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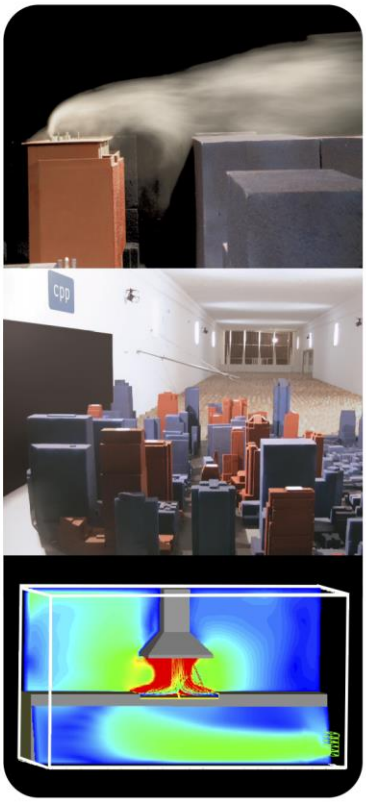
Interim Report



Solar Reflectivity Assessment for:

The Landmark Quarter

St Leonards, NSW

Prepared for:

New Hope Evergreen

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25/03/22	Draft report	CS	MG	MG
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1 INTRODUCTION

CPP has been engaged by New Hope Evergreen to provide an assessment on the potential for sunlight to reflect off facades of the proposed development and generate solar disability glare onto vehicular traffic using surrounding public roadway locations, Figure 1. The proposed Landmark Quarter development is bordered by a railway line and Canberra Ave to the east, Marshall Ave to the north and Holdsworth Ave to the west.

The proposed development consists of three buildings with a maximum height 84.5 m (Building 1) above Canberra Ave, Figure 2, and is surrounded by mixture of low to medium-rise buildings, with some high- rise buildings to the north.

Figure 1: Aerial view of the proposed development site (Google Earth, 2020).

Figure 2: 3D render of proposed development (View from north perspective).

2 LANE COVE COUNCIL CONSIDERATIONS

Lane Cove Council DCP (2010) includes a general requirement relating to glare under Section B.6, item 6.3 of the DCP:

"All developments should use high performance glass with minimal glare impacts where possible."

Many other New South Wales Council development controls, such as those City of Sydney make a general recommendation for reflectivity limits for building materials to not exceed 20%:

City of Sydney Development Control Plan 2012, General Provisions, Section 3.2.7 Reflectivity

(2) Generally, light reflectivity from building materials used on facades must not exceed 20%

It is not explicitly defined in Councils' DCP to which component to reflections, specular or diffuse, the prescribed limit is applicable. CPP presumes the reflectivity limit is applicable to the specular component of reflections as they are most associated with traffic disability glare. It is therefore assumed exterior elements on the facades studied in this report will have a specular reflectivity coefficient of 20% or less. This is defined as the percentage of solar reflection when light strikes and reflects normal to the façade plane.

This analysis studies the glazing materials/ surfaces only, as they are the façade element that can produce the greatest amount of specular reflection, being the worst-case scenario, when compared to other façade materials.

3 ASSESSMENT METHODOLOGY

This report assesses the potential for disability glare from solar reflections from the proposed development taking into consideration:

- Seasonal and diurnal solar paths (sun altitude and azimuth) at the project altitude, and the relative angle of the incident and reflected solar rays (reflectivity coefficients of glazing increase with increasing incident angle),
- An assumed specular reflectivity coefficient of 20 % for the external glazing is used in the calculations, and allowance is made for reflectivity coefficients of glazing to increase with increasing incident angle,
- Receiver locations of interest (the alignment of adjoining public roadways and rail line being of particular interest, Figure 6), and
- Architectural drawings provided by Rothelowman dated July 24. These updated drawings reflect increase in heights for Towers 1, 2, and 4.

Calculations in this report assume the façade surfaces of the proposed development will produce typical/ standard levels of specular type reflections from materials such as glazing, where the reflected ray angle is equal to the incident solar ray angle, being valid for many smooth surface façade materials

CPP use, in part, methodology developed by Hassall (1991), and the concept of veiling luminance and contrast when quantifying the potential for hazard rogue specular solar reflections from the proposed development onto selected surrounding receiver locations, Figure 6. Hassall suggests a veiling luminance limit of 500 cd/m^2 as calculated from the Holladay formula.

Proprietary software was used to calculate veiling luminance values at expected maximum impact locations of vehicles and trains travelling in the directions as marked in Figure 6 where potential future changes in traffic conditions have been considered.

By definition, diffuse reflections have a greater scatter of reflected angles with lower concentration of reflected light in any given direction and are generally less likely to cast hazardous distant disability glare reflections than flat surface glazing.

From a thermal perspective, concave façade curvature is known to potentially concentrate reflections to hazardous levels at focal points a distance from the development site. The development does not contain concave façade curvature elements to our knowledge, and as such there is negligible potential for any concentrated reflections at focal points.

