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Cassa Blanka Pty Ltd

362-384 Oxford St, Bondi Junction NSW

Reflectivity Assessment Report

20E-21-0341-TRP-22700-3

21 February 2025

Job Title:	362-384 Oxford St, Bondi Junction NSW
Report Title:	Reflectivity Assessment Report
Document Reference:	20E-21-0341-TRP-22700-3

Prepared For:	**Prepared By:**
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Revision History:

Rev. #	*Comments / Details of change(s) made*	*Date*	*Revised by:*
Rev. 01	SSDA	26 Nov 2024	
Rev. 02	SSDA	11 Dec 2024	
Rev. 03	SSDA	21 Feb 2025	

Executive Summary

This reflectivity assessment report has been prepared by Vipac Consulting to accompany a detailed State Significant Development Application (SSDA) for a shop top housing development at 362-374 & 376-384 Oxford Street, Bondi Junction. The site is made up of seven lots. The legal description of the site is outlined in Table below.

Legal Description.

Property Address	Title Description
362 Oxford Street Bondi Junction	Lot 4 in DP508369
364 Oxford Street Bondi Junction	Lot 5 in DP39086
366-368 Oxford Street Bondi Junction	Lot 6 in DP39086
366-368 Oxford Street Bondi Junction	Lot 7 in DP39086
374 Oxford Street Bondi Junction	Lot 1 in DP163647
376-382 Oxford Street Bondi Junction	Lot 10 in DP1128739
384 Oxford Street Bondi Junction	Lot 12 in DP717346
Site Area	1,553.8sqm

Based on the submitted DA plans, the development comprises the development will be a mixed-use high rise residential building.

The development will consist of:

- Basement levels for Carparking;
- Retail areas on Ground Floor and Basement 1;
- Commercial areas on Levels 1 & 2;
- Residential Floors.

Objectives:

In compliance with Waverley Council’s Development Control Plan 2022, Part B15, Section 15.5, the development will satisfy the following objectives:

(a) Mitigate adverse glare from reflective surfaces on street level.
(b) Ensure reflectivity does not impact upon the function of the public domain.
(c) Minimise adverse solar reflection through the reduction of reflective materials and the use of shading devices.
(d) Avoid façade treatments containing large areas of glazing.
(e) Minimise potential impact on pedestrians and occupants of neighbouring buildings.

Compliance requirements and performance of the development:

The design and construction team will ensure the following criteria is met as part of the detailed design:

1. Limit the use of large areas of glass in facades to a maximum of 60% of the façade surface area above ground level.
2. Shade glass areas with shading devices appropriate to the orientation.
3. Reflected solar glare on drivers should not exceed 500 candelas/m2.
4. Mirrored glass and other highly reflective materials will not be used on building exteriors.
5. All panels and elements on vertical façades are to have a maximum specular reflectivity of visible light from normal angles of incidence of 20%.
6. Any surface inclined by more than 20 degrees to the vertical (inclined glass awnings or cladding on inclined roofs) are to have a maximum specular reflectivity of visible light from normal angles of incidence of 10%.

Subject to satisfaction of the above, the proposed development will perform well in-terms of solar reflectivity and glare is unlikely to exceed the limits of acceptability of Hassall methodology that could affect surrounding streets and the reflected light on the motorists will not exceed 500 cd/m2.

The purpose of the project is to facilitate the delivery of (market and affordable) housing at a strategically located site and to deliver a built form outcome that is consistent with the desired future character of the ‘Bondi Junction Town Centre’.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-71481718).

This report concludes that the proposed development is suitable and warrants approval, subject to compliance with the conditions noted in this report.

Table of Contents

1 Introduction

Several development consents are applicable to the site. On 24 August 2017, development consent was granted to DA 89/2016 which authorised the demolition of the existing building, and the construction of a 14 storey shop top housing development including residential units, serviced apartments, retail, basement parking, and a planning agreement at 362-374 Oxford Street, Bondi Junction (the 2017 Consent)

Subsequently, the adjoining properties at 376-384OxfordStreet, Bondi Junction were acquired and DA-157/2022 was lodged which sought consent to redevelop the land at 376-384 Oxford Street as well as make alterations to the 2017 Consent.

On 4 October 2023, the Land and Environment Court approved DA -157/2022, authorising demolition of existing buildings, construction of a shop top housing development and basement car parking, including modification to approved shop top housing development DA-89/2016 and associated civil and landscaping works at 362-374 Oxford Street and 376-384 Oxford Street, Bondi Junction, subject to conditions (the 2023 Consent). The 2017 Consent and 2023 Consent are hereafter referred to as the Consent.

The proposed SSDA generally seeks approval for the redevelopment of 362-384 Oxford Street, Bondi Junction, proposing to retain key design principles and built form generally in accordance with the Consent. The proposal will introduce new, in-fill affordable housing in accordance with the provisions under the Housing SEPP and incorporate a 30% increase in Gross Floor Area (GFA) and building height.

The development of the site has physically commenced pursuant to the Consent with demolition completed and excavation well underway. Certification under the Consent has been obtained and construction is intended to continue for the lower portion of the building (up to Level 8).

Simultaneously with the construction of the lower parts of the building, the proponent seeks approval for new works to the remaining levels of the building (above level 8) as well as the internal fit out and servicing for the whole of the building (basement to Level 15).

It is intended that the relationship between the approval of the SSDA and the Consent be managed through the imposition of a condition pursuant to s 4.17(1)(b) of the EP&A Act and lodgement of a Notice of Modification pursuant to cl. 67 of the EP&A Regulation to ensure consistency across all development consents.

The Applicant has carefully managed the additional 30% floor space and height incentives while retaining the core design principles of the existing approvals.

The proposal while technically constituting a single building due to the consolidated basement and connecting central breezeway spanning the building's height, is functionally composed of two parts. For clarity and ease of discussion, these parts are designated as Site A for the eastern portion and Site B for the western portion of the site.

Figure 1-1 provides a visual representation of the proposed SSDA strategy.

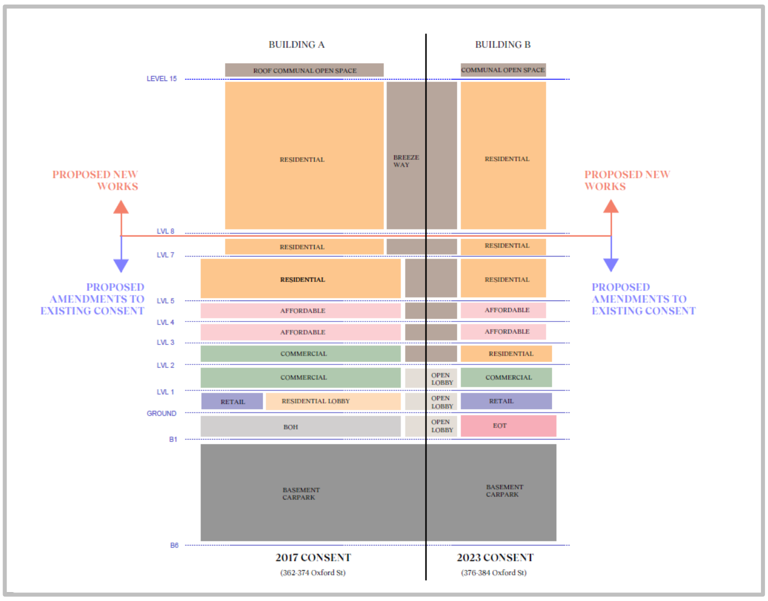


Figure 1-1 – Proposed SSDA - Source: SJB Architects

Specifically, the SSDA seeks development consent for:

Proposed New Works:

- Construction of Levels 8 – 15 of the residential towers including Buildings A and B (achieving a maximum height of RL 127.90), comprising:
    - Building A (362-374 Oxford Street, Bondi Junction) with a maximum height of RL 127.90
    - Building B (376-384 Oxford Street, Bondi Junction) with a maximum height of RL 125.76
    - Communal open space and rooftop amenity.
    - Plant and lift overrun.
- Internal fit out of Level 8 to 15

Proposed Amendments to Existing Consents

- The internal fit out of Basement levels 1- 6.
- Internal fit out of Ground to Level 7.
- The allocation of 1,529m2 of affordable housing on Levels 3, 4 and 5.

Cumulative Development (Existing Consents and Subject SSDA)

- A 15-storey residential tower (achieving a maximum height of RL 127.90 for Building A and RL 125.76 for Building B), comprising:
    - The delivery of a total of 10,100m2 of GFA.
    - 1,588m2 non-residential GFA including, 851m2 of commercial GFA and 737m2 of retail GFA.
    - 118 apartments, equating to a total residential GFA of 8,512m2 including 1,525m2 of affordable housing GFA.
    - The apartments will comprise the following mix:
- 1 Bed: 48 apartments (41%)
- 1 Bed + Study: 7 apartments (6%)
- 2 Bed: 57 apartments. (48%)
- 3 Bed: 6 apartments. (5%)
    - 6 levels of basement for 124 car parking spaces, and 37 motorbikes, with vehicular access from Rowe Lane.
    - Storage areas and services.
    - Communal open space and associated landscaping.

Vehicular access from Rowe Lane along the northern boundary.

The proposed development is located at 362-384 Oxford St, Bondi Junction NSW and will be a mixed-use high-rise residential building. The location of development is depicted in Figure 1-2.

The development will consist of:

- Basement levels for Carparking;
- Retail areas on Ground Floor and Basement 1;
- Commercial areas on Levels 1 & 2;
- Residential Floors.

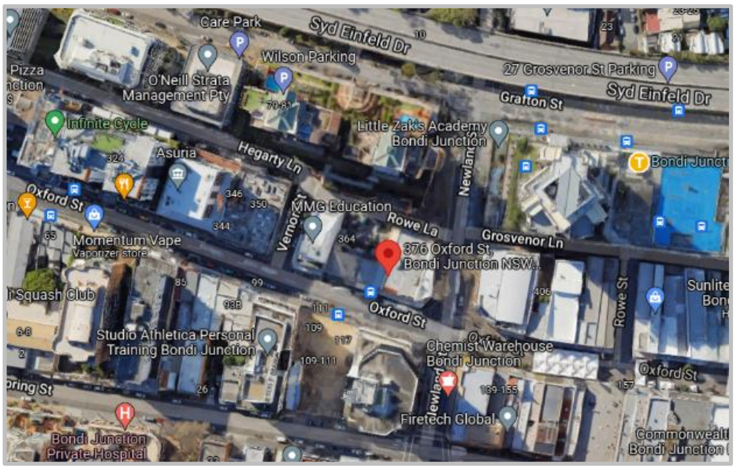


Figure 1-2 Development location - 362-384 Oxford St, Bondi Junction NSW.

2 The Site

The site is located at 362-374 and 376-384 Oxford Street, Bondi Junction within the Waverley local government area (LGA). The site is legally described as:

- 362-374 Oxford Street, Bondi Junction (the western portion of the site):
  - Lot 4 in DP508369
  - Lot 5 in DP39086
  - Lot 6 in DP39086
  - Lot 7 in DP39086
  - Lot 1 in DP163647
- 376-384 Oxford Street, Bondi Junction (eastern portion of the site):
  - Lot 10 in DP1128739
  - Lot 12 in DP717346.

The site is centrally located within the Bondi Junction Town Centre and is approximately 4.5km south-east of the Sydney Central Business District (CBD).

The site has a cumulative area of approximately 1,553.8m^2 and has frontages to Oxford Street to the south, Newland Street to the east, and Rowe Lane to the north.

The immediate urban context surrounding the site is characterised by a mix of commercial, retail, residential, and recreational land uses. The Bondi Junction Town Centre commercial core is located directly east of the site and is characterised by activated ground floor uses.

The site benefits from excellent access to public transport, being located approximately 200m from Bondi Junction Bus Interchange and Bondi Junction Station. Bondi Junction Station is serviced by the T4 Eastern Suburbs and Illawarra Line which provides direct and convenient connections to Sydney CBD and beyond. An extensive number of bus services also operate either from the Interchange or adjacent to the site on Oxford Street.

The site is currently vacant except for the heritage facades at 362-374 Oxford Street, previously occupied by small-scale commercial tenancies known as the "Imperial Building," a locally listed heritage item. The remainder of the site, 376-384 Oxford Street, was occupied by commercial tenancies that have recently been demolished in accordance with the existing development consents.

The site will be progressively developed under the existing approvals and the remaining works will be the subject of this application. Figure 2-1 and Figure 2-2 show the Site Location Plan and Aerial Photograph, respectively.

Figure 2-1 Site Location Plan - Source: Urbis GIS, 2023.

Figure 2-2 Aerial Photograph - Source: Urbis GIS, 2024.

The development is located in Bondi Junction NSW which is within the NCC climate zone 5 (Warm temperate). The climate zone map of the development is depicted in Figure 2-3.

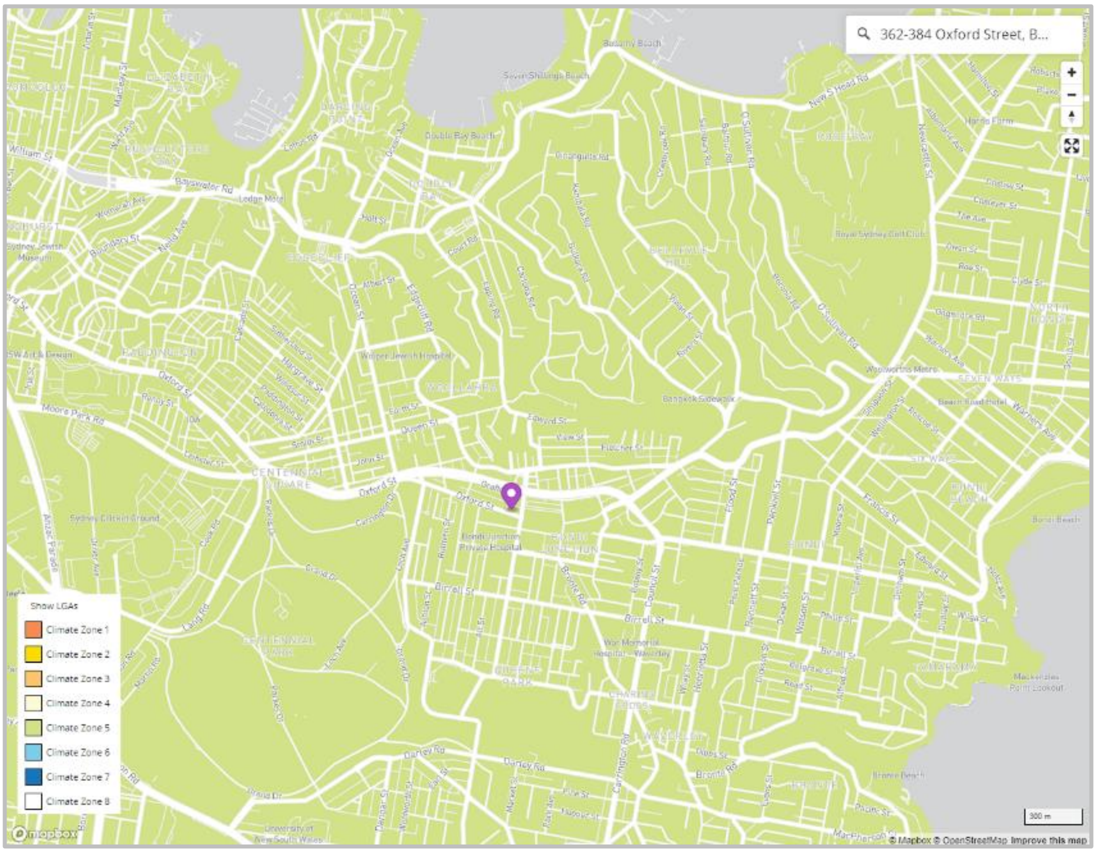


Figure 2-3 climate zone map

2.1 Information Used in Review

Our review is based on the following architectural drawings provided by SJB Architects in February 2025. Architectural drawings are listed in Table 2-1.

