

LegPro 45 Pty Ltd ATF LegPro 45 Unit Trust




253-265 Pacific Highway, North Sydney

Qualitative Natural Ventilation Study



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Executive Summary

Vipac Engineers & Scientists Pty Ltd has been engaged by **LegPro 45 Pty Ltd ATF LegPro 45 Unit Trust** to conduct a qualitative assessment of natural ventilation potential of the proposed **253-265 Pacific Highway, North Sydney**. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Drawings of the proposed development were provided by **Nettletontribe Architect** in **April 2025**.

Based on our engineering observations and the qualitative study, it is concluded that for the proposed development:

- **70% (20 out of 28)** apartments are expected to be cross ventilated with the current design; thereby meeting the Apartment Design Guide (ADG) requirements; and
- Middle façade apartments are expected to satisfy the recommended Air Change Per Hour (ACH) of 3 **with the recommendation**.

This analysis has been made on the basis of our engineering assumptions and experience gained from model scale wind tunnel or Computational Fluid Dynamics (CFD) analysis of a range of developments of similar magnitude to the proposed development.

Quantitative modelling is recommended to confirm the natural ventilation potential for the problematic apartments and determine proper wind control measures wherever necessary.

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1 Introduction

Vipac Engineers and Scientists Pty Ltd has been commissioned by **LegPro45 Pty Ltd ATF LegPro 45 Unit Trust** to undertake a qualitative cross ventilation assessment at **253-265 Pacific Highway, North Sydney**. This report will be a qualitative review of the natural ventilation under Apartment Design Guide (ADG).

Natural ventilation is taken to mean that quantify of fresh air that enters a building without mechanical assistance. Supply of outside air to the indoors can decrease the level of indoor pollutant or when a building requires cooling. There are two main mechanisms for natural ventilation: 'stack (or chimney)' effect and 'wind pressure' effect.

Stack effect is produced by two columns of air at different temperature, where the interference between the two columns is unstable and tends to allow the colder air to move into the warmer air at low level and the warmer air into cooler air at an upper level. The rate of air circulation due to stack effect in a building depends on separated distance (height) of the cold and hot air, opening area at a bottom and top of the building and temperature difference.

Wind pressure effect is produced by the interaction of wind with the building. The interaction will produce a building surface with local suctions and pressures. The pressure area used as intake of outside air and suction as removal of indoor air. The different pressure distribution across the building will be used to achieve the required indoor air circulation.

The proposed development is 12 storey residential building with an approximate roof height of 45m from the ground level. The project site is bounded Church Ln to the east and Pacific Highway to the west, and existing development to the north and south. A satellite image of the proposed development site and western elevation of the proposed development are shown in Figure 1 and Figure 2, respectively. Assumed terrain categories for wind speed estimation is shown in Figure 3.

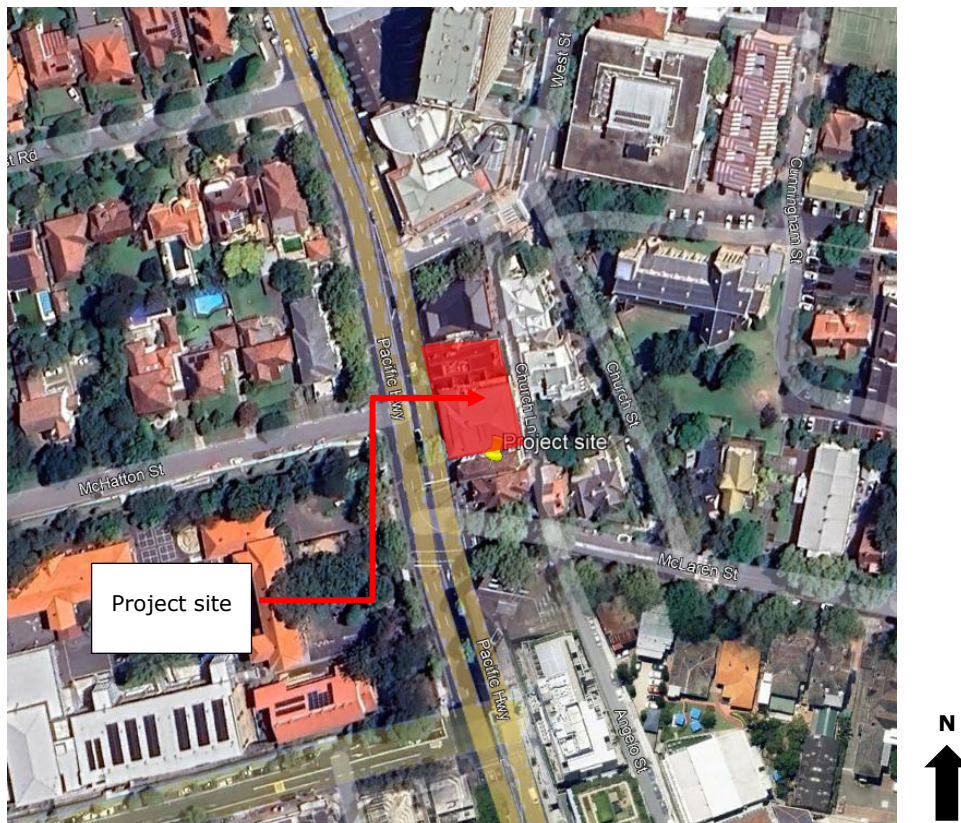


Figure 1: Aerial view of the proposed development site.

