EXPERT OPINION | VERIFICATION

SEPP 65 AMENITY SOLAR ACCESS AND NATURAL VENTILATION

MIXED USE DEVELOPMENT
717-727 CANTERBURY ROAD BELMORE

11 October 2016

Signed,

.....

Steve King

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1.0 PRELIMINARIES/SUMMARY

1.1 I provide this report as an expert opinion and peer review of the Applicant's analysis, relating to s**olar access and cross ventilation** compliance with relevant local controls, and with the Apartment Design Guide (ADG) as it gives effect to the Amenity provisions of SEPP65.

The report applies to a proposed mixed use **residential flat building** at 717-727 Canterbury Road Belmore.

1.2 My qualifications and experience are included at *2.0 Credentials*.

1.3 The documentation on which I rely is set out in *3.0 Documents*.

1.4 **Solar access**. Analysis is by use of a full 3D digital and illustrated by half-hourly views from the sun. The number of apartments projected to receive over 2 hours of sun to Living areas on June 21 is 115 units (67.6%) from a total of 170, if I take account of six apartments with a predicted 1.5 hours of sun between 9am and 3pm, but that may preserve solar access before 9am. The ADG recommends a minimum of 70%.

As I discuss in *4. GENERAL MASSING, PLANNING AND DESIGN RESPONSE* the subject site is constrained by its orientation, shape and dimensions, such that there is effectively a limit to the proportion of apartments that can meet the requirement for a minimum period of direct sun at mid-winter. Based on my experience of assessing achievable solar access on a large number of former brownfields sites – particularly in the Mascot, Meadowbank and Canterbury areas – I consider this outcome in the context of the site constraints to be the result of considerable design effort, and one which can be fairly described as effectively the 'natural limit' of the winter solar access that may be expected.

In my considered opinion, it would be appropriate for the determining authority to exercise the discretion available in the controls with respect to the solar access achieved by this proposed development.

1.5 **Natural ventilation.**
The Applicant reported compliance with the relevant *Design criterion* of the ADG (60%). However, the characterization of some apartments as cross ventilated relied, in my view inappropriately, on deep 'facade slots'.

I have recommended to the applicant that cross ventilation be assured for a number of those apartments by way of suitably designed ceiling plenums connected to the opposite side of the building. In addition, I have also reviewed the likely ventilation performance of a small number of suitably designed and oriented south facing apartments, of a type that I have previously investigated by simulation. These apartments can be characterized as 'enhanced for single sided ventilation' equivalent to at least some of the complying cross ventilated apartments.

I provide a detailed explanation of the basis for my expert opinion.

If I take into account those apartments which in my considered opinion meet the performance requirements of the ADG, a total of 102 out of 170 apartments (60%) may be deemed to comply.

On that basis, in my considered opinion, the requirements of the ADG for natural ventilation are satisfied.

2.0 CREDENTIALS

I have taught architectural design, thermal comfort and building services at the Universities of Sydney, Canberra and New South Wales since 1971. From 1992, I was a Research Project Leader in SOLARCH, the National Solar Architecture Research Unit at the University of NSW. Until its disestablishment in November 2006, I was the Associate Director, Centre for Sustainable Built Environments, UNSW.

My research and consultancy includes work in solar access, energy simulation and assessment for houses and multi-dwelling developments, building assessments under the NSW SEDA Energy Smart Buildings program, appropriate design and alternative technologies for museums and other cultural institutions, and asthma and domestic building design. I am the principal author of *SITE PLANNING IN AUSTRALIA: Strategies for energy efficient residential planning*, funded by the then Department of Primary Industry and Energy, and published by AGPS, and of the RAIA Environment Design Guides on the same topic. Through UNISEARCH, NEERG Seminars and Linarch P/L, I conduct training in solar

access and overshadowing assessment for Local Councils. I have delivered professional development courses on topics relating to energy efficient design both in Australia and internationally.

SOLARCH/UNISEARCH were the contractors to SEDA NSW for the setting up and administration of the House Energy Rating Management Body (HMB), which accredits assessors under the Nationwide House Energy Rating Scheme (NatHERS), NSW. I was the technical supervisor of the HMB, with a broad overview of the dwelling thermal performance assessments carried out in NSW over five years. I have been a member of the NSW BRAC Energy Subcommittee, and also a member of the AGO Technical Advisory Committee on the implementation of AccuRate, the new mandated software tool under NatHERS. I undertook the Expert Review for the NSW Department of Planning, of the comparison of NatHERS and DIY methods of compliance for Thermal Comfort under BASIX, and was subsequently a member of a three person expert panel advising on the implementation of AccuRate in BASIX.

I have delivered the key papers in the general area of assessment of ventilation and solar access performance and compliance, for NEERG Seminars, cited by Commissioners of the LEC. Senior Commissioner Moore cited my assistance in reframing of the Planning Principle related to solar access (formerly known as the Parsonage Principle) in *The Benevolent Society v Waverley Council [2010] NSWLEC 1082.*

Of particular relevance, I have taught the wind and ventilation components of environmental control in the undergraduate and postgraduate courses in architecture at UNSW, and am the author of internationally referenced, web accessed coursework materials on the subject. I have supervised PhD research specifically on the problem of single sided ventilation of multi-storey apartments.

I practiced as a Registered Architect from 1971 to 2014, and now maintain a specialist consultancy practice advising on sustainability and amenity compliance in buildings. I regularly assist the Land and Environment Court as an expert witness in related matters.

3.0 DOCUMENTS

3.1 I base my report on

- Revision F DA documents issued to me digitally by Architecture and Building Works (ABW) Architects, dated 16/09/2016, including annotated schedules of solar access and ventilation compliance.
- Digital 3D model in ..3ds file format.

3.2 I have visited the site.

4.0 GENERAL MASSING, PLANNING AND DESIGN RESPONSE

4.1 Site

The site may be described as an irregular square, bounded to the south-east by Canterbury Rd, and to the south-west by Burwood Rd. There are relatively low existing metal, and brick and metal buildings on and close to the north-west and part of the north-east boundaries, and the brick party wall of two storey industrial/retail premises on the remaining part of the north east boundary. Drummond Lane gives access to approximately the mid-point of that boundary, while an existing substation on the Burwood Rd frontage has to be retained. The land falls markedly from east to west, approximately 6.5m.

The major determinants of the design are:

- The square proportion of the site gives rise to two street elevations with an unfavourable southerly orientation;
- The diagonal direction of True North determines that generally north-south ‘wings’ parallel to the Canterbury Rd commercial frontages will have favourable solar exposure on the north-west side;
- The north to south dimension of the site favours two such wings, if building separation is to meet and exceed that recommended by the ADG, combined with a required setback on the north-west boundary.

Given the intent to achieve higher densities with limits on general height of the development, the likely proportion of apartments to achieve the recommended levels of midwinter solar access is inherently limited to approximately half of the dwellings.

This is an outcome of the combination of geometric factors relating the orientation of the site to the expected storey heights of the building(s). In other words, while the ratio of apartments with faces to the sunny quadrant (from north-east to north-west) is increased from the nominal 50% by good design, a significant number of appropriately oriented apartments will nevertheless be subject of mutual overshadowing.

4.2 Design response

4.2.1 I have given considerable thought to what broad massing strategies on this site could achieve optimum proportions of apartments with high levels of midwinter of solar access.

Clearly, the option of high-rise point blocks, or widely spaced low rise medium density development is not envisaged by the local controls, and from an urban design perspective not appropriate in this location.

4.2.2 The proposed building form develops logically in response to the constraints:

- The lower wing to the north-west and higher to the Canterbury Rd boundary, thus largely controlling the internal self-shading between wings.
- I am aware of a previous scheme for the site utilising three east-west wings with a shallower floor plate. The present design, by leaving out the middle wing, significantly increases solar access for the central courtyard.
- A relative disadvantage of the 'two wing' site plan is that in order to realise the development potential, the floor plates are necessarily double loaded.

4.2.3 After giving due consideration to the apparent options for the site, I am of the view that the proposed site layout optimises the balance between solar access for apartments and the provision of winter solar access for common open space during the relevant parts of the day, and competing urban design and amenity issues.

5.0 SOLAR ACCESS DISCUSSION AND ANALYSIS

5.1 Methodology

5.1.1 Quantification of solar access for compliance with the requirements of the ADG and the local controls has been carried out by use of a 3D digital model in the *Trimble SketchUp* software package. The SketchUp software prepares the shadow projections by reference to accurate solar geometry.

5.1.2 The model was prepared by the architects in a commercial CAD application. For my analysis, the model was exported as a .skp format file for the *Trimble SketchUp* software package.

5.1.3 I have undertaken a summary check of the topographical and building dimensions of the 3D digital model by reference to dimensions assumed from the plans and sections. I feel confident to rely on the general accuracy of the modelling. I have independently geolocated the model, and verified the direction of True North by reference to the cadastral grid north.

5.1.4 I note that the Architects' analysis is exhaustive, but relies on a plan notation in 2D that is difficult to interpret, and likely to fail to take account of the overshadowing impacts of self-shading. I have therefore carried out a new detailed analysis, relying primarily on projections known as *'View from the Sun'*.