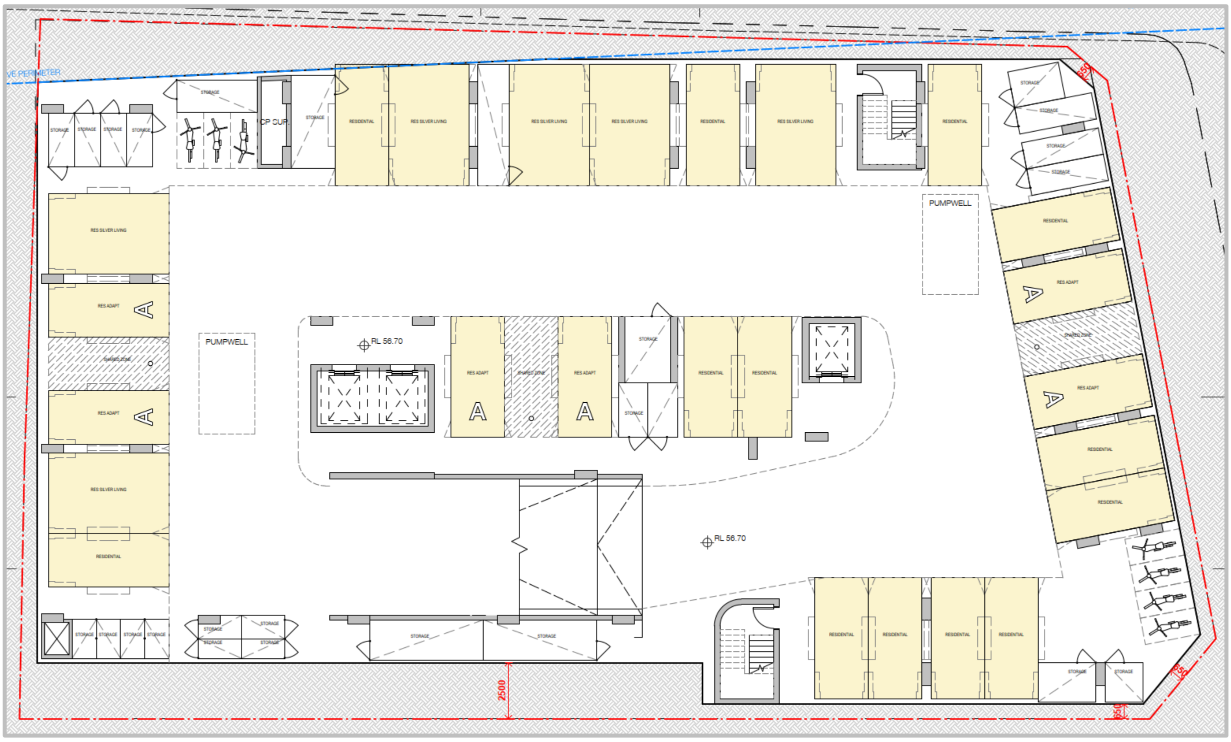
Table 2-1 Architectural drawing reference.

Drawing title	Drawing number
Cover	DA-0001
Site Analysis	DA-0103
Site Analysis - Rail Stratum	DA-0104
Basement 6 Plan	DA-0204
Basement 5 Plan	DA-0205
Basement 4 Plan	DA-0206
Basement 3 Plan	DA-0207
Basement 2 Plan	DA-0208
Basement 1 Plan	DA-0209
Ground Plan	DA-0210
Level 1 Plan	DA-0211
Level 2 Plan	DA-0212
Level 3 Plan	DA-0213
Level 4-6 Plan	DA-0214
Level 7 Plan	DA-0217
Level 8 Plan	DA-0218
Level 9 Plan	DA-0219
Level 10 Plan	DA-0220
Level 11 Plan	DA-0221
Level 12 Plan	DA-0222
Level 13 Plan	DA-0223
Level 14 Plan	DA-0224
Level 15 - Roof	DA-0225
Oxford St Elevation	DA-1401
Newland St Elevation	DA-1402
Rowe Lane Elevation	DA-1403
Western Inside Elevation	DA-1404
Eastern Inside Elevation	DA-1405
Western Elevation	DA-1406
Heritage Elevation - Oxford St	DA-1410
Heritage Facade Section (Oxford St)	DA-1411
Section Sheet 1	DA-1501
Section Sheet 2	DA-1502
Section - Detail	DA-1510
External Materials & Finishes	DA-3401
Adaptable Apartment Type 1	DA-4420
Adaptable Apartment Type 2	DA-4422
Adaptable Apartment Type 3	DA-4423
Typical Apartment Types	DA-4424
Typical Apartment Types Schedules	DA-4425
Solar Analysis	DA-6020
Cross Ventilation Analysis	DA-6021
Solar Pov	DA-6030
Solar Pov	DA-6031
Solar Pov	DA-6032
Communal Open Space	DA-6040
Overshadowing Plan	DA-6050
Overshadowing Autumn Equinox Sheet 1	DA-6051
Overshadowing Autumn Equinox Sheet 2	DA-6052
Overshadowing Spring Equinox Sheet 1	DA-6053
Overshadowing Spring Equinox Sheet 2	DA-6054
Overshadowing Winter Solstice Sheet 1	DA-6055
Overshadowing Winter Solstice Sheet 2	DA-6056
Overshadowing Summer Solstice Sheet 1	DA-6057
Overshadowing Summer Solstice Sheet 2	DA-6058
GFA Plans - Sheet 1	DA-6110
GFA Plans - Sheet 2	DA-6111
3D Perspective	DA-7010
3D Perspective	DA-7011
3D Perspective	DA-7012
Analysis - Height Plane Diagram	DA-7021
Analysis - Height Plane Diagram	DA-7022

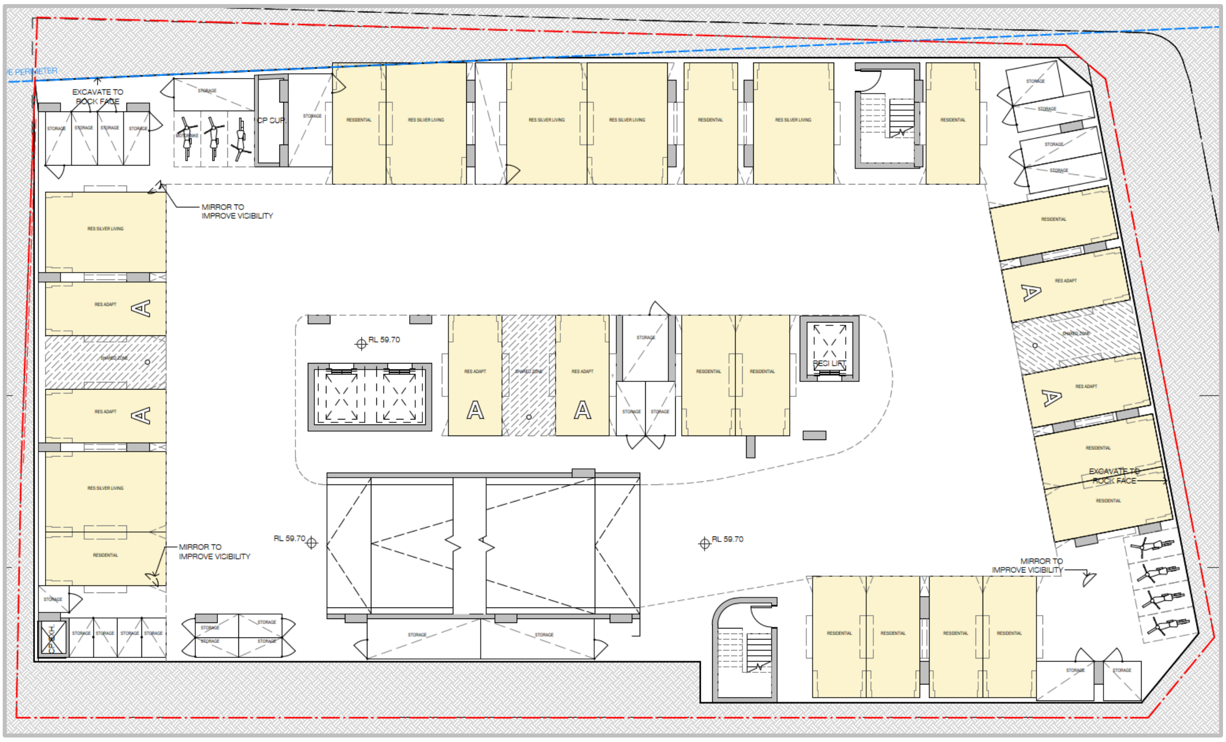
2.2 Architectural Drawings

Selected architectural drawings of the proposed development are provided below.