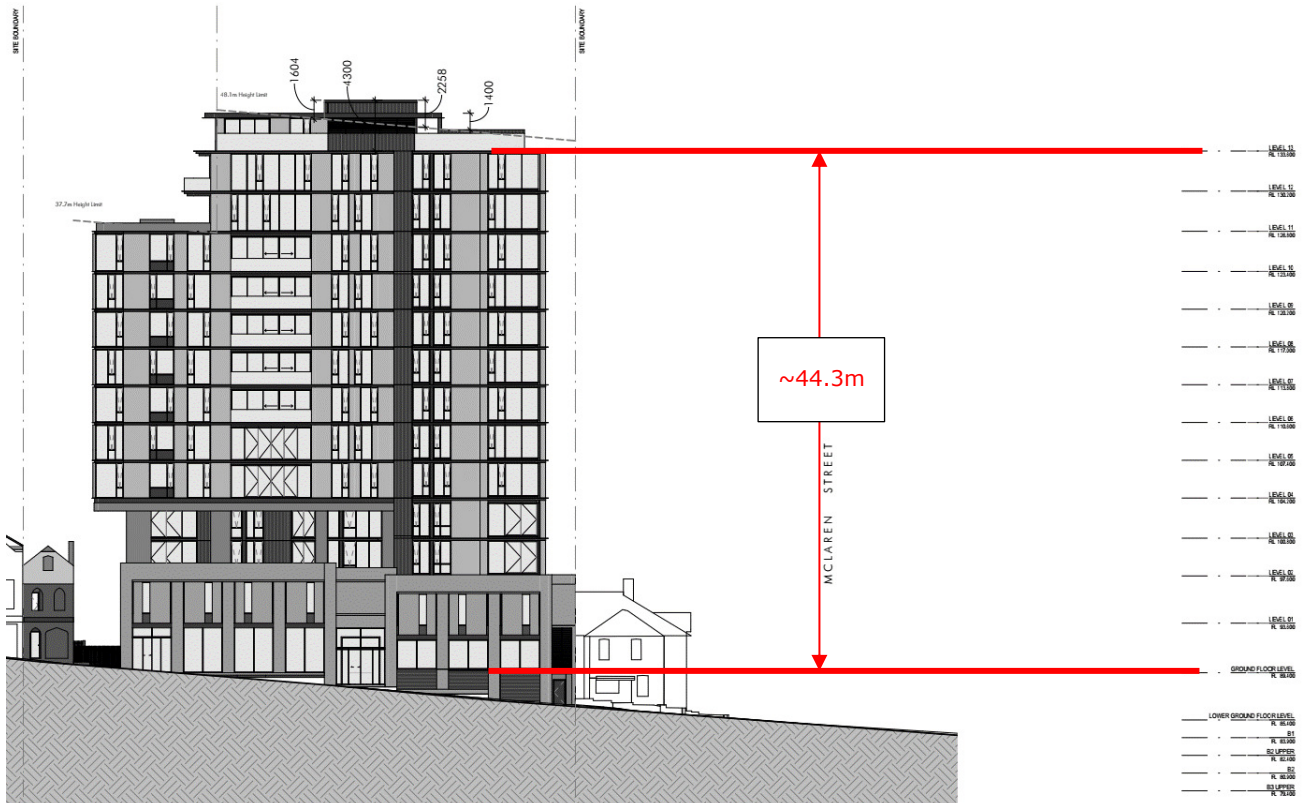


Figure 2: Western elevation of the proposed development.

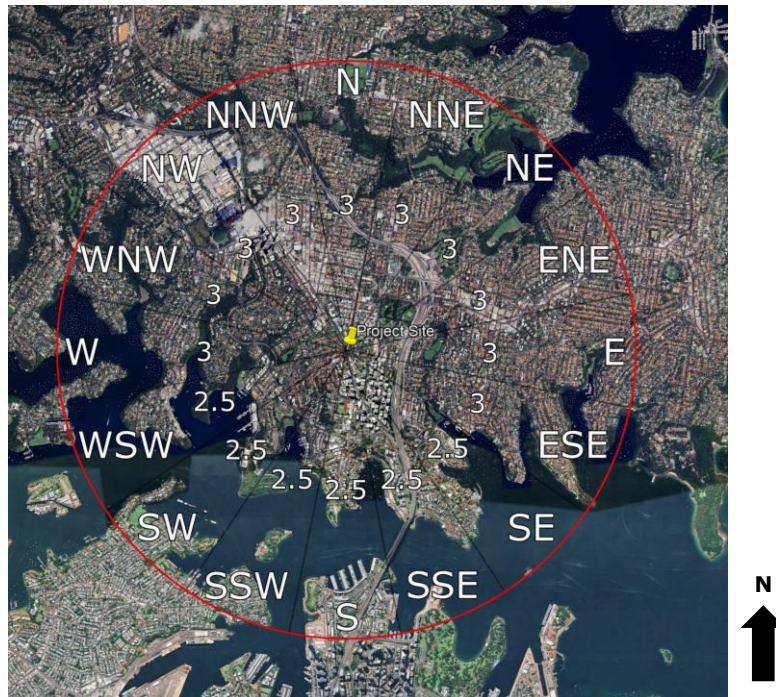


Figure 3: Assumed terrain categories (TC) for wind speed estimation.

2 Sydney Wind Climate

The mean and gust wind speeds have been recorded in the Sydney Airport wind station (**WS_066037**) for over 30 years. These data have been analysed and directional probability distribution of wind speeds have been determined. The probability distribution of hourly mean wind speed and directionality at a gradient height (~500 m) is shown in Figure 4. The winds from the west are strongest and more frequent followed by those from the northeast and south directions.



Figure 4: Wind probability of mean wind speed and direction for Sydney wind climate.

3 Natural Ventilation Analysis

Natural ventilation through apartments is driven by differential pressures between dominant openings, which are generated by the outside wind flow around the building structure and additional elements. The pressure distribution will vary according to the incoming wind directions and turbulence characteristics from the upstream, the angle between the local wind and the building façade, elevation of the apartment to ground level, local façade geometry, and size of door opening.