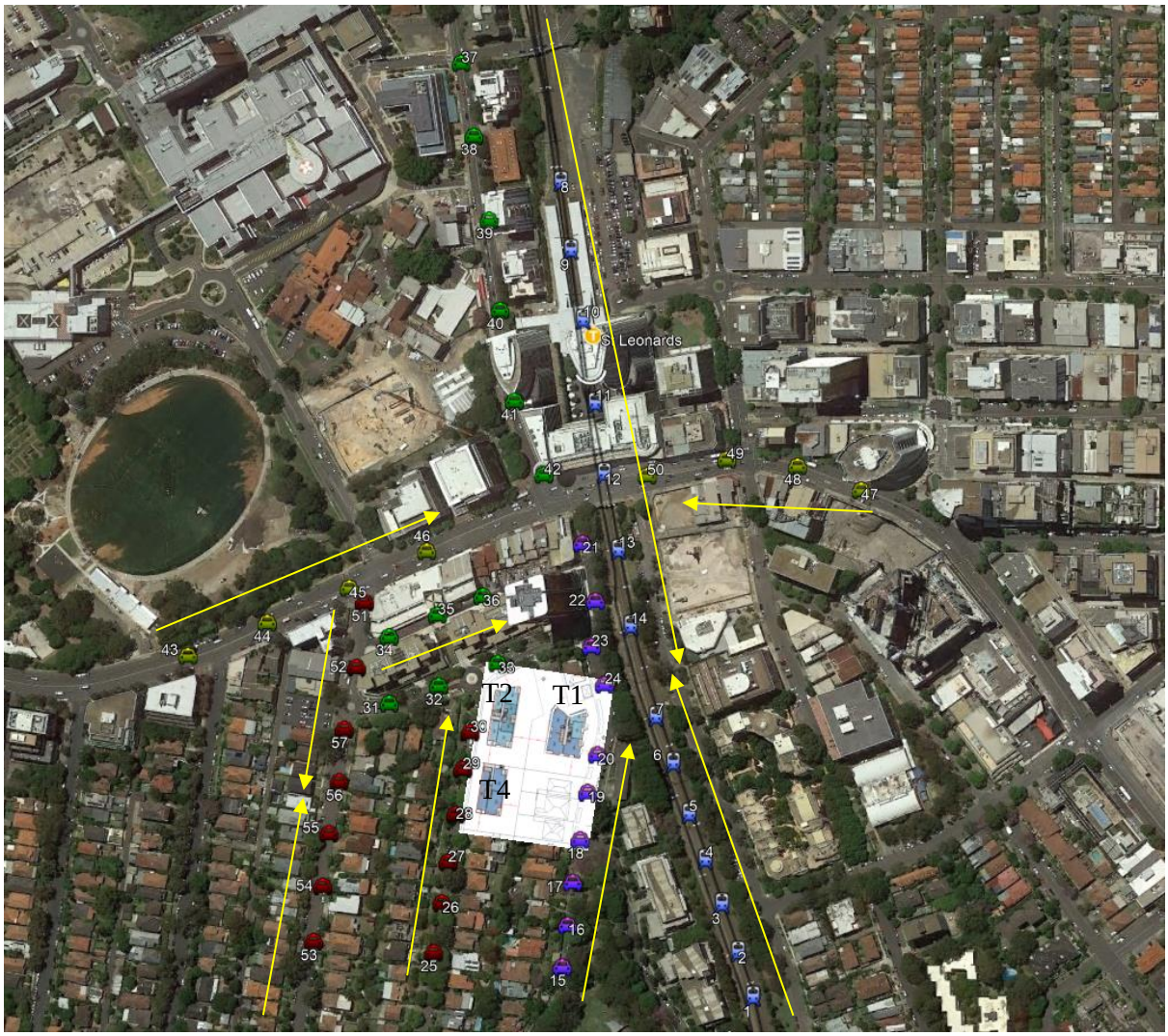

Figure 3: Investigated impact locations of vehicles travelling in indicated directions.

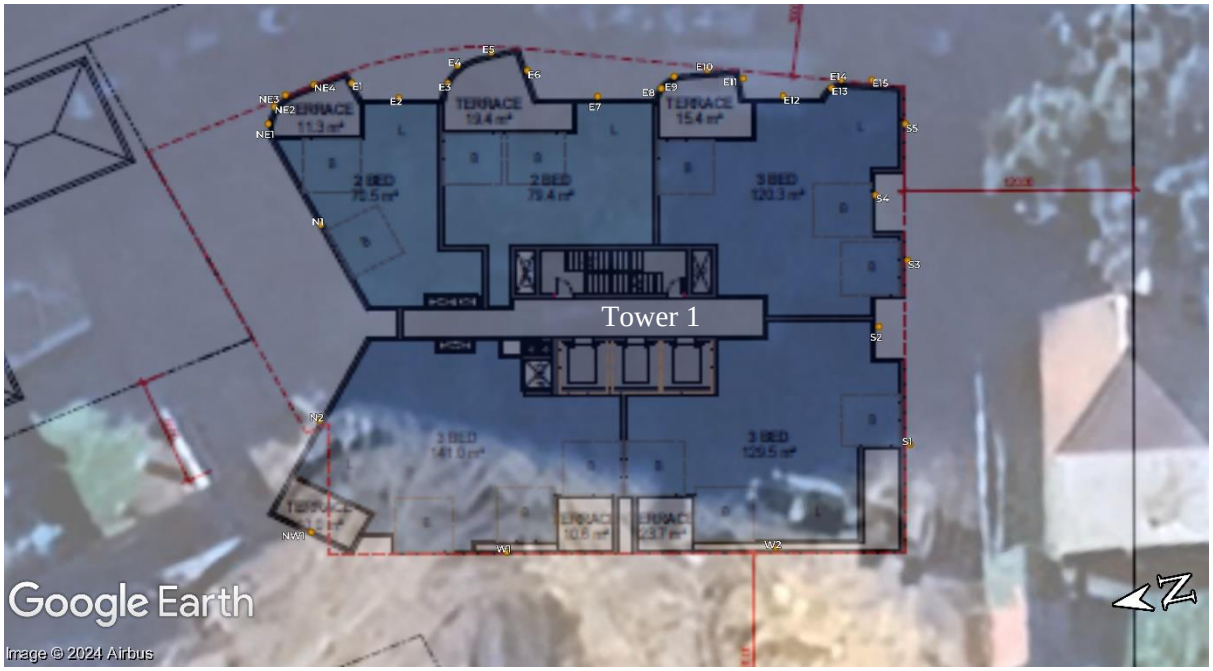

Figure 4: Investigated facades on Tower 1.

