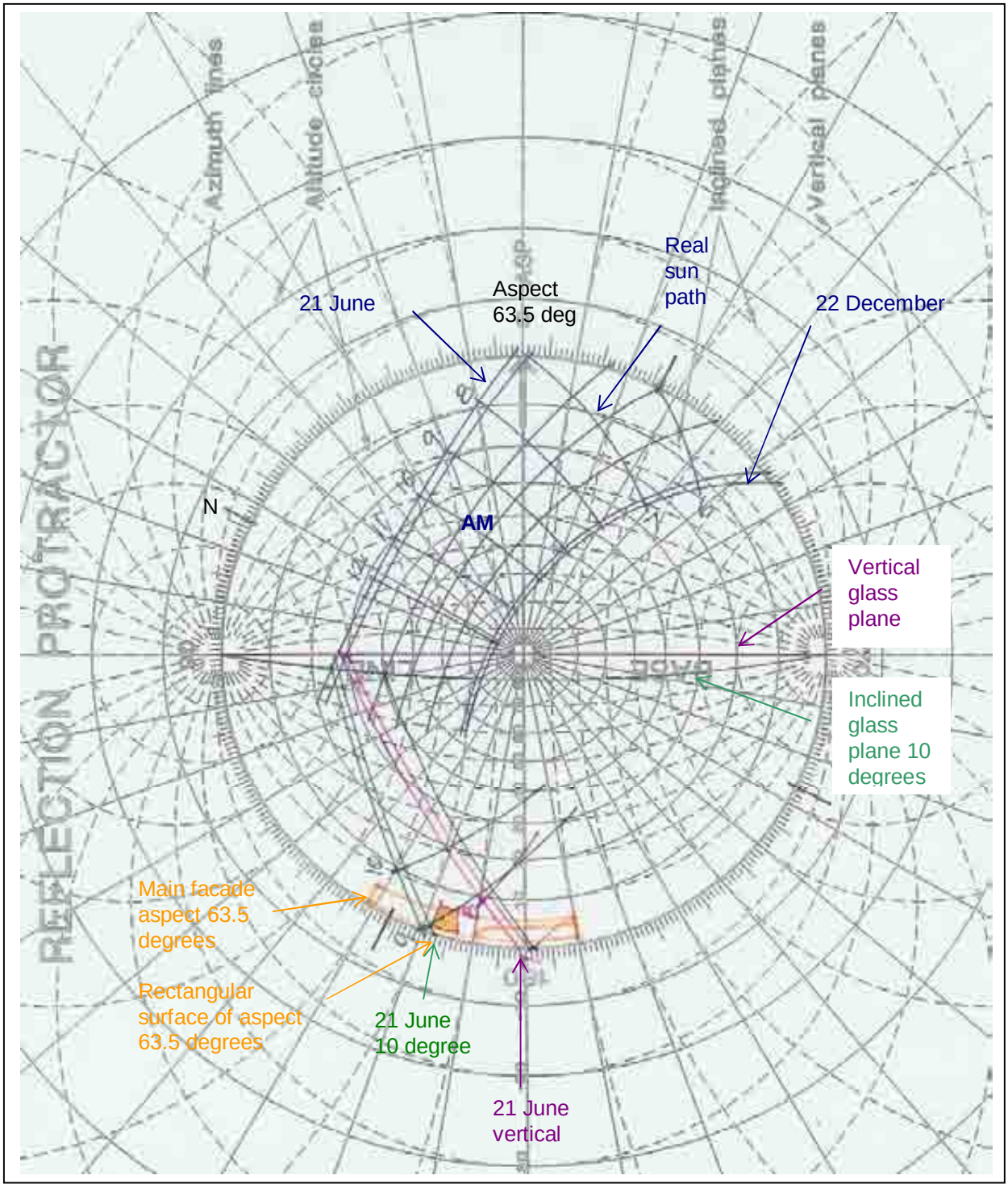

Figure 12 *Solar reflection from a surface – from glass façade/canopy towards a pedestrian at location OP4. The figure shows that the surface which has an aspect (ASP) of 63.5 degrees, that, if the surface is vertical (in purple) there will be no reflection towards a pedestrian at position OP4 from the curved canopy aspect 63.5 degrees as the rectangular surface never intersects the reflected sun path, and from the main façade virtually no reflection except from the southern end for that part that is visible above the dense trees. If the canopy surface is tilted back 10 degrees (green) there will be reflected sun towards OP4 from this surface in May and July approximately 0900 hours.*