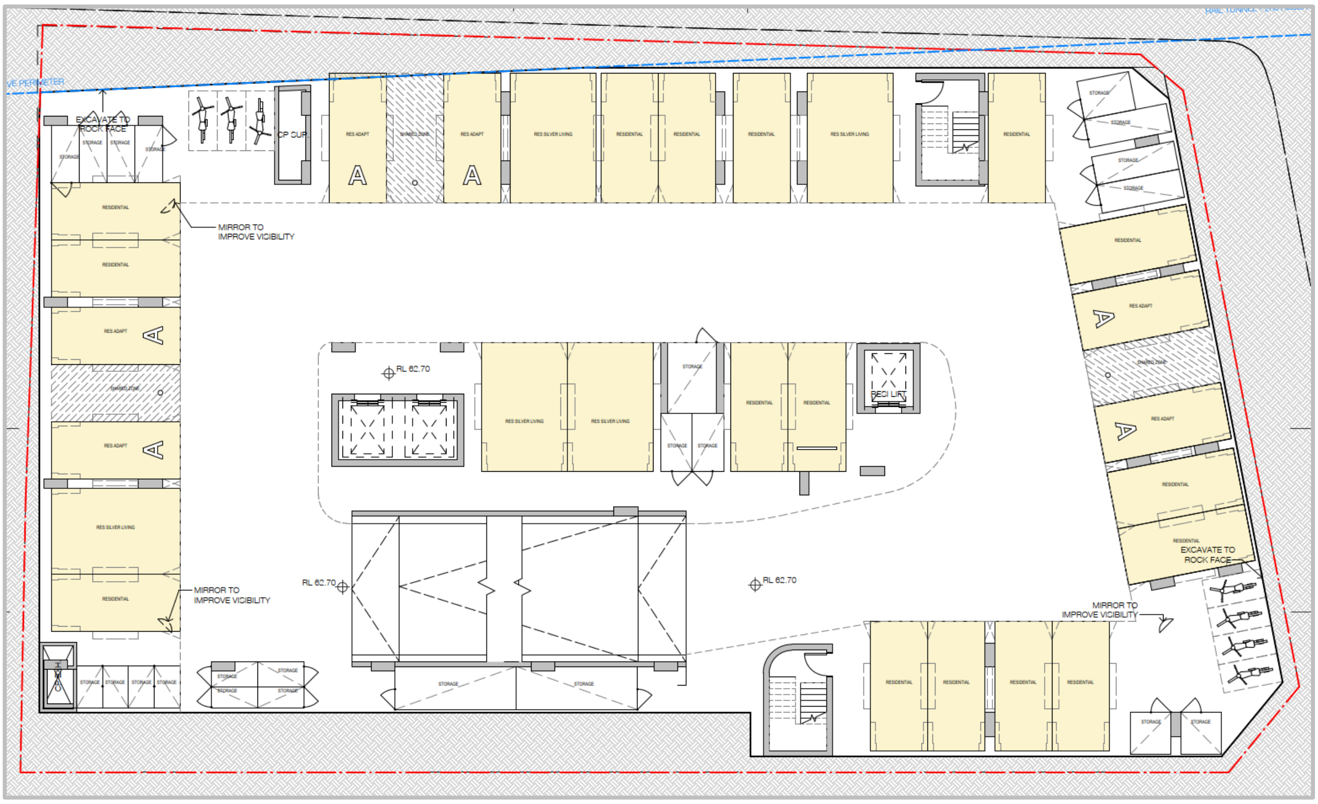
Basement 6 – Floor Plan



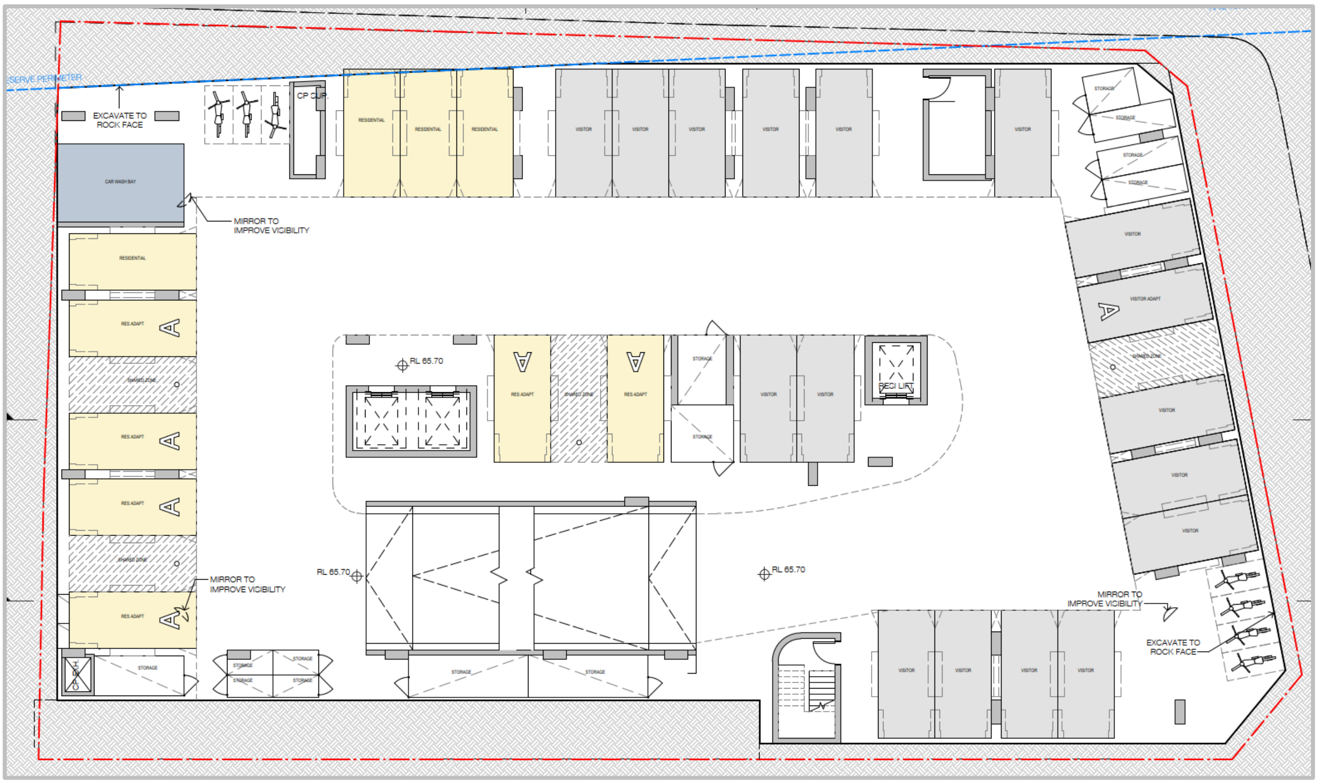
Basement 5 – Floor Plan



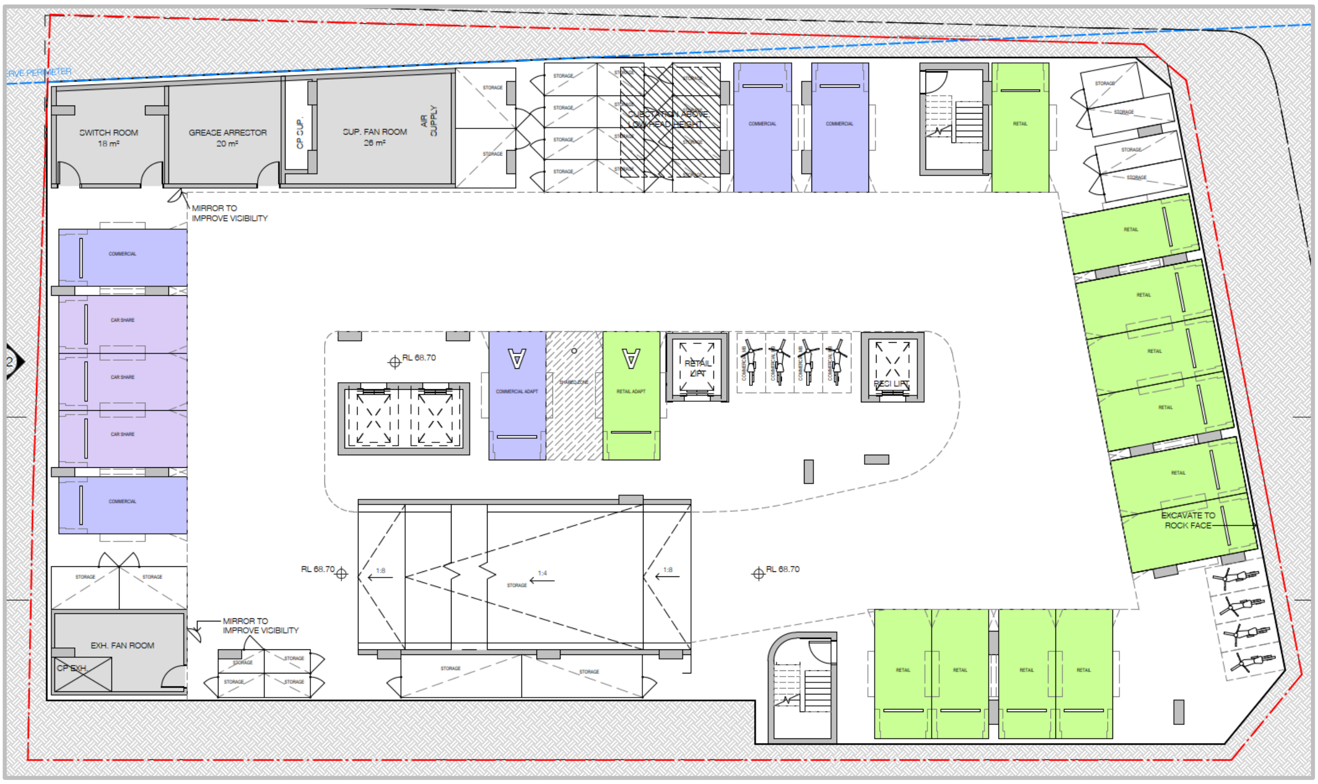
Basement 4 – Floor Plan



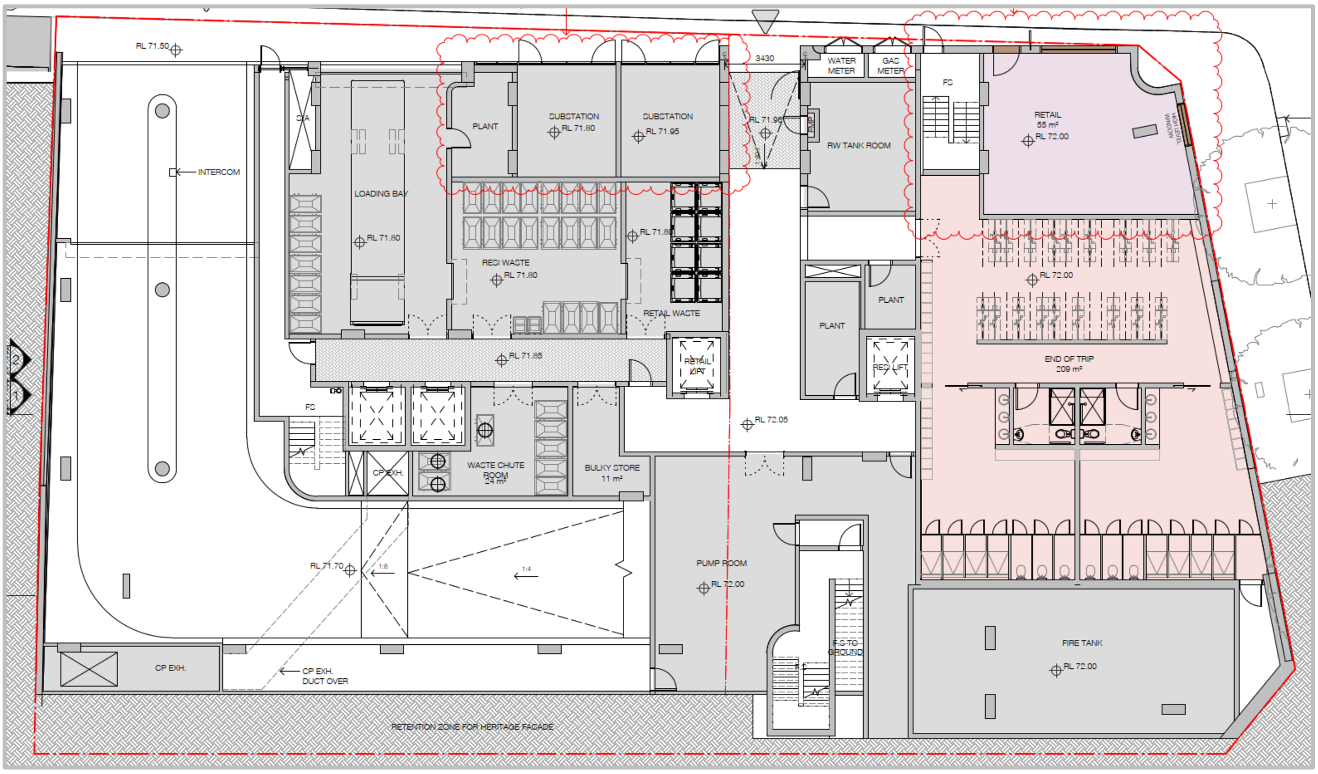
Basement 3 – Floor Plan



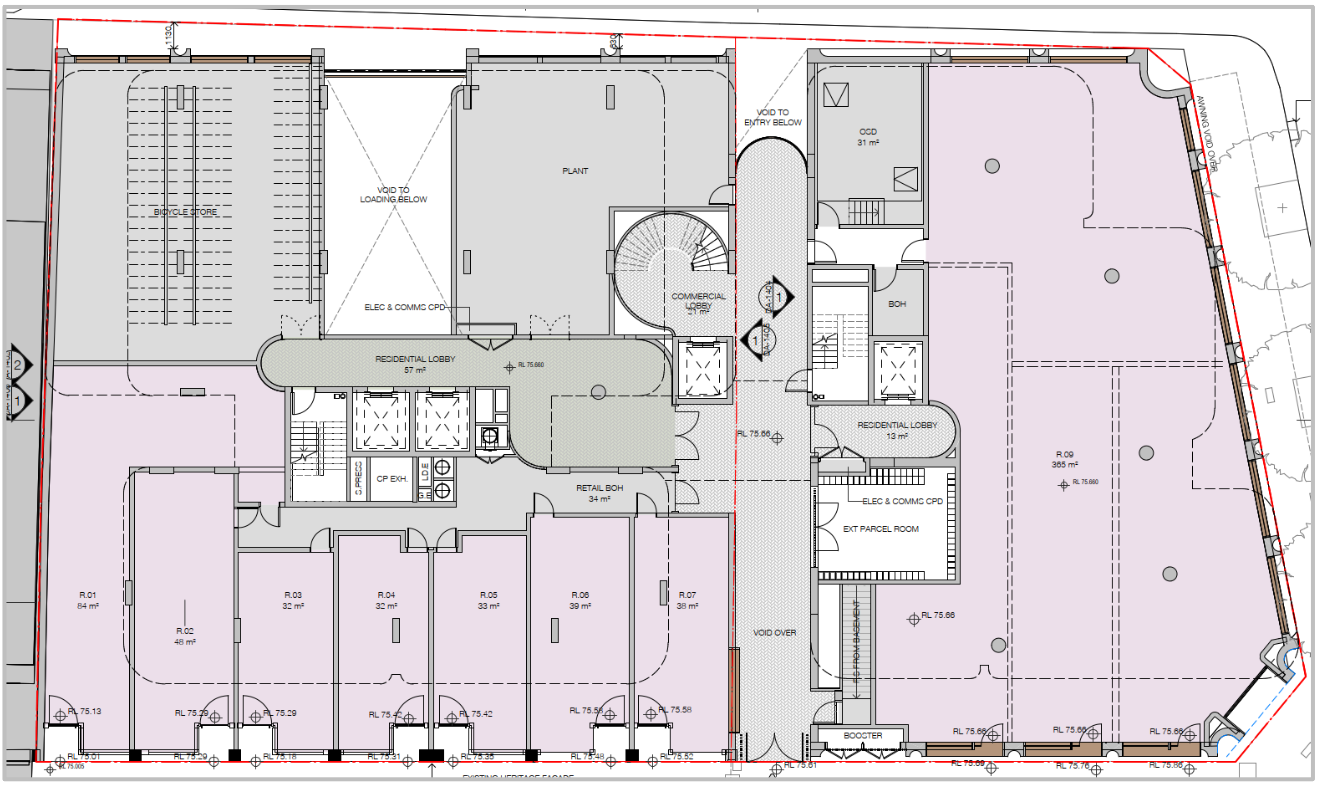
Basement 2 – Floor Plan



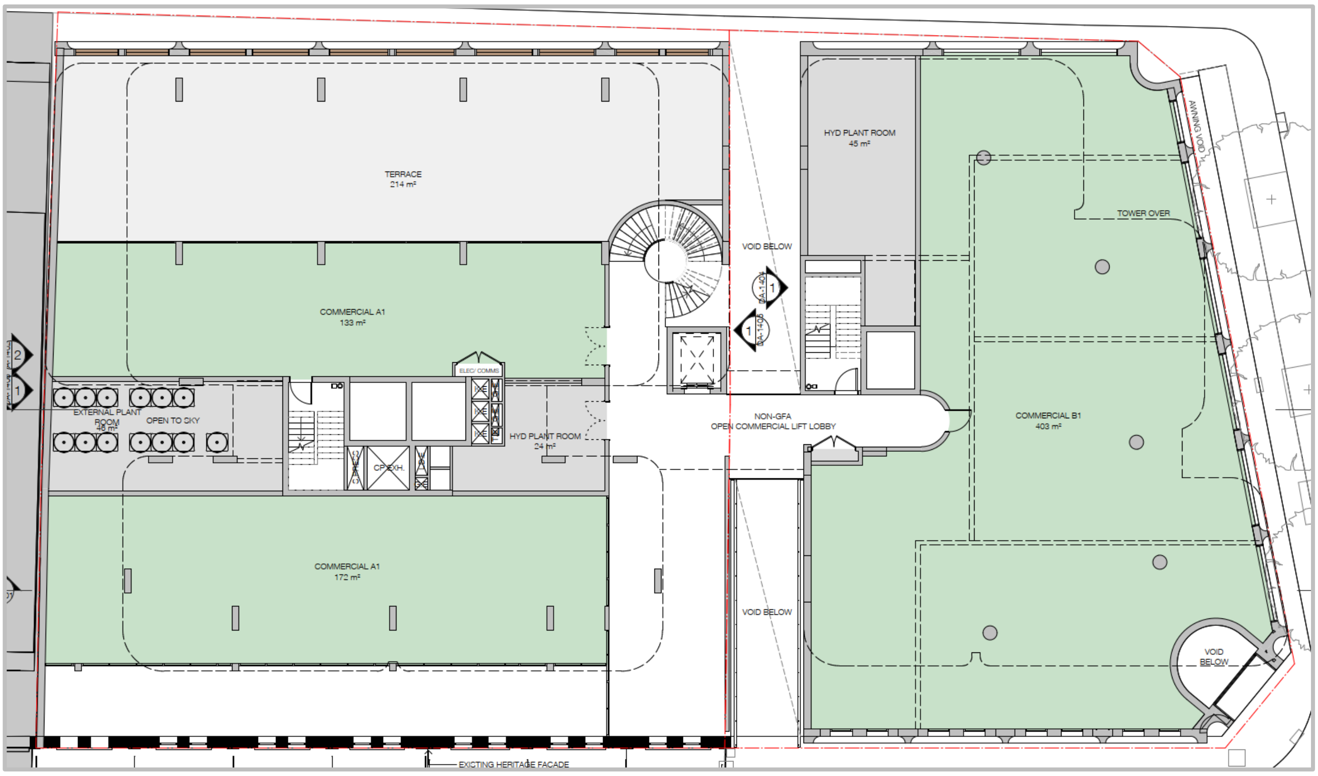
Basement 1 – Floor Plan



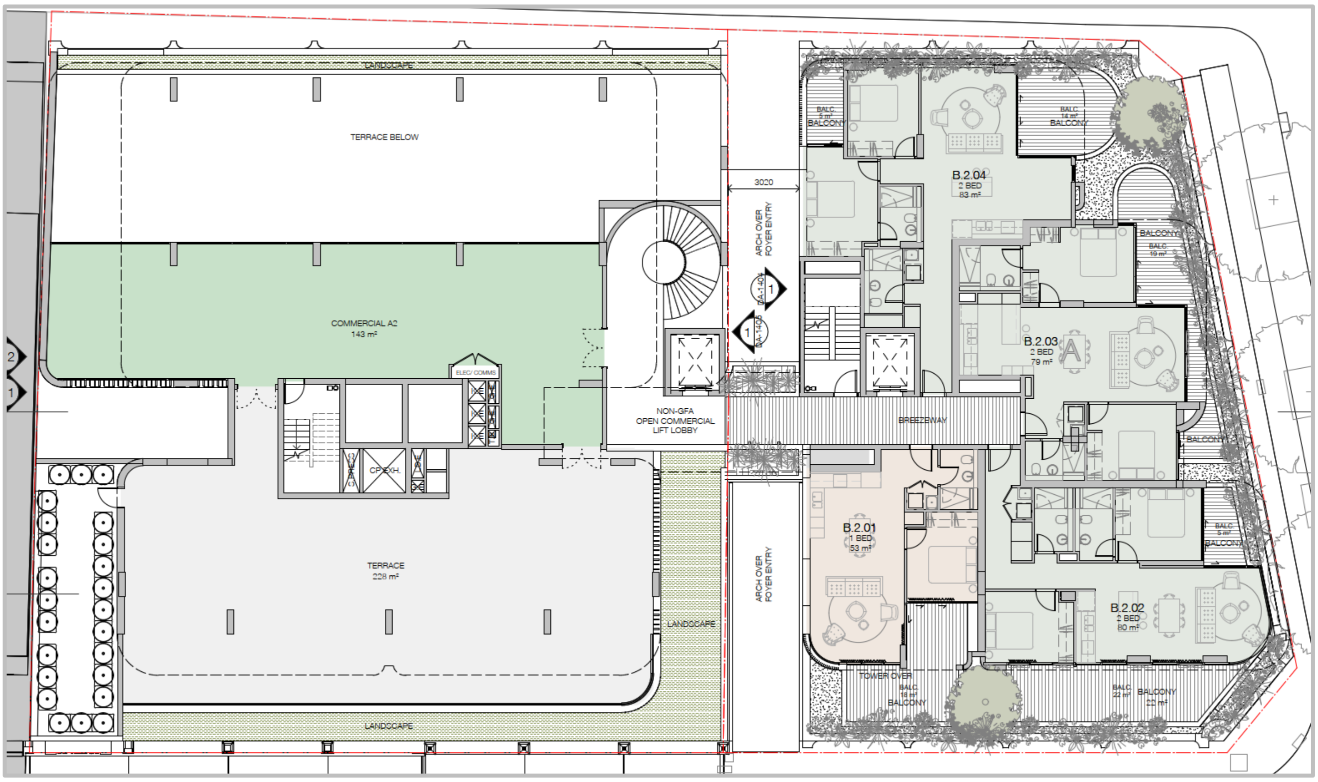
Ground Floor – Floor Plan



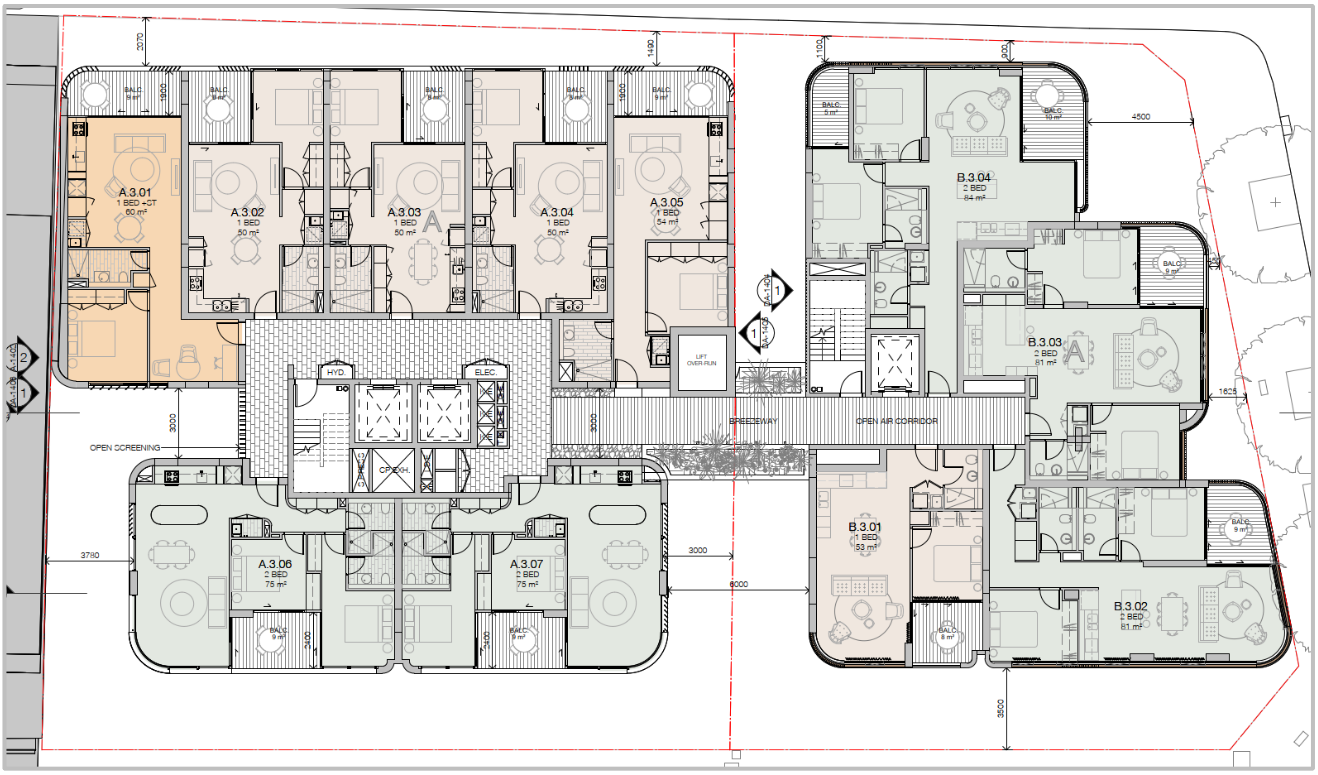
Level 1 – Floor Plan



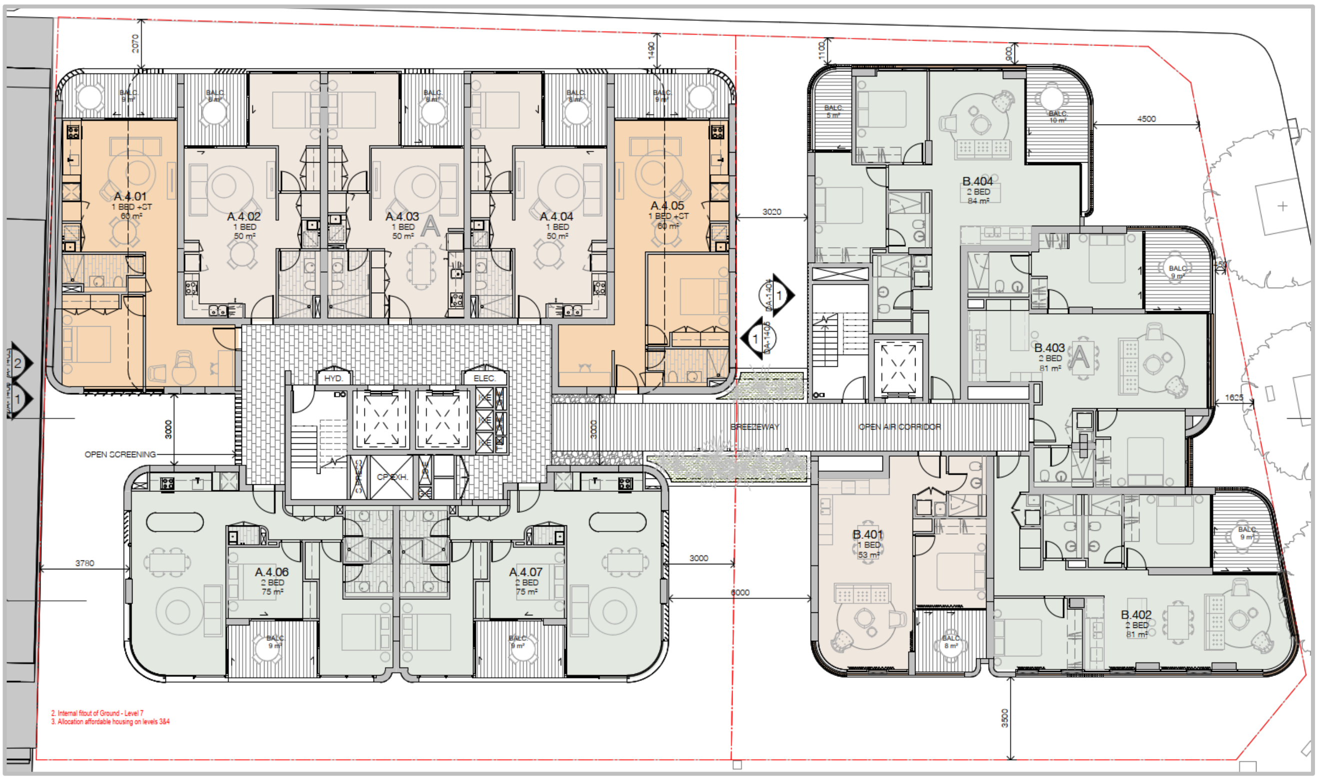
Level 2 – Floor Plan



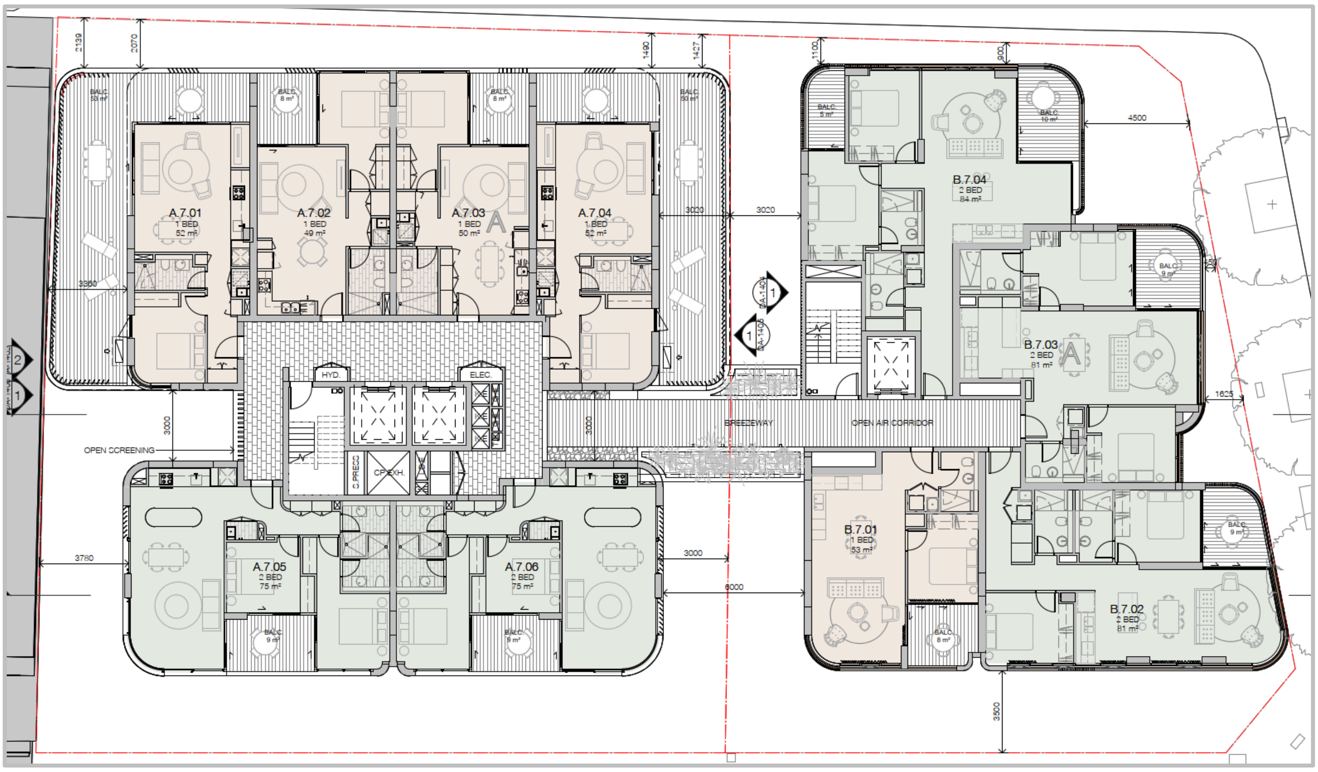
Level 3 – Floor Plan



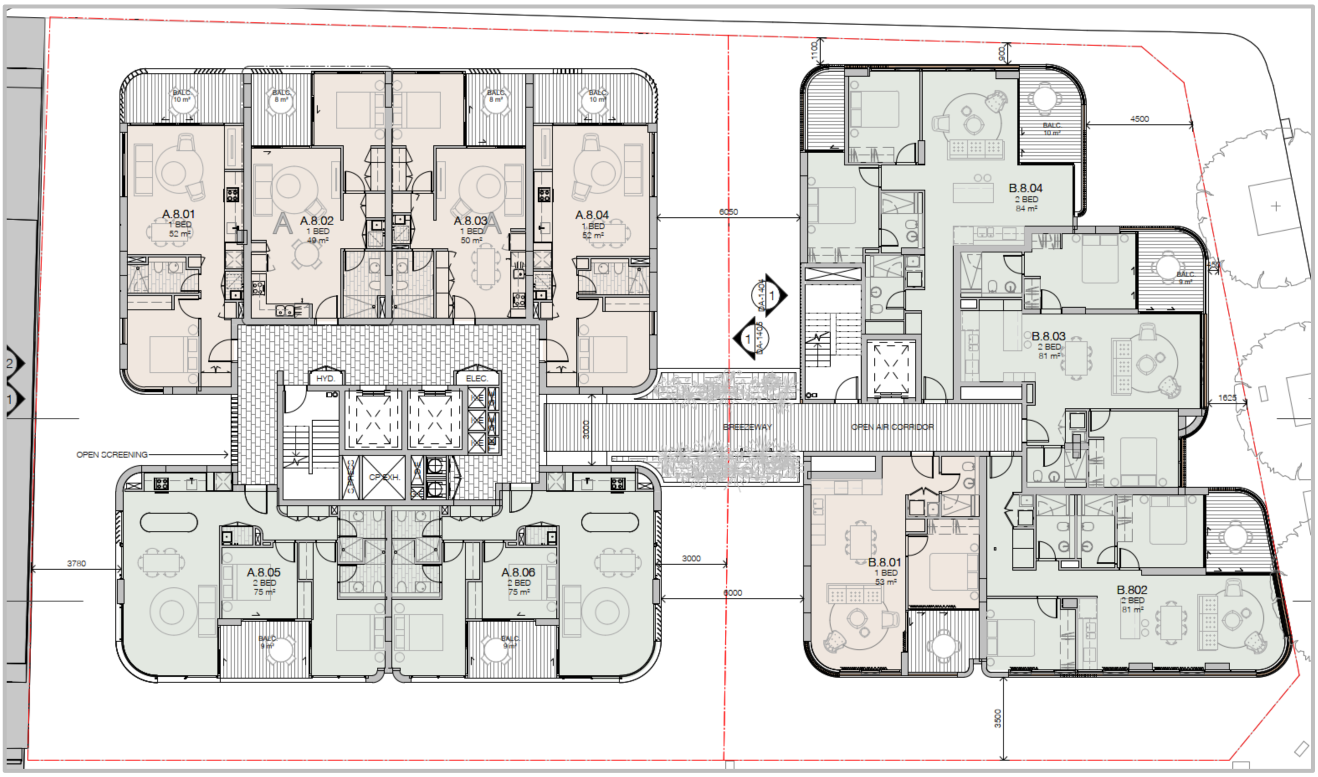
Level 4-6 – Floor Plan



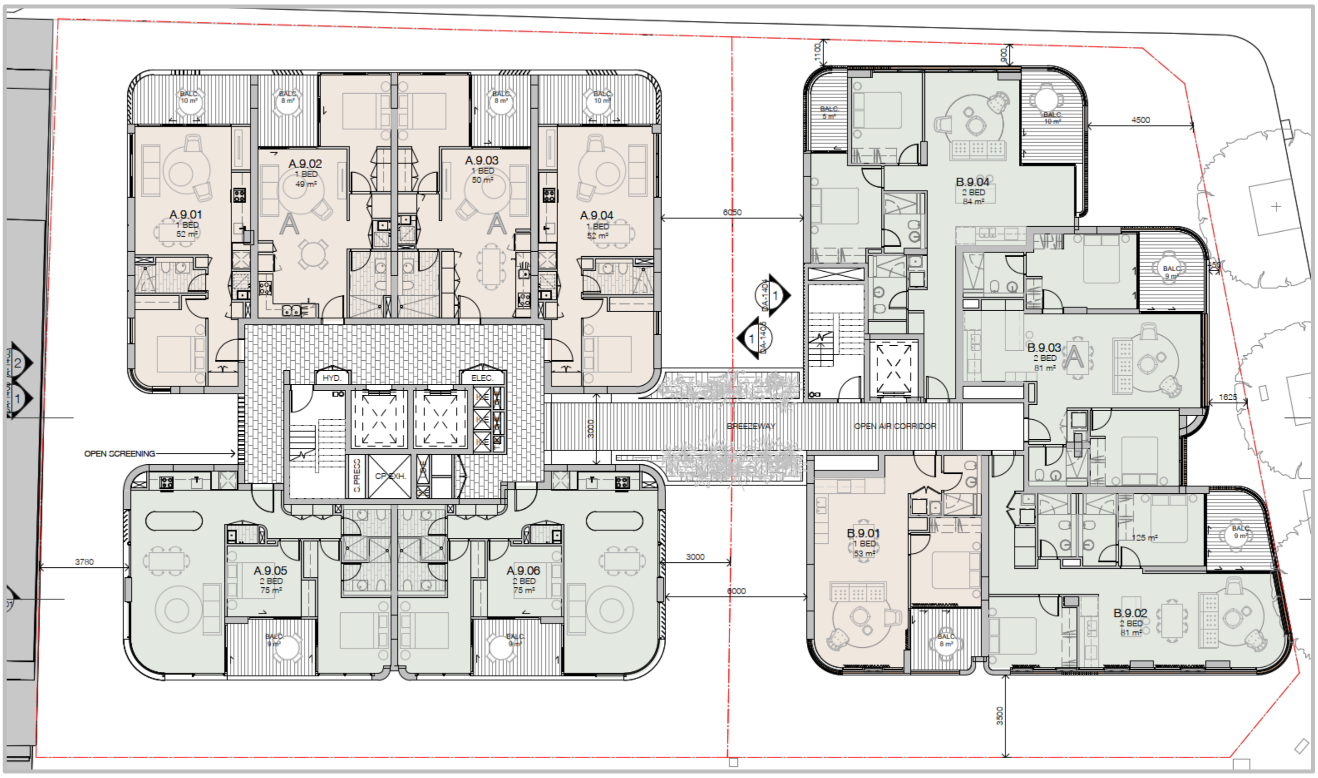
Level 7 – Floor Plan



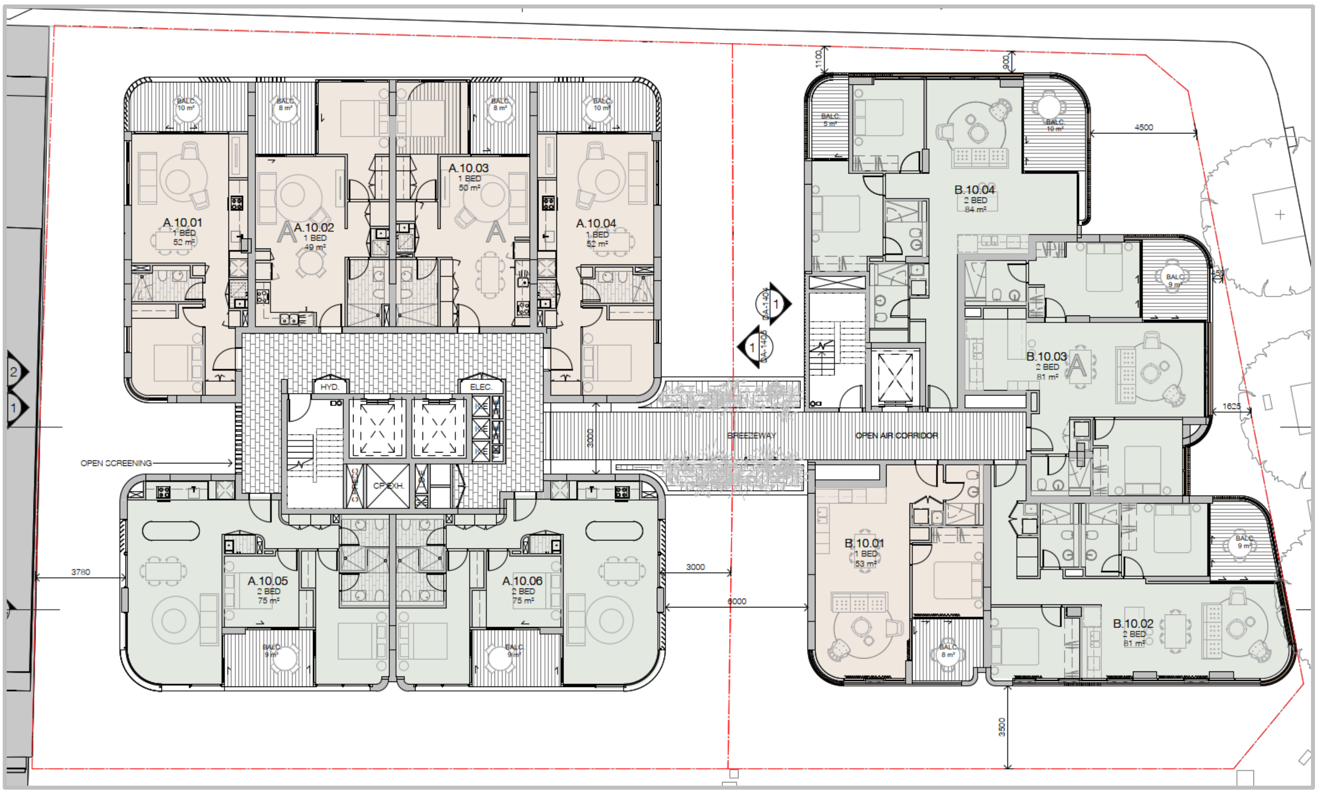
Level 8 – Floor Plan



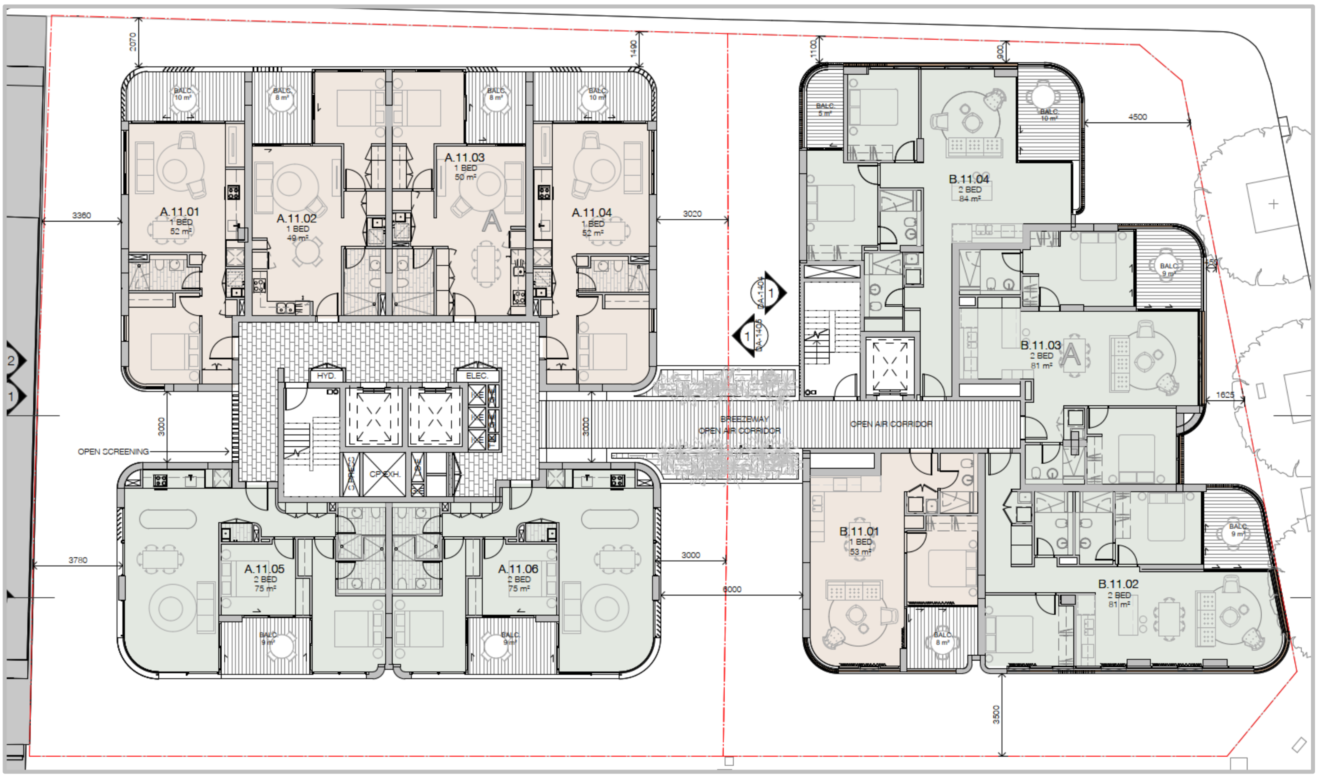
Level 9 – Floor Plan



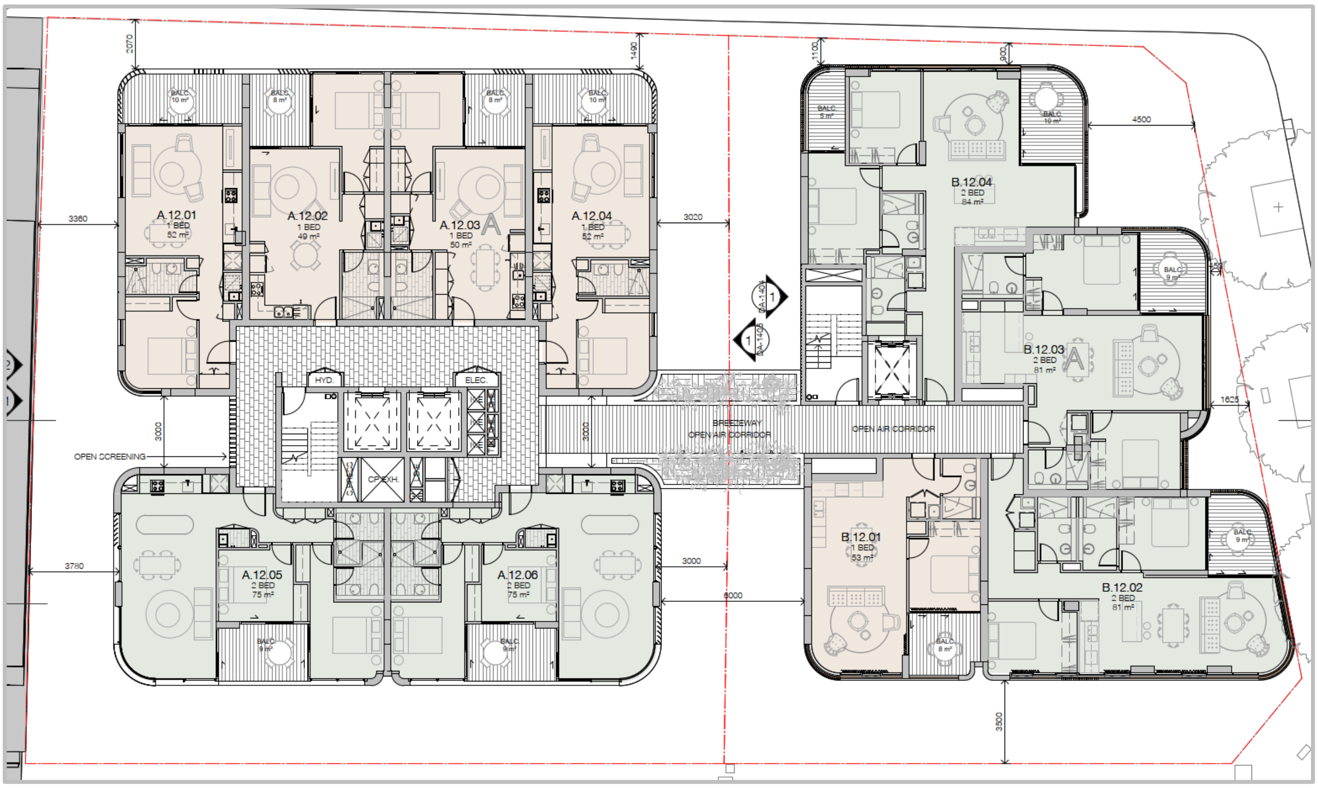
Level 10 – Floor Plan



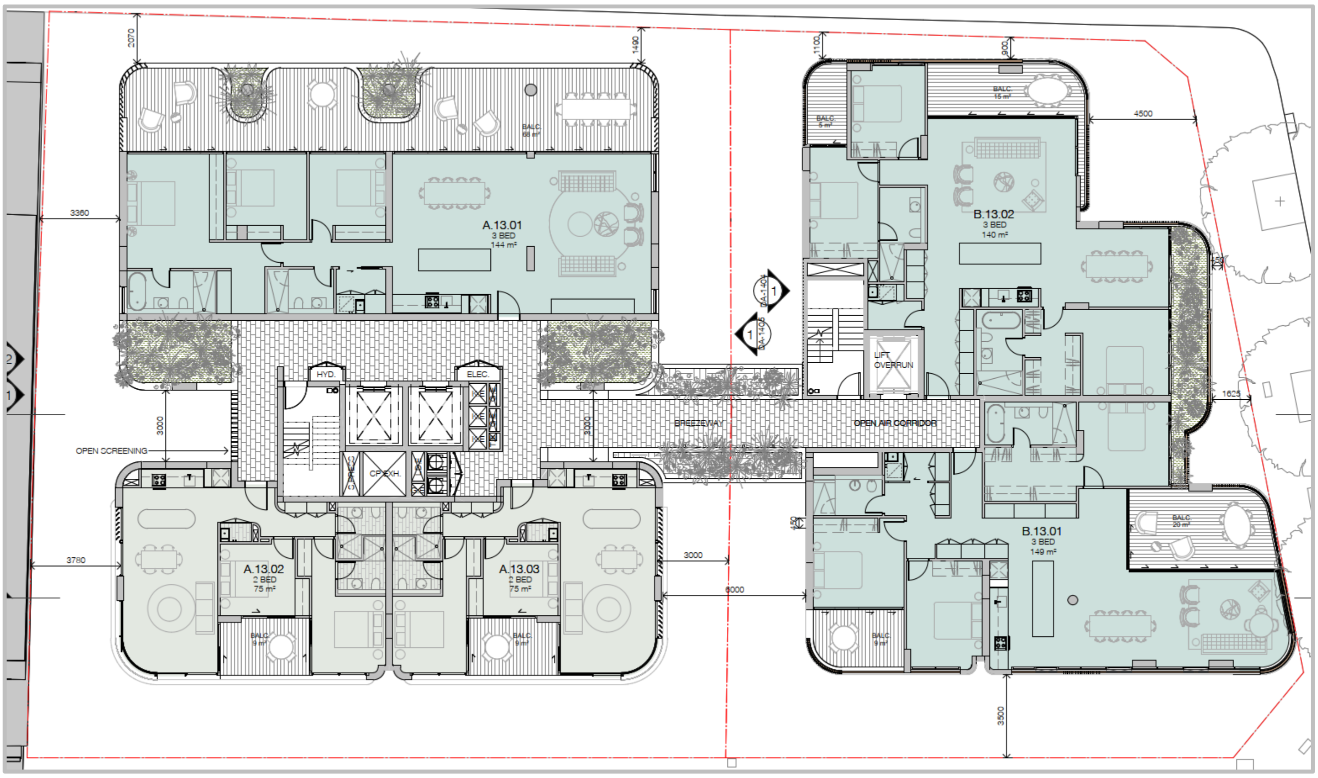
Level 11 – Floor Plan



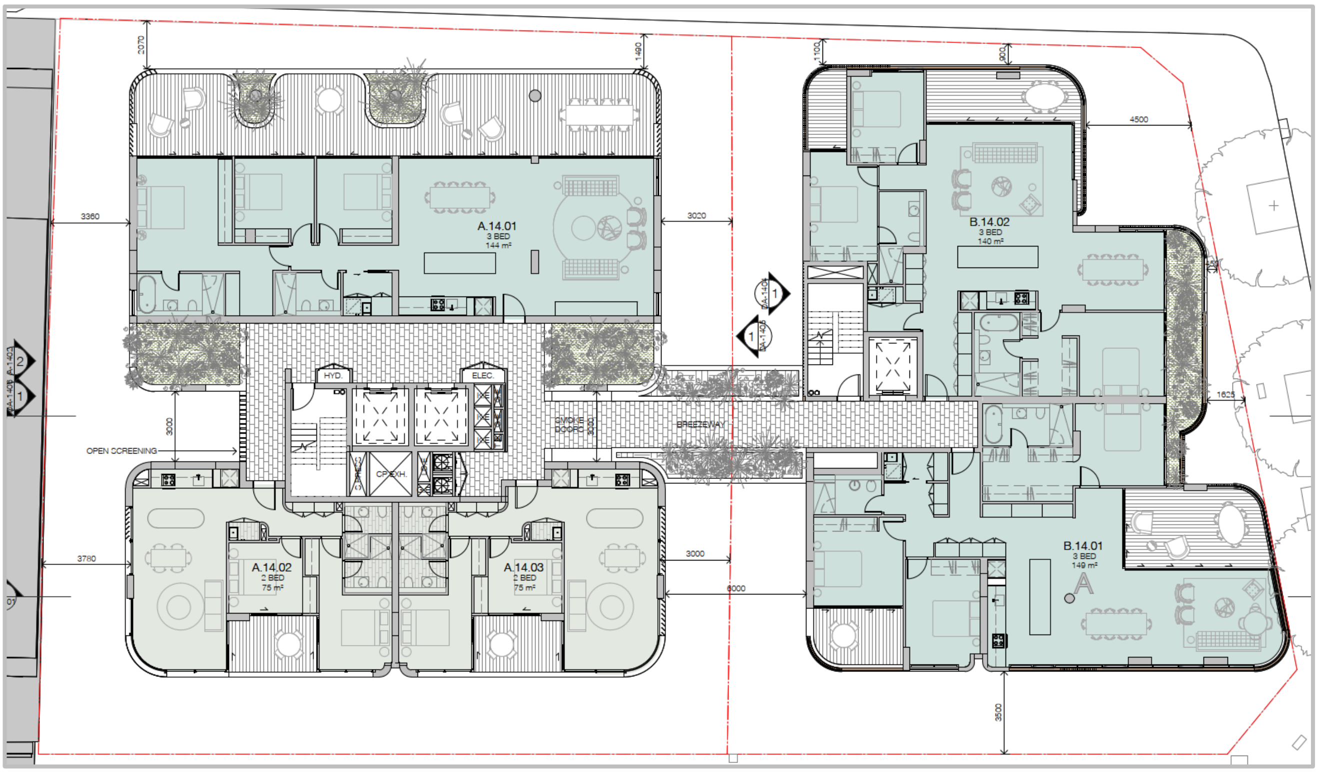
Level 12 – Floor Plan



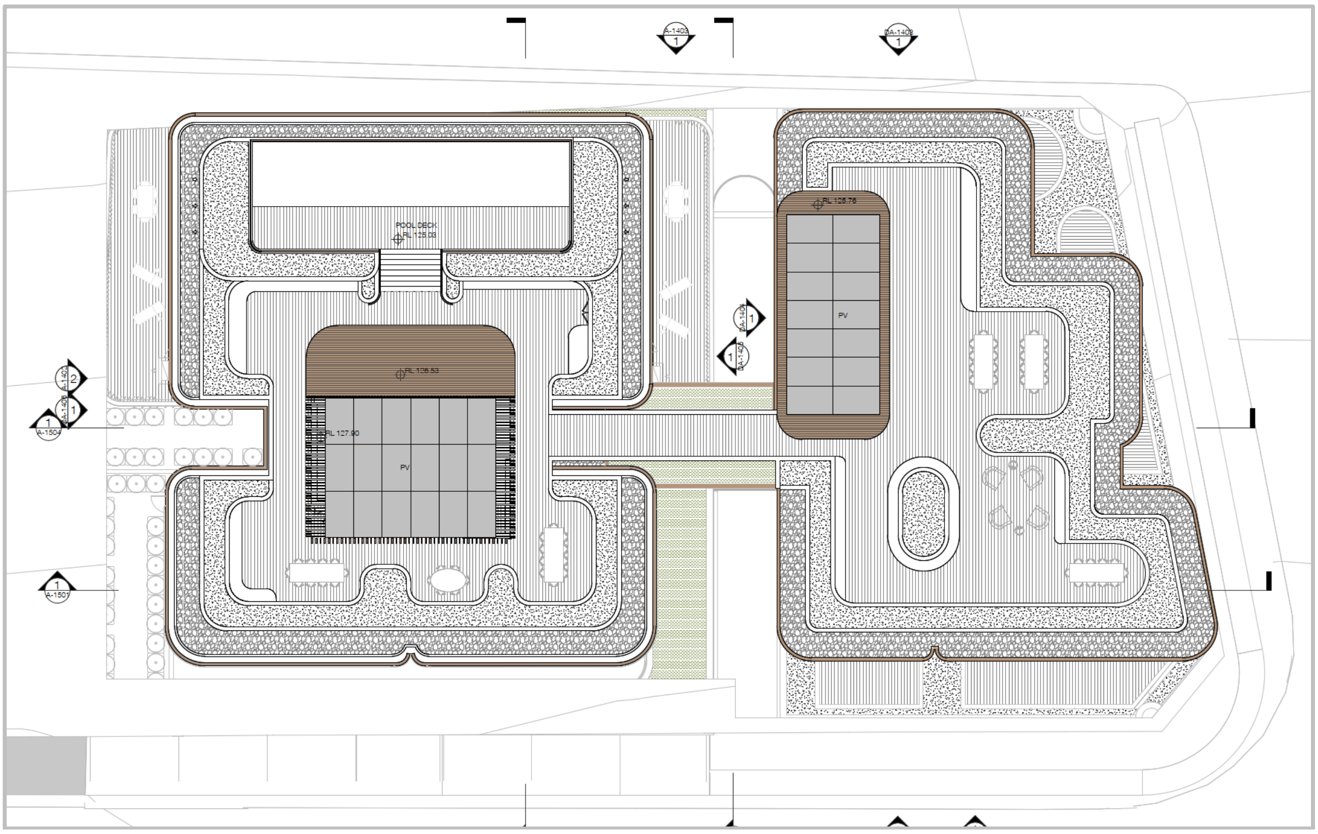
Level 13 – Floor Plan



Level 14 – Floor Plan



Roof Plan

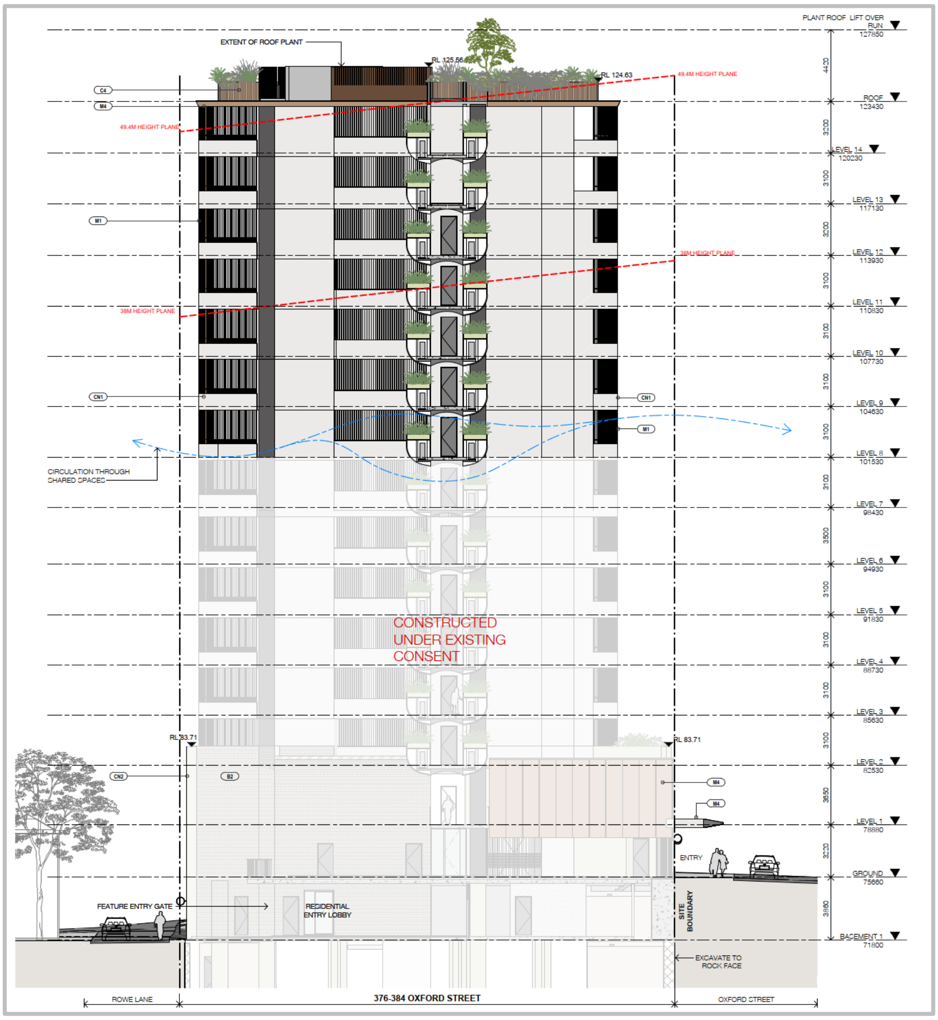


Oxford Street Elevation

New Land Street Elevation

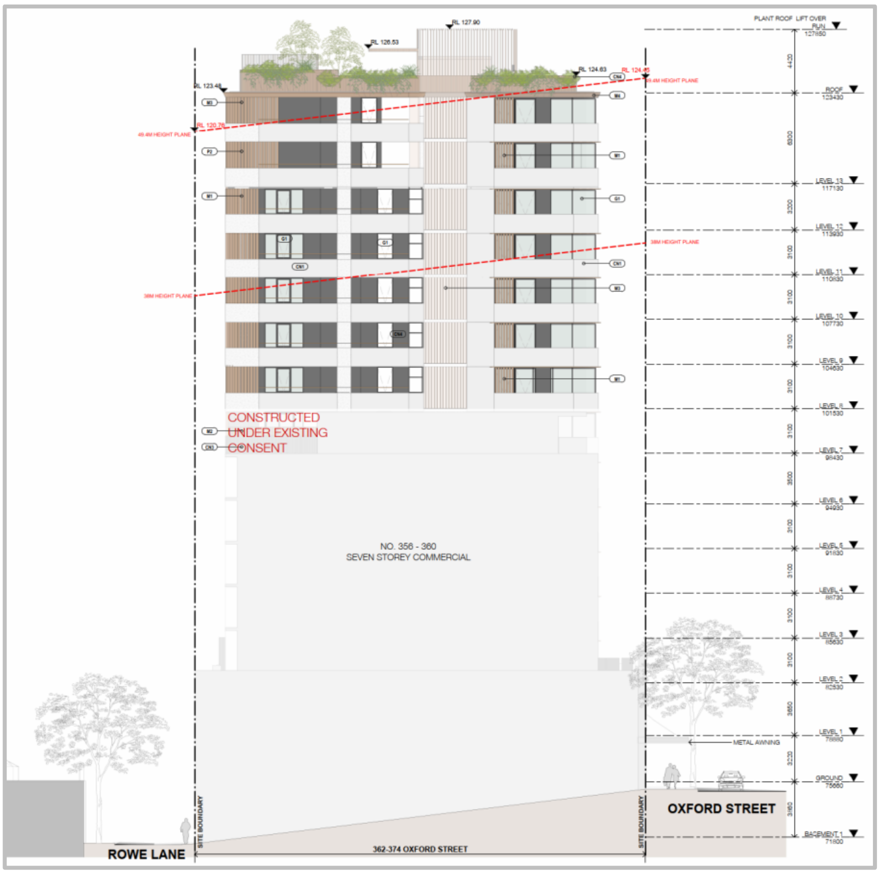
Row Lane Elevation

Western Inside Elevation



Eastern Inside Section

Western Elevation



3 Reflectivity

3.1 Assessment Methodology