Figure 5: Investigated facades on Tower 2.

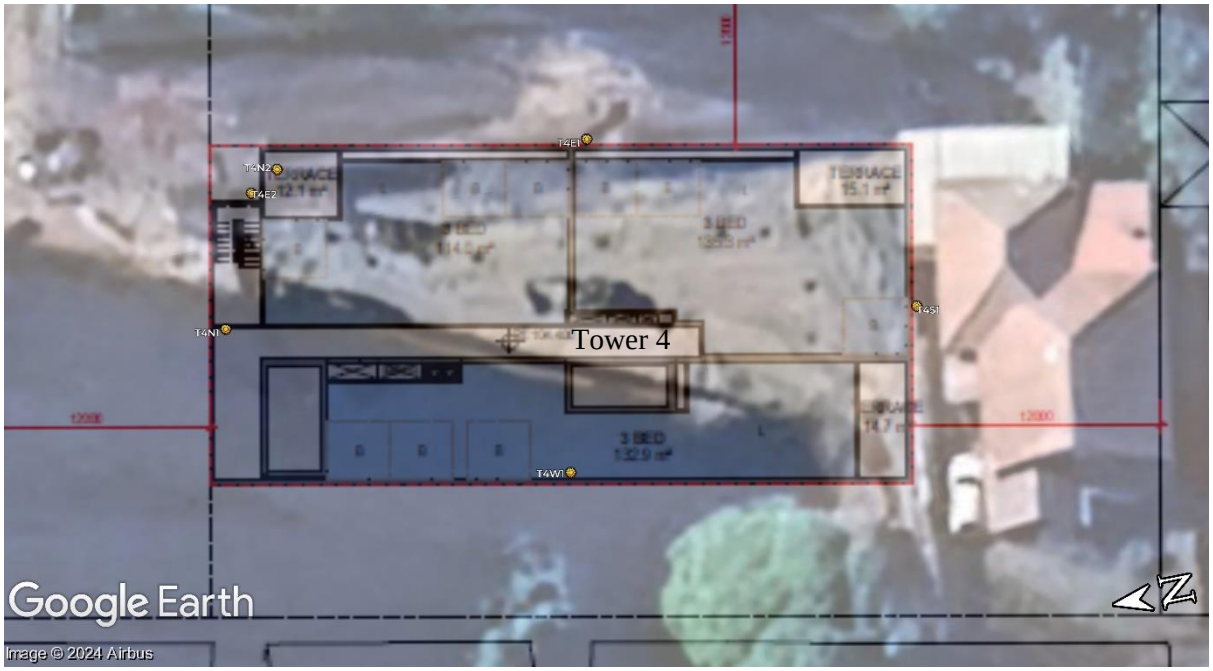

Figure 6: Investigated facades on Tower 4.

In the first instance as a 'worse-case' scenario is assumed whereby the proposed building was modelled as isolated, from surrounding buildings. The investigated example locations in Figure 6 consider future changes to traffic conditions along the adjacent roadways. The façade reflective surfaces are assumed to be flat and vertical.

Results of the assessment are visualised using the publicly available SunCalc tool (Hoffmann), which plots the movement of the sun and sunlight-phase at a specific location and time in the year, Figure 7. The solar plot in Figure 7, plots the incoming solar rays (radial yellow line) from the Sun (orange circle) reflecting off the façade of a building (green line) in the southern hemisphere, onto a receiver location (labelled "a"). The orange radial line, red radial line, and yellow arc mark the Sun's sunrise position, sunset position, and trajectory, respectively, on the subject day. The shaded yellow region shows the variation of the path of the sun throughout the year; the closer the Sun is to the centre, the higher the sun is above the horizon.