A view from the sun shows all sunlit surfaces at a given time and date. It therefore allows a very precise count of sunlight hours on any glazing or horizontal surface, with little or no requirement for secondary calculations or interpolation. The technique is illustrated in Figure 1. *Note that the views from the sun do not show any shadows. Shadows are those areas exactly coinciding with objects in the foreground.*

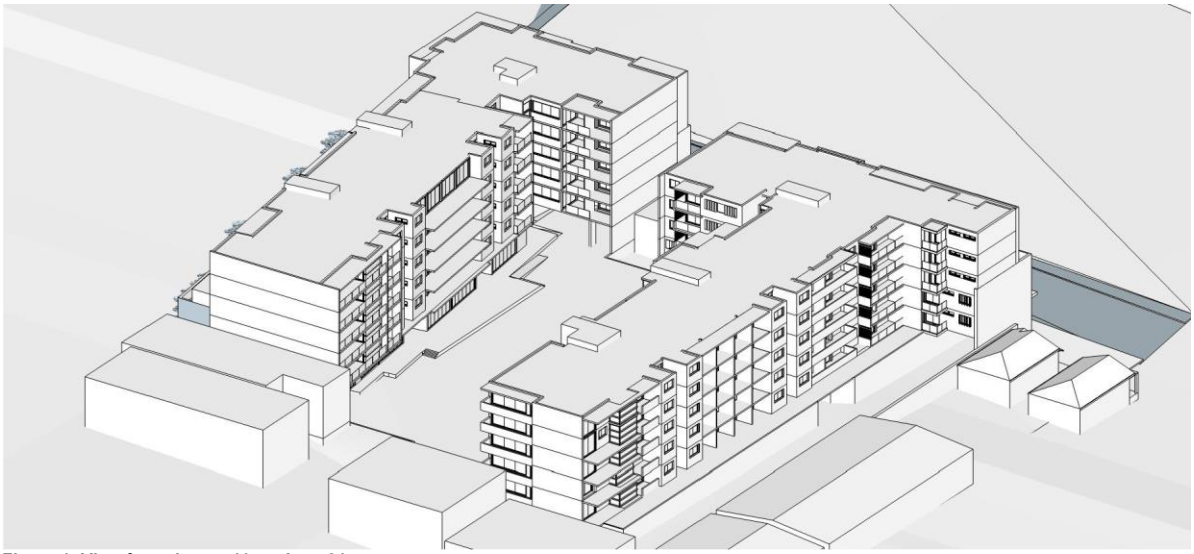


Figure 1: View from the sun10am June 21

In Appendix B I provide a table of half-hourly views from the sun on June 21.

5.2 Characterisation of solar access compliance

5.2.1 For the purpose of calculating the compliance with the control, I have examined sun patches on the relevant glazing line of each apartment.

5.2.2 Because of its key importance in the determination of what is 'effective sunlight' for characterisation of compliance, I refer specifically to the relevant *L+EC Planning Principle (The Benevolent Society v Waverley Council [2010] NSWLEC 1082):*

- I ignore very large angles of incidence to the glazing surface, and unusably small areas of sunlit glazing;
- I quantify as complying all sun patches of 'reasonable size'.

There is no generally accepted standard for the absolute limit of acceptable area of the sunpatch on partly shaded glazing. In accordance with the Court's *Planning Principle*, I regard an area of sunlit glazing to be of 'reasonable size' to be approximately $1m^2$ – on the basis that it exceeds 50% of the area of a standard window 1500 x 1200 high, which would normally be accepted as complying.

5.3 Relevant solar access standards

5.3.1 Apartment Design Guide

Notwithstanding the proposal to be considered under the *State Environmental Planning Policy (Affordable Rental Housing) 2009*, SEPP65 Amenity standards are applicable. The Apartment Design Guide gives the following quantified recommendations:

Design criteria
1. Living rooms and private open spaces of at least 70% of apartments in a building receive a minimum of 2 hours direct sunlight between 9 am and 3 pm at mid winter in the Sydney Metropolitan Area and in the Newcastle and Wollongong local government areas
2. In all other areas, living rooms and private open spaces of at least 70% of apartments in a building receive a minimum of 3 hours direct sunlight between 9 am and 3 pm at mid winter
3. A maximum of 15% of apartments in a building receive no direct sunlight between 9 am and 3 pm at mid winter

5.3.2 Local controls

The local control is Canterbury DCP 2012 PART 6.2 GENERAL CONTROLS – CLIMATE AND RESOURCE EFFICIENCY. The DCP adopts provisions that are, on the whole, consistent with the requirement of the ADG.

In quantifying the compliance for solar access for this application, I rely on satisfying the ADG as also satisfying the DCP.

5.4 Projected solar access

I have independently generated my own quantification and compliance table. Table 1 summarises the projected levels of compliance for the individual dwellings. Appendix A lists the individual apartments with their solar access status.

Table 1: Summary of solar access compliance

Number of units	170	
Units with 2hours or more sunlight to Living between 9am and 3pm	**109**	**64.1%**
Top floor units with 2hours or more sunlight to Living, which have south facing POS	7	
Additional units with 2hours or more sunlight to Living and POS between 8am and 4pm	6	
Total units which may be deemed to comply	**115**	**67.6%**
Units with no sun 9am to 3pm on June 21	41	21.4%

The ADG *Design criteria* nominate as a minimum 70%, of dwellings to receive prescribed hours of sun, but offer relief, primarily for limitations imposed by site orientation and other site related factors.

As I discuss in *4. GENERAL MASSING, PLANNING AND DESIGN RESPONSE* the subject site is constrained by its orientation, shape and dimensions, such that there is effectively a limit to the proportion of apartments that can meet the requirement for a minimum period of direct sun at mid-winter..

The most difficult of the constraints is that the two street façades to Canterbury Road and Burwood are adversely oriented for complying solar access. I note in particular that the design systematically distributes a higher proportion of apartments designed with narrow living spaces to the northerly facades, and wider, shallower apartments to the unfavourable orientations.

If I take account of six apartments with a predicted 1.5 hours of sun between 9am and 3pm, but that may preserve solar access before 9am, *the number of dwellings which may be deemed to comply with the performance objectives of the ADG is 115 of the total of 170, being 67.6%.*

Based on my experience of assessing achievable solar access on a large number of former brownfields sites – particularly in the Mascot, Meadowbank and Canterbury areas – I consider this outcome in the context of the site constraints to be the result of considerable design effort, and one which can be fairly described as effectively the 'natural limit' of the winter solar access that may be expected.

In my considered opinion, it would be appropriate for the determining authority to exercise the discretion available in the controls with respect to the solar access achieved by this proposed development.

6.0 NATURAL VENTILATION

6.1 Performance Objectives

SEPP65 itself does not refer to prescribed quantitative standards, but may be regarded as a performance based regulatory instrument. Proper reading of the ADG as it interprets SEPP65 similarly makes clear the performance based approach of the Guide.

I note that the control of energy efficiency and energy use for assuring thermal comfort is now vested exclusively in SEPP BASIX. Specific performance measures for buildings designed in compliance with SEPP65 are therefore scrutinized only in light of an objective of *natural ventilation for general amenity*.

The Apartment Design Guide gives the following *Design criteria*:

1.	At least 60% of apartments are naturally cross ventilated in the first nine storeys of the building. Apartments at ten storeys or greater are deemed to be cross ventilated only if any enclosure of the balconies at these levels allows adequate natural ventilation and cannot be fully enclosed
2.	Overall depth of a cross-over or cross-through apartment does not exceed 18m, measured glass line to glass line

6.2 Natural ventilation/cross ventilation

So-called 'cross-ventilation' is an expedient for checking the likely contribution of natural ventilation to projected comfort conditions. Simple cross-ventilation is taken to mean where a dwelling has operable openings to two or more distinctly different orientations, thus making likely that in any conditions of breeze, relative pressure differentials will assure some air movement through connected spaces in the dwelling.

The *Design criteria* in the ADG give a quantified recommendation *with respect only to cross ventilation*, relating to the overall proportion of complying dwellings, but not to the expected performance for any one dwelling.

6.2.1 Cross ventilation by openings in adjacent or opposite facades

In the subject development, all such apartments are classified as cross-ventilated without further discussion here. The simple definition of cross ventilation is met by all 'corner' apartments in the complex.

6.2.2 Cross ventilation by roof openings

Apartments on the top floor of the building can be characterised as cross ventilated by provision of suitably designed ventilated skylights or raised monitors with operable vertical glazed sashes. In a flat roof under all wind directions, such openings may be relied on to be in a region of reduced static pressure, and therefore to act as outlet openings for cross ventilation. In this proposal, this method of providing cross ventilation is employed for all top floor apartments which do not have simple cross ventilation with conventional vertical glazing.

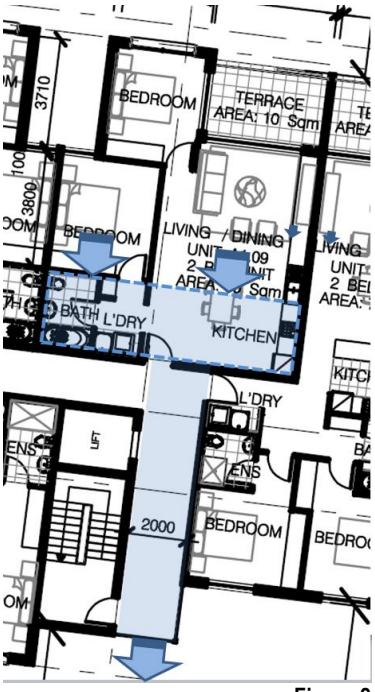


Figure 2

5.2.3 Cross ventilation by ventilation plenum

A small number of single aspect apartments present an opportunity to be provided with a ventilation plenum as illustrated in Figure 2.

Because of its potentially large cross-sectional area and unobstructed opportunity for louvred registers at both the apartment and the outer edge of the breezeway corridor, this plenum provides for an effective air path between the inlet openings (by way of conventional windows and openable balcony doors), and the opposite façade.

I generally make this recommendation only for one apartment in relation to each opportunity to vent to the opposite side of the building. I do so in order to maximise the available cross-sectional area for the air path, and to ensure that the connecting plenum can be in a straight line, without bends. In brief, any apartment of this design can be qualified as cross ventilated.

6.2.4 Cross ventilation by different orientations in one façade / façade 'slots'

Apartments may have widely separated openings relating to walls which effectively create facade elements facing in different directions, as part of the heavy modelling of one of the primary elevations. Where this is likely to create significant pressure differentials between those openings, and to encourage effective air paths between them, I characterised those apartments as a 'local corner condition', and effectively cross ventilated.

I note that his potential performance is often injudiciously assumed to be a general outcome from façade indentations, sometimes referred to as 'slots'. *However, I apply this categorisation with caution*, and limited to apartments of suitable internal layout and primary orientation for wind exposure. The ADG offers some *Design guidance* for the preferred proportions of façade indentations, emphasizing width over depth, but that design guidance is not intended to automatically qualify all facade slots as providing cross ventilation.

6.2.5 Two storey apartments

I would normally also characterised as cross ventilated two-storey apartments where the glazing is to one orientation, but where the operable openings can be widely vertically separated, and a suitable air path between them provided. In this proposal, this method of providing cross ventilation is not employed.

6.3 Design for enhanced single sided natural ventilation

As a consequence of the double loaded planning, a significant proportion of the apartments in the proposed development relate to single primary facades, and don't have the benefit of cross ventilation as described in any of the categories *5.2.1 to 5.2.4* above.

