ARUP

Wardle Architects

436 Lonsdale Street, Melbourne

Environmental Wind Assessment

Reference: REP-WIND-001

Revision 01 | 22 May 2024

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Job number 292627-00

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ADVERTISED PLAN

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Executive Summary

Arup have been commissioned by Wardle Architects to provide an experienced-based impact assessment of the proposed development at 436 Lonsdale Street, Melbourne, on the pedestrian level wind conditions for comfort and safety in and around the site.

It is considered that the proposed redevelopment would have a small impact on the ground level wind conditions in and around the site. The nestled nature of the building in the overall city massing reduces the impact of the building on the local wind environment.

Qualitatively, integrating the expected directional wind conditions around the site with the wind climate, it is considered that wind conditions at the majority of locations around the site would be classified as suitable for pedestrian walking, or standing type activities, in accordance with the wind controls in the Melbourne Planning Scheme. The wind comfort conditions would be similar to the existing conditions.

All accessible areas on the ground plane are expected to meet the safety criterion.

To quantify the qualitative advice provided in this report, numerical or physical modelling of the development would be required, which is best conducted during detailed design.

ADVERTISED PLAN

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Disclaimer

This assessment of the site environmental wind conditions is presented based on engineering judgement. In addition, experience from more detailed simulations have been used to refine recommendations. No detailed simulation, physical or computational study has been made to develop the recommendations presented in this report.

1. Introduction

Wardle Architects have engaged Arup to provide a qualitative environmental wind assessment for the proposed redevelopment at 436 Lonsdale Street, Melbourne. This report outlines the assessment and subsequent recommendations for wind engineering services related to pedestrian wind comfort and safety on the ground level.

2. Site description

The proposed site is located on the block bounded by Lonsdale, William, Little Lonsdale and Queen Streets, Figure 1. The site is located on the southern side of the block on Lonsdale Street, in the middle of the block between William and Queen Street. Lonsdale Lane is located immediately to the west of the site. As such, the site is well-embedded in the middle of the block and CBD. Topography surrounding the site is typically flat from a wind perspective, with a gradual drop to the east across the site. Pedestrian traffic occurs on all road and laneways around the site.

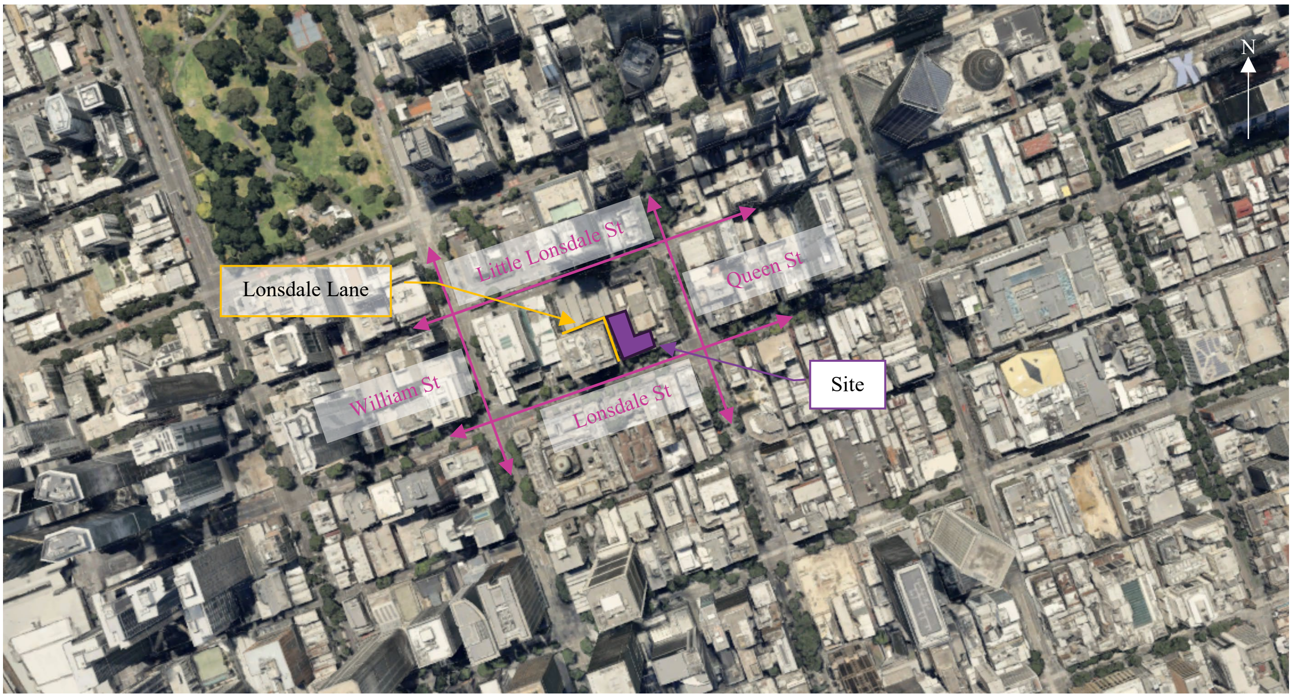

Figure 1: Site location (source: Google Earth, 2024)

An existing nine storey L-shaped building currently exists on the site, which will be largely demolished with the exception of the heritage façade on Lonsdale Street. The proposed redevelopment will comprise a commercial development, with an eight-storey podium, behind the heritage façade, and 16-storey rectangular tower on top, Figure 2 and Figure 3. The total building height is approximately 97 m above ground level. There are accessible terraces on Level 7 and rooftop (Level 23).

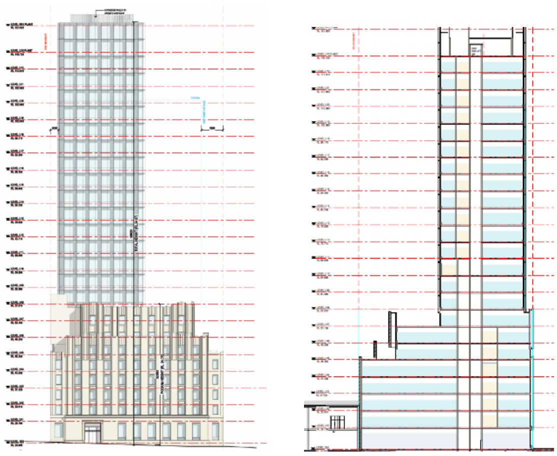

Figure 2: South elevation (Londsdale Street, L), and north-south section looking west (R)