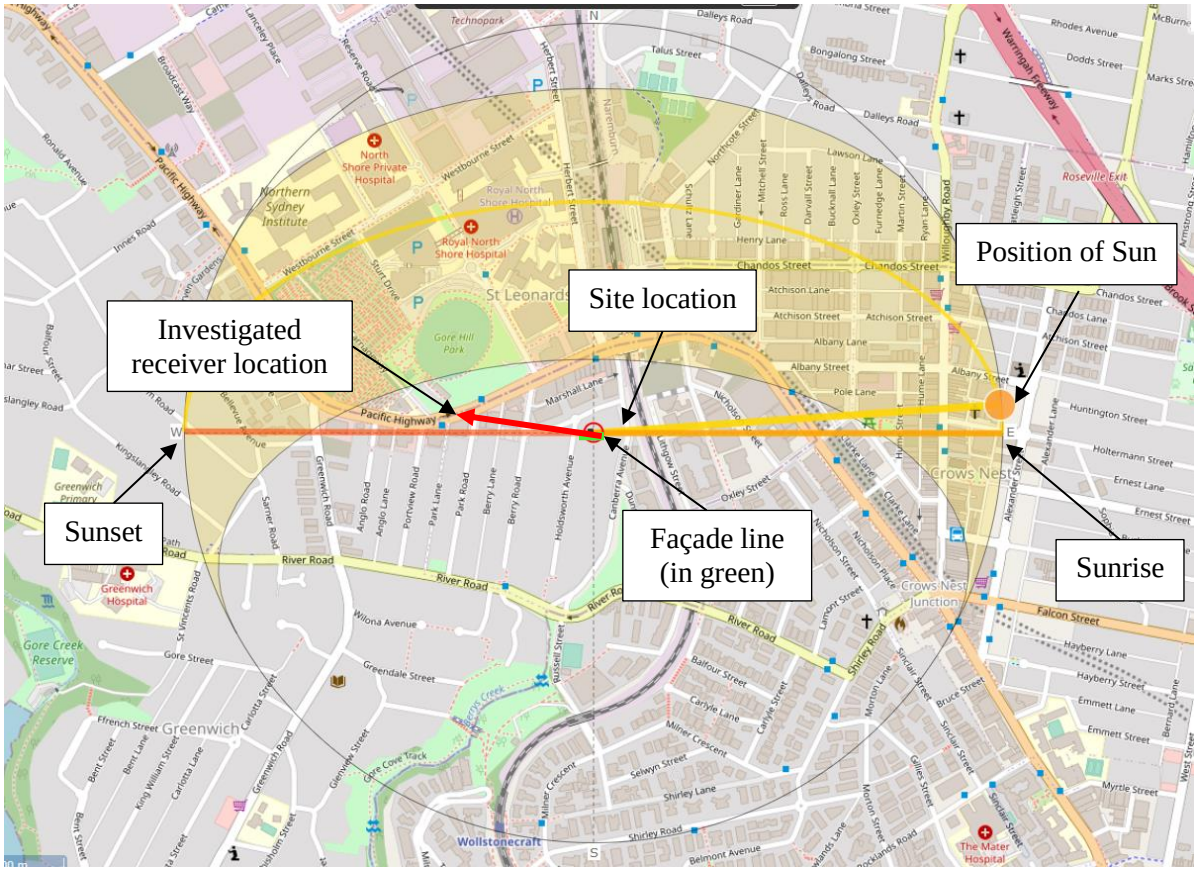

Figure 7: Example usage of the SunCalc tool to visualise solar rays reflecting from north façade of Tower 2.

3 REFLECTIVITY IMPACT RESULTS

3.1 Summary

The summary table below lists the investigated locations that were found to potentially experience a level of solar glare from the proposed buildings in order of maximum Veiling Luminance (Max L_v). The following sections of the report will discuss the assessment results in detail, including recommendations for mitigating glare issues.

Table 1: Summary of reflectivity assessment results (potential exceedances) along surrounding roadways.

Facade	Location	Max Lv	Date Range 1		Time Range 1		Date Range 2		Time Range 2	
N2	Herbert St 40	1580	03-Mar	22-Mar	7:10 AM	7:47 AM	21-Sep	11-Oct	7:03 AM	7:13 AM
NW1	Herbert St 40	1491	15-Feb	06-Mar	7:05 PM	7:09 PM	07-Oct	26-Oct	6:11 PM	6:51 PM
T2SW1	Holdsworth Ave 25	1471	01-Jan	26-Jan	7:13 PM	7:49 PM	16-Nov	31-Dec	7:05 PM	7:15 PM
NE2	Herbert St 40	1366	01-Jan	16-Jan	6:14 AM	6:17 AM	27-Nov	31-Dec	5:55 AM	6:20 AM
NE2	Herbert St 37	1341	01-Jan	21-Jan	6:19 AM	6:28 AM	21-Nov	31-Dec	6:05 AM	6:30 AM
NE2	Herbert St 38	1322	01-Jan	21-Jan	6:18 AM	6:27 AM	22-Nov	31-Dec	6:04 AM	6:29 AM
NE2	Herbert St 39	1301	01-Jan	19-Jan	6:18 AM	6:25 AM	23-Nov	31-Dec	6:03 AM	6:28 AM
T2NW2	Marshall Ave 31	1286	02-Apr	24-Apr	7:43 AM	8:30 AM	19-Aug	10-Sep	8:09 AM	8:09 AM
T2NE2	Herbert St 37	1257	30-Jan	09-Feb	6:48 AM	6:52 AM	03-Nov	12-Nov	6:05 AM	6:22 AM
N2	Herbert St 39	1208	07-Mar	22-Mar	7:12 AM	7:41 AM	21-Sep	06-Oct	7:06 AM	7:15 AM
N2	Herbert St 37	1207	11-Mar	21-Mar	7:11 AM	7:29 AM	22-Sep	03-Oct	7:05 AM	7:11 AM
N2	Herbert St 38	1207	10-Mar	21-Mar	7:12 AM	7:32 AM	22-Sep	04-Oct	7:05 AM	7:12 AM
T2SW2	Holdsworth Ave 25	1186	07-May	05-Aug	4:23 PM	4:32 PM				
T2SW2	Holdsworth Ave 26	1166	06-May	06-Aug	4:29 PM	4:40 PM				
T2NE2	Herbert St 38	1164	30-Jan	10-Feb	6:52 AM	6:56 AM	01-Nov	12-Nov	6:08 AM	6:27 AM
NE2	Railway Line 10	1142	28-Jan	16-Feb	7:20 AM	7:25 AM	26-Oct	14-Nov	6:32 AM	6:33 AM
NW1	Herbert St 38	1139	23-Feb	06-Mar	7:04 PM	7:07 PM	07-Oct	18-Oct	6:28 PM	6:50 PM
NW1	Herbert St 39	1139	19-Feb	05-Mar	7:06 PM	7:10 PM	08-Oct	22-Oct	6:22 PM	6:50 PM
NW1	Herbert St 37	1136	25-Feb	06-Mar	7:03 PM	7:05 PM	07-Oct	16-Oct	6:31 PM	6:49 PM
T2SW1	Holdsworth Ave 26	1065	01-Jan	20-Jan	7:23 PM	7:49 PM	22-Nov	31-Dec	7:16 PM	7:26 PM
T2NE2	Herbert St 40	1053	27-Jan	13-Feb	7:05 AM	7:09 AM	29-Oct	16-Nov	6:18 AM	6:18 AM
NE2	Railway Line 8	1046	29-Jan	12-Feb	7:03 AM	7:07 AM	30-Oct	13-Nov	6:16 AM	6:16 AM
T2NE2	Herbert St 39	1007	30-Jan	12-Feb	7:00 AM	7:04 AM	31-Oct	12-Nov	6:13 AM	6:13 AM
T2SW2	Holdsworth Ave 27	993	06-May	06-Aug	4:41 PM	4:52 PM				
T2SE1	Holdsworth Ave 25	874	31-Mar	29-Apr	8:52 AM	8:55 AM	13-Aug	12-Sep	8:29 AM	8:29 AM
T2NE1	Herbert St 37	864	14-Jun	29-Jun	8:38 AM	8:41 AM				
T2NE1	Herbert St 38	789	10-Jun	02-Jul	8:46 AM	8:47 AM				
NE2	Railway Line 9	769	28-Jan	13-Feb	7:09 AM	7:14 AM	30-Oct	14-Nov	6:22 AM	6:22 AM
T2NW1	Herbert St 37	758	12-Mar	17-Mar	6:43 PM	6:53 PM	26-Sep	01-Oct	6:23 PM	6:26 PM
T2SE1	Holdsworth Ave 26	686	07-Apr	04-May	8:09 AM	8:13 AM	09-Aug	05-Sep	8:46 AM	8:47 AM
T2NW1	Herbert St 38	685	09-Mar	14-Mar	6:43 PM	6:54 PM	28-Sep	04-Oct	6:28 PM	6:33 PM
T2NE1	Herbert St 40	683	28-May	16-Jul	8:57 AM	8:59 AM				
T2NE1	Herbert St 39	680	06-Jun	07-Jul	8:52 AM	8:54 AM				
E13	Railway Line 3	668	04-Jun	07-Jul	3:47 PM	3:48 PM				