6.3.1 Enhanced single sided natural ventilation

I have previously demonstrated with respect to a number of other projects, that natural ventilation compliance under the RFDC – and subsequently the ADG – is achievable by suitably designed *single sided apartments with reliable exposure to the prevailing summer cooling breezes* in Sydney. To achieve this condition, apartments must have the following attributes:

- Demonstrated exposure to one or both dominant prevailing cooling wind regimes in summer, producing an incident wind direction at significant 'yaw' in relation to the relevant façade(s);
- Appropriate design of the dominant windward façade(s), in order to be able to locate two or more openings in regions of likely different pressure, which will give rise to air movement between such openings and through the apartment. Suitable variations in pressure distribution can be assured by the use of protruding elements and recessed balconies, and the provision of variable openings to respond to changing directions of available breezes, as notably employed in this design;
- Suitable internal layout such that air paths between the 'inlet' and 'outlet' openings create meaningful internal ventilation patterns 'scouring' the majority of the apartment.

Where apartments meet this and other design pre-requisites, and are suitably oriented, the ventilation regime of such single sided, multi-room frontage apartments is sufficiently comparable to cross ventilation to satisfy the performance objectives for ventilation for summer amenity.

I discuss below the applicable wind regime and validation studies to which I have referred. The characterisation of compliance as *'enhanced single sided ventilation'* is limited to those apartments exposed to the north-east and south to south-east cooling winds, as modified in direction in relation to the facade by local externalities. For instance, apartments facing only to the west facades would not be considered to be exposed to suitable summer cooling breezes. The characterization of compliance is therefore conservative. Appendix A Table 2 lists the apartments types with their ventilation status as assessed against the criteria described, and summarises the compliance deemed to be achieved.

6.3.1.1 COOLING WIND AND BREEZE EXPOSURE

Figure 2 illustrates the relative distribution of frequency and velocity of summer winds for Sydney, based on the Reference Meteorological Year.

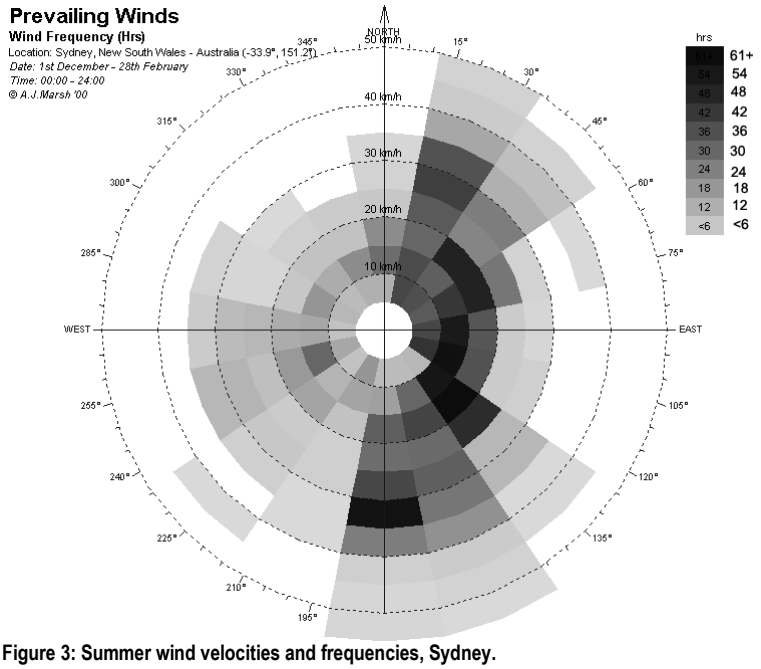


Figure 3: Summer wind velocities and frequencies, Sydney.

The chart shows relative frequencies for the whole day. It may be noted that the most frequent winds suitable for general cooling are the sea breezes from just east of north to south-east. Southerly 'busters' can achieve rapid cooling, often accompanied by rapid temperature drops and higher wind speeds. These also occur with useful frequency.

I normally exclude single sided apartments which face west from consideration as they do not benefit from the summer cooling breezes, and I do so on this site. I also exclude apartments on the lowest stories.

6.3.1.2 APARTMENT DESIGN FOR ENHANCING SINGLE SIDED VENTILATION

The ventilation potential of single sided apartments is significantly enhanced by some design attributes:

- Detailing of façade elements that is likely to create and enhance local pressure differentials between adjacent rooms and/or openings to the same room.
- Internal layout that is relatively 'clean', i.e. minimizes obstructions to air movement;
- Internal openings of significant area provided to bedrooms, assuring least loss of momentum for the air stream where air movement between living and sleeping zones is envisaged;
- Window sizes and operable sash areas in excess of industry average provisions;
- Optionally, physical protection of principal openings to assure shelter in conditions of wind driven rain.

The key to enhanced single sided ventilation design is to employ multiple openings, associated with vertical blades or fins (or other marked relief) on the facade.

The potential of such facade design in increasing volumetric air exchange and maximising internal air velocities was originally demonstrated by Givoni in 1969 by wind tunnel tests. My Figure 3 is the summary table from that work; the figures on the diagrams represent the measured percentage of available wind speed from various directions.

Particularly notable is the significant increase in internal ventilation as wind direction moves closer to parallel with the facade. Based on those wind tunnel tests, Givoni concluded:

> "When the two windows were provided with vertical projections **the indoor velocity reached a level comparable with that existing in rooms with good cross-ventilation**, particularly when the wind was oblique to the wall"
> Givoni 1969

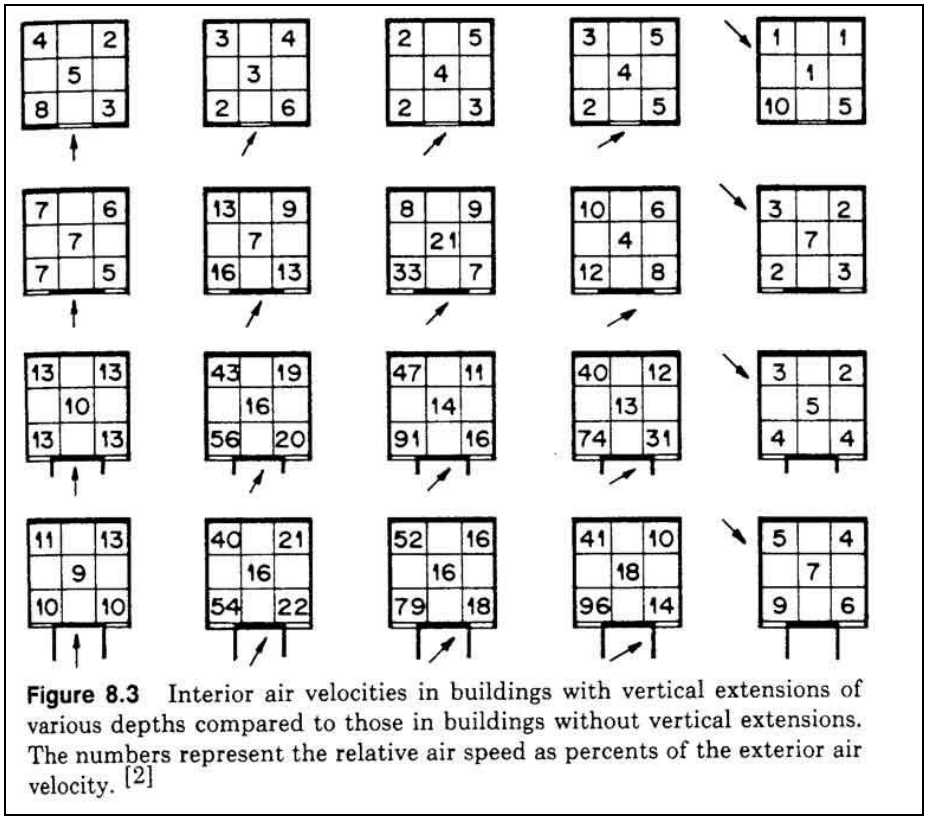


Figure 8.3 Interior air velocities in buildings with vertical extensions of various depths compared to those in buildings without vertical extensions. The numbers represent the relative air speed as percents of the exterior air velocity. [2]

Figure 4: Relative internal air velocities with multiple openings and facade relief (Givoni 1969)

The specific three room wide configuration of the two bedroom units proposed on the long south-east façade in the subject proposal are ideally suited for this enhanced ventilation performance. These typical apartments are illustrated in Figure 4. The configurations and orientations correlate sufficiently with apartment designs for which I have previously commissioned simulation analysis, for those studies to serve as precedents.

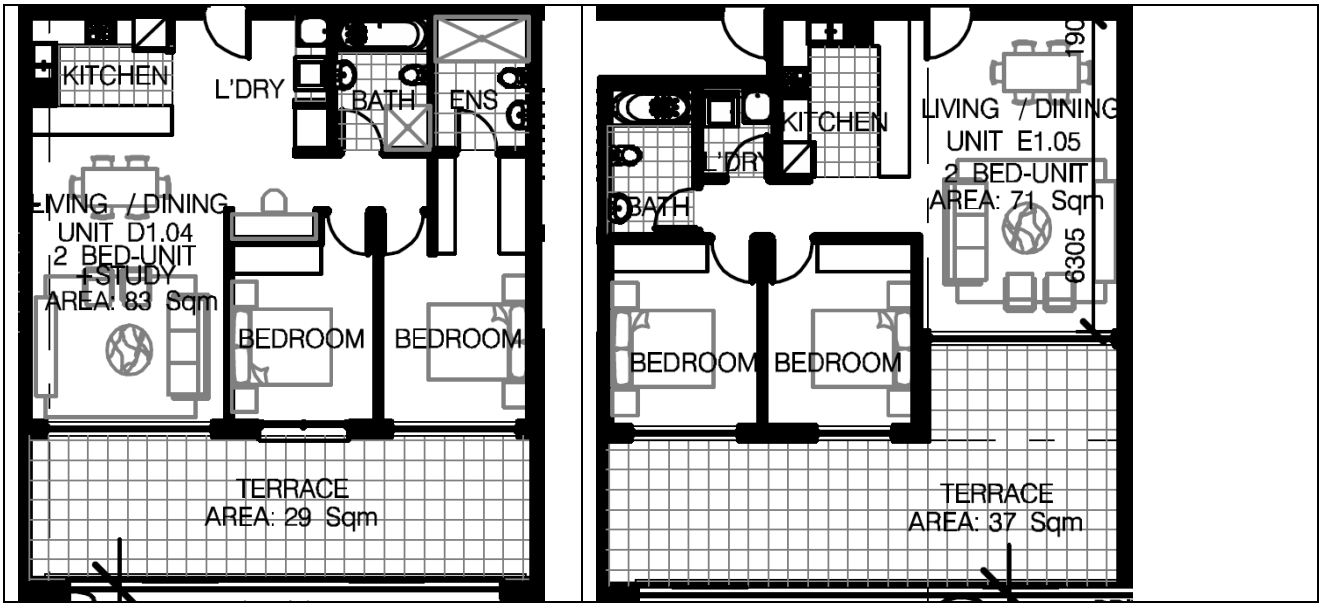


Figure 5: Typical single aspect units, south-east elevation of south building

6.3.2.3 VALIDATION STUDIES

In forming my expert opinion for the assessment of likely enhanced single sided ventilation performance, I have the benefit of a number of simulation based validation studies. Those studies have been carried out under my direction

by Vipac Engineers and Scientists Ltd., Heggies Australia (now SLR), and CPP Wind Engineering, on a number of apartment proposals where comparable conditions and apartment designs were under consideration.

