ARUP

Longhurst

Edgecliff Centre

Environmental Wind Assessment Report

Reference: Wind

Rev. 03 | 5th March 2024

Job number 274377-05

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Executive Summary

Arup have been commissioned to prepare an experienced-based environmental wind impact assessment report for the proposed Edgecliff Centre development on the pedestrian level wind conditions for comfort and safety in and around the site. It is considered that the proposed development would have an impact on the local wind conditions, with any issues being able to be ameliorated through design development.

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, with some locations at the upper bound of this level, and others pedestrian standing. In general, the wind conditions on the ground plane would be expected to meet the safety criterion, with conditions close to the western corners along New McLean Street approaching the safety criterion level.

Benefits of the design from a pedestrian level wind perspective include the significant tower setbacks from the podium edge, and the curved tower corners to reduce the impacts of downwash flow.

Wind conditions through the highly porous podium levels would be expected to experience pressure-driven flow at the narrowest locations along the flow paths. These conditions would be suitable for use as transient spaces. Local amelioration would be required for more sedentary activities.

Wind conditions on the pedestrian accessible podium roof area would be expected to exceed the safety criterion close to the corners of the taller towers. Any quantified exceedances of the criterion would be able to be ameliorated through local treatments during detailed design, or operational management of the terrace space. From a comfort perspective, the podium roof would be expected to be classified as suitable pedestrian walking close to the towers. Further from the buildings, such as the north-west corner would be expected to meet the classification for pedestrian standing type activities. Appropriate local amelioration for wind sensitive areas such as outdoor seating areas, would be developed during detailed design to improve the wind conditions.

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 once the geometry is more developed. It would be recommended to conduct such studies for this significant development. Upon completion, the level of amelioration required can be developed through detailed design.

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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

This qualitative environmental wind assessment report has been prepared on behalf of Longhurst Investments No. 1 Pty. Ltd. in support of a planning proposal for the Edgecliff Centre (the site). The planning proposal will support amendments to the Woollahra Local Environmental Plan 2014 in order to facilitate the future redevelopment of the site for a mixed-use development comprising retail/commercial/medical uses podium and residential tower.

This Planning Proposal relates to the Edgecliff Centre at 203–233 New South Head Road and part of the adjoining Council-owned road reserve fronting New McLean Street (herein collectively identified as the **site**). It seeks the following amendments to the Woollahra Local Environmental Plan 2014 (**WLEP 2014**) to support the mixed-use redevelopment of the site:

- Increasing the maximum permitted Height of Buildings from part 0m, part 6m and 26m to part 13 and part 35 storeys plus plant.
- Increase the maximum permitted GFA on the Edgecliff Centre portion of the site to 44,190 sqm;
- Increase the maximum permitted GFA on the Council-owned road reserve to 3,300 sqm; and
- Introduce a site-specific provision to retain a minimum 2:1 FSR for non-residential purposes.

The Planning Proposal will also incorporate a portion of residual land which forms part of the New MacLean Street road-reserve, abutting the southern boundary of the Site, and the FSR and Height of Buildings development standard proposed for the Site are proposed to extend to this portion of land.

The Planning Proposal is supported by an indicative development concept to demonstrate the anticipated built form outcome envisioned for the site under the proposed amendments to the WLEP 2014. The concept is centred around revitalising the site for a vibrant mixed-use development that can simultaneously give back to the community through a combination of community uses and public open spaces, the provision of essential medical services whilst increasing employment generating floor space and housing close to transport.

Specifically, the concept includes:

- A combination of commercial (including office and retail), residential, and medical land uses with a total Gross Floor Area of circa 44,190 sqm;
- The distribution of form comprising:
  - A mixed-use podium between two and three storeys with retail, office, medical, community uses and public open space;
  - Two individual tower components for commercial and residential uses up to a height of part 13 storeys and part 35 storeys plus plant;
- Basement with capacity for End of Trip facilities along with circa 333 car parking spaces, 429 bicycle spaces and 34 motorcycle spaces;
- Activated and landscaped frontages to New McLean and New South Head Road within an integrated civic ground floor retail precinct;
- Delivery of a town square plaza, open green space and forecourt visibly prominent and publicly accessible, and
- Introduction of a network of pedestrian laneways, through site links and colonnade.