Any glazed building has the potential to cause solar reflections in many directions at any time at which the sun is visible. This study assesses the possibility of undesirable solar reflections that affects the viewer in a way that they are unable to accomplish a visual task such as driving or reading without taking indirect action such asturning away or raising a hand to shield the eyes in the direction of glare. It is critical that a driver's view is not affected by disability glare as this has the risk of road accidents.
The methodology employed in this report follows David n. H. Hassall of the University of New South Wales,which is detailed in steps outlined below:

1. The size orientation and extent of reflective objects on each façade are determined by examination of drawings provided by the architect, the site and surrounds and expected glazing materials.
2. Observers are chosen for critical facades, representing drivers and pedestrians.
3. Times at which the sun is reflected off the façade are determined as well as the directions in which it is reflected.
4. For each observer, several times are selected at which solar reflection are assessed for their effect onthe observer.
5. For each observer and each selected time, the equivalent veiling luminance in the eye of the observer is calculated, using as benchmark a glass reflectance of 80%. This involves calculation so the strength of solar illumination, the position of the sun in front of the façade, the apparent position of the sun reflected in the façade, and the reflected solar illumination by the observer.
6. The calculated equivalent veiling luminance is compared with the maximum allowed level of 500cd/m^2.
7. For situations where the maximum level is exceeded, the case is further investigated to assess whetherthe offending section of façade is shaded by external shading devices or adjacent buildings, within the observer's view of the façade, and presents a large solid angle to the