Figure 5 illustrates streamline patterns for a small apartment exposed to the two dominant summer cooling wind regimes (Source: Vipac). The configuration is not identical to the typical apartments in the subject development – less well exposed, and not quite as favourably configured internally. It gives an excellent indication of the effect of a recessed veranda and multiple opening sashes achieving deep penetration of air flow in such apartments. The example is from the Ashfield RSL project, which was determined for approval by Senior Commissioner Roseth in s34 Conference in the Land and Environment Court.

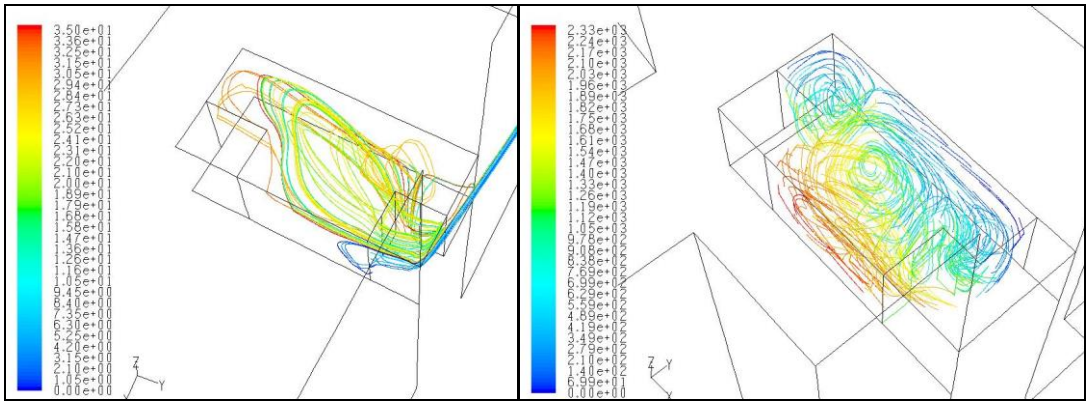


Figure 6: Simulated ventilation of a narrow single sided apartment with recessed veranda
Showing a range of wind directions incident on the façade from very large 'yaw' on the left, to more typical moderate angle of attack on the right
Source: Vipac.

Figure 6 illustrates an apartment with a longer air path, situated at a relatively low level in a comparably long facade. The simulation confirmed that the internal ventilation patterns likely under typical summer wind orientations and conditions 'sweep' the interiors of the living areas and the bedroom facing the veranda at useful air speeds, as well as assuring ventilation volumes far exceeding any minimum standards.

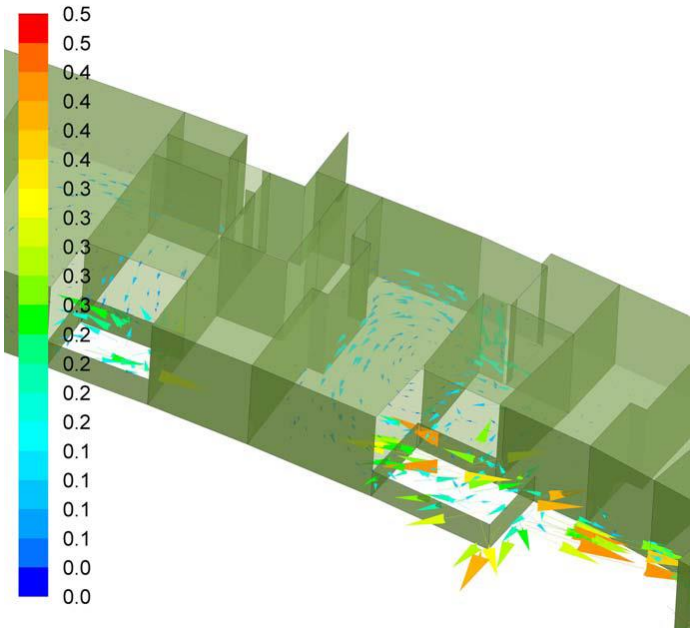


Figure 7: Close up view of vector contour at Level 4 on the internal spaces
Source: Vipac. The example is from the Kiewa apartments, Rhodes project

The results of such CFD simulations confirm that the single sided ventilation effects are sufficiently reliable under the influence of Sydney's prevailing wind regime. It is therefore confidently predicted that ventilation for *mass heat flow* (ie. removal of excess heat from the air volume and building fabric at appropriate times) will be sufficient to ensure adequate cooling performance.

So-called *comfort ventilation*, which relies on adequate *air velocities*, can also be expected to be adequate for all units in the development which are exposed to the nominated cooling breeze directions, at most times. Given the detailed design of the single aspect apartments under consideration, I am confident that such usable air velocities occur in relevant parts of the living spaces of those apartments.

For completeness, I refer to Figure 7, which illustrates wind effects on a relatively well exposed east facing facade of a low rise apartment block, featuring deep 'slots' for windows of the master bedrooms. While not identical to the layout of the apartments in the subject proposal, it is sufficiently analogous to make relevant inferences as to likely ventilation effectiveness.

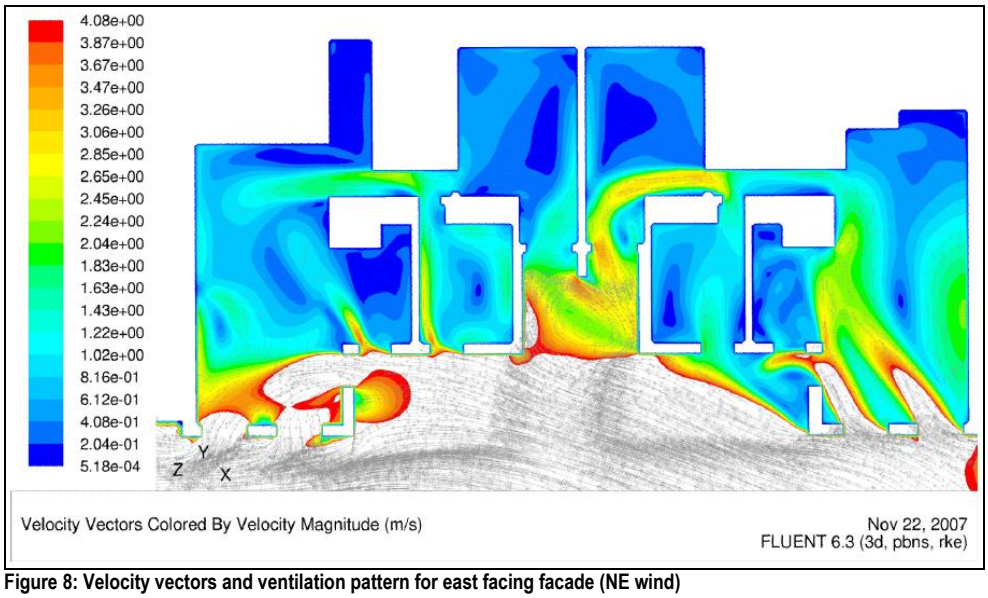


Figure 8: Velocity vectors and ventilation pattern for east facing facade (NE wind)
Source: CPD Wind. The example is from the Vaucluse Boys High School site project

I note that the mirrored layout at any one time responds differently for the two apartments. Both layouts do exhibit air flow of usable velocities between inlets and outlets, including by way of the relatively deep 'snorkel' bedrooms. However, the simulation may also be taken to confirm the inference in the relevant ADG *Design guidance* that the deep 'slot' is likely to connect the air paths of the two apartments. For that reason, I prefer not to characterise the arrangement as complying cross ventilation.

6.4 Quantification of ventilation compliance

6.4.1 Table 2 summarises the apartment types with their ventilation status as assessed against the criteria described, and reports the compliance deemed to be achieved. Apartments identified as having *'enhanced single sided ventilation'* potential are included as deemed complying with the RFDC performance objectives.

I apply my opinion only to specific apartments in the proposed design. A characterisation of compliance as *'enhanced single sided ventilation'* is limited to those single sided apartments that have been qualified by the necessary design attributes, and *directly comparable to previous simulation based investigations.* In brief, these are apartments exposed to the north-east and/or south to south-east cooling winds, as they are expected to be available to the principal elevations of this development.

I specifically *exclude* apartments which may be otherwise similar, but where I consider the likely level of exposure to prevailing summer cooling breezes to be insufficient. Apartments fall into this category where they are:

- too close to ground level, or
- inappropriately oriented, or
- with insufficient openings across a narrow facade.

I believe my characterization of compliance is therefore conservative. In Appendix A, Table 3 identifies the basis of classification of natural ventilation performance for each of the individual apartments.

Simply cross ventilated	**78**	
Cross ventilated employing a ceiling plenum	16	
Enhanced single sided ventilation	8	
Total	170	
Total deemed complying	**102**	**60%**

Table 2: Ventilation compliance

6.4.2 The overall number of apartments in the proposed development which may be characterized as simply cross-ventilated, or deemed complying with the performance requirements for natural ventilation is 102 out of the total of 170 being 60.0%.

The proportion required by the relevant *Design criterion* in the ADG is a minimum of 60%. Therefore, in my view, compliance with the ADG is satisfied.

7.0 CONCLUSIONS

7.1 Solar access

7.1.1 Peer review

I confirm that I was commissioned to peer review solar access and natural ventilation compliance of the project. For this report, I have carried out my own analysis and quantification of the predicted solar access and cross-ventilation achieved.