For this assessment, only westerly winds were chosen as it is main contribution for the western façade of the middle apartments (203, 303, 402, 502, 602, 702, 802, and 902). Wind frequency exceeded at 80% of the time were selected for this assessment. This resulted in a calm to light breeze reference wind speed of 2m/s.

3.1 Australian Design Guide (ADG) Requirements

The NSW State Environmental Planning Policy No. 65 (SEPP65) supported by the Australian Design Guide (ADG) is relevant to the assessment of the natural ventilation through residential components of proposed development. Section 4B-3 of the Australian Design Guide (ADG) states that:

"At least 60% of the 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 fully enclosed".

The proposed development implements a number of the ADG recommendations to maximize the natural cross ventilation throughout the development:

- The proposed development has been provided with opening on multiple sides of the apartments for the majority of the proposed floor plans, allowing it to make use of wind-induced natural ventilation throughout the year and thereby minimising energy costs; and
- The overall depth of cross-over or cross through units does not exceed 18m as per Design Criteria of Objective 4B-3.

There are no specific requirements to calculate Air Change Hour (ACH) in the ADG guideline. However, AS1668.2-2002 "The use of ventilation and air conditioning in buildings Part 2" states:

Ventilation design for indoor air contaminant control (excluding requirements for the health aspects of tobacco smoke exposure) recommends 3 ACH for habitable rooms to satisfy the air quality requirements [9].

3.2 Assumptions and Limitations

The results from the desktop natural ventilation assessment should not be used for structural or cladding wind load analysis. Door size information has not provided by the client. Therefore, standard sliding window size (1.5m (H) x 1.0m (W)) has been assumed for the ACH calculation. For this assessment, all entrance swing doors are assumed to be closed to represent a worst-case scenario.

For the first nine storey, the proposed development has 28 apartments in total. The corner apartments are expected to be the best option for the cross natural ventilation. Apartments in the middle are expected to be the worst. To simplify the analysis to achieve 3 ACH for the problematic apartments, middle apartments (**203, 303, 402, 502, 602, 702, 802, and 902**) are selected for the analysis.

For wind-driven cross ventilation, the flow rate (Q) and Air Change Per Hour (ACH) equations can be written as follows:

$$Q = C_d A_{\text{opening}} U_{\text{ref}} \sqrt{C_{p_{\text{windward}}} - C_{p_{\text{leeward}}}} \quad (\text{or}) \quad Q = C_d A_{\text{opening}} \sqrt{\frac{2\Delta P}{\text{Air density}}} \quad (\text{eqn. 1})$$

$$\text{ACH} = \frac{Q}{V} \times 3600 \quad (\text{eqn. 2})$$

Where, Q is the volumetric flow rate entering inside the apartment space, C_d is the discharge coefficient, V is the volume of the enclosed space, U_{ref} is the reference wind speed, and A is the equivalent opening area.

Discharge coefficient is a source of uncertainty in the calculation of volumetric airflow rates. It characterizes the local contraction of the flow at opening level, shear stress forces, and dimensions of the opening. For small sharp-edge openings, typical values for discharge coefficient are within the range of **0.40-0.65 [14]**. For this assessment, all openings discharge coefficient of **0.65** is considered. Thus, result presented in the report represent a best-case scenario.

For this assessment:

- All windows and entrance doors are assumed to be open. This should be considered as a best scenario to calculate ACH within the apartment units;
- Extract the building façade pressure (windward and leeward side) using ASNZ1170.2-2021 for different elevations; and
- Calculate the flow rates (Q) at the opening sides for different wind directions and calculate ACH based on equation 1 and 2.

4 Results and Discussions

4.1 SEPP65 Assessment (ADG)

The natural ventilation for the proposed residential apartments has been qualitatively assessed. Cross ventilation is achieved by the differential pressure between the windward and leeward building façades. Description of the natural ventilation principles that apply for the proposed development are shown in Appendix A.

The following comments are made regarding the proposed cross ventilation system for the development:

- Balconies featuring sliding doors are positioned on all façades above the Level 1, offering openings to various directions, thus significantly improving airflow, which is a favourable design selection. Reducing shielding is anticipated for the upper levels as a result; therefore, the proposed development benefits from all prevailing Sydney winds, creating the potential for cross ventilation (Figure 5 to Figure 7);
- Based on a qualitative study **70% (20 out of 28)** of the apartments within the proposed development comply with the cross-ventilation requirements of the Australian Design Guide (ADG) for the first nine store (Table 1). and
- From experience Vipac has found that numerical solutions including Computational Fluid Dynamics (CFD) and wind tunnel studies can prove these apartments to provide appropriate through apartment ventilation and circulation for natural ventilation requirements.

Table 1: Apartments with openings to support cross ventilation.

Levels	Number of Apartments	Number of Apartments with Openings to Support Cross Ventilation (as per ADG)	Percentage (%)
L1	0	0	0%
L2	5	4	80%
L3	5	4	80%
L4	3	2	67%
L5	3	2	67%
L6	3	2	67%
L7	3	2	67%
L8	3	2	67%
L9	3	2	67%
Total	28	20	70%