observe. If the offending façade section is shaded beyond the observer's view of the facade, or too small to reflect the sun to the observer, the case is disregarded. Where there is no shade projected towards the façade the glass reflectance is reduced until the level of luminance towards driver's sensitive vision is reduced below 500cd/m^2. The new reflectance is then considered the maximum reflectance allowed for that particular section of the façade.
8. With knowledge of the impact of solar reflections on numerous observers for each façade the investigation is generalised for all small observers within sight of each façade.
9. For calculation purposes, it is assumed that drivers and pedestrians face horizontally and parallel totheir direction of travel.

Each of the above assumption was considered appropriate, and the Hassall methodology is considered bestpractice for such analysis.

3.2 Glare and Reflection

3.2.1 Overview

Importance of Reflection Analysis

Human vision is highly subjective and understandably highly valued and critical to the conduct of our lives. Situations may arise in which vision is adversely impacted. The strobing of a artificial light, or spotlight, or more naturally the sunrise all are situations in which human vision is impaired at that particular time. Mitigation of the impact often involves looking away or shielding. Glare and Reflection in the context of this report are situations in which there is a presence of potentially vision impairment circumstances. The likelihood of these situations causing a hazardous situation is dependent on factors such as the person's ability to look away, shield, or the intensity or duration of the light source.