I concluded that the Applicant's 2D analysis failed to adequately account for a number of apartments which are subject to mutual or self-shading, and that therefore the minimum 70% proportion of total apartments, as required by the relevant *Design criterion* in the ADG is not achieved.

That said, I note that while the Solar access (6.1) *Design criteria* in the ADG by virtue of Cl. 6A of SEPP65, take precedence over these controls contained in Councils' DCPs, the ADG Design criteria themselves are discretionary controls.

7.1.2 Solar access compliance

The ADG *Design criteria* nominate as a minimum 70%, of dwellings to receive prescribed hours of sun, but offer relief primarily for limitations imposed by site orientation and other site related factors.

The subject site is constrained by its orientation, shape and dimensions, such that there is effectively a limit to the proportion of apartments that can meet the requirement for a minimum period of direct sun at mid-winter. I discuss this in *4. GENERAL MASSING, PLANNING AND DESIGN RESPONSE.*

The most difficult of the constraints is that the two street façades to Canterbury Road and Burwood are adversely oriented for complying solar access. I note in particular that the design systematically distributes a higher proportion of apartments designed with narrow living spaces to the northerly facades, and wider, shallower apartments to the unfavourable orientations.

If I take account of six apartments with a predicted 1.5 hours of sun between 9am and 3pm, but that may preserve solar access before 9am, *the number of dwellings which may be deemed to comply with the performance objectives of the ADG is 115 of the total of 170, being 67.6%.*

Based on my experience of assessing achievable solar access on a large number of former brownfields sites – particularly in the Mascot, Meadowbank and Canterbury areas – I consider this outcome in the context of the site constraints to be the result of considerable design effort, and one which can be fairly described as effectively the 'natural limit' of the winter solar access that may be expected.

In my considered opinion, it would be appropriate for the determining authority to exercise the discretion available in the controls with respect to the solar access achieved by this proposed development.

7.2 Natural ventilation

7.1.1 Peer review

The Applicant reported compliance with the relevant *Design criterion* of the ADG which requires a minimum of 60% of dwellings to have cross ventilation. However, the characterization of some apartments as cross ventilated relied, in my view inappropriately, on deep 'facade slots'.

While such facade indentation can achieve single sided ventilation similar to simple cross ventilation with adequate wind exposure, it cannot be relied on to do so for all the instances in which it was nominated as complying.

7.2.2 Natural ventilation compliance

I have recommended to the applicant that cross ventilation be provided to a number of those apartments by way of suitably designed ceiling plenums connected to the opposite side of the building.

I have also reviewed the likely ventilation performance of a number of suitably designed and oriented south facing apartments, of a type that I have previously investigated by simulation. These apartments can be characterized as 'enhanced for single sided ventilation' equivalent to at least some of the complying cross ventilated apartments.

I provide a detailed explanation of the basis for my expert opinion.

If I take into account those apartments which meet the simple requirements of the ADG *Design criteria* for cross ventilation, and the additional number which in my considered opinion meet the performance requirements, a total of 102 out of 170 apartments (60%) may be deemed to comply.

On that basis, in my considered opinion, the requirements of the ADG for natural ventilation are satisfied.

A.0 APPENDIX: DETAILED COMPLIANCE TABLE

Table 3: Solar access and cross ventilation for individual dwellings

	UNIT	8	830	9	930	10	1030	11	1130	12	1230	13	1330	14	1430	15	1530	16	>3 hrs 9-3	>2 hrs 9-3 (>3hrs 8-4)	>2 hrs 9-3	>2hrs 8-4	No sun 9-3	POS 9-3	POS 8-4	Cross vent	Notes
	AG.01																						YES			YES	
	AG.02																						YES				
	AG.03																	L					YES				
	AG.04																	L					YES				
	AG.05			L	L	L	L	L	L	L	L	L	L						YES					YES		YES	
	AG.06							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	AG.07							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	AG.08	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES			
	AG.09	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	AG.10								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	AG.11																						YES				
	AG.12																						YES				
	AG.13																						YES				
	BG.01								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	BG.02	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	BG.03	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	BG.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
G	BG.05	L	L	L	L	L	L	L												YES				YES		YES	
	A1.01																						YES			YES	
	A1.02																						YES				
	A1.03																	L					YES				
	A1.04																	L					YES				
	A1.05	L	L	L	L	L	L	L	L	L	L	L	L						YES					YES		YES	
	A1.06							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A1.07							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A1.08	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A1.09	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	A1.10								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	A1.11																						YES				
	A1.12																						YES				
	A1.13		L	L																							
	B1.01								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	B1.02	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	B1.03	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	B1.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	B1.05	L	L	L	L	L	L	L												YES				YES		YES	
	C1.01	L	L	L	L	L	L															YES			YES	YES	
	C1.02	L	L	L	L	L	L	L	L	L	L	B	B						YES					YES			
	C1.03												B	B	B											YES	
	C1.04																						YES			YES	
	C1.05																	B					YES				
1	C1.06																						YES				

	UNIT	8	830	9	930	10	1030	11	1130	12	1230	13	1330	14	1430	15	1530	16	>3 hrs 9-3	>2 hrs 9-3 (>3hrs 8-4)	>2 hrs 9-3	>2hrs 8-4	No sun 9-3	POS 9-3	POS 8-4	Cross vent	Notes
	D1.01			B	B	B	B	B	L	L	L	L	L	L	B						YES			YES		NO	
	D1.02							B	B	B	L	L	L	L	L	L					YES			YES		YES	Plenum
	D1.03										L	L	L	L	L	L					YES			YES		YES	
	D1.04																						YES			YES	Enhanced single sided ventilation
	E1.01			B	B	B	B	B	B	B	L	L	L	L	L	L					YES			YES		YES	Plenum
	E1.02							B	B	B	L	L	L	L	L	L					YES			YES		NO	
	E1.03		L	L	L	L	L	L	L	L	L	L	L	L	L	L			YES					YES			
	E1.04																						YES			YES	
	E1.05																						YES			YES	Enhanced single sided ventilation
	E1.06										L	L	L	L	L	L					YES			YES		YES	
	A2.01																						YES			YES	
	A2.02															B	B	B									
	A2.03														B	B	B	B									
	A2.04															B	B	B									
	A2.05	L	L	L	L	L	L	L	L	L	L	L	L						YES					YES		YES	
	A2.06							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A2.07							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A2.08	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A2.09	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	A2.10								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	A2.11																						YES				
	A2.12																						YES				
	A2.13	L	L	L	L																						
	B2.01								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	B2.02	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	B2.03	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	B2.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	B2.05	L	L	L	L	L	L	L												YES				YES		YES	
	C2.01	L	L	L	L	L	L															YES			YES	YES	
	C2.02	L	L	L	L	L	L	L	L	L	L	B	B						YES					YES			
	C2.03												B	B	B											YES	
	C2.04																						YES			YES	
	C2.05																	B					YES				
	C2.06																						YES				
	D2.01			B	B	B	B	B	L	L	L	L	L	L	L	L			YES					YES		NO	
	D2.02							B	B	B	L	L	L	L	L	L	L			YES				YES		YES	Plenum
	D2.03										L	L	L	L	L	L	L			YES				YES		YES	
	D2.04																						YES			YES	Enhanced single sided ventilation
	E2.01			B	B	B	B	B	B	B	L	L	L	L	L	L	L			YES				YES		YES	Plenum
	E2.02							B	B	B	L	L	L	L	L	L	L			YES				YES		NO	
	E2.03		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		YES					YES			
	E2.04																						YES			YES	
	E2.05																						YES			YES	Enhanced single sided ventilation
2	E2.06										L	L	L	L	L	L	L			YES				YES		YES	
	A3.01																						YES			YES	
3	A3.02															B	B	B									

	UNIT	8	830	9	930	10	1030	11	1130	12	1230	13	1330	14	1430	15	1530	16	>3 hrs 9-3	>2 hrs 9-3 (>3hrs 8-4)	>2 hrs 9-3	>2hrs 8-4	No sun 9-3	POS 9-3	POS 8-4	Cross vent	Notes
	A3.03														B	B	B	B									
	A3.04															B	B	B									
	A3.05	L	L	L	L	L	L	L	L	L	L	L	L						YES					YES		YES	
	A3.06							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A3.07							L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A3.08	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES			
	A3.09	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	A3.10								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	A3.11																						YES				
	A3.12																						YES				
	A3.13	L	L	L	L	L	L															YES			YES		
	B3.01								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	B3.02	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Plenum
	B3.03	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	B3.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	B3.05	L	L	L	L	L	L	L												YES				YES		YES	
	C3.01	L	L	L	L	L	L											B				YES			YES	YES	
	C3.02	L	L	L	L	L	L	L	L	L	L	B	B						YES					YES			
	C3.03												B	B	B											YES	
	C3.04																						YES			YES	
	C3.05																B	B					YES				
	C3.06															B	B	B									
	D3.01			B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		NO	
	D3.02							B	B	B	L	L	L	L	L	L	L	L		YES				YES		YES	Plenum
	D3.03										L	L	L	L	L	L	L	L		YES				YES		YES	
	D3.04																						YES			YES	Enhanced single sided ventilation
	E3.01			B	B	B	B	B	B	B	L	L	L	L	L	L	L	L		YES				YES		YES	Plenum
	E3.02							B	B	B	L	L	L	L	L	L	L	L		YES				YES		NO	
	E3.03		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	E3.04																						YES			YES	
	E3.05																						YES			YES	Enhanced single sided ventilation
	E3.06										L	L	L	L	L	L	L	L		YES				YES		YES	
	A4.01	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Skylight
	A4.02	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	A4.03	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	A4.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	A4.05	L	L	L	L	L	L	L	L	L	L	L	L	L					YES					YES		YES	
	A4.06							L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	A4.07							L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	A4.08	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	A4.09	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight or Plenum
	A4.10								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	A4.11	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	A4.12	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	A4.13	L	L	L	L	L	L															YES			YES	YES	Ventilated skylight
4	B4.01								L	L	L	L	L	L	L	L	L	L	YES					YES		YES	