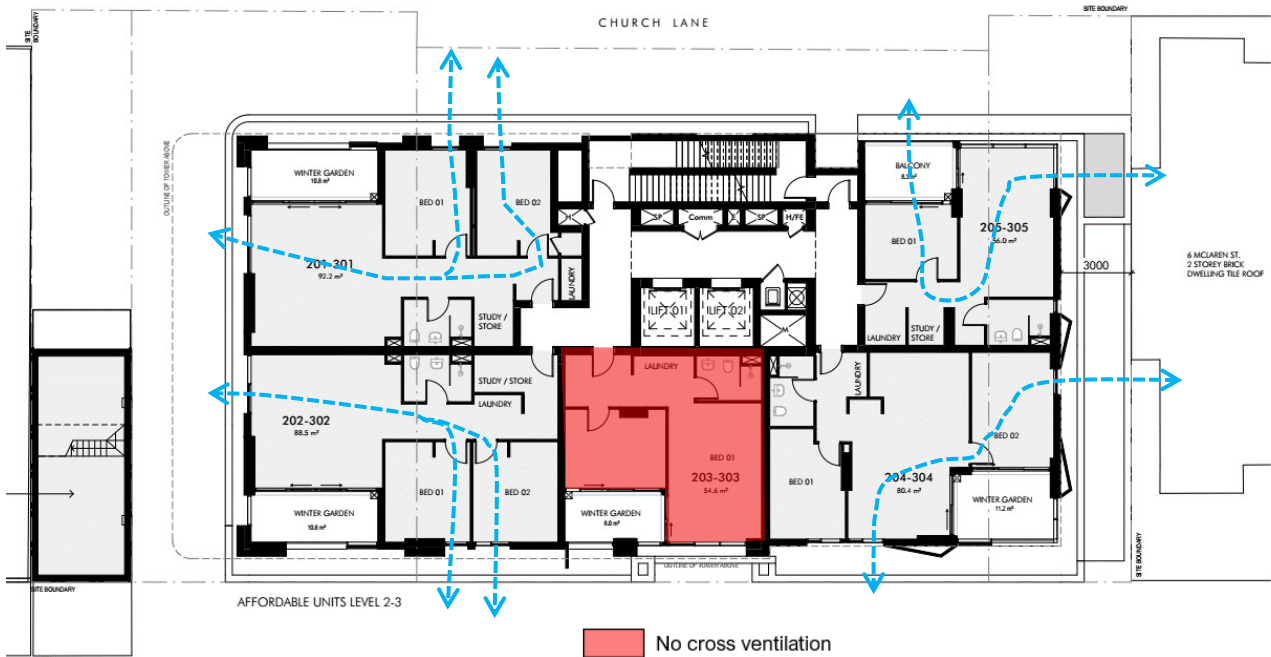


Figure 5: Natural cross ventilation flow paths for Level 2 and 3.

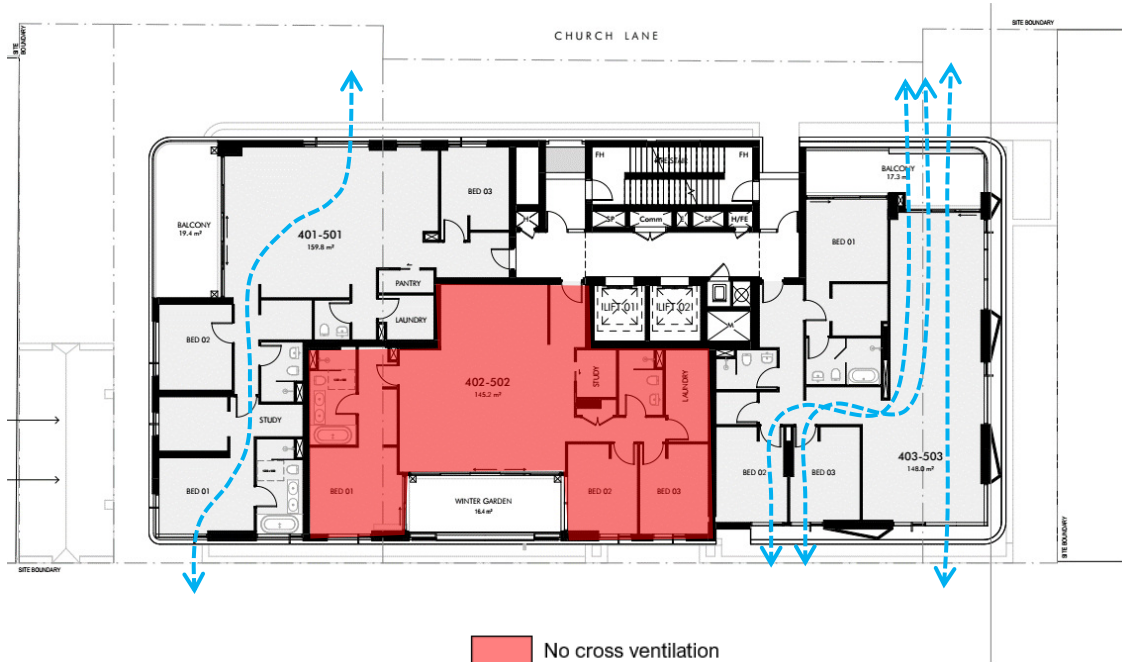


Figure 6: Natural cross ventilation flow paths for Level 4 and 5.