This report will briefly outline some of the considerations and conduct a review of reflection generated light from the sun.

Glare

Glare is considered to be the presence of strong and disconcerting light, often dazzling or disorientating. It is often perceived differently due to individual's preference, lighting conditions, activity being undertaken, intensity and colour, movement of light (i.e., strobing), angle of incidence (direction and height), exposure (i.e. sunglasses, windscreen). As levels of luminance increase to an amount that the eye can no longer discern differences in contrast between objects, adequate lighting becomes too bright and glare phenomena now exists.
Three classifications of glare can be considered:

1. Sensory Overload – luminance values are greater than the eye's ability to process
2. Optical Degradation – Veiling glare, in which the contrast of the view is reduced to degrade the quality of the image
3. Psychological - Discomfort Glare – can be a combination or part therefore of the above two

conditions the first two classes of glare can be considered as disability glare.

Refer to the Human Vision section for Glare in the human eye.

Reflection

Reflection is the reflected light from a surface, having a direct relationship to the angle of incidence, and the physical properties of the material, including the reflective and specular properties – such that diffuse surfaces, like a rendered matt painted white wall can have a reflectance of 80% but scatters the light in all directions leading to a reflection luminance of less than 2 Cd/cm2, and is considered to be highly diffuse. Glass on the other hand, being glossy and reflective, does not scatter light but rather reflects a high percentage and is considered specular.