A detailed description is provided within the Planning Proposal Justification Report prepared by Ethos Urban.

2. Wind assessment

2.1 Local wind climate

Weather data recorded by the Bureau of Meteorology at a standard height of 10 m at Sydney Airport have been used in this analysis, Figure 1. The arms of the wind rose point in the direction from where the wind is coming from. The anemometer is located about 10 km to the south-west of the site. The directional wind speeds measured here are considered representative of the wind conditions at the site.

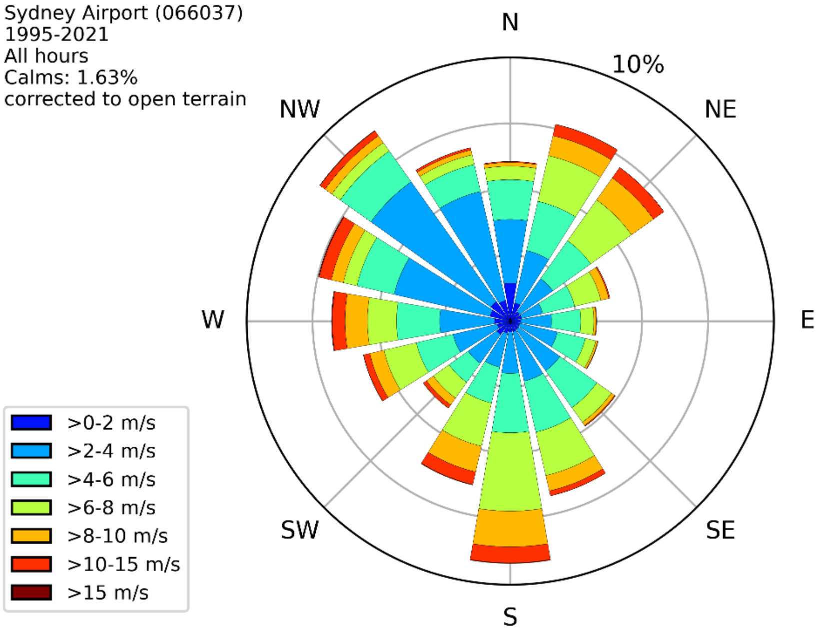

Figure 1: Wind rose showing probability of time of wind direction and speed

It is evident from Figure 1 that strong prevailing winds are organised into three main groups which centre at about the north-east, south, and west quadrants. The measured mean wind speed is about 4.5 m/s, and the 5% exceedance mean wind speed 9.5 m/s.

Strong summer winds occur mainly from the south quadrant and the north-east. Winds from the south are associated with large synoptic frontal systems and generally provide the strongest gusts during summer. Moderate intensity winds from the north-east tend to bring cooling relief on hot summer afternoons typically lasting from noon to dusk. These are small-scale temperature driven effects; the larger the temperature differential between land and sea, the stronger the wind.

Winter and early spring strong winds typically occur from the south-west, and west quadrants. West quadrant winds provide the strongest winds affecting the area throughout the year and tend to be associated with large scale synoptic events that can be hot or cold depending on inland conditions.

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

2.2 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.

Woollahra Council has no specific wind controls for the site. The wind controls used in this wind assessment are based on the work of Lawson (1990) as described in Figure 15 and Table 1. The comfort criterion are based on a mean or gust equivalent mean wind speed exceeding specific wind speeds for 5% of the time during daylight hours. The safety criterion is based on a maximum 0.5 s gust wind speed of 24 m/s occurring once per annum during daylight hours.