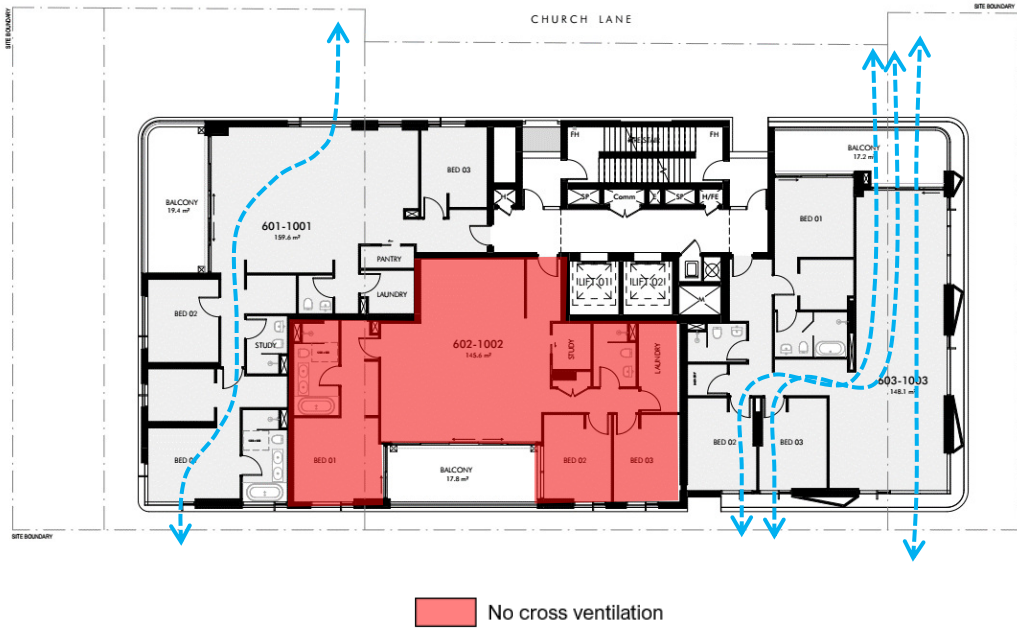


Figure 7: Natural cross ventilation flow paths for Level 6 and 10.

4.2 Natural Ventilation (AS 1668.2) Detail Assessment

A space is considered sufficiently naturally ventilated by the determination of Air Change Hour (ACH) driven by environmental wind conditions. As the Australian Design Guide (ADG) do not specify criteria therefore an ACH of 3 is used in accordance to AS 1668.2. The environmental wind speeds, pressures and volume of the apartments were analysed to determine compliance against this criterion. To calculate ACH, **203, 303, 402, 502, 602, 702, 802, and 902** apartments were selected for this analysis to represent problematic apartments.

Wind Pressures & ACH

The table below of the wind pressure calculation is based on the Australian Standard which incorporates a number of assumptions and generalization. For more accurate results, wind tunnel testing or Computational Fluid Dynamics (CFD) is recommended.

Table 2: Wind pressure calculation based on ASNZ1170.2-2021 and ACH for the various apartment units.

Westerly Winds				
Apartment	Windward Pressure (Pa)	Leeward Pressure (Pa)	Differential Pressure (Pa)	Air Change Hour (ACH)
203	1.87	-0.8	1.07	1.5
303	2.0	-0.8	1.2	1.5
402	2.1	-0.8	1.3	0.54
502	2.1	-0.8	1.3	0.55
602	2.2	-0.8	1.4	0.56
702	2.2	-0.8	1.4	0.58
802	2.3	-0.8	1.5	0.60
902	2.4	-0.8	1.6	0.60

As per section, sliding windows with an opening of 1.5m² has been assumed for the ACH calculation. With this opening, the units fail to satisfy the ACH requirement of 3.

Recommendations

As the selected apartments units have failed to satisfy criteria for Air Change Hours (ACH), some changes are necessary in order to achieve sufficient natural ventilation.

In review of the proposed design, Vipac recommend the following mitigation to achieve sufficient airflow rate inside the apartments:

- Introduce a façade opening to the western side of the selected apartments. This would be expected the apartment to achieve recommended Air Change Hour (ACH) of 3 (Figure 8 to Figure 10).

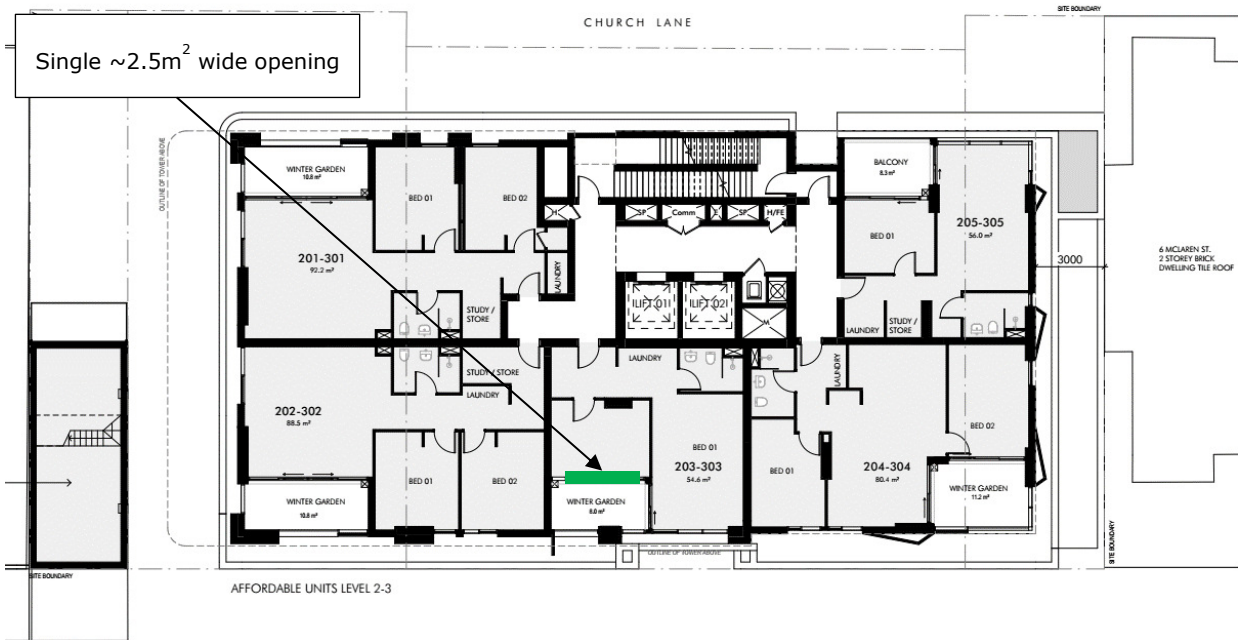


Figure 8: Introduce opening to the western side of the middle apartments (203 and 303).



Figure 9: Introduce opening to the western side of the middle apartments (402 and 502).