3.5 Observation Point 5 (OP5)

Location OP5 represents a point on the new residential development, Wharfs 8 and 9, with a view towards Project STAR as shown in Figure 13. There is no reflection from the canopy when the glass is vertical from surfaces with an aspect of 48 degrees as shown in Figure 14.

Figure 13 Observer point OP5 below residential apartments

Figure 15 shows that if there was a flat horizon (that is no city buildings to the East) then there is potential for reflection of sunlight from the main façade and the front of the canopy at sunrise for a very brief time during March/April and August/September. However, the sun is at such a low angle that the city high rise buildings will screen most of the direct sunlight from reaching the STAR project Pirrama Road façade during this time.

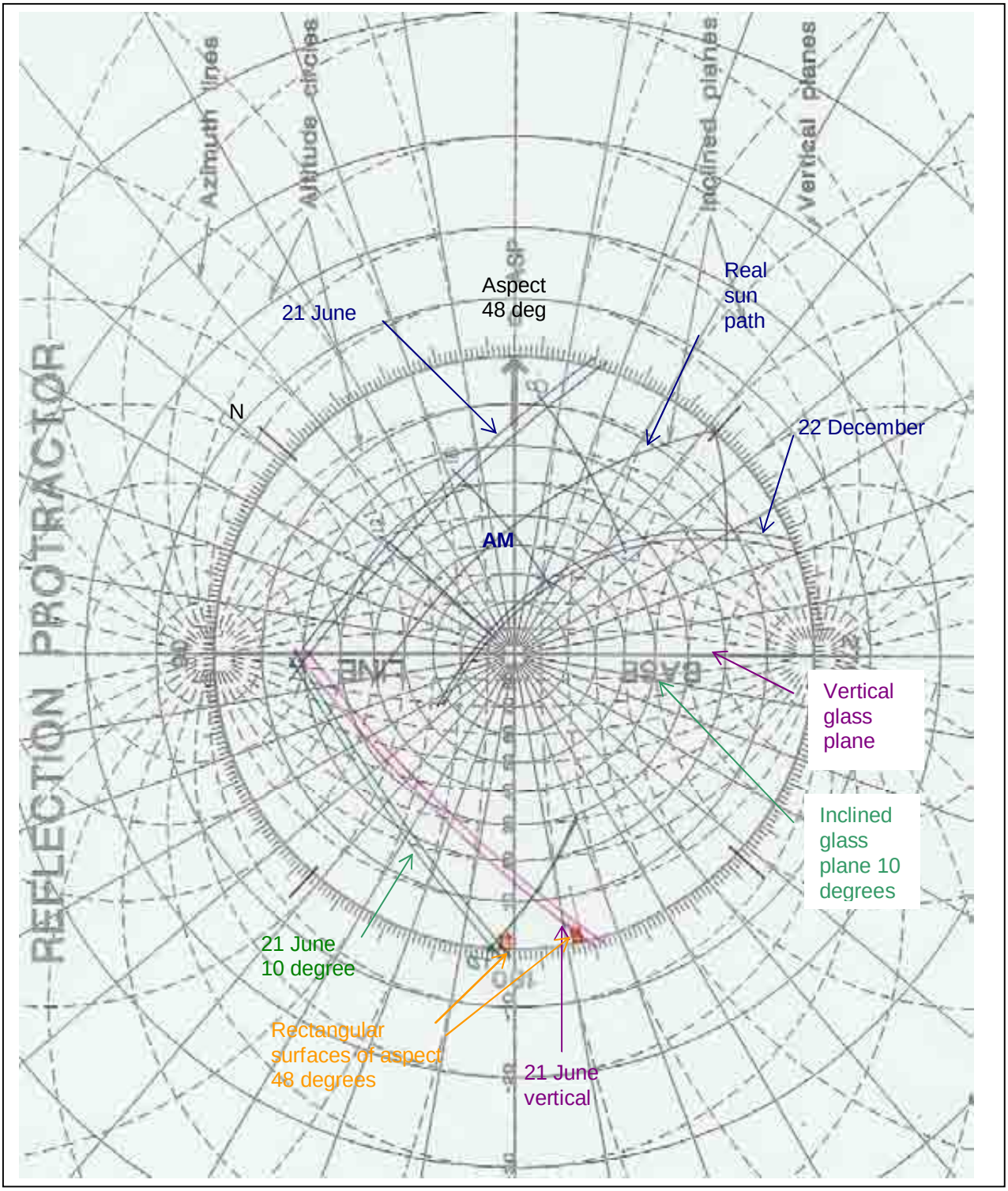

Figure 14 Solar reflection from a surface – from glass canopy and south end of façade towards residential observer at location OP5. The figure shows that the canopy surface which has an aspect (ASP) of 48 degrees, that, if the surface is vertical (purple reflected sun path) there will be no reflection towards a resident at position OP5 from the curved canopy aspect 48 degrees as the rectangular surface never intersects the reflected sun paths. If the surface is tilted back 10 degrees there will be reflected sun towards OP5 from this surface in June briefly at approximately 0900 hours. For the section of façade on the south end there is potential sun reflection from the top edge on the southern tip only in the middle of June.