T2SW1	Holdsworth Ave 27	663	01-Jan	05-Jan	7:39 PM	7:43 PM	07-Dec	31-Dec	7:29 PM	7:40 PM
NE2	Railway Line 11	660	01-Feb	17-Feb	7:06 AM	7:36 AM	25-Oct	11-Nov	6:48 AM	6:49 AM
N2	Railway Line 8	624	25-Mar	02-Apr	7:35 AM	7:48 AM	11-Sep	19-Sep	7:27 AM	7:42 AM
NW1	Railway Line 8	613	28-Jan	08-Feb	7:11 PM	7:14 PM	02-Nov	13-Nov	6:40 PM	6:55 PM
T2N2	Pacific Hwy 43	612	14-Mar	19-Mar	7:39 AM	7:49 AM	25-Sep	30-Sep	7:21 AM	7:32 AM
NW1	Railway Line 10	599	01-Jan	25-Jan	6:51 PM	7:25 PM	17-Nov	31-Dec	6:41 PM	6:54 PM
N2	Railway Line 10	595	25-Mar	05-Apr	7:56 AM	8:05 AM	07-Sep	18-Sep	7:41 AM	8:02 AM
T2NW2	Marshall Ave 32	593	16-Apr	03-May	8:13 AM	8:17 AM	10-Aug	27-Aug	8:18 AM	8:45 AM
T2NW1	Herbert St 39	584	03-Mar	10-Mar	6:42 PM	6:55 PM	03-Oct	10-Oct	6:17 PM	6:33 PM
T2NW1	Herbert St 40	549	26-Feb	05-Mar	6:46 PM	6:47 PM	08-Oct	15-Oct	6:15 PM	6:30 PM
NE2	Herbert St 42	538	01-Jan	02-Jan	6:30 AM	6:30 AM	11-Dec	31-Dec	6:19 AM	6:33 AM
T2SE1	Holdsworth Ave 27	536	20-Apr	06-May	8:36 AM	8:40 AM	07-Aug	22-Aug	8:38 AM	8:58 AM
NE2	Herbert St 41	533	16-Dec	27-Dec	6:06 AM	6:11 AM				

Note: The results shown above have already been filtered to discard exceedances where the facades are obscured by one of the towers or negated by orientation with respect to the driver location. Only exceedances that have potential to cause accidents (above veiling luminance limit of 500 cd/m^2) have been shortlisted for assessment.

4 SOLAR REFLECTIVITY ASSESSMENT

4.1 North Facades

4.1.1 Railway Line and Herbert St

The assessment showed there is potential for southbound train drivers at Locations 8-11, and southbound car drivers along Herbert St to the north, Locations 37-42 Figure 6, to experience solar reflections from the north façades of Tower 1 and Tower 2.

For northern, northwestern, and northeastern facades of Towers 1 and 2, the base analysis showed that between 5:55 am and 8:30 am during Autumn and Summer, southbound drivers along Herbert Street (Locations 37-42) would experience solar reflections much higher than the veiling luminance limit of 500 cd/m^2 (Hassall 1991) and similarly for train drivers southbound from St Leonards station (Locations 8-11) between 6:16 am and 8:05 am during Autumns and Springs. Sun path mechanism for this season is shown in Figure 8. It would be recommended to use glazing with a reflectivity coefficient of 15% or less, around the north-east and north-west corner façades of Towers 1 and 2 to reduce reflection of early morning and late evening sun.