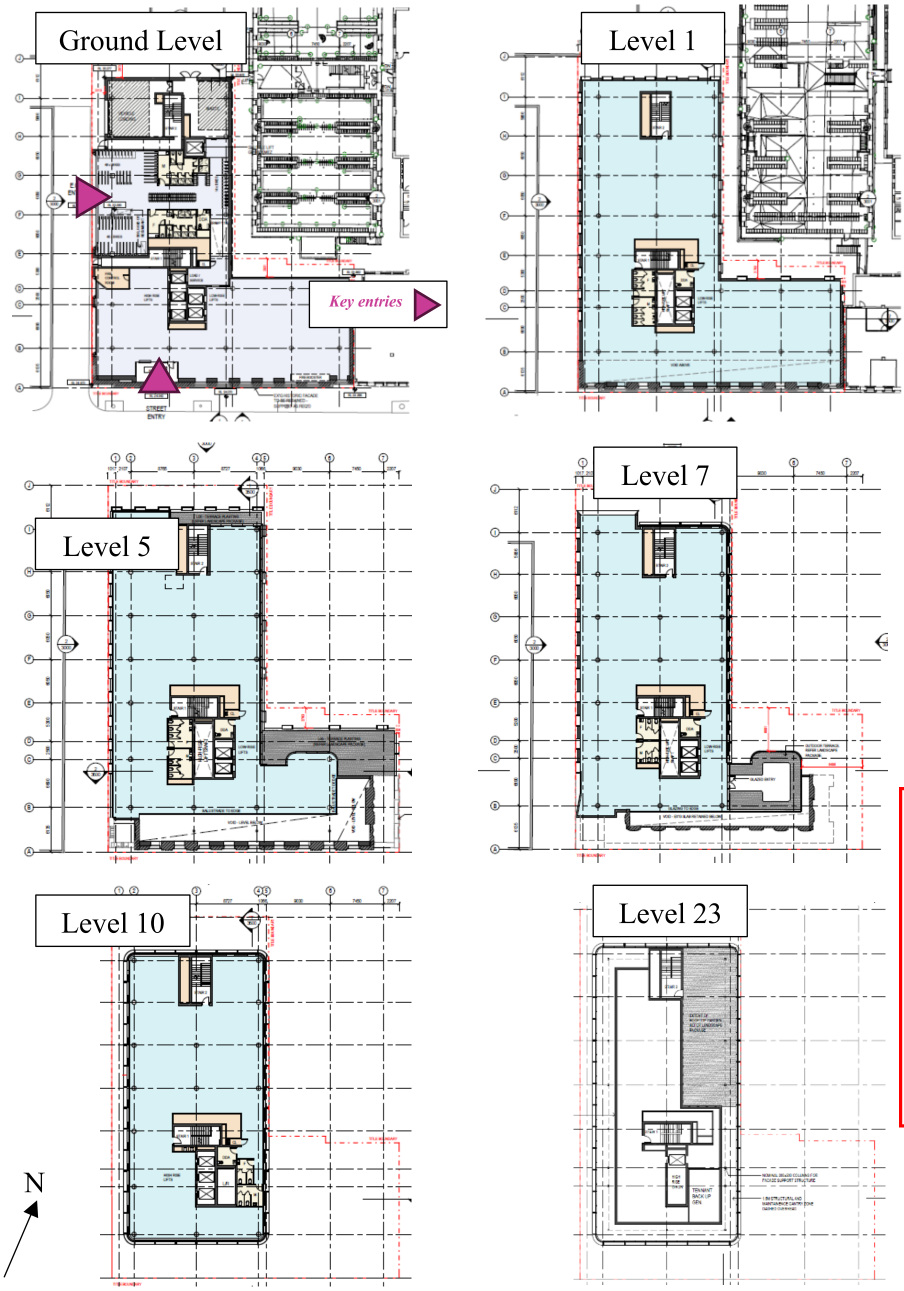

Figure 3: Various floor plans

3. Wind assessment

3.1 Local wind climate

Weather data recorded at Melbourne Airport by the Bureau of Meteorology has been analysed for this project. The anemometer is located about 20 km to the north-west of the site. The arms of the wind rose point in the direction from where the wind is coming from. The directional wind speeds measured here are considered representative of the incident wind conditions at the site.

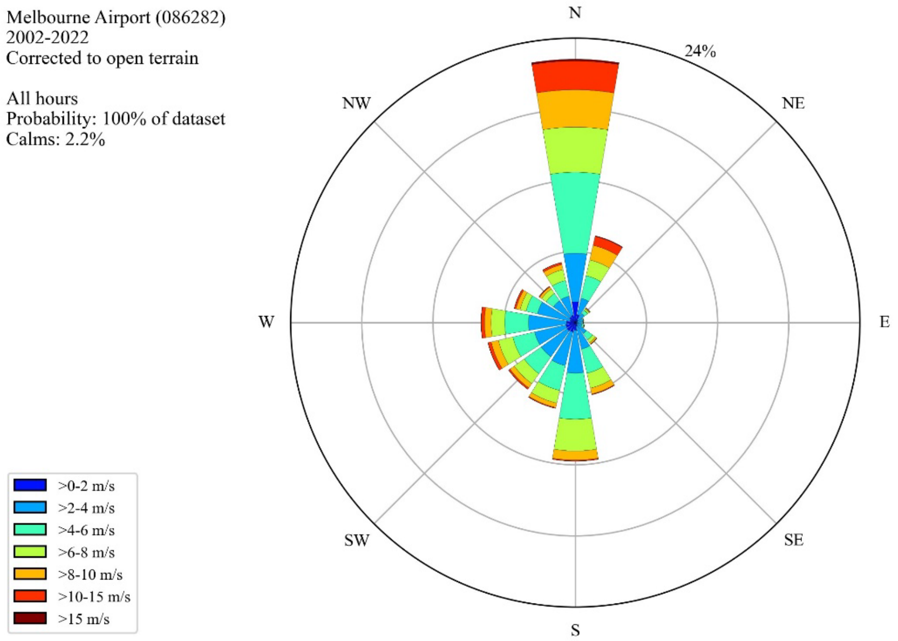

Figure 4: Wind rose showing probability of time of wind direction and speed

It is evident from Figure 4 that the prevailing wind directions are from north and south quadrants with stronger winds from the north and west directions. Temporal wind roses for Melbourne are presented in Figure 5, illustrating morning winds predominantly from the north, and winds from the north and south for the remainder of the day.

A general description on flow patterns around buildings is given in Appendix A.1.