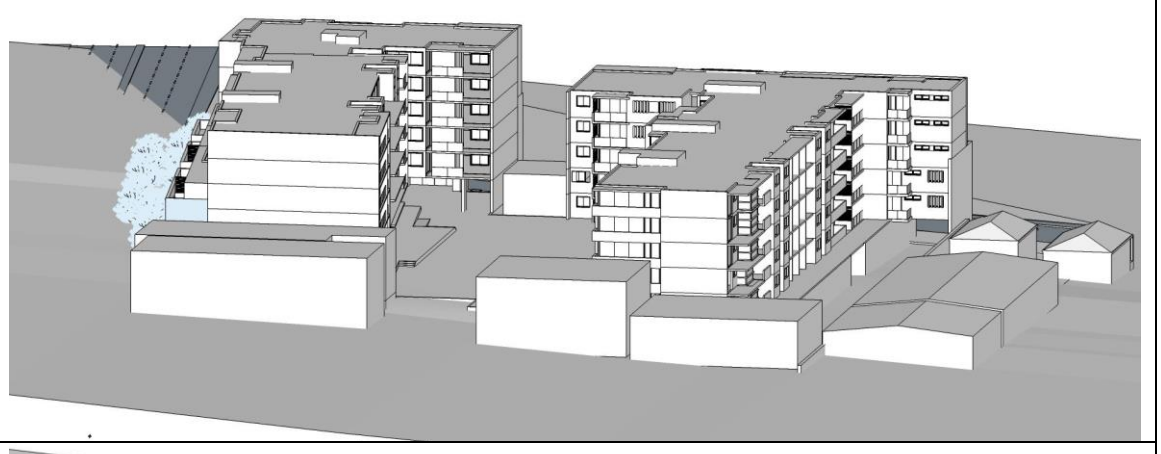
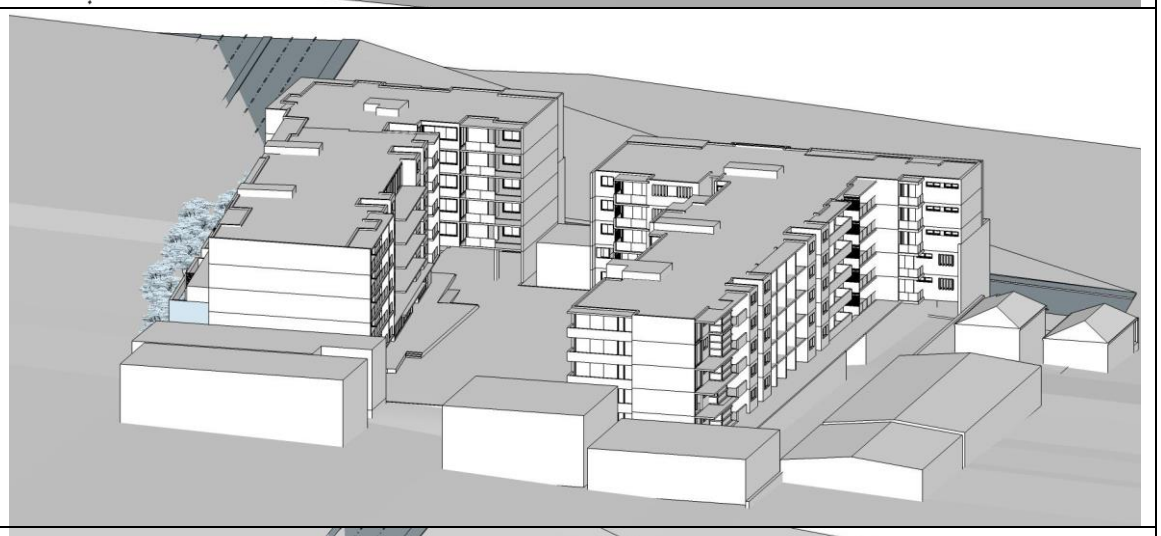
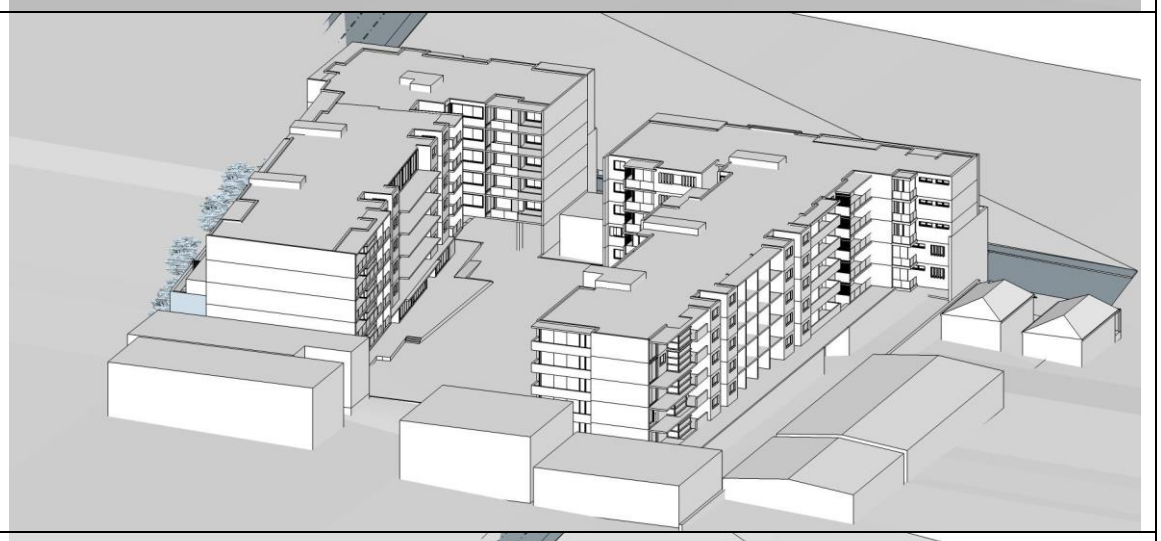
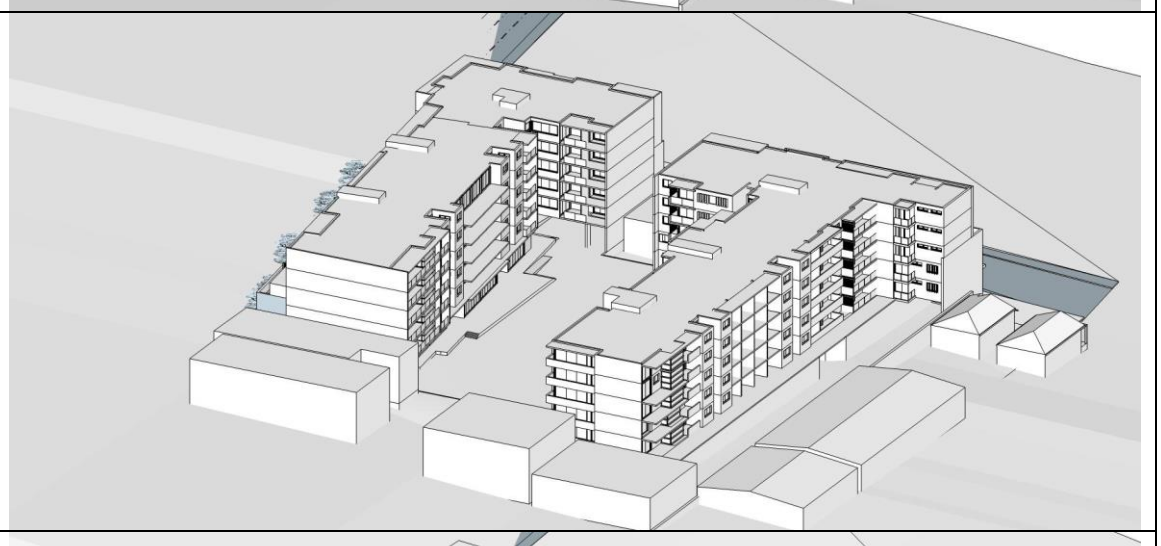
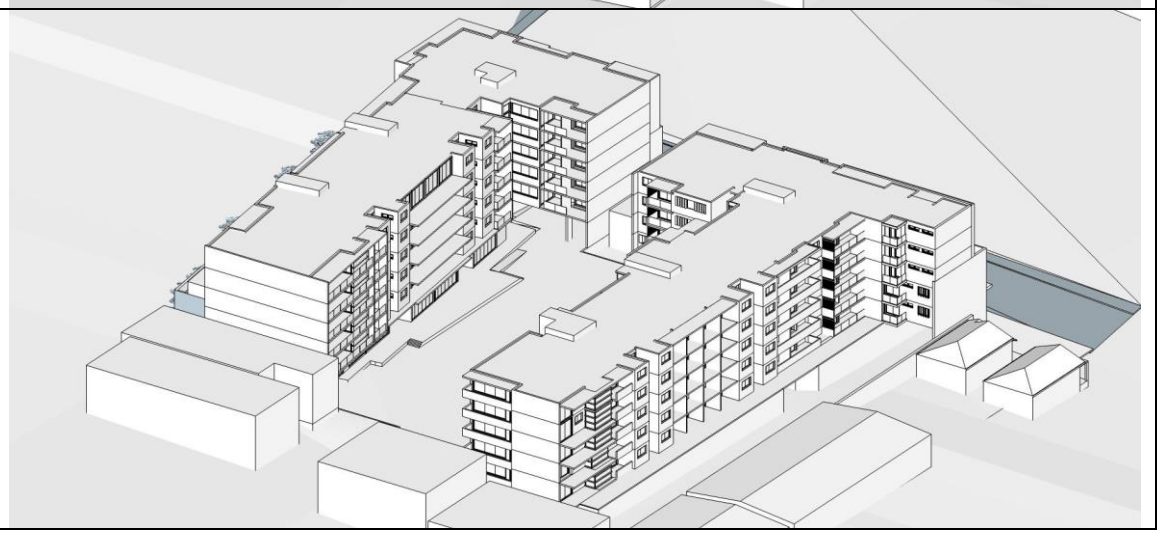
	UNIT	8	830	9	930	10	1030	11	1130	12	1230	13	1330	14	1430	15	1530	16	>3 hrs 9-3	>2 hrs 9-3 (>3hrs 8-4)	>2 hrs 9-3	>2hrs 8-4	No sun 9-3	POS 9-3	POS 8-4	Cross vent	Notes
	B4.02	B	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight or Plenum
	B4.03	B	B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	B4.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	
	B4.05	L	L	L	L	L	L	L												YES				YES		YES	
	C4.01	L	L	L	L	L	L											B				YES			YES	YES	
	C4.02	L	L	L	L	L	L	L	L	L	L	B	B	B					YES					YES			
	C4.03												B	B	B	B										YES	
	C4.04																						YES			YES	
	C4.05																B	B					YES				
	C4.06															B	B	B									
	D4.01			B	B	B	B	B	L	L	L	L	L	L	L	L	L	L	YES					YES		NO	
	D4.02							B	B	B	L	L	L	L	L	L	L	L		YES				YES		YES	Plenum
	D4.03										L	L	L	L	L	L	L	L		YES				YES		YES	
	D4.04																						YES			YES	Enhanced single sided ventilation
	E4.01			B	B	B	B	B	B	B	L	L	L	L	L	L	L	L		YES				YES		YES	Plenum
	E4.02							B	B	B	L	L	L	L	L	L	L	L		YES				YES		NO	
	E4.03		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES			
	E4.04																						YES			YES	
	E4.05																						YES			YES	Enhanced single sided ventilation
	E4.06										L	L	L	L	L	L	L	L		YES				YES		YES	
	C5.01	L	L	L	L	L	L	L												YES				YES		YES	
	C5.02	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	C5.03	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Skylight
	C5.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Skylight
	C5.05	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	C5.06	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	D5.01	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight t
	D5.02	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	D5.03									L	L	L	L	L	L	L	L	L	YES					YES		YES	
	D5.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	E5.01	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	E5.02	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	E5.03	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES					YES		YES	Ventilated skylight
	E5.04	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
	E5.05	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	YES							YES	Ventilated skylight
5	E5.06									L	L	L	L	L	L	L	L	L	YES					YES		YES	
	170																		82	21	6	6	41	96	6	102	
																			48.2%	12.4%	3.5%	3.5%	24.1%	56.5%	3.5%	**60.0%**	
																				60.6%	**64.1%**	**67.6%**			**60.0%**		