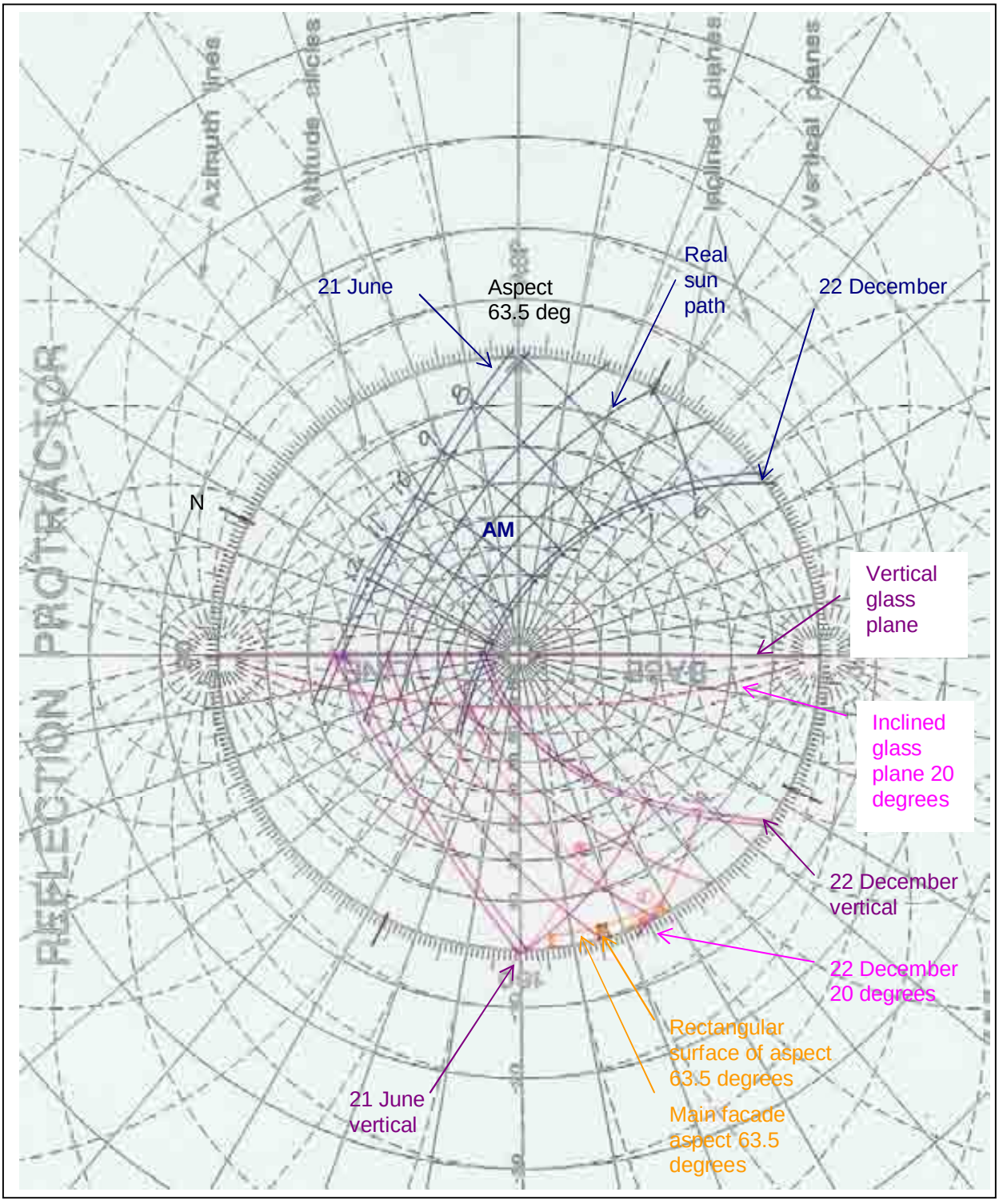

Figure 15 Solar reflection from a surface – from glass façade/canopy towards residential location OP5. The figure shows that the surface which has an aspect (ASP) of 63.5 degrees, that, there is potential for solar reflection at sunrise March/April and August/September, however, the city skyline will obscure some of the direct sun at this time. Changing the tilt of the glass would not prevent the effect; it would simply change the time of year that it occurred.

3.6 Observation Point 6 (OP6)

Figure 16 View of casino for pedestrian at observer position OP6

3.7 Observation Point 7 (OP7)

Figure 17 View of casino from observer position OP7

Figure 17 provides a pedestrian view from observer position OP7 which is at the end of King Street. Figure 18 shows that there is no reflection from the façade area that is inclined at approximately 80 degrees, however, there would be solar reflection from the canopy area from the beginning of June to end of August and from mid April to mid July from 1130 to 1200 hours