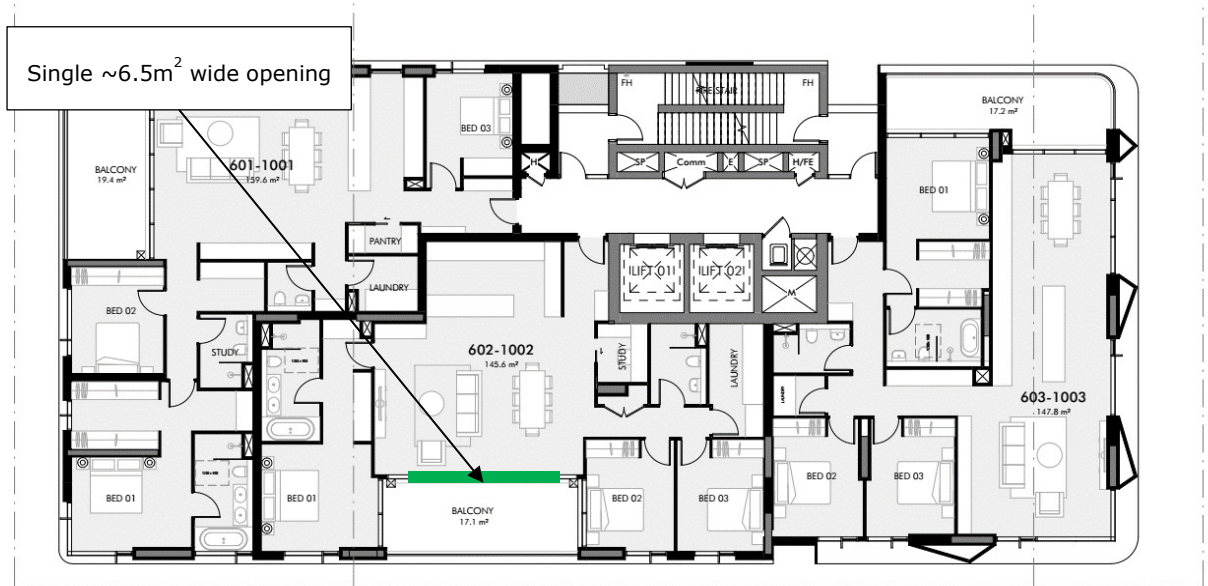


Figure 10: Introduce opening to the western side of the middle apartments (602 and 902).

5 Conclusion

Vipac Engineers & Scientists Pty Ltd has been engaged by **LegPro 45 Pty Ltd ATF LegPro 45 Unit Trust** to conduct a qualitative assessment of natural ventilation potential of the proposed development at **253-265 Pacific Highway, North Sydney**. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

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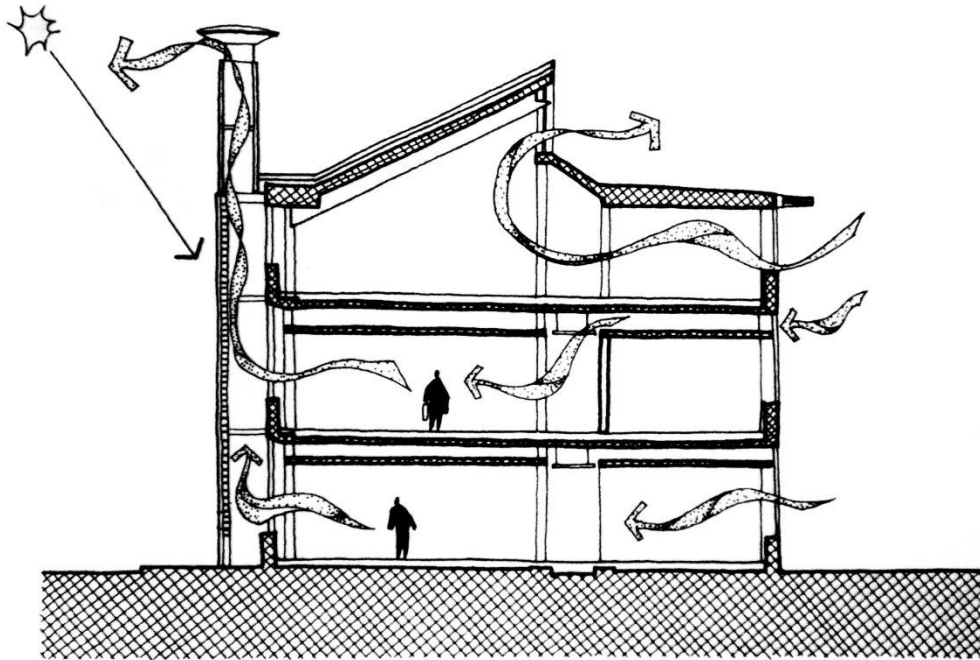
This analysis has been made on the basis of our engineering assumptions and on experience gained from model scale wind tunnel or Computational Fluid Dynamics (CFD) analysis of a range of developments of similar magnitude to the proposed development.

Quantitative modelling is recommended to confirm the natural ventilation potential for the problematic apartments and determine proper wind control measures wherever necessary.

Appendix A Environmental Wind Effects

Natural Ventilation (Stack effects)

Stack ventilation uses temperature differences to move air. Hot air rises because it generates lower pressure due to the density variation. For this reason, it is sometimes called buoyancy driven flow ventilation. In the stack effect, hot air plume rises due to buoyancy and its low-pressure sucks in fresh air from outside.