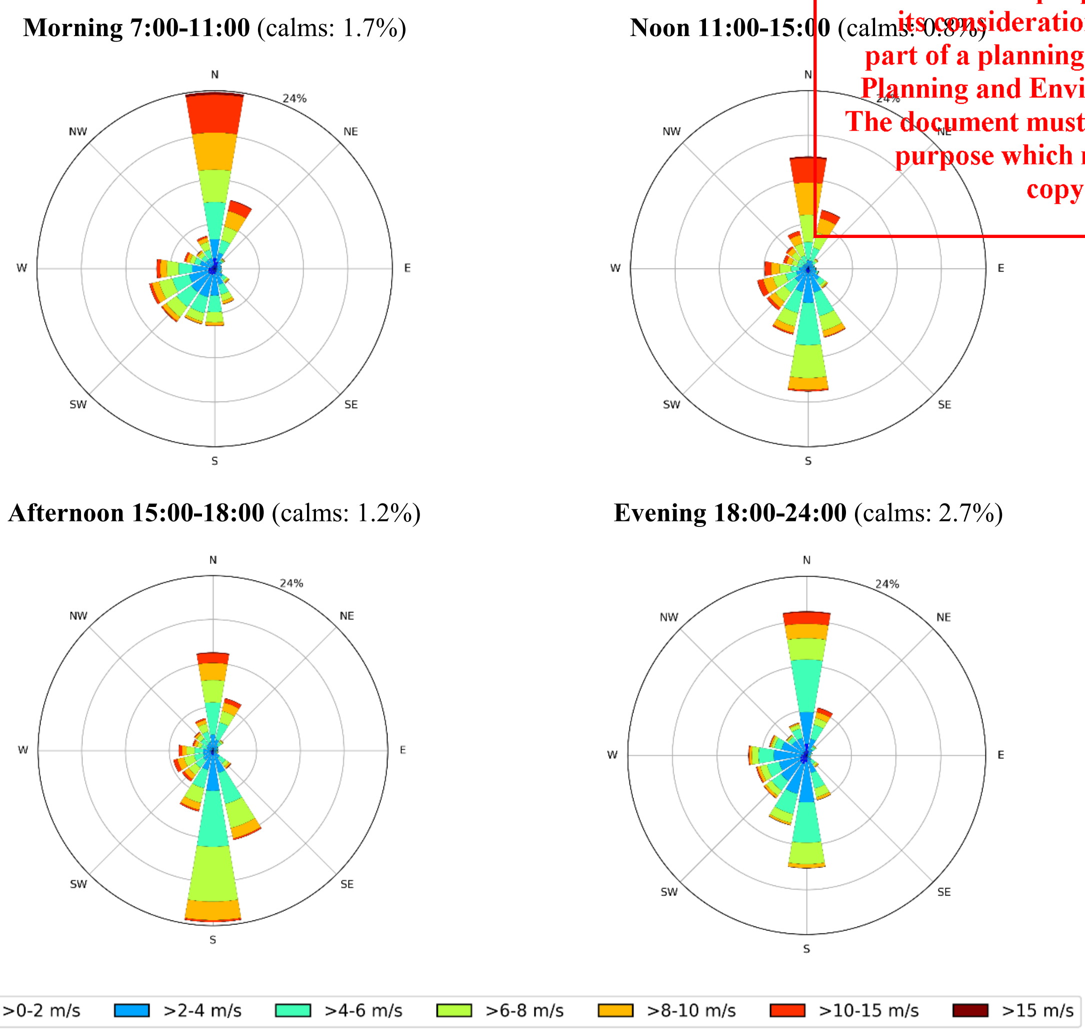

Figure 5: Temporal wind roses for Melbourne Airport showing probability of time of wind direction and speed; 2002-2022, corrected to open terrain

3.2 Specific wind controls

Wind comfort is generally measured in terms of wind speed and rate of change of wind speed, where higher wind speeds and gradients are considered less comfortable. Air speed has a large impact on thermal comfort and are generally welcome during hot summer conditions. This assessment is focused on wind speed in terms of mechanical comfort.

There have been many wind comfort criteria proposed, and a general discussion is presented in Appendix A.2.

The site is located in Melbourne Planning Scheme Zone DDO10. The current Melbourne Planning Scheme (2017) controls have been considered for this study, as defined in Table 1 and illustrated in Figure 19.

Table 1: Pedestrian comfort criteria for various activities

Comfort (max. of mean or GEM wind speed exceeded 20% of the time from any wind direction)	
≤3 m/s	Sitting
3-4 m/s	Standing
4-5 m/s	Walking
>5 m/s	Uncomfortable
Safety (max 3 s gust occurring in an hour from any wind direction)	
>20 m/s	Unsafe

3.3 Predicted wind conditions on ground plane

This section of the report outlines the predicted wind conditions in and around the site based on the local climate, topography, and building form. For all but isolated buildings, local wind flow patterns are governed by the geometry of the compound shape of the local building group.

The building is nestled to the north-west of the CBD, close to neighbouring buildings of similar and greater height, and therefore would be expected to have an impact on the pedestrian level wind conditions. The following sections will discuss the impact of the proposed development for the prevailing incident wind directions.

Winds from the north

For winds from the north, the site is shielded by the taller buildings to the north, Figure 6. Upper level winds will be directed around the site by these taller buildings, with the site located in the wake region, hence the stronger flow passing over or around the site. Given the narrow aspect of the tower is aligned with winds from the north, for any flow reaching the site, the tower is not expected to direct a significant amount of flow to ground level.

At this location in the CBD, pedestrian level winds from the north will be channelled along Queen and William Streets. As such, the proposed site is well-shielded for winds from the north at pedestrian level along Lonsdale Street. There is the potential for flow along Lonsdale Lane from the north, which would be similar to existing conditions.