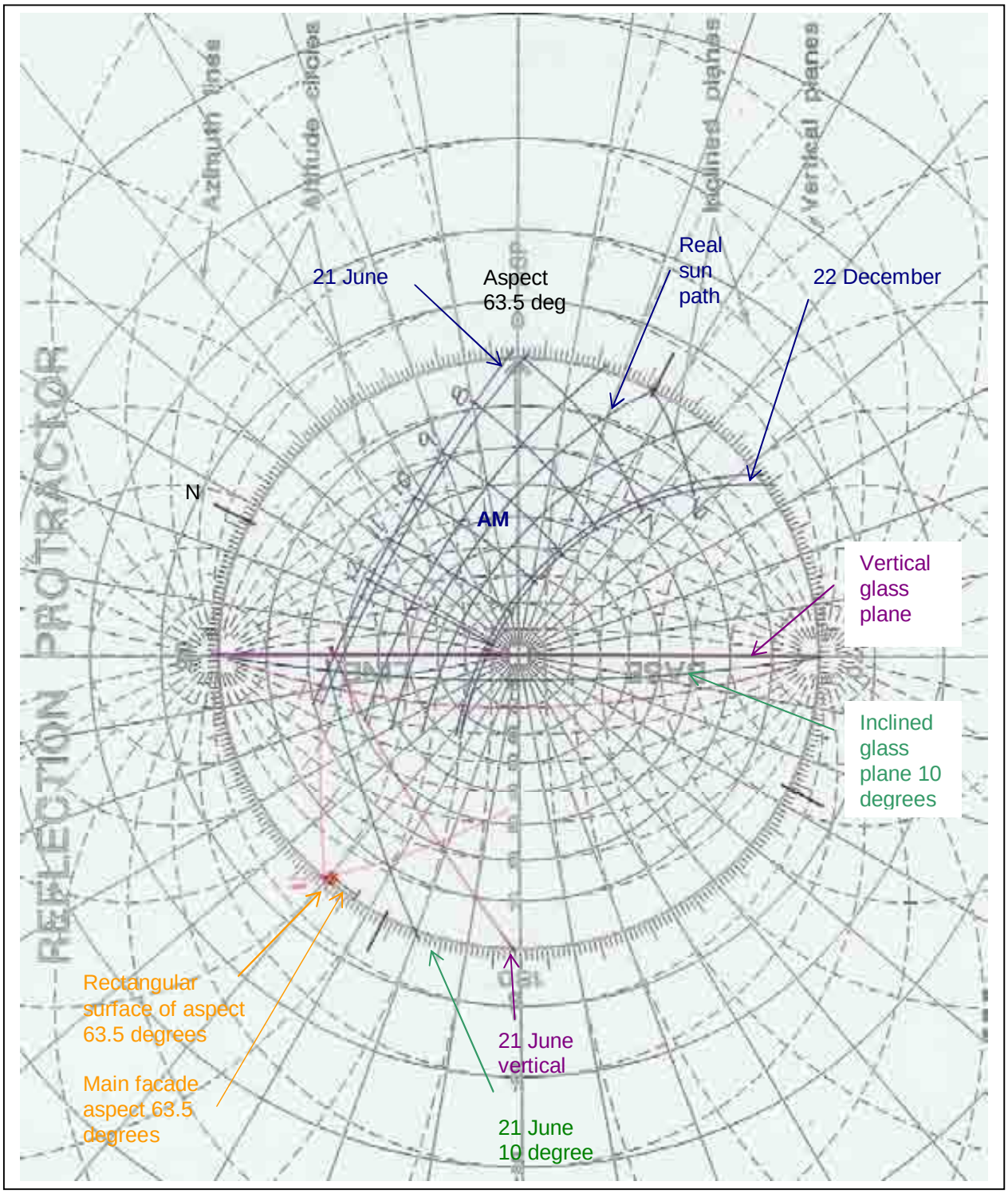

Figure 18 Solar reflection from a surface – from glass façade/canopy towards pedestrian location OP7. The figure shows that the surface which has an aspect (ASP) of 63.5 degrees, that, there is no sunlight reflection towards this point from a vertical surface and the rectangles representing the surfaces do not intersect with the reflected solar sun path. Having a 10 degree tilt on the canopy would not have any effect at this location either.

(no allowance for daylight savings time). The reflections off the canopy will be in the critical 60 degrees and over zone albeit a very small angular size viewed from position OP7.

3.8 Observation Point 8 (OP8)

Figure 19 Pedestrian view of the casino from observer position OP8

Figure 19 indicates no pedestrian view from observer position OP8.

3.9 Observation Point 9 (OP9)

Observation point is just off the corner of the pontoon as if a ferry or water taxis operator was approaching the location in a direct line from the East. If the ferry or water taxis approaches this point in any different way such as in a wider arc and ultimately facing east, than none of the information in or associated with Figures 20 and 21 are relevant.

Figure 20 shows that from mid May to mid July there is a maximum of a 20 minute period shortly after sunrise when there is potential for sunlight reflection from the part of the canopy that has an aspect of 48 degrees. If the canopy had a slope of 10 degrees it would simply shift the time during the year that this occurred.

Figure 21 shows that from the main façade and from the front of the canopy where the aspect is 63.5 degrees and the surfaces are vertical, there is potential for sunlight reflection early in the morning. During this time of day the sunlight is not at full strength. Also, the angle at which any sunlight strikes the glazing will be well within 60 degrees of normal to the glass and therefore if the recommended glass is used the reflection will be 5 percent of the incident radiation.