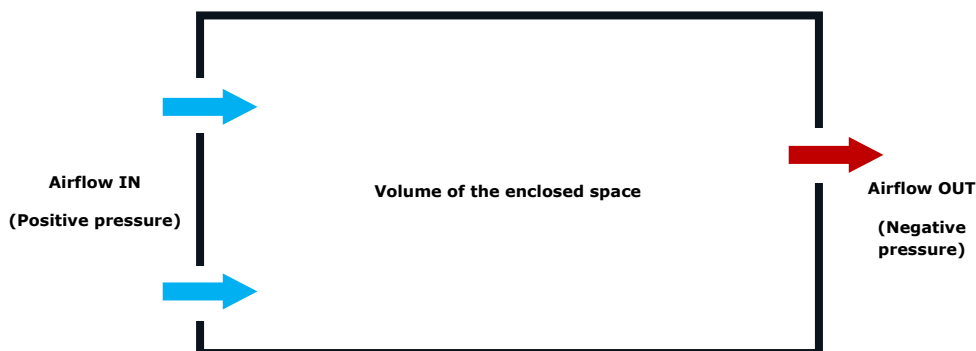


Source: G.Z brown and Mark Dekay, published by Wiley.

Natural Ventilation (Wind effects)

Wind induced natural ventilation works on the pressure differential concept. If a building massing has multiple openings and there exists a pressure difference between those openings, e.g. the wind pressure at one opening is greater than the pressure at the other side of the openings; airflow will be pushed through building openings in the direction positive to negative sign.

$$ACH = \frac{\text{Volumetric flow rate inside the enclosed space } \left(\frac{m^3}{s}\right)}{\text{Volume of the enclosed space } (m^3)} \times 3600$$