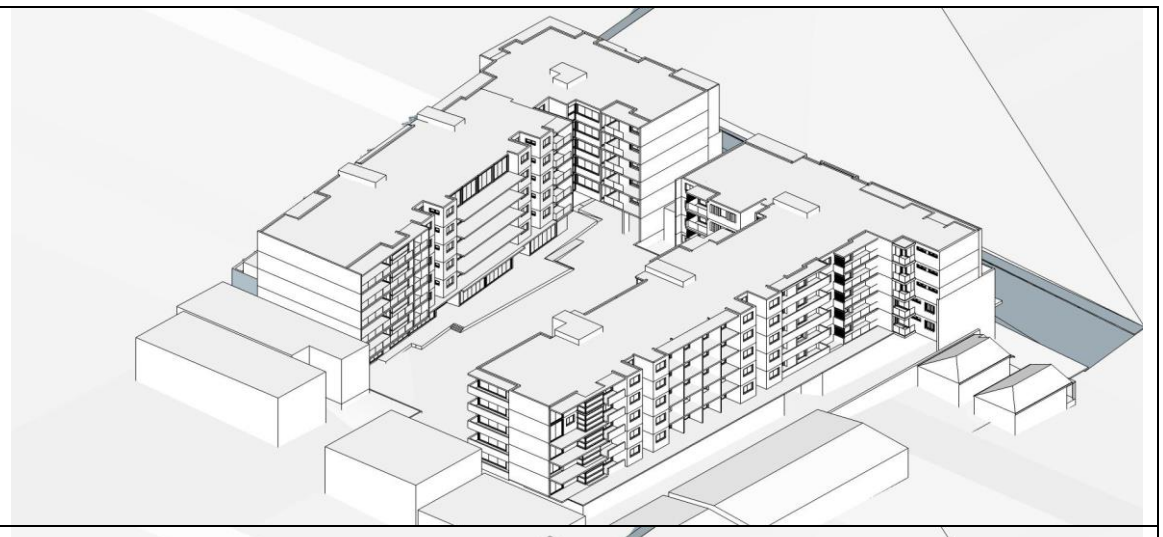
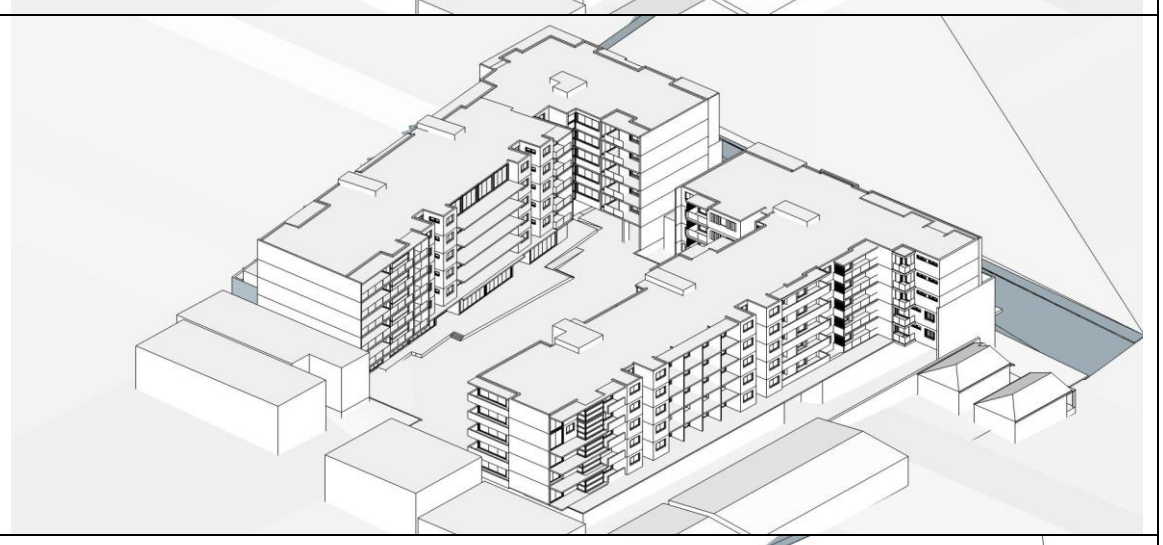
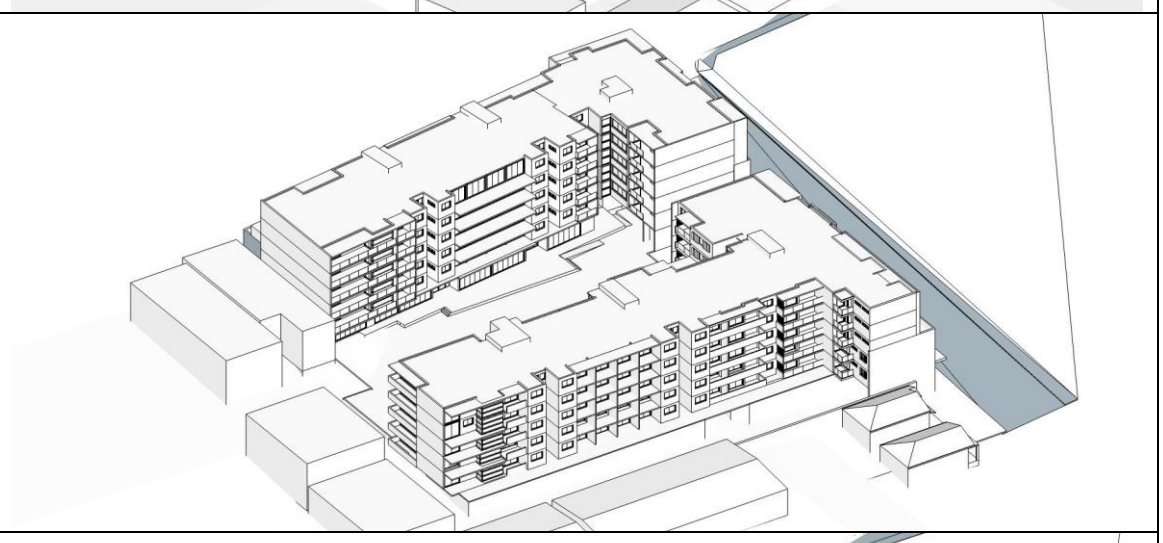
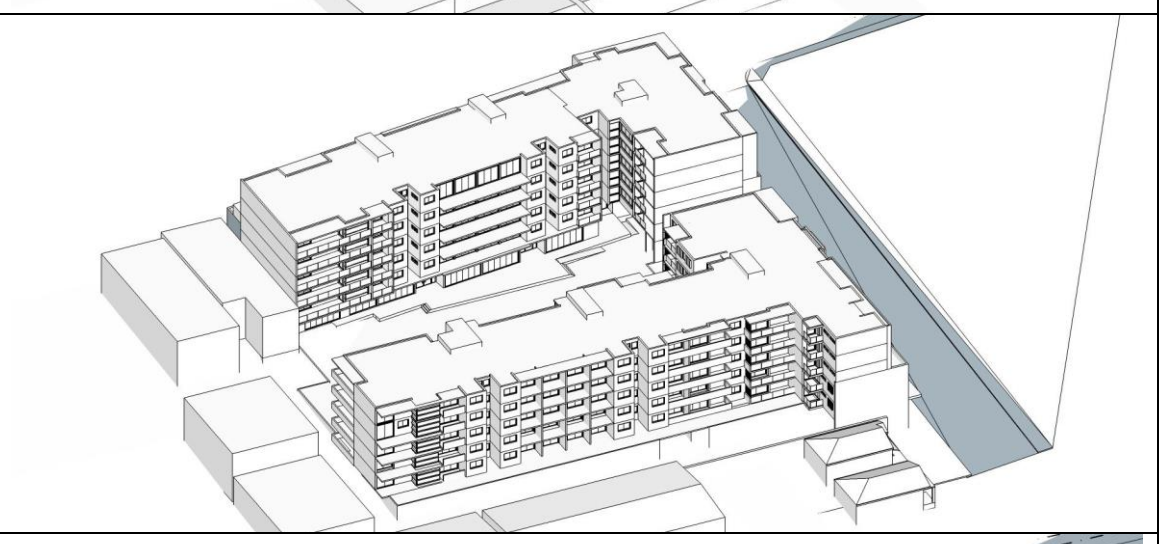
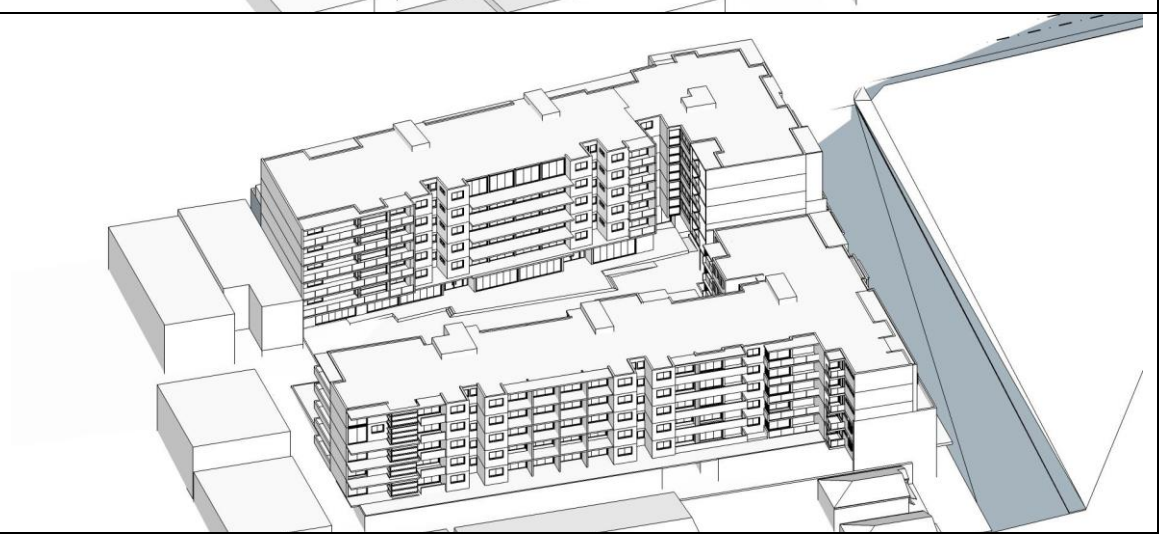
KEY	
L	Living
B	Bedroom only