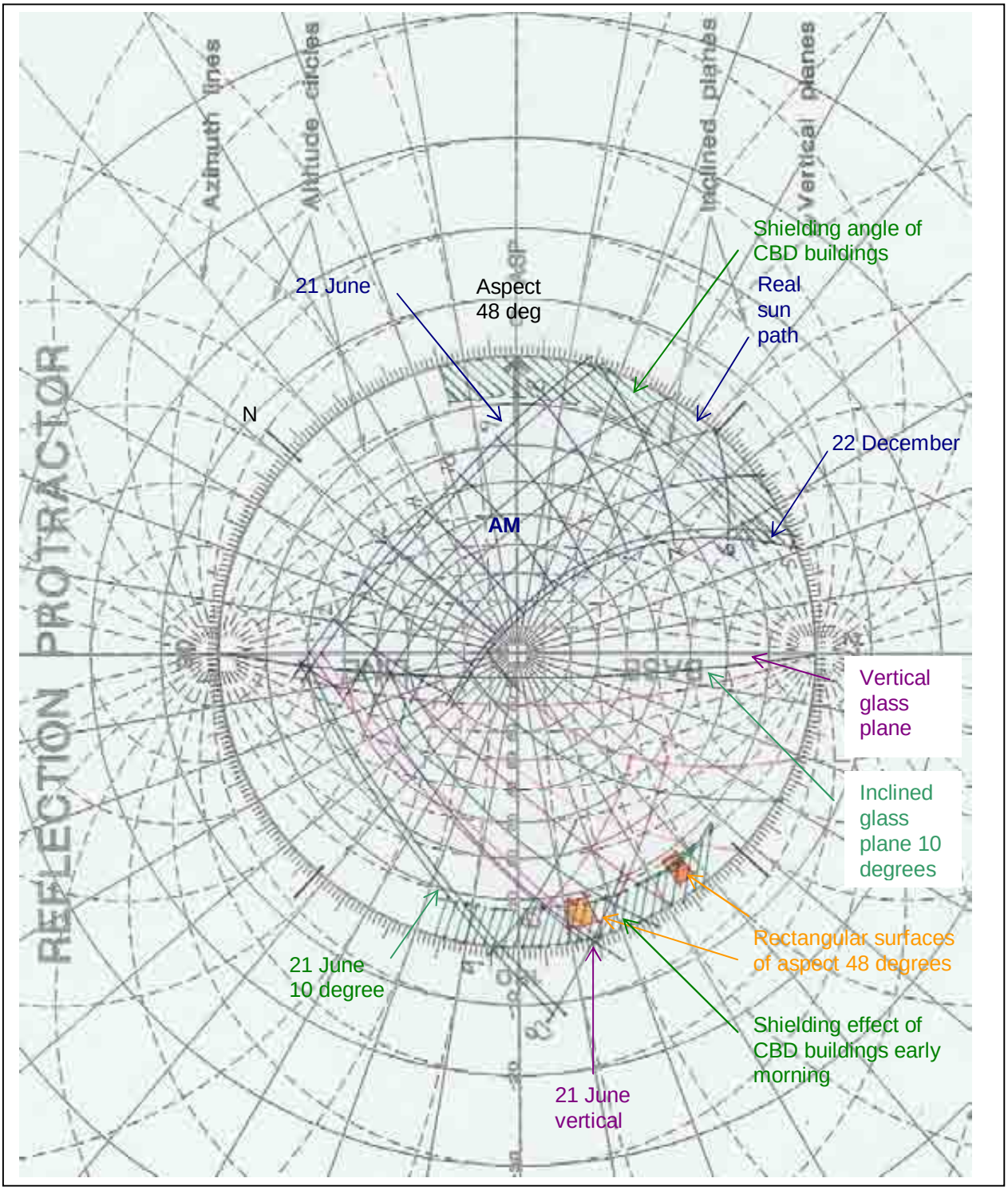

Figure 20 *Solar reflection from a surface – from glass canopy towards a boat operator at location OP9. The figure shows that the surface which has an aspect (ASP) of 48 degrees, that, if the surface is vertical (in purple) it will have the potential to reflect sunlight only for a brief 5 minute period shortly after sunrise from mid May to mid July from the top edge of the canopy because most of the time the wall of CBD buildings shield the surface from direct sunlight until the sun has risen at least 8 degrees above the horizon. Changing the tilt of the glass would not prevent the effect; it would simply change the time of year that it occurred. Similarly for the south end of the façade for a brief 5 minute period shortly after sunrise mid March and mid September from the top edge of the south end of the facade because most of the time the wall of CBD buildings shield the surface from direct sunlight.*