Table 1 Pedestrian comfort criteria for various activities

Converting the wind climate to the site location, the mean wind speed exceeded 5% of the time would be approximately 6 m/s at pedestrian level. Form Table 1 these conditions would be classified as on the border of pedestrian standing and walking. From knowledge of the wind conditions in the locale, this would be an appropriate correct classification for the area.

Site description

The proposed Edgecliff Centre site is located to the west of the block bounded by New South Head Road, Ocean Street, and New McLean Street, Figure 2. The site is generally surrounded by low-rise buildings in all directions, with nearby isolated medium- to high-rise buildings to the east and north respectively. The site is located on complex topography from a wind perspective, dropping steeply to the south-west and north-east, dropping gently to the north, while rising gently to the south-east.

Figure 2 Site location (source: Google Maps 2021)

The existing building on the site rises to a maximum height of about 32 m above ground level along New South Head Road to the north of the site, with a two-storey car park to the south.

The indicative scheme consists of a porous mixed-use podium rising to a height of about 18 m above ground level along New South Head Road. To the north-east of the podium, a commercial building rises 13 storeys, about 60 m, above New South Head Road with no setback to the north. To the south of the site, a slender residential tower rises to 35 storeys, about 125 m, above New McLean Street ground level, Figure 3. The buildings sections are prismatic of irregular planform, Figure 3 and Figure 4. The residential tower is set back from the podium edge by about 42 m to the north, 12 m to the east, minimum of 6 m to the south, and no setback to the west up to Level 15, and 9 m for the upper levels, Figure 3. There is pedestrian access around the entire site.