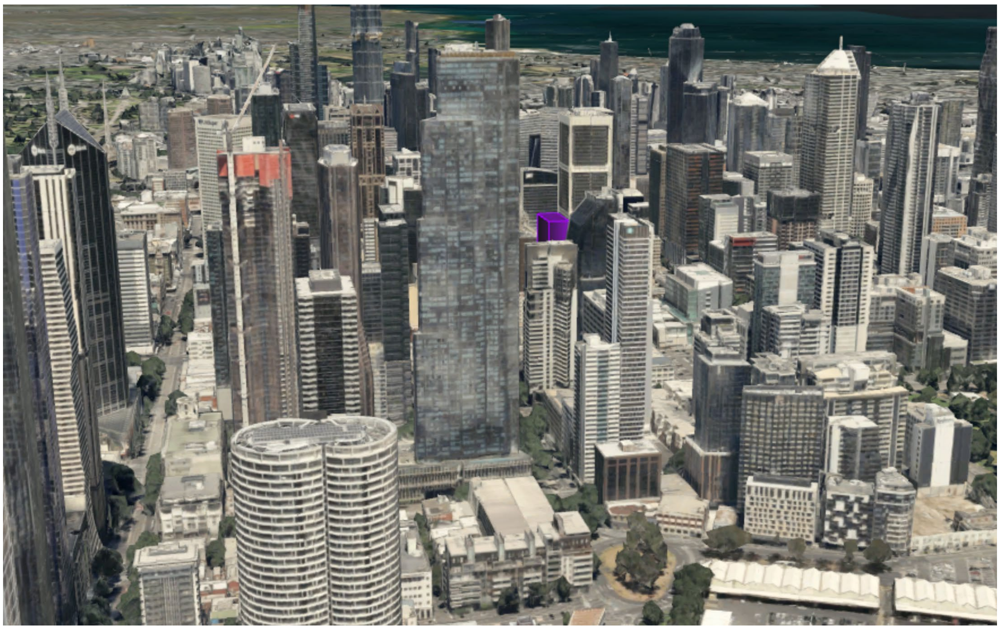

Figure 6: View from the north, with site envelope approximated in purple (Google Earth, 2024)

Winds from the south

Winds from the south will impact the site in a similar manner to winds from the north, given the similar alignment to prevailing winds (narrow aspect of the tower), position in the CBD (pedestrian level winds being channelled along Queen and William Streets) and upstream buildings shielding the site, Figure 7. The building would have minimal impact on the ground plane wind conditions.

Figure 7: View from the south, with site envelope approximated in purple (Google Earth, 2024)

Winds from the west

Winds form the west quadrant are shielded by the tall buildings upstream of the site, Figure 8. The site would be located in the wake of these taller buildings and therefore would have relatively minimal impact on the local wind conditions. At pedestrian level, winds will be channelled along Lonsdale Street. As the tower is not significantly exposed to winds from the west, pedestrian level conditions are expected to be similar to existing. Winds direction more towards the south-west has the potential to create downwash impact. The mid-rise building to the west of the proposed development would direct the downwash flow and limit the amount reaching the ground level. The Lonsdale Lane is narrow enough to mitigate the downwash impact.

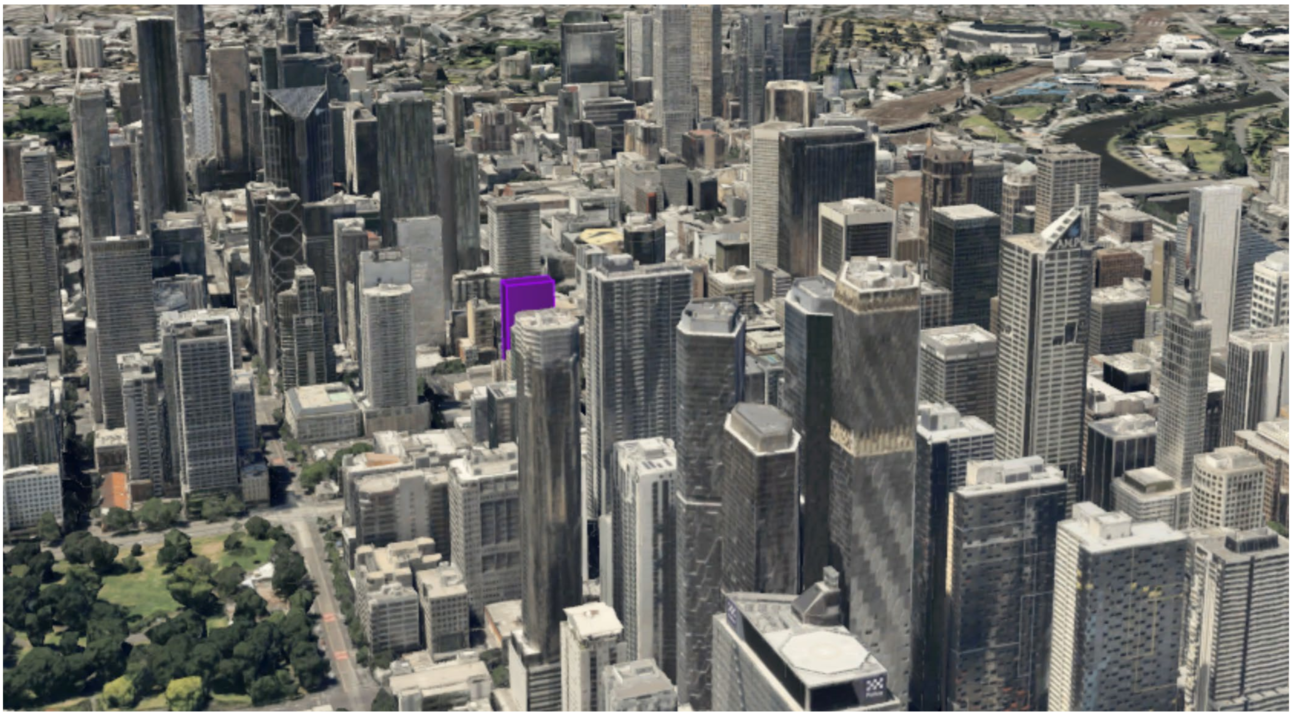

Figure 8: View from the west, with site envelope approximated in purple (Google Earth, 2024)

Summary

The site is located in the north-western corner of the Melbourne CBD, and is therefore largely shielded from the prevailing winds from the north, west, and south quadrants. The building is nestled close to neighbouring buildings of similar or greater height. The proposed redevelopment would be expected to have a minor impact on the pedestrian level wind conditions. It is expected that the wind speed would be slightly increased at the corner of the site. The immediate low-rise buildings surrounding the site would act similar to podium diverting downwash flow over their rooftop resulting in less wind impact on the ground level.

Qualitatively, integrating the expected directional wind conditions around the site with the wind climate, it is considered that from a comfort perspective, the wind conditions at the majority of locations around the site would be classified as suitable for pedestrian walking or standing at ground level. These wind conditions would be similar to the existing conditions.

All areas around the development would be expected to meet the pedestrian safety criterion.

4. References

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Appendix A

A.1 Wind flow mechanisms

An urban environment generates a complex wind flow pattern around closely spaced structures, hence it is exceptionally difficult to generalise the flow mechanisms and impact of specific buildings as the flow is generated by the entire surrounds. However, it is best to start with an understanding of the basic flow mechanisms around an isolated structure.

Isolated building

When the wind hits an isolated building, the wind is decelerated on the windward face generating an area of high pressure, Figure 9, with the highest pressure at the stagnation point at about two thirds of the height of the building. The higher pressure bubble extends a distance from the building face of about half the building height or width, whichever is lower. The flow is then accelerated down and around the windward corners to areas of lower pressure, Figure 9. This flow mechanism is called **downwash** and causes the windiest conditions at ground level on the windward corners and along the sides of the building.