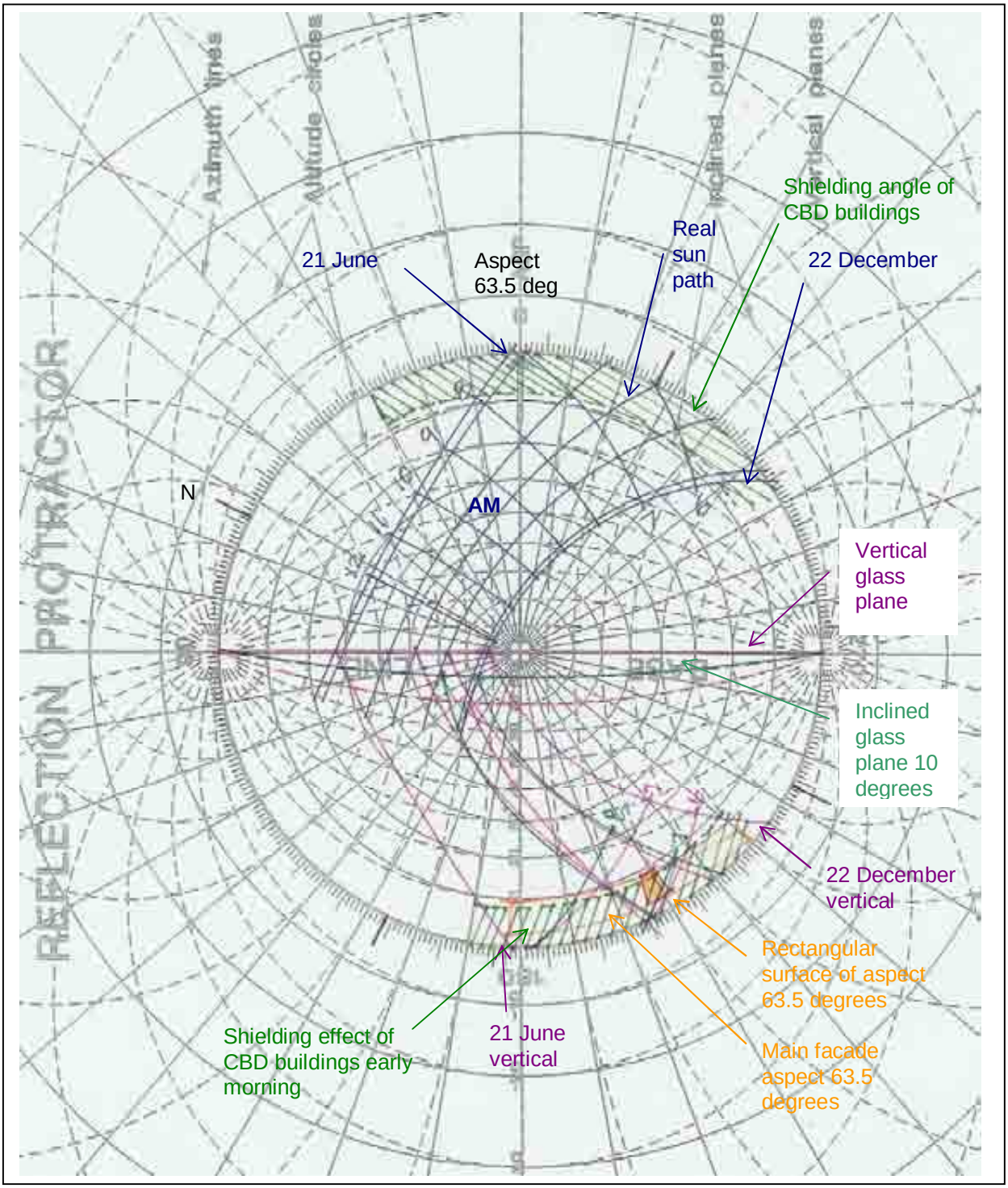

Figure 21 Solar reflection from a surface – from glass façade/canopy towards a boat operator at location OP9. The figure shows that for the surface which has an aspect (ASP) of 63.5 degrees, there is potential sunlight reflection only from the top edge towards this point from a vertical surface for a 5 to 10 minute period. During early morning sunlight is not at full strength. Also the angle at which any sunlight strikes the glazing will be well within 60 degrees of normal to the glass and therefore if the recommended glass is used the reflection will be only 5 percent. Observation point is just off the corner of the pontoon as if a ferry or water taxis operator was approaching the location in a direct line from the East. If the ferry or water taxis approaches this point in any different way such as in a wider arc and ultimately facing east, then none of the information in or associated with Figures 20 and 21 is relevant.