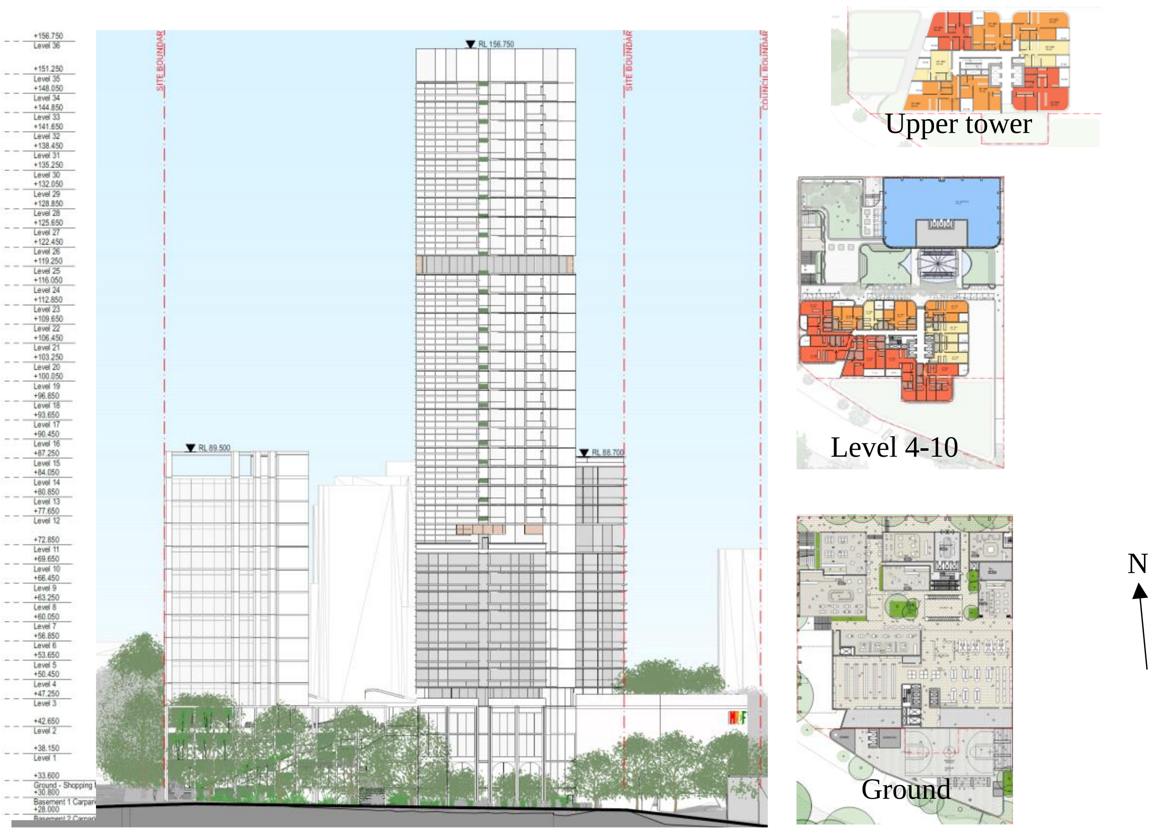

Figure 3: West elevation (L), various plans (R)

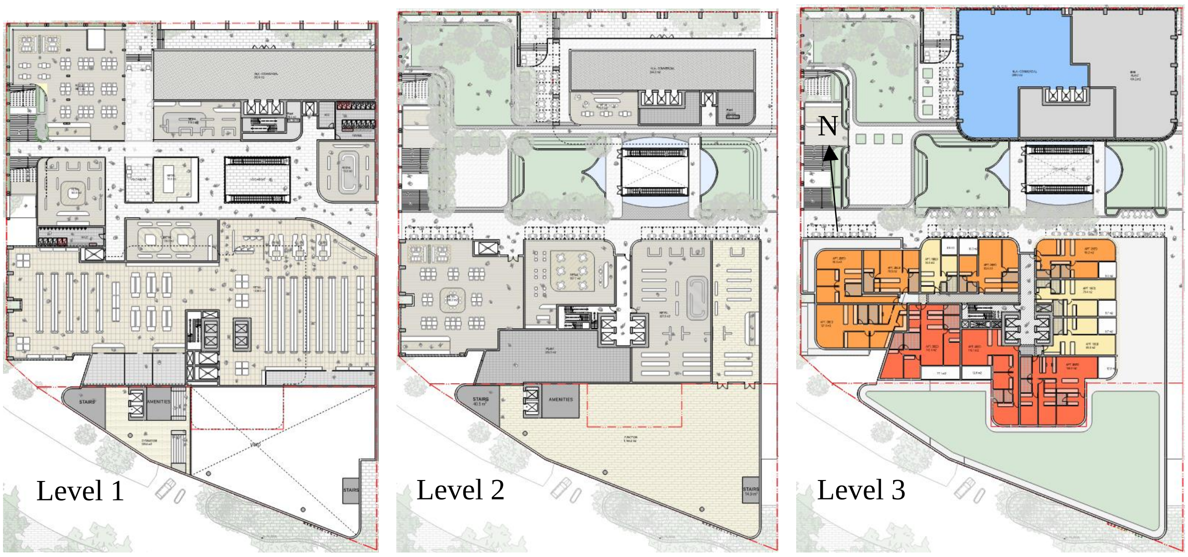

Figure 4: Additional podium plans

2.3 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 wind climate, topography, and changes to the building form. The wind conditions in this part of city are known to be relatively windy due to the local topography, particularly on the corner of New South Head Road and New McLean Street for winds from the south.

The overall massing of the proposed redevelopment is larger than the existing and surrounding buildings, and will therefore have an impact on the local wind conditions making some areas calmer and other areas windier depending on the incident wind direction as discussed below.

Winds from the north-east

Winds from the north-east would cross the harbour before accelerating up the local topography from Double Bay before reaching the site. As the buildings are taller that the surrounds the incident flow on the towers will be relatively undisturbed on reaching the site and would impinge on the corner of the Commercial and Residential towers encouraging the flow to pass around the buildings horizontally, rather than inducing downwash onto New South Head Road. The wide north face of the commercial building would direct the incident flow to the west across the podium roof, before impinging on the residential tower and discharged across New McLean Street. The wind conditions to the south of the tower along New McLean Street would be expected to increase slightly due to flow being drawn into the wake of the development. Local amelioration, or changes to the building form, can be developed through detailed design to ameliorate windy conditions.