Rounding the building corners or chamfering the edges reduces downwash by encouraging the flow to go around the building at higher levels. However, concave curving of the windward face can increase the amount of downwash. Depending on the orientation and isolation of the building, uncomfortable downwash can be experienced on buildings of greater than about 6 storeys.

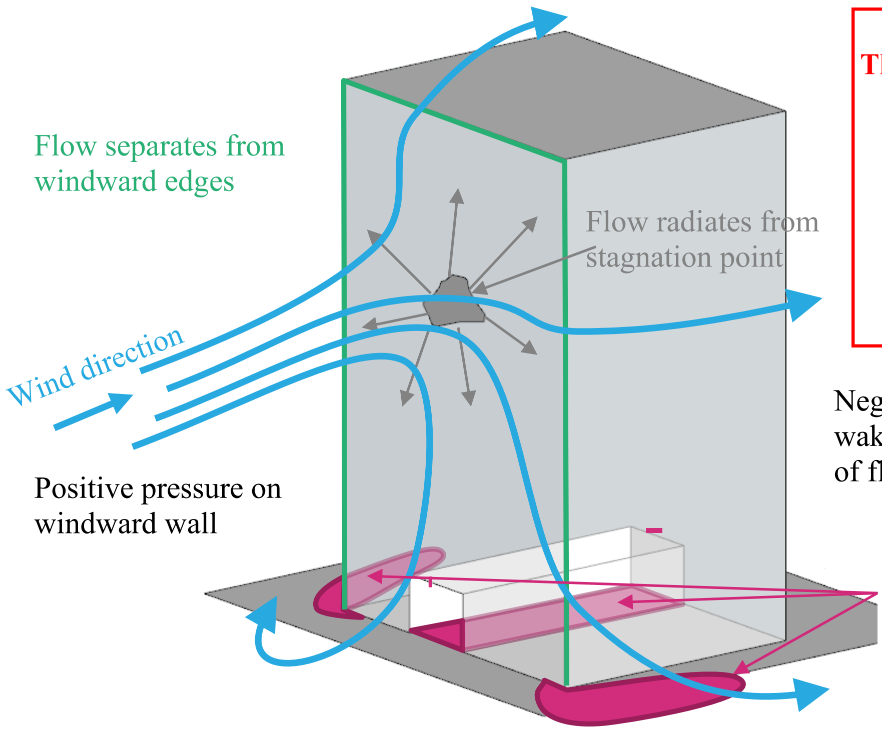

Figure 9: Schematic wind flow around tall isolated building

Techniques to mitigate the effects of downwash winds at ground level include the provision of horizontal elements, the most effective being a podium to divert the downward flow away from pavements and building entrances, but this will generate windy conditions on the podium roof, Figure 11. Generally, the lower the podium roof and deeper the setback from the podium edge to the tower improves the ground level wind conditions. The provision of an 8 m setback on an isolated building is generally sufficient to improve ground level conditions, but is highly dependent on the building isolation, orientation to prevailing wind directions, shape and width of the building, and any plan form changes at higher level.

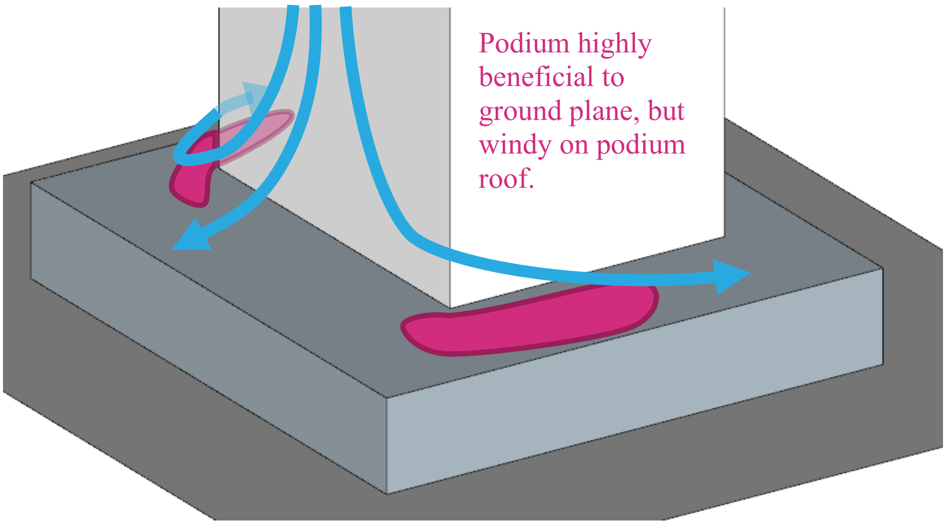

Figure 10: Schematic flow pattern around building with podium

Awnings along street frontages perform a similar function as a podium, and generally the larger the horizontal projection from the façade, the more effective it will be in diverting downwash flow, Figure 11. Awnings become less effective if they are not continuous along the entire façade, or on wide buildings as the positive pressure bubble extends beyond the awning resulting in horizontal flow under the awning.

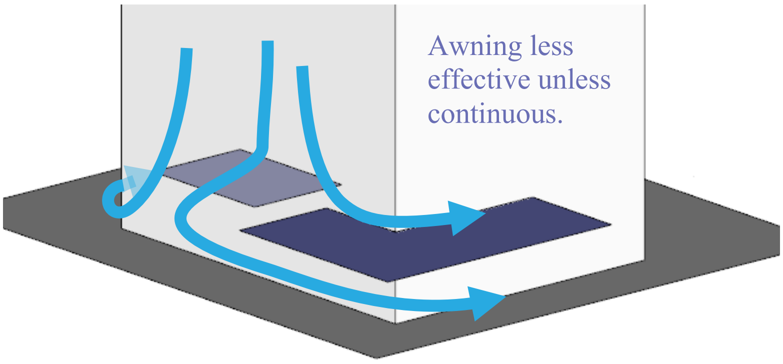

Figure 11: Schematic flow pattern around building with awning

It should be noted that colonnades at the base of a building with no podium generally create augmented windy conditions at the corners due to an increase in the pressure differential, Figure 12. Similarly, open through-site links through a building cause wind issues as the environment tries to equilibrate the pressure generated at the entrances to the link, Figure 9. If the link is blocked, wind conditions will be calm unless there is a flow path through the building, Figure 13. This area is in a region of high pressure and therefore the is the potential for internal flow issues. A ground level recessed corner has a similar effect as an undercroft, resulting in windier conditions, Figure 13.