4.0 Proposed Glazing

The proposed glazing by Hyder Consulting is shown in Table 1 below with the visible light spectrum percentage reflectance's taken from Viridian data sheets.

No.	Glass Supplier	Description of Glass Sample	Visible Light Reflectance, External (%)
1	Viridian Glass	ITO Neutral 54	7
2	Viridian Glass	ITO Grey 33	5
3	Viridian Glass	ITO SuperBlue 40	6
4	Viridian Glass	XIR EnergyTech 62	9
5	Viridian Glass	XIR Sunergy 54	8
6	Viridian Glass	ComfortPlus Grey 37	5
7	Viridian Glass	ComfortPlus SuperBlue 44	6

The glazing used on Darling Walk Project (Google Building) is CSY 130S which has a visible light reflectance of 15 percent and CED 31-58 which has a visible light reflectance of 14 percent.

5.0 Conclusions

This preliminary analysis shows that with the current façade design shown in the beginning of this report that there is no sunlight reflection towards driver location OP2. Likewise, for vertical glass, there is no sunlight reflection towards pedestrians at OP3.

There will be no reflection towards a pedestrian at position OP4 from the curved canopy aspect 48 degrees. From the 63.5 degrees aspect of the canopy and from most of the main façade there is no reflection. There is potential reflection from the southern end for that part that is visible above the dense trees shortly after sunrise for a short period of time. During early morning sunlight is not at full strength. Also the angle at which any sunlight strikes the glazing will be well within 60 degrees of normal to the glass and therefore if the recommended glass is used any reflection will be only 5 percent.

For residential position OP5 the surface which has an aspect (ASP) of 63.5 degrees has potential for solar reflection at sunrise March/April and August/September, however, the city skyline will obscure most of the direct sun at this time.

There are no views of Project STAR from observer positions OP6 and OP8. Also, there will be no reflection from the glazed façade towards OP7 with vertical glazing.

Boat operator position OP9 is based on an assumption that a ferry or water taxis operator was approaches the location in a direct line from the East. If the ferry or water taxis approaches this point in any different way such as in a wider arc and ultimately facing east, than none of the information in or associated with Figures 20 and 21 are relevant. From mid May to mid July there is a maximum of a 5 to 10 minute period following sunrise after the sun clears the top of the multistorey buildings of the CBD when there is potential for sunlight reflection from the part of the canopy and the south end of the façade top edge that has an aspect of 48 degrees. From the main façade and from the front of the canopy where the aspect is 63.5 degrees and the surfaces are vertical, there is potential for sunlight reflection early in the morning from the top edge of the façade for a 5 to 10 minute period. During early morning sunlight is not at full strength. Also, the angle at which any sunlight strikes the glazing

will be well within 60 degrees of normal to the glass and therefore if the recommended glass is used the reflection will be 5 to 9 percent (depending on which part of the façade the sun is being reflected from) of the incident radiation and of low impact.

Any impacts from the curved canopy glazing will be less than indicated in the report above because of the assumptions shown in Figure 6 where the curved shape is approximated to 3 flat planes. In reality the curve will consist of a series of smaller flat planes and hence the reflected sun image towards any one point at any one time will be much smaller and have lower impact.

The glass needs to have as low reflection characteristic as possible.

6.0 Recommendations

- Glazing to be vertical.
- Glazing to reflectance's to be no higher than those recommended by Hyder Consulting (Table 1).

7.0 References

Hassall D N H, 1991
Faculty of Architecture, University of New South Wales
REFLECTIVITY DEALING WITH ROGUE SOLAR REFLECTIONS

http://www.viridianglass.com/products/downloads/Viridian%20Glass%20Performance%20Data.pdf