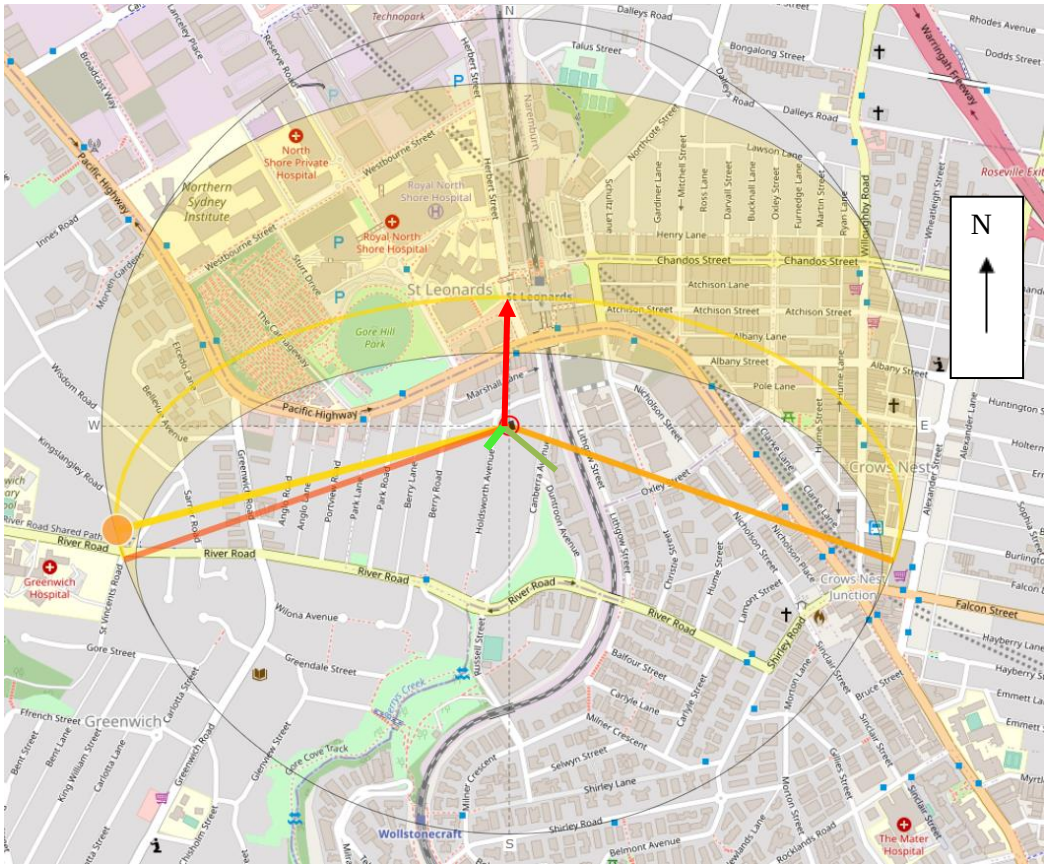

Figure 8: Representation of incident and reflection of solar rays from the curved north-west corner of Tower 2 onto Herbert St.

4.1.2 Pacific Highway and Marshall Ave

Glancing reflections off the north façade of Tower 2 also showed potential to produce solar glare above the 500 cd/m^2 limit for eastbound drivers on the Pacific Highway at location 43 between 7:21 am and 7:49 am in Autumn and Spring, as shown in the example given earlier in Figure 7. Between 7:43 am and 8:45 am, the location of maximum veiling luminance moves closer to the proposed development, with the base analysis showing veiling luminance levels above the 500 cd/m^2 threshold for Locations 31 and lower levels at 32 at the end of Marshall Ave, however, due to the low altitude of the sun at these times, the sun will be blocked by towers to the east and north-east in St Leonards Business District structures and disability glare is mitigated at locations on Marshall Avenue or the Pacific Highway. Potential for reflections from the north façade of Tower 4 was also identified, however these events were found to be well below the safe threshold and the incident sunlight causing the reflection events would be blocked by Tower 1 for most of the time.

4.2 East Façade

Potential for glare events off the east façades of all 3 towers were identified for Locations 1 - 7 on the Railway Line and 15 – 18 along Canberra Avenue for trains and cars travelling north towards the site, but with all identified glare events on Canberra Ave being lower than the 500 cd/m^2 threshold, except for Location 3 in Winter at 3:47 pm for a minute representing a low population glare dosage. Tower 1 also provides significant shielding for Towers 2 and 4 for morning sunlight from the east, further reducing the potential for glare events along the railway line and Canberra Avenue. The highest-level glare event identified for the railway line was found to occur for reflection off the east façade of Tower 1 and produced a veiling luminance of 668 cd/m^2 for an assumed reflectivity coefficient of 20%. Whilst this is below the recommended safe value of 500 cd/m^2, there would be benefit in limiting the reflectivity coefficient of glazing on the east façade of Tower 1 to 15%.