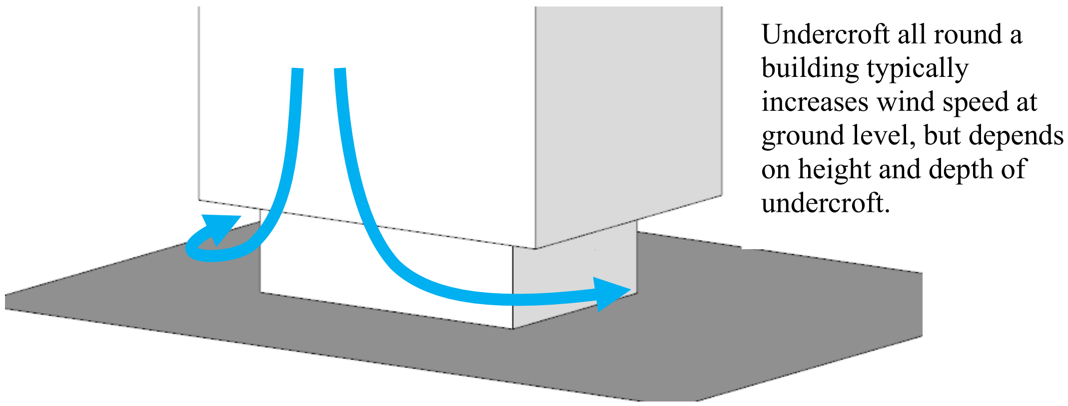

Figure 12 Schematic of flow patterns around isolated building with undercroft

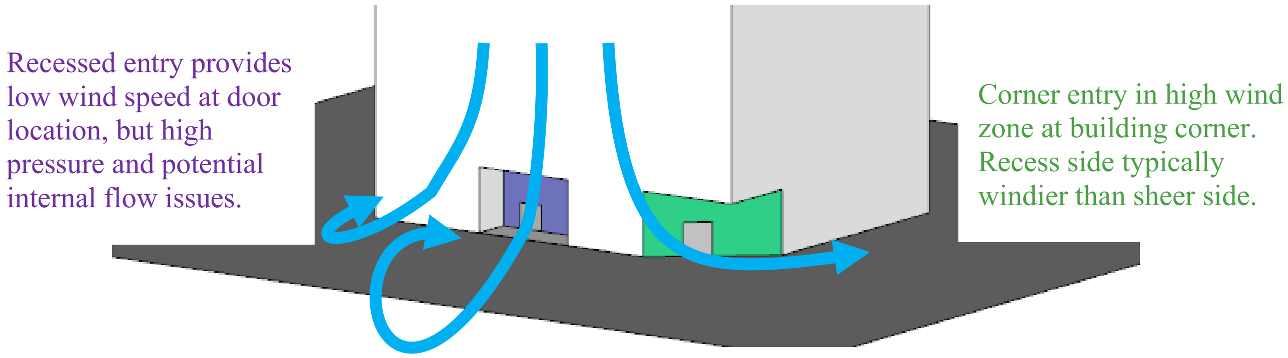

Figure 13: Schematic of flow patterns around isolated building with ground articulation

Multiple buildings

When a building is located in a city environment, depending on upwind buildings, the interference effects may be positive or negative, Figure 14. If the building is taller, more of the wind impacting on the exposed section of the building is likely to be drawn to ground level by the increase in height of the stagnation point, and the additional negative pressure induced at the base. If the upwind buildings are of similar height then the pressure around the building will be more uniform hence downwash is typically reduced with the flow passing over the buildings.

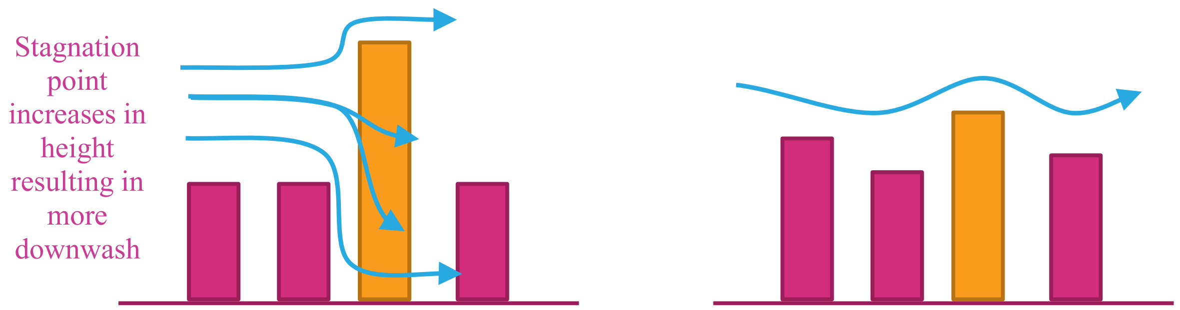

Figure 14: Schematic of flow pattern interference from surrounding buildings

The above discussion becomes more complex when three-dimensional effects are considered, both with orientation and staggering of buildings, and incident wind direction, Figure 15.

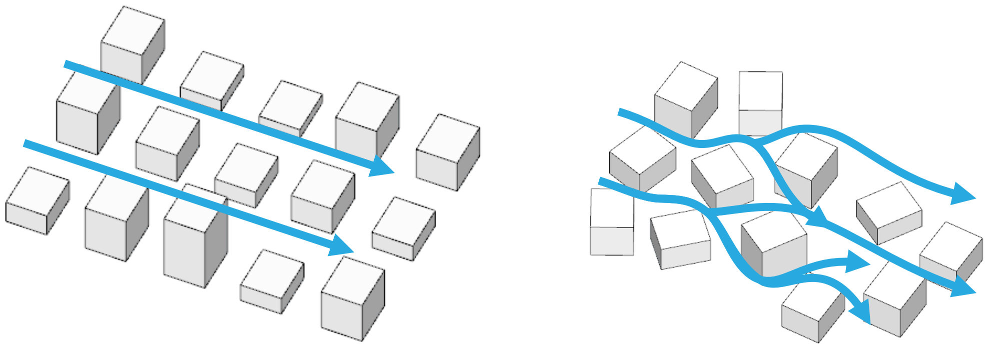

Figure 15: Schematic of flow patterns through a grid and random street layout

Channelling occurs when the wind is accelerated between two buildings, or along straight streets with buildings on either side, Figure 15(L), particularly on the edge of built-up areas where the approaching flow is diverted around the city massing and channelled along the fringe by a relatively continuous wall of building facades. This is generally the primary mechanism driving the wind conditions for this perimeter of a built-up area, particularly on corners, which are exposed to multiple wind directions. The perimeter edge zone in a built-up area is typically about two blocks deep. Downwash is more important flow mechanism for the edge zone of a built-up area with buildings of similar height.