Winds from the south

The site is exposed to winds from the south, which would accelerate up the local topography towards New South Head Road. The broad face of the tower is perpendicular to the incident wind direction and would induce downwash flow, as described in Appendix A.1. The lack of tower setback from the podium edge to the south-west below Level 15 would offer little resistance to downwash flow reaching ground level.

There are considered some significant benefits of the design to reduce the wind effects on the ground plane including:

1. the upper section of the residential tower has a significant setback for the podium edge to the west, which would discharge a portion of the flow at a higher level,
2. the curved corners on the corner below Level 15 will encourage more horizontal flow reducing the amount of downwash reaching ground level,
3. the significant tower setbacks from the east and south edges of the podium diverts a portion of the flow across the podium roof rather than descending to ground level, and
4. the rise in topography to the north along New McLean Street would reduce the amount of downwash.

The Level 3 pedestrian connection to the bus terminal outside the site boundary is exposed to the downwash flow. The 9 m setback from the east face of the residential tower to the laneway offers protection to pedestrians. Regardless, the wind conditions along the accessway are expected to be relatively windy. The conditions could be further ameliorated during detailed design with local protection such as a canopy roof, vertical barriers to the west of the walkway, or landscaping.

Winds from the west

Winds from the west are slightly accelerated up the local topography before reaching the site. The podium western façade of the development has increased in size, which would direct more flow along New South Head Road and New McLean Street. Windier locations would be expected to occur around the western corners. The porosity of the podium would help reduce the flow around the corners.

The west aspect of residential tower is relatively narrow with the lower levels having rounded corners, which would encourage horizontal flow around the tower thereby reducing downwash reaching ground level. The upper section of the tower is well setback from New McLean Street and the podium roof to the north and south would be expected to redirect a large component of the downwash flow before reaching ground level. Stronger windy conditions are expected around the western corners of the site.

The Commercial building to the north would similarly induce some downwash onto New South Head Road. The curved south-west tower corner, and undercroft at Level 2 would assist in reducing the flow reaching ground level. It would be recommended to include a canopy somewhere above the recessed entrance from New South Head Road, Figure 5.

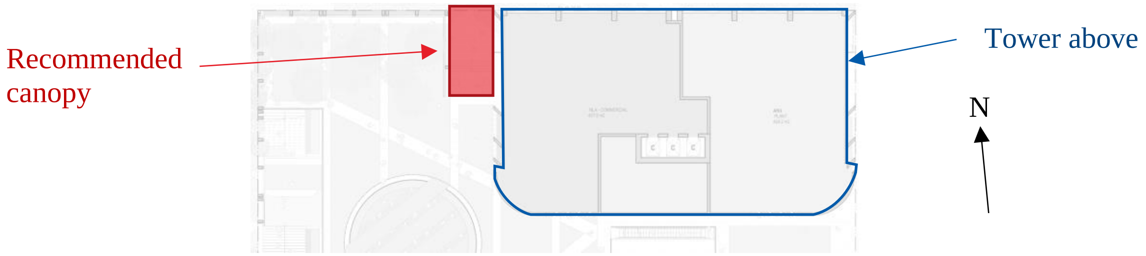

Figure 5: Level 2 plan showing proposed mitigation measures

Winds more from the north-west would generate downwash along the long north faces of the buildings. The downwash flow would be redirected by the podium and neighbouring roofs before reaching ground level. The wind conditions across the podium roof are expected to be relatively windy. Depending on the intended use of the spaces, wind conditions could be locally ameliorated during detailed design with local protection such as canopy roofs, vertical barriers, or landscaping.

Discussion

The height and massing of the proposed development is greater than the current conditions and would therefore impact the local wind environment making some areas windier and others calmer depending on the incident wind speed and direction.

Qualitatively, integrating the expected directional wind conditions around the site with the wind climate, it is considered that wind conditions would be classified as suitable for pedestrian walking, with locations on the western corners being at the upper end of this classification. These wind conditions on the ground plane would be considered suitable for the intended use of the space.