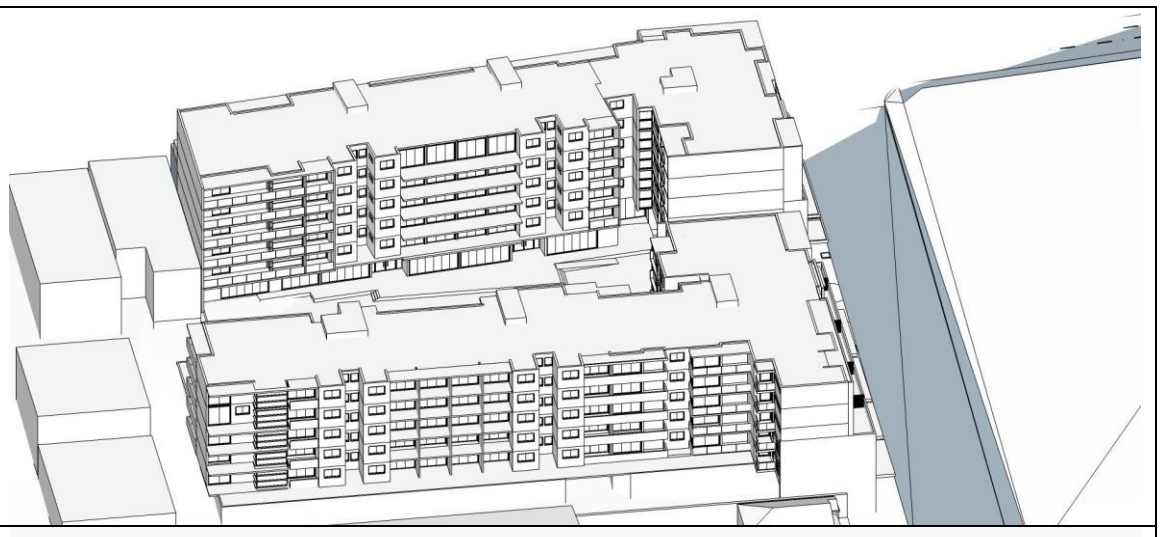
B.0 APPENDIX B: VIEWS FROM THE SUN

The Table below reproduces for reference the detailed ‘views from the sun’ on a half hourly basis.

Table 4: Views from the sun. These projections show half-hourly sun exposure of the subject development.

0800	
0830	
0900	
0930	
1000	

1030	
1100	
1130	
1200	
1230	

1300	
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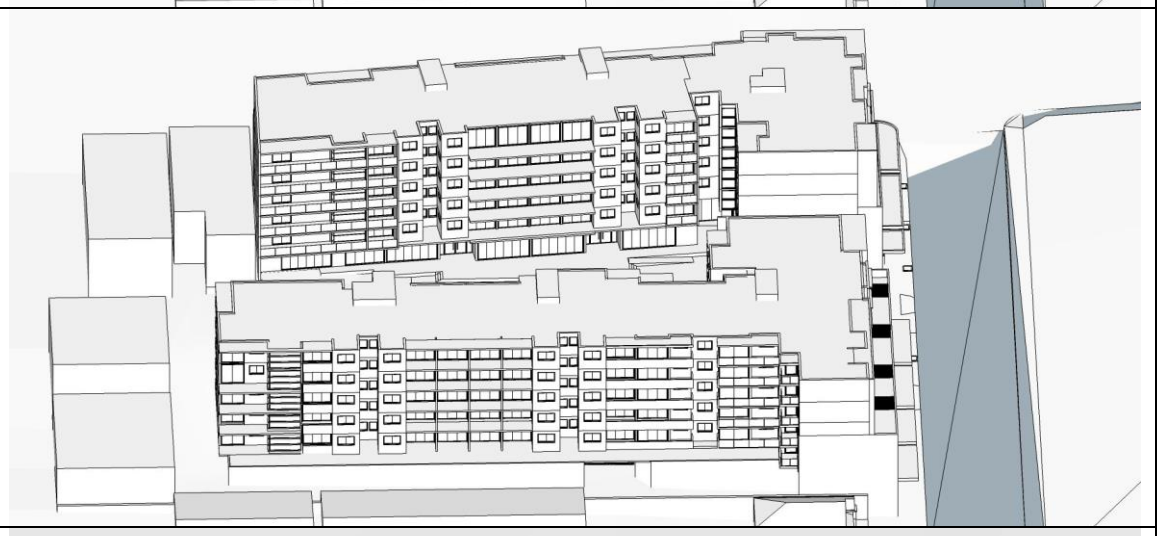
1400	
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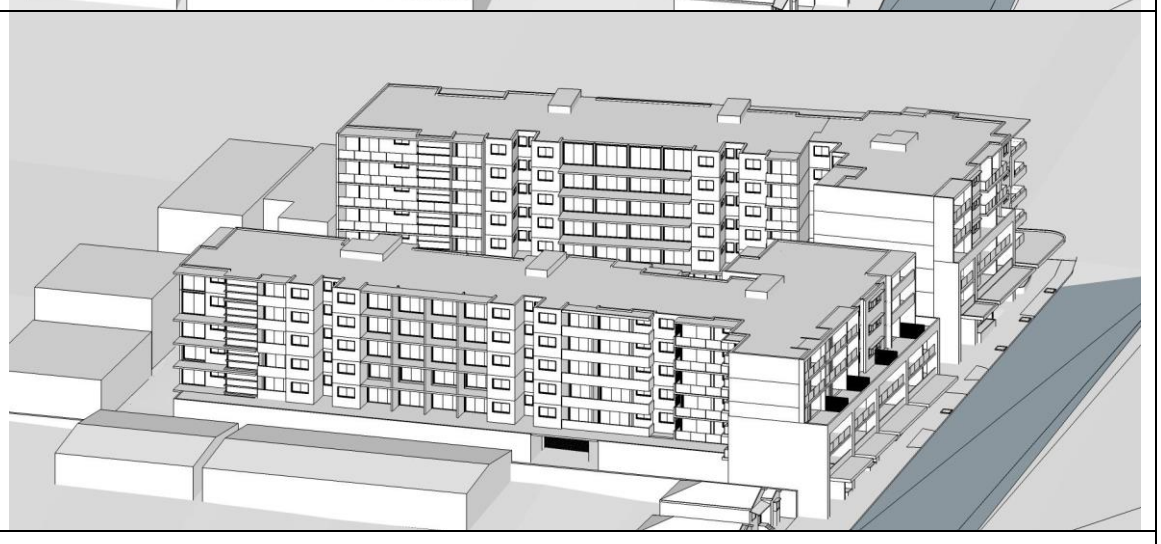
1500	
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	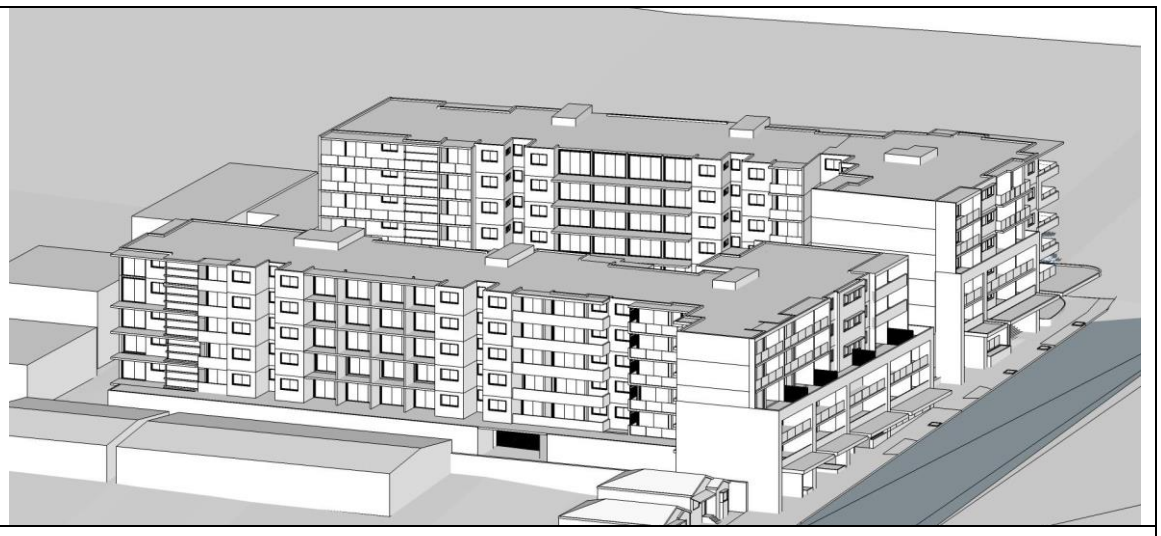
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