Appendix B Drawing List

Drawings Received: **April 2025**

14344_LEGACY_AR_ARCH_040425.ifc

14344_NT_Church Lane Development Summary [040425-B].pdf

14344_NT_Church Lane Scoping Meeting Arch. Drawings [040425-B] reduced.pdf

DA201 - ELEVATION - WEST [P6].pdf

DA202 - ELEVATION - EAST [P6].dwg

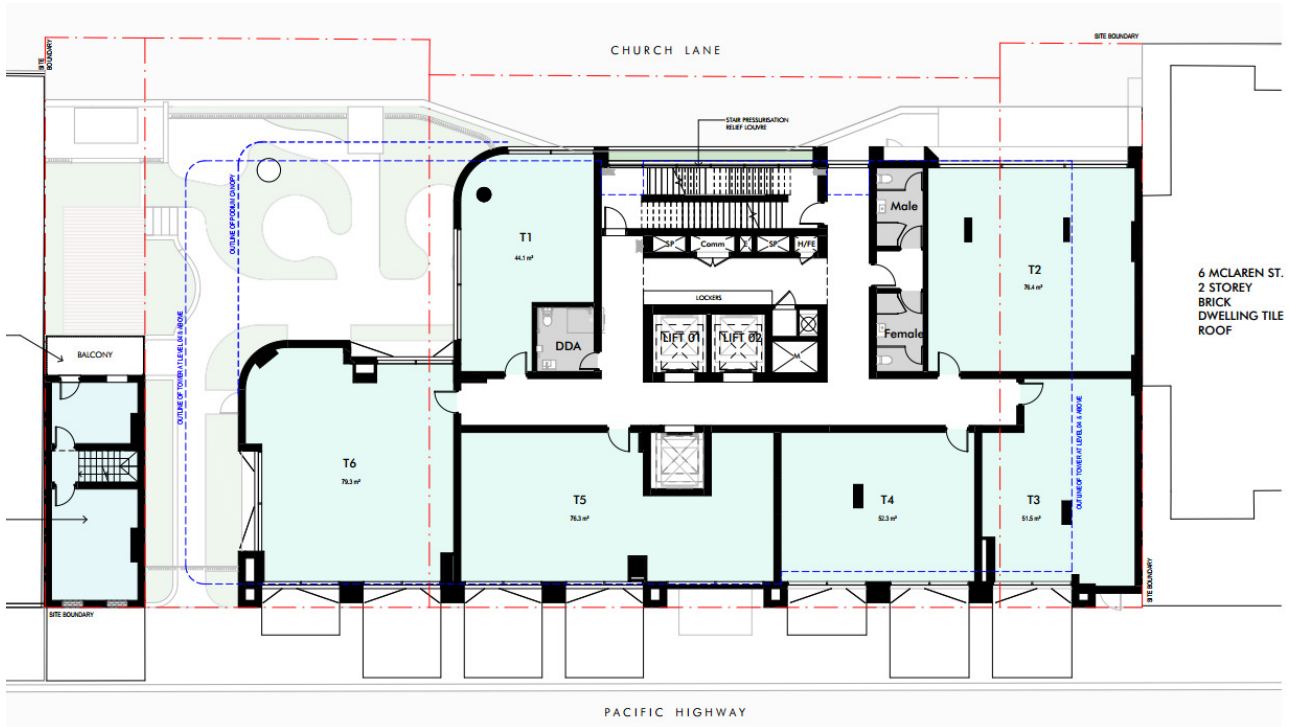
DA202 - ELEVATION - EAST [P6].pdf

DA203 - ELEVATION - NORTH & SOUTH [P6].dwg

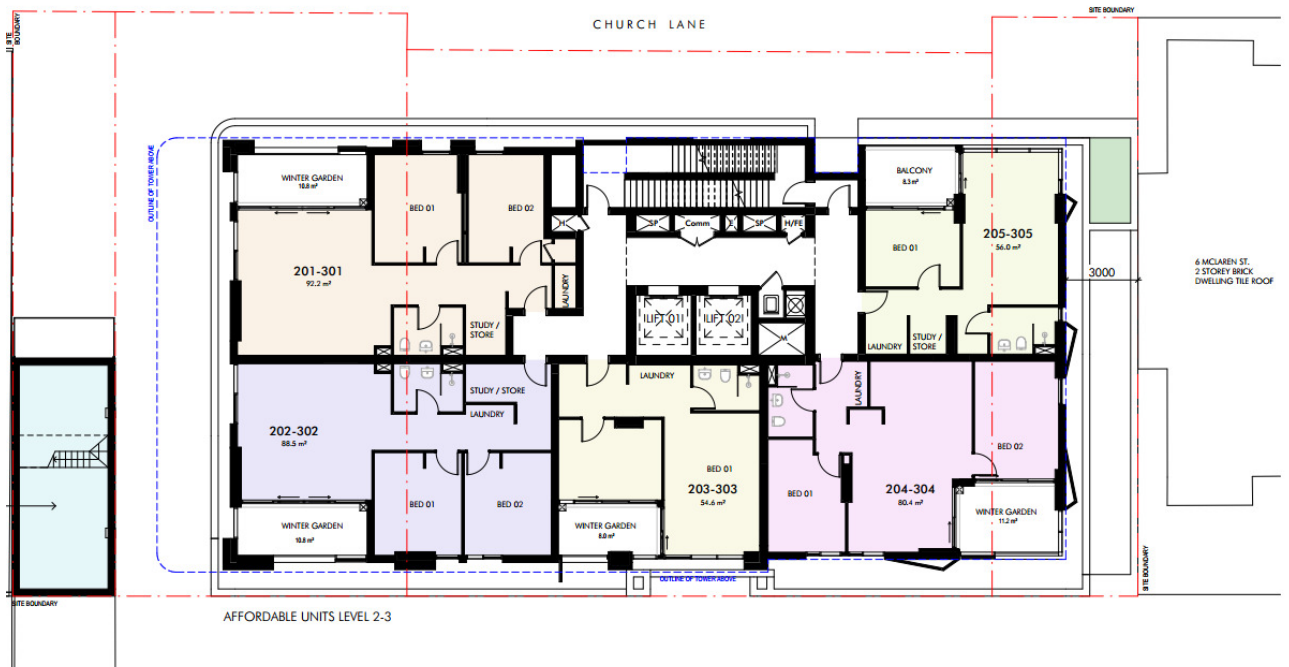
DA203 - ELEVATION - NORTH & SOUTH [P6].pdf

Appendix C Floor Plans

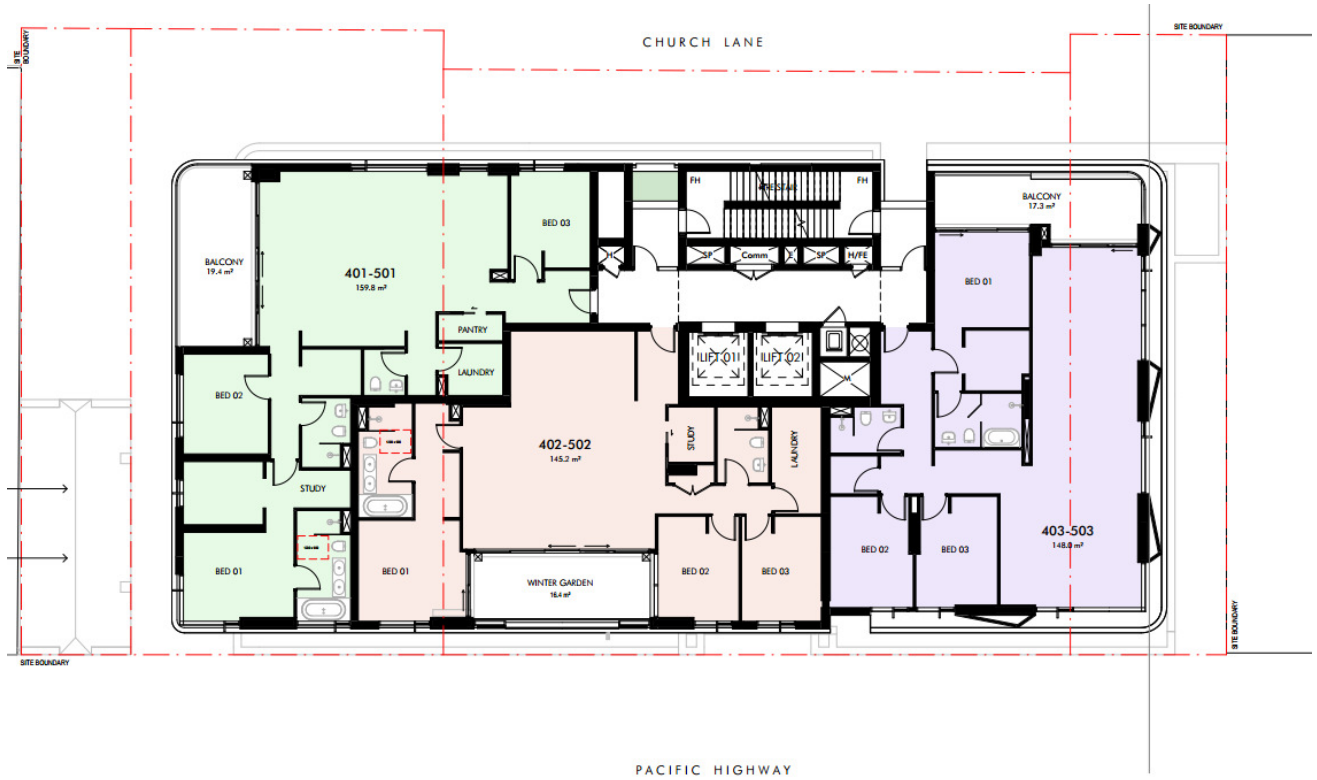
Level 1



Level 2 and 3



Level 4 and 5



Level 6 to 10



Appendix D References

- [1] Structural Design Actions, Part 0: General Principles, Australian/New Zealand Standard 1170.0:2011
- [2] Structural Design Actions, Part 2: Wind Actions, Australian/New Zealand Standard 1170.2:2021
- [3] Blocken, B. (2014) '50 years of Computational Wind Engineering: Past, present and future', *Journal of Wind Engineering and Industrial Aerodynamics*, 129, pp. 69–102.
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