All locations would be expected to pass the safety criterion, but it would be expected to approach the criterion level around the south-west corner of the development. The level of mitigation would be developed through detailed design after quantification of the wind conditions.

Local amelioration is expected to be required for any outdoor café areas around the development. These would typically take the form of permanent or temporary porous screens perpendicular to the façade, or more enclosed booths to create localised calm areas.

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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 6, 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 6. 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.

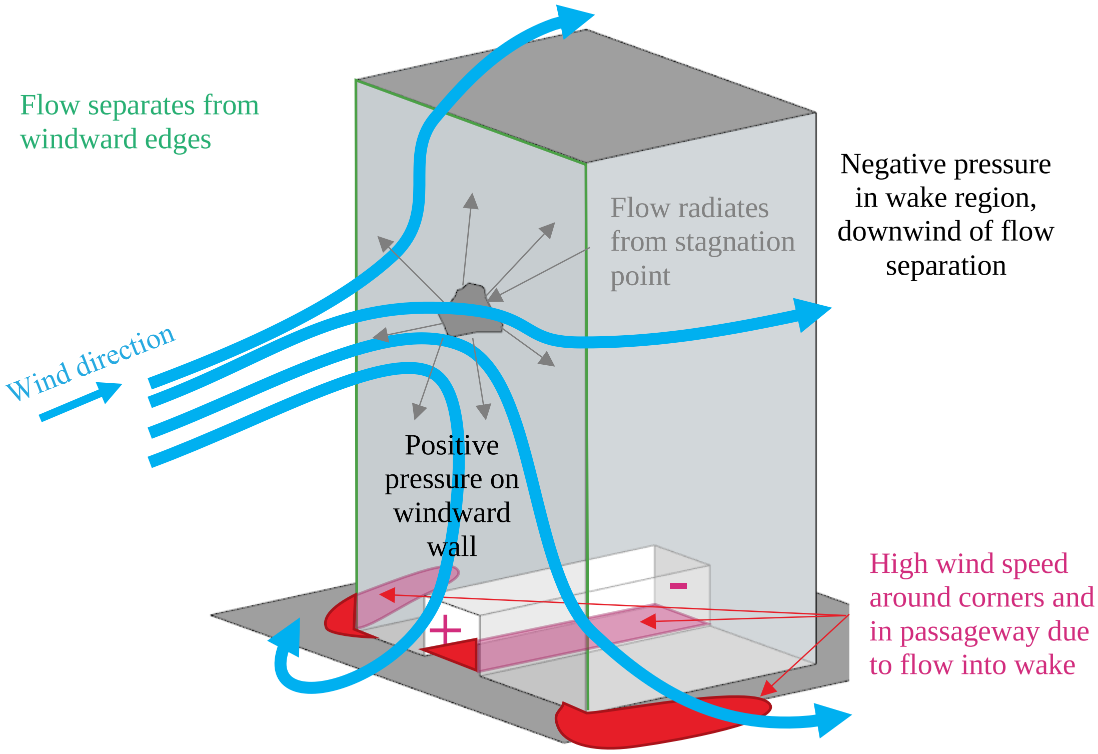


Figure 6: Schematic wind flow around tall isolated building

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 7. 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.