As the city expands, the central section of the city typically becomes calmer, particularly if the grid pattern of the streets is discontinued, Figure 15(R). When buildings are located on the corner of a central city block, the geometry becomes slightly more important with respect to the local wind environment.

Single barriers and screens

The wind flow pattern over a vertical barrier is illustrated in Figure 16, showing there will be recirculation zones near the windward wall and in the immediate lee of the barrier. The typical extent of these recirculation zones relative to the height of the barrier, h, is illustrated in Figure 16. These regions are not fixed but fluctuate in time. The mean wind speed in the wake areas drops significantly compared with the incident flow. With increasing distance from the barrier the flow pattern will resort to the undisturbed state. Typically the mean velocity and turbulence intensity at barrier height would be expected to be within 10% of the free stream conditions at 10 times the height of the structure downwind from the barrier.

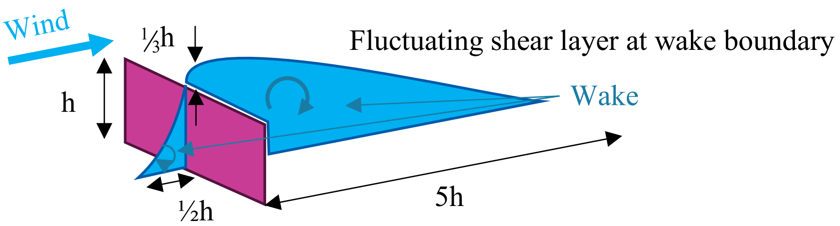

Figure 16: Sketch of the flow pattern over an isolated structure

A.2 Wind speed criteria

General discussion

Primary controls that are used in the assessment of how wind affects pedestrians are the wind speed, and rate of change of wind speed. A description of the effect of a specific wind speed on pedestrians is provided in Table 2. It should be noted that the turbulence, or rate of change of wind speed, will affect human response to wind and the descriptions are more associated with response to mean wind speed.

Table 2: Summary of wind effects on pedestrians

Description	Speed (m/s)	Effects
Calm, light air	0–2	Human perception to wind speed at about 0.2 m/s. Napkins blown away and newspapers flutter at about 1 m/s.
Light breeze	2–3	Wind felt on face. Light clothing disturbed. Cappuccino froth blown off at about 2.5 m/s.
Gentle breeze	3–5	Wind extends light flag. Hair is disturbed. Clothing flaps.
Moderate breeze	5–8	Raises dust, dry soil. Hair disarranged. Sand on beach saltates at about 5 m/s. Full paper coffee cup blown over at about 5.5 m/s.
Fresh breeze	8–11	Force felt on body. Limit of agreeable wind on land. Umbrellas used with difficulty. Wind sock fully extended at about 8 m/s.
Strong breeze	11–14	Hair blown straight. Difficult to walk steadily. Wind noise on ears unpleasant. Windborne snow above head height (blizzard).
Near gale	14–17	Inconvenience felt when walking.
Gale	17–21	Generally impedes progress. Difficulty with balance in gusts.
Strong gale	21–24	People blown over by gusts.

Local wind effects can be assessed with respect to a number of environmental wind speed criteria established by various researchers. These have all generally been developed around a 3 s gust, or 1 hour mean wind speed. During strong events, a pedestrian would react to a significantly shorter duration gust than a 3 s, and historic weather data is normally presented as a 10 minute mean.

Despite the apparent differences in numerical values and assumptions made in their development, it has been found that when these are compared on a probabilistic basis, there is some agreement between the various criteria. However, a number of studies have shown that over a wider range of flow conditions, such as smooth flow across water bodies, to turbulent flow in city centres, there is less general agreement among. The downside of these criteria is that they have seldom been benchmarked, or confirmed through long-term measurements in the field, particularly for comfort conditions. The wind criteria were all developed in temperate climates and are unfortunately not the only environmental factor that affects pedestrian comfort.

For assessing the effects of wind on pedestrians, neither the random peak gust wind speed (3 s or otherwise), nor the mean wind speed in isolation are adequate. The gust wind speed gives a measure of the extreme nature of the wind, but the mean wind speed indicates the longer duration impact on pedestrians. The extreme gust wind speed is considered to be suitable for safety considerations, but not necessarily for serviceability comfort issues such as outdoor dining. This is because the instantaneous gust velocity does not always correlate well with mean wind speed, and is not necessarily representative of the parent distribution. Hence, the perceived 'windiness' of a location can either be dictated by strong steady flows, or gusty turbulent flow with a smaller mean wind speed.

To measure the effect of turbulent wind conditions on pedestrians, a statistical procedure is required to combine the effects of both mean and gust. This has been conducted by various researchers to develop an equivalent mean wind speed to represent the perceived effect of a gust event. This is called the 'gust equivalent mean' or 'effective wind speed' and the relationship between the mean and 3 s gust wind speed is defined within the criteria, but two typical conversions are:

$$U_{GEM} = \frac{(U_{1\,hour\,mean} + 3 \cdot \sigma_u)}{1.85} \quad \text{and} \quad U_{GEM} = \frac{1.3 \cdot (U_{1\,hour\,mean} + 2 \cdot \sigma_u)}{1.85}$$

It is evident that a standard description of the relationship between the mean and impact of the gust would vary considerably depending on the approach turbulence, and use of the space.

A comparison between the mean and 3 s gust wind speed criteria from a probabilistic basis are presented in Figure 17 and Figure 19. The grey lines are typical results from modelling and show how the various criteria would classify a single location. City of Auckland has control mechanisms for accessing usability of spaces from a wind perspective as illustrated in Figure 17 with definitions of the intended use of the space categories defined in Figure 18.