A building is often made up of various materials of different reflective characteristics. It is the interaction of the diffuse nature at the surface which has the most significant impact on the reflective energy or luminous intensity (Cd/m2) which is of concern for this report. Parts of a building, typically Glass, can create a "virtual second sun" such that the reflected sun can present significant intensity to present eyesight impairment.

The human eye operates between 1 and 2 Cd/cm2, whilst the sun's luminance ranges from 600 Cd/cm2 near horizon (sunrise / sunset) to over 150,000 Cd/cm2 at noon.

Clear glass has a reflectance of around 8% measured at normal (90°), thus can reflect from 46 Cd/cm2 to over 12,000 Cd/cm2 depending on time of day. Thus, at any given time of day, sun reflected from glass has the potential to exceed the capabilities of the human eye and thus cause vision impairment.

3.2.2 Sun

The sun follows a known solar trajectory and can be plotted in a number of ways. In building design resources such as "Sunlight and Shade" by CSIRO's Ralph Phillips provide solar protractors to determine sun position – Altitude and Azimuth.

This report uses the extensive computer algorithm known as the IES Daylight system embedded into the Autodesk software 3D Max, using the Ray tracing of the "Mental Ray" processing. This is a certified Internationale Engineering Society algorithm that determines the position of the sun, intensity of the sun, sky vault luminance and atmospheric conditions (Cloudy, Clear Sky) and provides a computer simulation of the sun and sky as an interrelated daylight system.

The location of the proposed design is determined by Latitude and Longitude and a daylight system is created in which any time of day, time of year is available.

The scope of this report is to examine direct beam solar radiation, and as such only the Sun's direct rays are used in analysis, discounting the diffuse and reflected radiation from other sources (including geography, built environment, atmosphere).

The sky itself contributes from 1000 Cd/m2 (away from the sun in a dark patch of blue sky), up to around 30, 000 Cd/m2 nearer the sun circle. The effects of the sky-vault have been removed from the calculation of solar reflectance, as the impacts of sky-vault generally reduce the potential glare and veiling effects that we are investigating – i.e., we are looking at worst case scenario with high contrast conditions.

Precise values of the sun's illumination (Table 3-1) can be provided however as a guide, from Hopkinson et al 1966:

Table 3-1 sun's Illumination Parameters.

Sun Altitude	Illumination (Lux)
5°	12,900
15°	56,800
30°	86,800
50° +	100,000 +

3.2.3 Human Vision

The human eye's normal conditions operate in a luminance of 1 to 2 cd/cm2. (Hassall 1991)

Any light source that exceeds this luminance will cause vision impairment, with the intensity (luminance) of the source and duration being factors. A concept known as Veiling Glare can also impinge human vision, in which a bright light source is not directly shining into the retina of the eye but surrounding areas of the eye, which then scatter the bright light causing vision impairment. This is often the case when reflective glass is used. The eye can be actively shielded from bright light by way of normal activity – for instance not looking up at the bright sun, casting vision aside or down during sunrise, or protective measures such as sunglasses, windscreen shades, hand shielding and so on. Of importance are situations in which it is likely the human eye's vision will be impaired due to a set of conditions that render these normal activities impractical. For instance, when stopped at traffic lights, the driver is obligated to look towards the traffic signal and cannot selectively lower their vision.

Glare

A value of 500 Cd/m2 as calculated by the Holladay formula (Hassall 1991) (refer to methodology section) is considered as a practical limit to the amount of reflected solar glare a driver should be exposed to.

As discussed, the activity required also becomes a factor in consideration of thresholds for the determination of reflective interference. The surrounding environs, and time of day and weather all have an influence on this threshold value – i.e. the point at which a reflection becomes a problem.

Visual Acuity is the eye's ability to distinguish four key factors

1. Size
2. Luminance – Brightness is a subjective evaluation of luminance
3. Contrast – the difference in luminance of an object against a background
4. Time

Items 2 and 3 contribute to form the classifications of Glare as discussed in previous section, whilst "time" considers the physiological response and recovery of the eye as it adapts to different luminance levels.

The Traffic Authority of NSW (Hassall 1991) quotes

"It is important to note that the effects of glare on visual efficiency do not cease at the instant that glare ceases

to enter the eyes - there is a recovery period which may be several seconds in the case of sun glare (Dobrash and Saur 1952). Sensitivity to glare and the amount of time it takes the visual system to recover after glare ceases to enter the eyes are both affected by a number of factors such as age of the individual, their health, and whether certain drugs have been taken.

(Moser and lind 1980) - including alcohol (Banchevska 1981) "(Hassall 1991)

Field of View

pedestrian:

The field of view can be influenced by the activity such as pedestrians using the range of binocular vision as determined by Helms.

Showing the "Stationary" Human eyes field of view and the areas of key importance.

Area A is the most sensitive part of the vision, the foveal vision in which light focuses on the fovea aspect of the retina. Area B is the area of sensitive vision, beyond this field movement but not colour can be distinguished. The human field of view by Helms is illustrated in Figure 3-1.

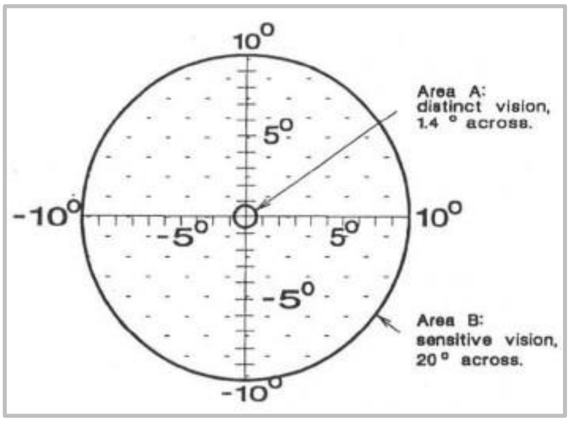


Figure 3-1 Human Field of View by Helms.

Vehicle field of view:

The measurements as described by Schreuder, using 95% of vehicles measured produces a field of vision template that can be used to provide CUT OFF values to the pedestrian field of view, to account for windscreen design and even sun visor design. The windscreen template by Hassall is depicted in Figure 3-2.

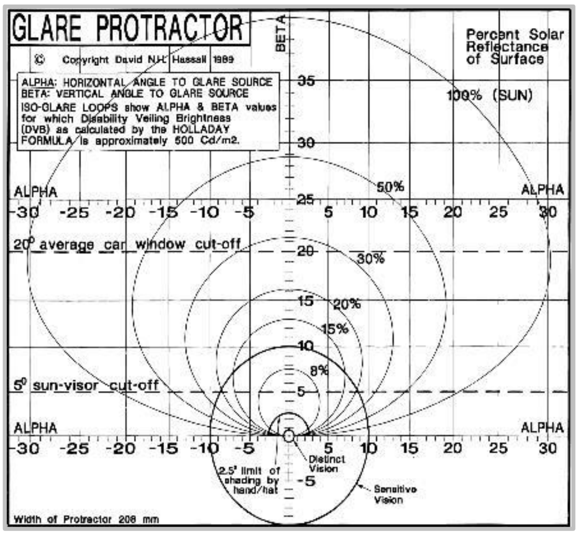


Figure 3-2 Windscreen Template by Hassall.

3.2.4 Glass

Highly reflective materials used in buildings present the most interest when analysing reflectivity concerns. Whilst polished metal and highly polished materials like stone, ceramic etc, may present glossy surfaces that contribute to reflectivity, by and large the most important consideration is the location and areas of glazing, type of glazing and the sun's path to the glazed areas (i.e. shade systems).

Glass properties consists of Absorptance (a), Transmittance (t) and Reflectance (r) given as

$$a + r + t = 1$$

The value of Reflectance is greatly influenced by the angle the light beam strikes the surface, ranging from 8 % at 0° incidence angle, to over 50% at 80°. The reflectance value for various angles of incidence of standard clear glass is shown in

Figure 3-3.

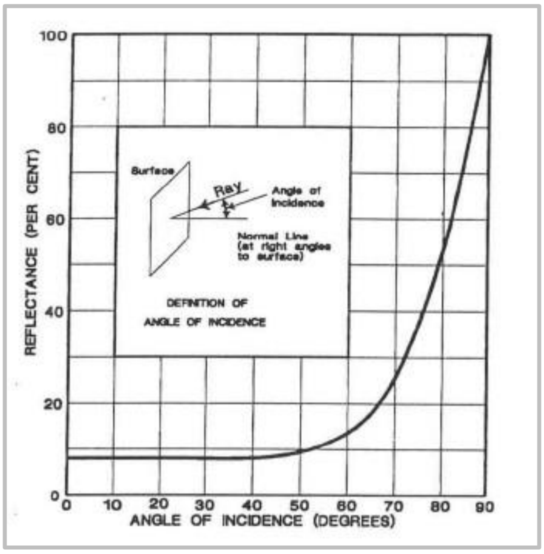


Figure 3-3 Angle of Incidence of Standard Clear Glass.

Glass systems use the above formulae to balance the Absorptance and Transmittance and Reflectance to modify the visual and thermal properties. As the graph below suggests, most glass treatments have greatest impact when the angle of incidence is low (i.e., at 90° to the surface) and as the angle increases the reflective properties of most glass tends to become highly reflective. The reflectance value for various angle of incidence for different types of glass is shown in Figure 3-4.

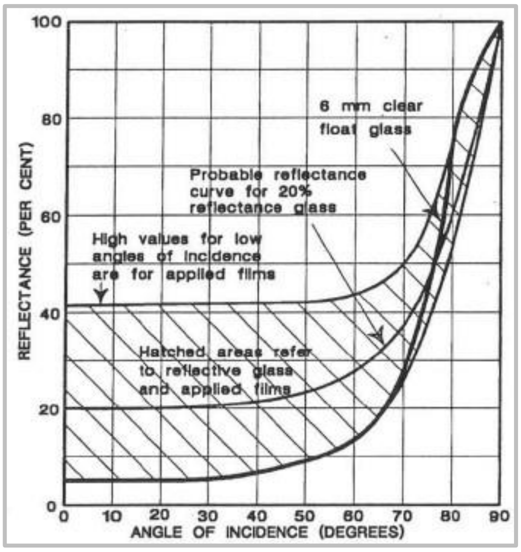


Figure 3-4 Reflectance for different types of Glass – Hassall.

3.2.5 Glossy Materials – Metal Surfaces

The use of metal surfaces under given conditions and surface treatments – i.e., high gloss light colours, may provide similar reflectance properties as that of glass. The specification of Galvanised finish and even to a lesser extent the pre-painted Colourbond steel, presents the requirement to discuss the material properties of reflective surfaces. Generally, the smaller the surface imperfections – such as highly polished, at a micrometre level, the higher the potential for specular reflection (angle of incidence equals angle of reflection). Metal surfaces will generally suffer from weathering (abrasive and accumulative actions) that degrade the smoothness of the surface over time - with Galvanised steel presenting a higher yield of surface change over time than painted surfaces. Installation of new metal sheeting will generally see the highest gloss levels and smoothness of surface with rapid decline (less than 1 year) until a stable semi smooth surface is achieved.

Further details of the reflective nature of metal surfaces are discussed in BlueScope's Technical Bulletin 28 "Building Materials, Thermal Efficiency and Reflectivity". This technical note discusses the issue of Reflectivity Index and the complications associated with it as a sole discretionary tool.

This report will use the worst-case specification of materials – i.e., highly glossy light coloured, and determine the extent of reflectivity and areas influenced.

Due to the large variation in surface treatments and material properties, individual analysis of reflectance per angle of incidence for the material is required to be conducted by certified laboratory testing in order to establish the Index of Reflection (IOR) curves as per provide in the above section for Glass.

Typically, the Stage 1 analysis will use a worst-case surface and use a solid opaque highly glossy surface (think of it as opaque glass) to determine the cast of reflections and the areas of interest. Only in Stage 2 and beyond assessment will the surface properties be required to be entered in order to determine the intensity and thus potential glare hazard of the reflected ray.

As such glossy materials properties can be considered to consist of Absorptance (a) and Reflectance (r) with Transmittance taken as 0 (opaque) such the formula.

$$a + r = 1$$

Care should be taken however as for instance the Absorptance values given in the Colourbond colour specifications (as they relate to BCA and BASIX) should not be simply inverted to find Reflectance. These values are provided as a thermal property and are not suitable for visual impacts – with reference to the BlueScope technical Bulletin 28.

3.3 Reflectivity Analysis

The Methodology used to assess a building design is provided in the following section. It should be noted that not all stages of assessment may be required to form recommendations, and that it is common for Stage 1 assessments to be conducted only. The assessment protocol requires a sequential process from Stage 1 to 2 and 3.

3.3.1 STAGE 1 Reflectivity Heat Map

STAGE 1 assessment uses the ray tracing capability of 3D MAX (Autodesk) to trace back reflected light rays (known as photons in the software) to determine the location and intensity of reflected light from a light source. The material characteristics of the surface are physically accurate, such that glass and rendered painted surfaces each take on the correct physical attributes in respect to reflectance, diffuse scattering, IOR (Index of Refraction – for transparent materials) and colour.

For a given time, the IES Sunlight shoots photons towards the target surface and ray tracing algorithm traces these reflections and captures them on the return – typically on the surrounding terrain plane or neighbouring buildings.

Colour coding may be employed to provide visual ability to assess various components of the design – i.e. a typical situation is a high rise tower may be colour coded per level, in order to determine the impact of various heights, OR colour coding of various orientations or types of windows in order to better understand the propagation of reflections according to the design.

Some post processing for the addition of graphics, overlay of aerial images, points of interest or amalgamation of time sequences may be present in a Stage 1 Heat Map.

The process of computer rendering requires some settings in order to produce suitable images – such as:

1. Resolution of Image (pixel count)
2. Rays traced (photons) typically 10 – 50 000 rays are produced for the sun light source
3. Filter size of Rays – this is essentially the allocation of ray to a surface area – i.e. rather than showing as a small pinprick the size of the ray is magnified, typically to be 1 – 5 m diameter.
4. Exposure – similar to photographic exposure the image produced requires a dynamic range that crops the light values. Exposure generally adjusts to provide neutral results across the day – suitable that bright reflected light rays remain visible. As such it is typical for the exposure of white surfaces to be rendered grey.
5. Colour rendition – as mentioned colour coding is used to indicate areas of interest, and the influence of the colour temperature and its ability to influence light quality is not in consideration for this section of the analysis.
6. 3D Modelling – the 3D data – i.e., the physical geometry of the design and the environs influences the analysis – in particular it is often that landscaping and trees are not included in the analysis due to the variation in representation of this information. For instance, a generic tree may have significantly different foliage and height to what actually is specified, and the industry may not necessarily appreciate the relationship between landscape plan, reflectance analysis and on-site planting.
7. IES Daylight system requires suitable Latitude and Longitude and True North.

Stage 1 Heat Maps show areas in which reflected light will be located. They therefore represent the first stage in determining the impact of reflections and glare hazard by locating specific areas of concern or interest that may require further investigation.

They enable a relatively comprehensive review of the entire 3D design in numerous time periods throughout the year. Typically, Mid-Winter and Equinox daylight hours are the most common analysis periods.

Stage 1 Heat Maps cannot determine the existence of GLARE HAZARDS, but merely suggest the location and time in which to conduct further reviews of reflectivity. The Sample of Heat Map is presented in Figure 3-5.