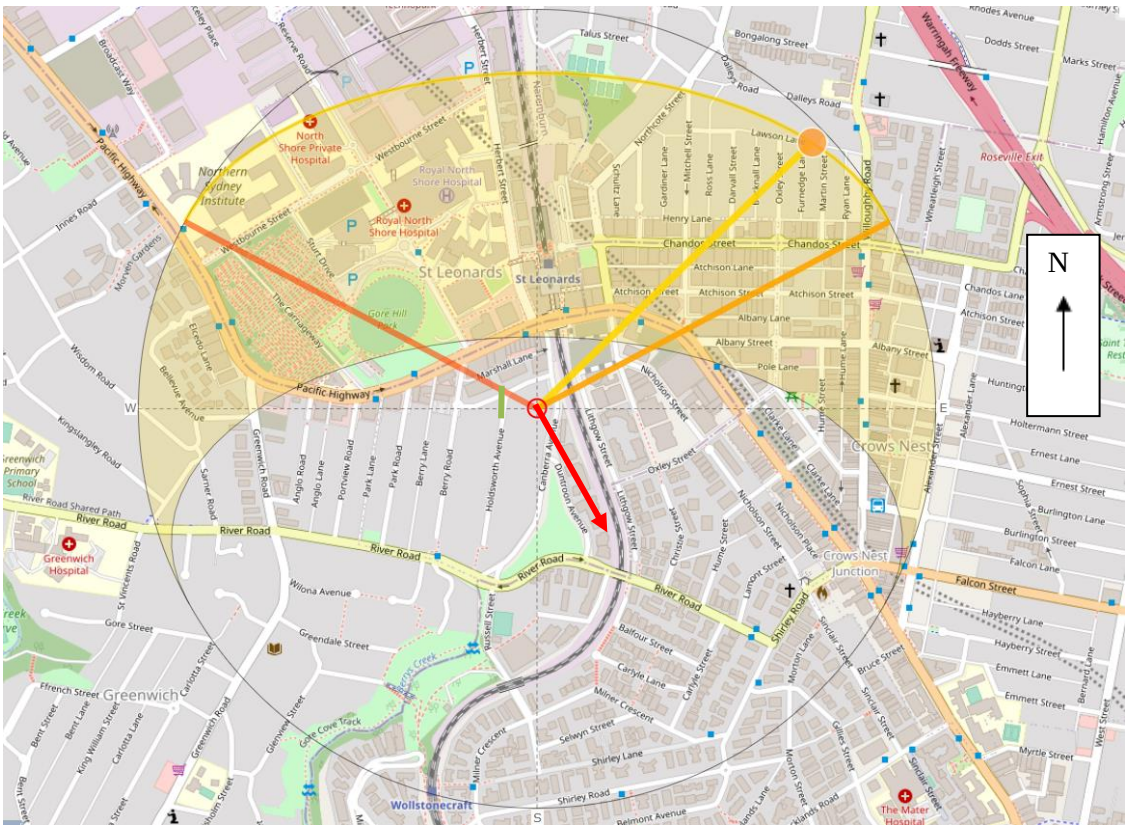

Figure 9: Representation of incident and reflection of solar rays from the Tower 1 east façade onto the railway line.

4.3 South Facade

4.3.1 Railway Line

The assessment showed there is potential for train drivers at Locations 1 - 5, Figure 6, travelling north along the railway line toward the development site, to experience low levels of glare reflections from the south façades of all three towers in the early evenings in late spring to mid-summer. These events occur for glancing reflections of low-lying evening sun from the west, Figure 10, with veiling luminance levels well below the recommended limit.

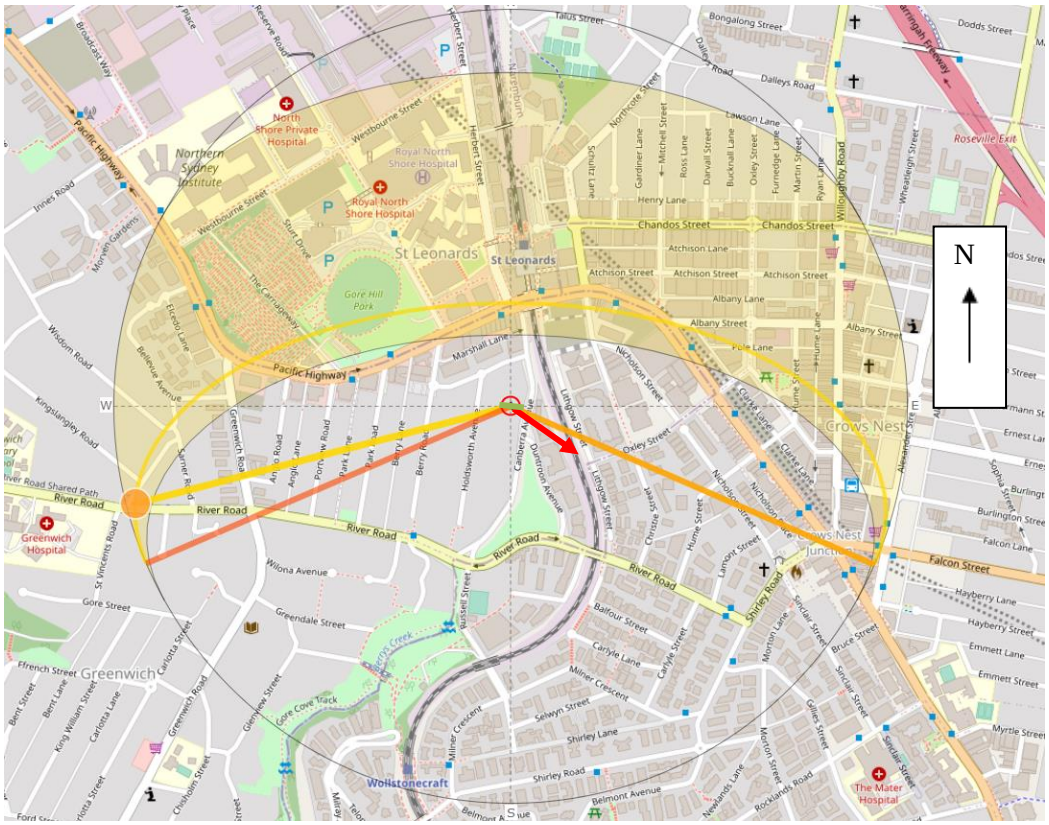

Figure 10: Representation of incident and reflection of solar rays from the south façade of Tower 1 onto Railway Line.