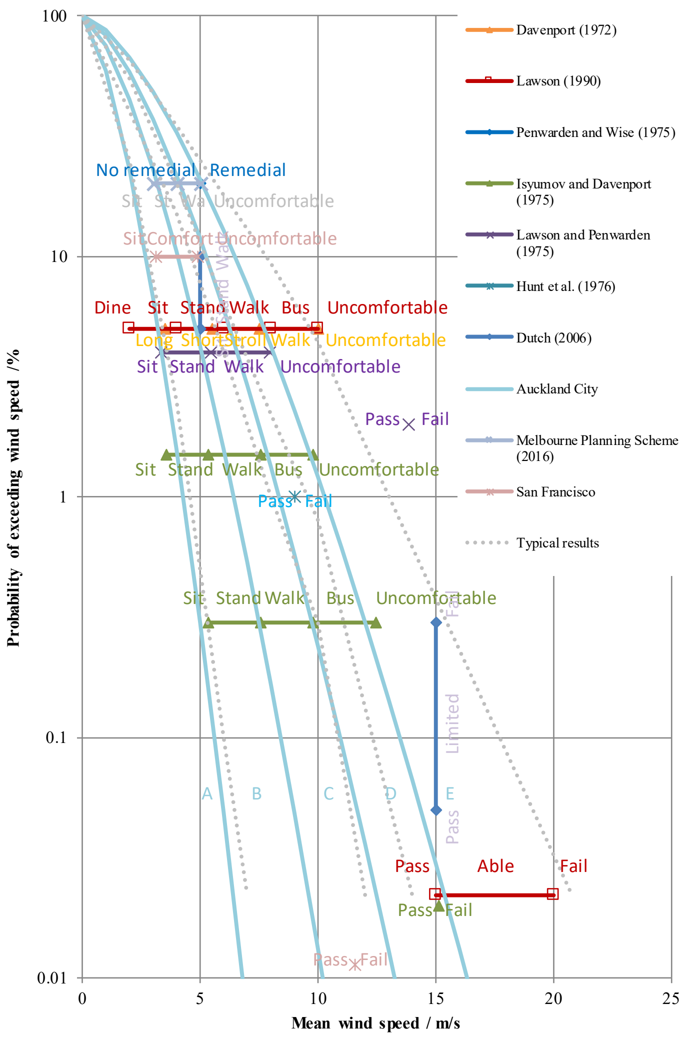

Figure 17: Probabilistic comparison between wind criteria based on mean wind speed

Category A	Areas of pedestrian use or adjacent dwellings containing significant formal elements and features intended to encourage longer term recreational or relaxation use i.e. public open space and adjacent outdoor living space
Category B	Areas of pedestrian use or adjacent dwellings containing minor elements and features intended to encourage short term recreation or relaxation, including adjacent private residential properties
Category C	Areas of formed footpath or open space pedestrian linkages, used primarily for pedestrian transit and devoid of significant or repeated recreational or relaxational features, such as footpaths not covered in categories A or B above
Category D	Areas of road, carriage way, or vehicular routes, used primarily for vehicular transit and open storage, such as roads generally where devoid of any features or form which would include the spaces in categories A - C above.
Category E	Category E represents conditions which are dangerous to the elderly and infants and of considerable cumulative discomfort to others, including residents in adjacent sites. Category E

Figure 18: Auckland Utility Plan (2016) wind categories

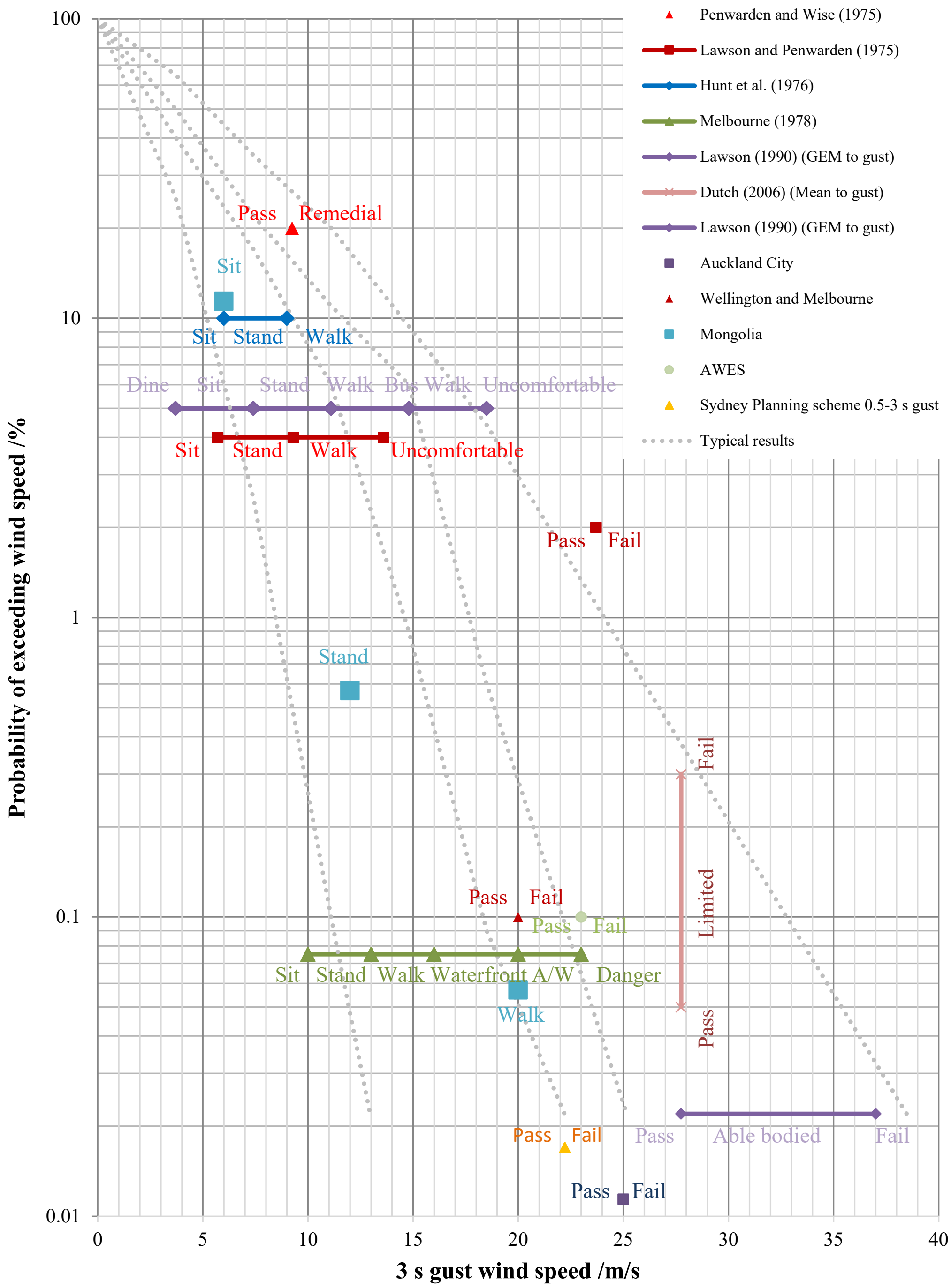

Figure 19: Probabilistic comparison between wind criteria based on 3 s gust wind speed

A.3 Reference documents

In preparing the assessment, the following documents have been referenced to understand the building massing and features:

- Architectural Drawings, dated 24 May 2024 (Revision 1, Town Planning Issue)