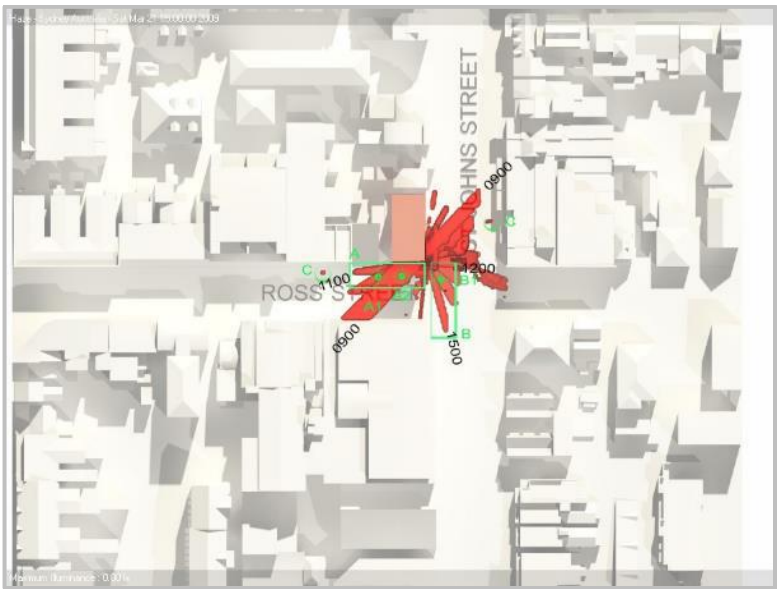


Figure 3-5 Sample of Heat Map.

3.3.2 STAGE 2 Detail Review – Calculation of Glare Hazard

Upon review of Stage 1 analysis, specific locations around the site may require more detailed investigation. Likely situations occur in which one or more of the following situations occur:

Location of reflection is on a significant position – such as a traffic intersection

1. Duration of reflection is such that a Glare Hazard may be of significance
2. Intensity of reflection is such that a Glare Hazard may occur

Depending on the design and scope of service, as well as the specific locations required for further review several methods may be used to answer the question:

"How much Reflection constitutes a glare, and how much Glare is too much"?

3.3.2.1 Glare Photomontage

To determine the presence of GLARE, the intensity and position relative to the field of view of the activity and the contrast are required to be calculated. The following workflow determines the analysis of the glare:

Vipac uses the Photomontage Method. A digital image (computer render of the proposed view – proposed design and environs) and OR a photomontage is aligned with the HASSALL GLARE PROTRACTOR and the reflected virtual sun is plotted. Reading of the values from the protractor will determine the existence of potential glare and if required a glare intensity (Veiling Glare) table calculation is run to determine if the intensity threshold constitutes a Glare Hazard. A digital image as a sample of glare photomontage is depicted in Figure 3-6 Sample of Glare Photomontage (Digital Image).

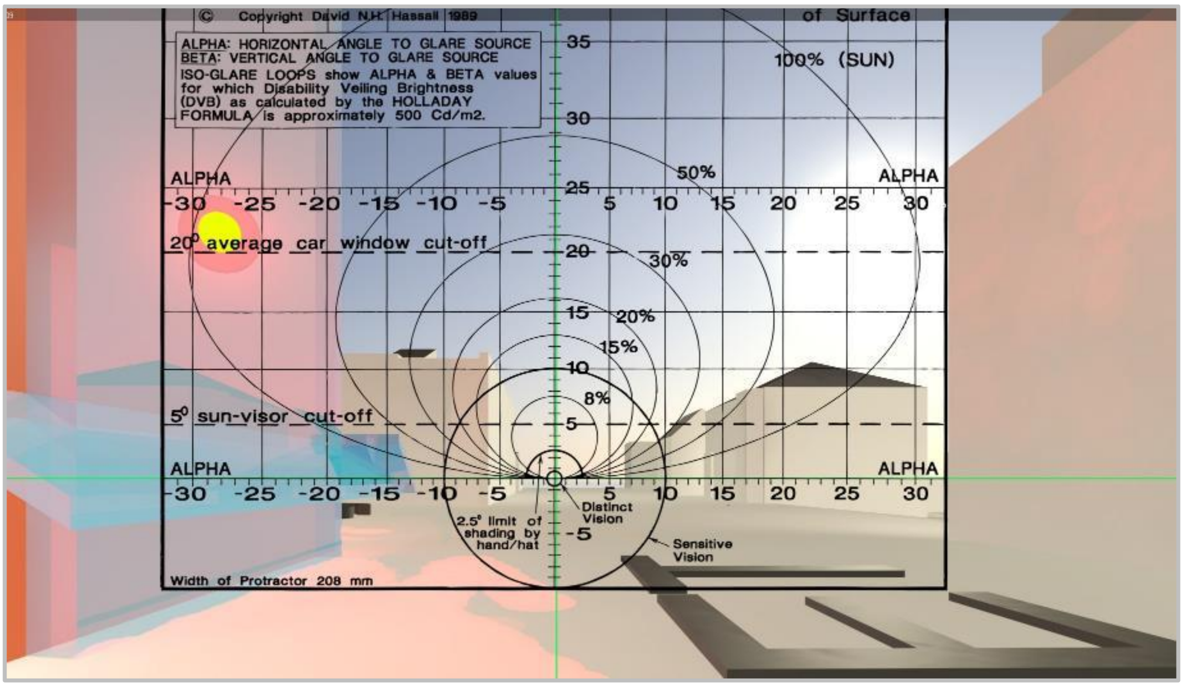


Figure 3-6 Sample of Glare Photomontage (Digital Image).

3.3.2.2 Veiling Glare

Upon review of the location of the reflection using the above method of Glare Photomontage the next step is to determine the intensity of the Glare to determine if it is to be considered a disability glare. The following workflow can be used but more often the Veiling Luminance can be calculated from spreadsheet which is an electronic version of Hassall Veiling Glare Calculations.

1. Holladay Formula for Calculating Glare. Provides a numerical table for interpreting flat plane surfaces and applying first principles to determine glare intensity. using Hassall section 5.1.
2. Illumination value from the sun, using Hassall section 5.2 considering the luminance efficiency of the sun for

a given altitude, and the angle of incidence to the reflecting surface. Angle relative to the human viewing position isreferred to in Section 5.3 Hassall.

3. Veiling Luminance – to determine if the value of glare luminance is above the threshold of 500 Cd/m2 (the definition adopted to refer to the existence of GLARE).

If this method is applicable a reference to the formulae and worksheets will be provided. Figure 3-7 below provides a sample of veiling glare worksheet.

CALCULATION OF GLARE									
Location		A1							
Month		Winter							
Time		900							
Façade Aspect Orientation	ASP	105	°	Degrees relative to Solar North					
View Line Bearing	BRG	348	°						
Sun Pos	AZI	42	°						
	ALT	19	°						
GLASS	Type	2	Class	1 CLEAR 2 20%Reflective 3 40 % Reflective (tint)					
Fraction of Façade that is reflective		1		Decimal number - 1 is 100% Glass					
Solar Power	W	635	W/m2	If Alt 0 - 10 then W = 50*ALT					
				If Alt 10-33 then W=500+(ALT-10)*15					
Luminous Efficacy	n	117	lm/W	If ALT<10 then n=90					
				If ALT 10 - 20 then n = 117					
Solar Illumination	E	74295	Lux	If ALT 20 - 30 then n = 125					
	Normal Beam								
Sun Position with Façade									
	H.S.A	-63	Degrees	Azi - ASP			Tan	Cos	
	V.SA	37.17838	Degrees	Atn(Tan ALT / Cos H.S.A)			0.344328	0.45399	
Angle of Incidence	I	65	Degrees	Atn(Sqr(Tan2 H.SA + Tan2 V.S.A)			3.85184	0.575241	
		60	Rounded						
Virtual Suns Position				VERTICAL ONLY					
Virtual Altitude	VALT	19	Degrees						
Virtual Azimuth	VAZI	-12	Degrees	ASP - H.S.A - 180					
Glare Position with Observer									
	ALPHA	-360		VAZI-BRG					
	BETA	19		VALT					
	THETA	19.0		ATAN(SQR(SIN2ALPHA + TAN2 BETA)) / COS ALPHA					
							SIN	TAN	COS
							6E-32	0.118562	1
REFLECTIVITY OF GLASS									
Look Up suitable Reflectance Curves for Glass			%		13	27	44		
Normal Incidence	RN	5	0.05	Angle of Inc	Clear Float	20% Reflec	Film Tint		
Reflectivity at Angle of Incidence	R	27	0.27	0	5	20	42		
				10	5	20	42		
				20	5	20	42		
				30	6	21	42		
				40	7	22	42		
				50	9	24	43		
				60	13	27	44		
				70	25	37	50		
				80	70	60	75		
				90	99	99	99		
Illumination at eye									
				Illumination at observers eye due to glare source in plane normal to Lin					
E.G		18966.77	LUX	EG = E*R%*F*COSTHETA					
				0.945519					
Equivalent VEILING LUMINANCE									
(Holladay Formula)		525	cd/m2	LV = 10*EG/THETA2					
Provisional Limit to VEILING LUMINANCE									
	500	cd/m2	considered threshold	C					

Figure 3-7 Sample of Veiling Glare Worksheet.

3.3.3 STAGE 3 Design Iteration

Upon review of Stage 2 Calculations of Glare Hazards, design recommendations and various techniques such as but not limited to the following may be explored and therefore tested:

1. Reduction in glazing
2. Introduction of shading devices or other mechanisms to physically block the suns path into or from the point ofreflectance
3. Reflectance of material adjustments – i.e., glass type.

The Stage 3 workflow generally forms a feedback loop in which recommendations are tested and reviewed in Stage 2 tests.

4 Façade Orientation and Observer Location

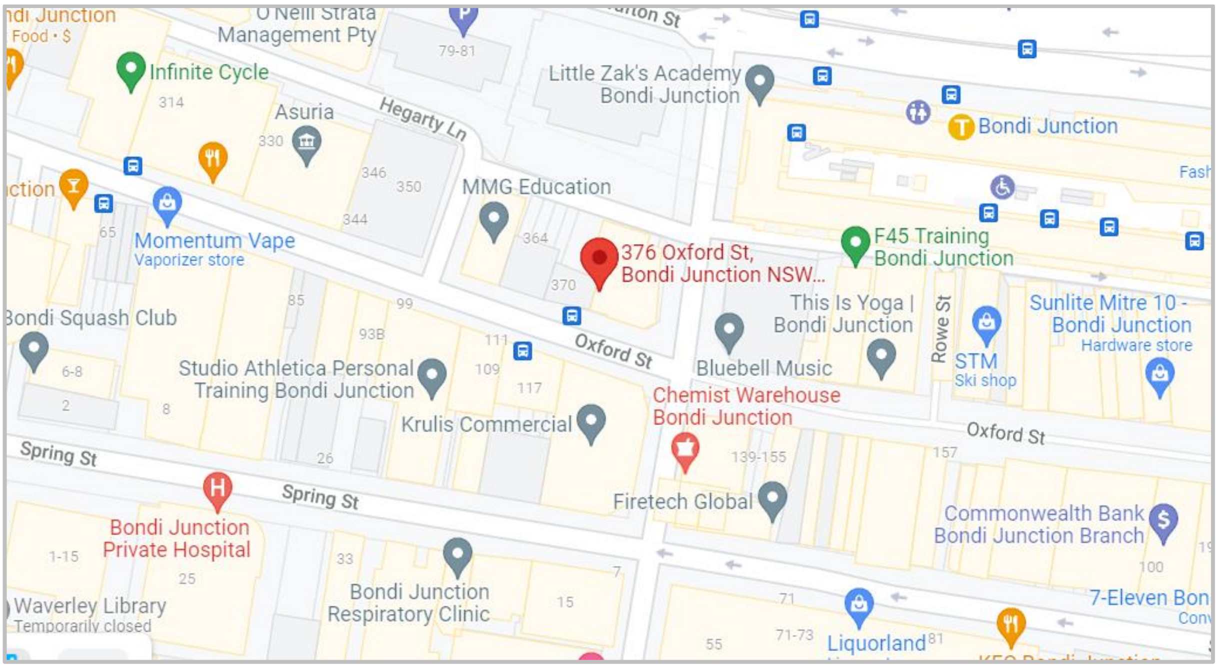


Figure 4-1 Location.

The building was modelled as per architectural plans and elevations. Figure 4-2 to Figure 4-5 provide a representation of various elevations and floors as constructed in the simulation model. The exact observer viewing points will be investigated as part of the detailed design stage.

Figure 4-2 Perspective of the building model.

Figure 4-3 Northern Façade of the whole building model.

Figure 4-4 Southern Façade of the whole building model.

Figure 4-5 Perspective of the building model.

5 Façade Orientations and Reflection Analysis

This section of the report provides further analysis for each point where potential glare issue is observed. The selection of viewing points considered at various position of drivers on surrounding streets. The criteria for the selection of viewing points considered every surrounding street that allows the driver to visualise a glazed portion of at least one façade as shown in Figure 4. Based on site survey following observer points were identified for detailed analysis.

5.1 Neighbouring Buildings and Occupants

The impact of glare or veiling luminance on neighbouring building is dependent on a number of factors including those listed below:

- Glare intensity;
- Duration of glare impact;
- Type of glazed element used on facades such as clear, tinted;
- Shading devices; and
- Level of tolerance, acceptance and age factor.

To limit the glare impact, we recommend the glazing reflectivity be limited to not greater than 20% to avoidadverse solar glare to occupants of neighbouring buildings.

5.2 Metallic Surfaces of the Facade

It is noted that some parts of the building façade of the proposed development will have metallic surfaces, such as louvers or shading devices, which would likely to have a painted or powder coated finish. It is not expected that adverse glare will be observed from these surfaces of the façade, since the maximum specular reflectance of visible light of metallic façade materials with a painted or powder coated finish range from 1 to 5%. That range is well within the maximum 20% limit adopted by the Waverly City Council DCP Part E1 requirements.

6 Disclaimer

This report is prepared using the information described above. Whilst Vipac has endeavoured to ensure the information used is accurate, no responsibility or liability to any third party is accepted for any loss or damage arising out of the use of this report by any third party. Any third party wishing to act upon any material contained in this report should first contact Vipac for detailed advice which will take into account that party's particular requirements.

Building performance simulation provides an estimate of building performance. This estimate is based on a necessarily simplified and idealised version of the building that does not and cannot fully represent all of the intricacies of the building once built. As a result, simulation results only represent an interpretation of the potential performance of the building. No guarantee or warrantee of building performance in practice can be based on simulation results alone. Vipac and its employees and agents shall not be liable for any loss arising because of, any person using or relying on the Report and whether caused by reason or error, negligent act or omission in the Report. This draft assessment has been prepared based on the preliminary architectural design with the view to conduct a detailed assessment once the design is further developed.

This reflectivity assessment report should be read in conjunction with the relevant plans and specifications and any supplementary regulatory information. The performance and design documentation for architectural design shall be consistent with the recommendations of this report.

7 Conclusion

In compliance with Waverley Council's Development Control Plan 2022, Part B15, Section 15.5, the development shall satisfy the following objectives:

(a) Mitigate adverse glare from reflective surfaces on street level.
(b) Ensure reflectivity does not impact upon the function of the public domain.
(c) Minimise adverse solar reflection through the reduction of reflective materials and the use of shading devices.
(d) Avoid façade treatments containing large areas of glazing.
(e) Minimise potential impact on pedestrians and occupants of neighbouring buildings.

Compliance requirements and performance of the development:

The design and construction team will ensure the following criteria is met as part of the detailed design:

1. Limit the use of large areas of glass in facades to a maximum of 60% of the façade surface area above ground level.
2. Shade glass areas with shading devices appropriate to the orientation.
3. Reflected solar glare on drivers should not exceed 500 candelas/m2.
4. Mirrored glass and other highly reflective materials will not be used on building exteriors.
5. All panels and elements on vertical façades are to have a maximum specular reflectivity of visible light from normal angles of incidence of 20%.
6. Any surface inclined by more than 20 degrees to the vertical (inclined glass awnings or cladding on inclined roofs) are to have a maximum specular reflectivity of visible light from normal angles of incidence of 10%.

Subject to satisfaction of the above, the proposed development will perform well in-terms of solar reflectivity and glare is unlikely to exceed the limits of acceptability of Hassall methodology that could affect surrounding streets and the reflected light on the motorists will not exceed 500 cd/m2.