4.4 West Facade

4.4.1 Holdsworth Ave

The assessment showed there is potential for drivers at Locations 25 - 27, Figure 6, travelling north along Holdsworth Avenue toward the development site, to experience high levels of glare exceeding the 500 cd/m^2 limit from the west façade of Tower 2 between 4:23 pm and 7:49 pm and 8:29 and 8:58 am during Autumns, Summer, and Winter. Analysis showed that the majority of high-luminance reflections occurred from the slight curve in the façade at the south-west corner of Tower 2 for low-lying sun just before sunset, Figure 11., Limiting the reflectivity coefficient to 10% for the narrow width of glazing around the south-western corner of Tower 2, would be recommended to ensure levels of glare along Holdsworth Avenue remain below 500 cd/m^2.

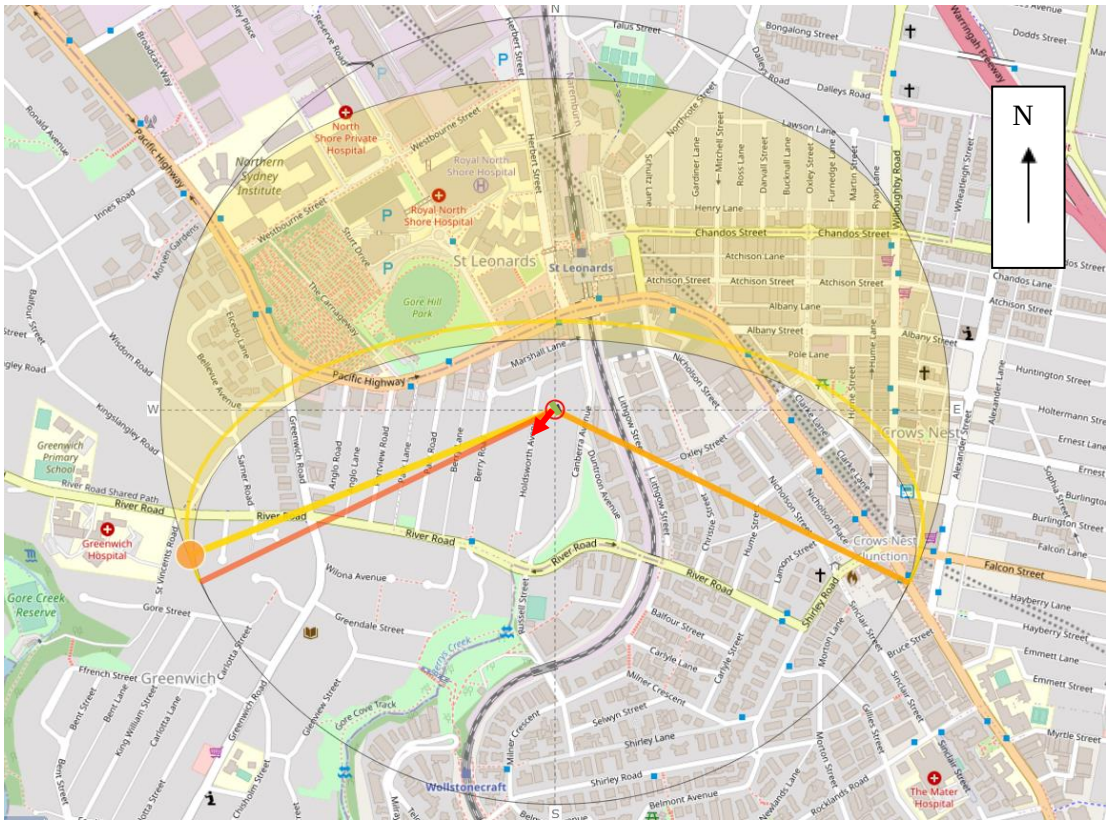

Figure 11: Representation of incident and reflection of solar rays from the south-west façade onto Holdsworth Avenue.

5 CONCLUSION

The proposed The Landmark Quarter development in St Leonards, NSW was studied to determine the potential for sunlight to reflect off exterior facade surfaces of the proposed development and generate solar disability glare onto vehicular traffic using surrounding public roadway and train line locations.

At investigated locations along the adjacent roadways and railway line, some potential for disability glare was identified at isolated locations, primarily from the faceted façades on the north-east, north-west, and south-west of Tower 2. Mitigation measures have been provided in this report which would be sufficient to prevent disability glare for drivers at these locations.

6 REFERENCES

Hassall (1991), “Reflectivity, Dealing with Rogue Solar Reflections”, Faculty of Architecture, University of NSW.

Hoffmann, SunCalc, https://www.suncalc.org/

Lane Cove Council Development Control Plan (2010).

New South Wales State Government, City of Sydney Council, Sydney Development Control Plans 2012, Section 5.

Rothelowman, “St Leonards WIP Drawing Set_A”, July 2024.