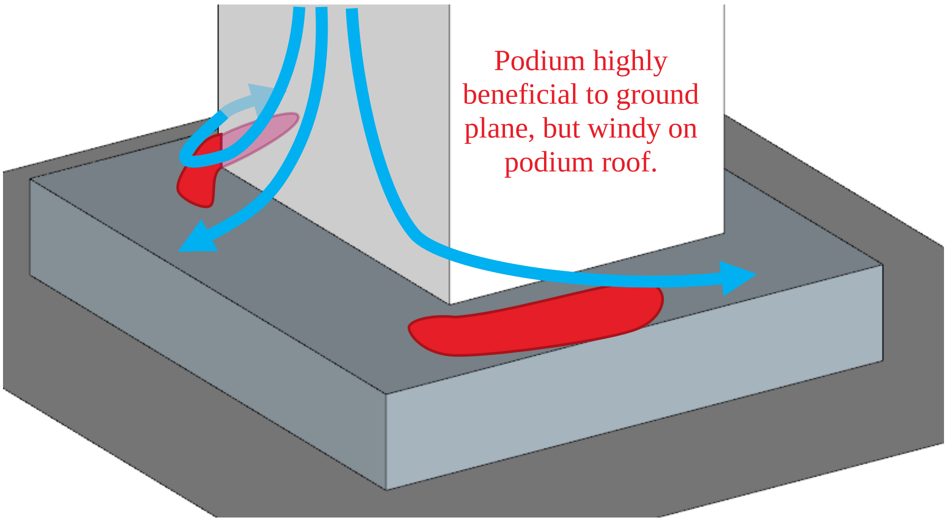


Figure 7: Schematic flow pattern around building with podium

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 8. 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.

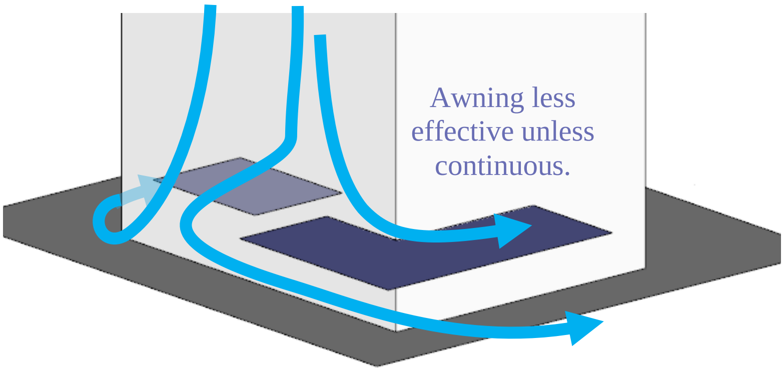


Figure 8: Schematic flow pattern around building with podium

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 9. Similarly, open through-site links through a building cause wind issues as the pressure tries to equilibrate between the entrances to the link causing strong flow, Figure 6. If the link is blocked, wind conditions will be relatively calm, Figure 10. This area is in a region of high pressure and therefore there is the potential for internal flow issues. A ground level recessed corner has a similar effect as an undercroft, resulting in windier conditions, Figure 10.

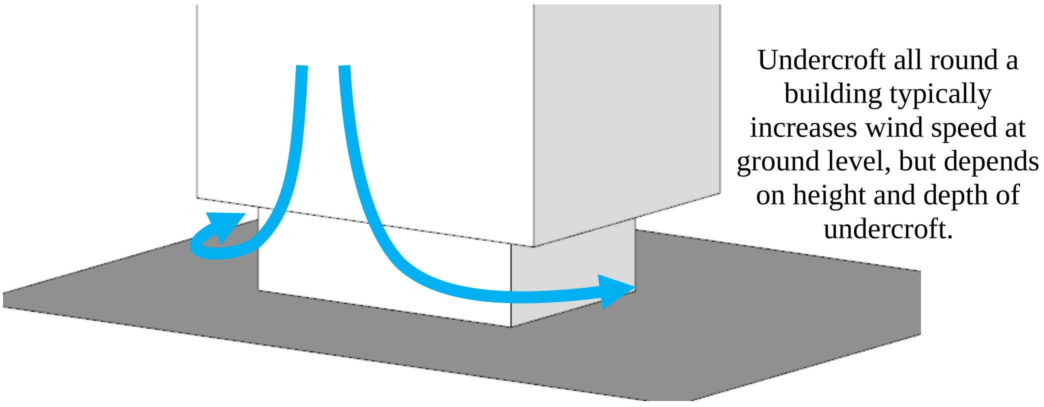


Figure 9: Schematic of flow patterns around isolated building with undercroft

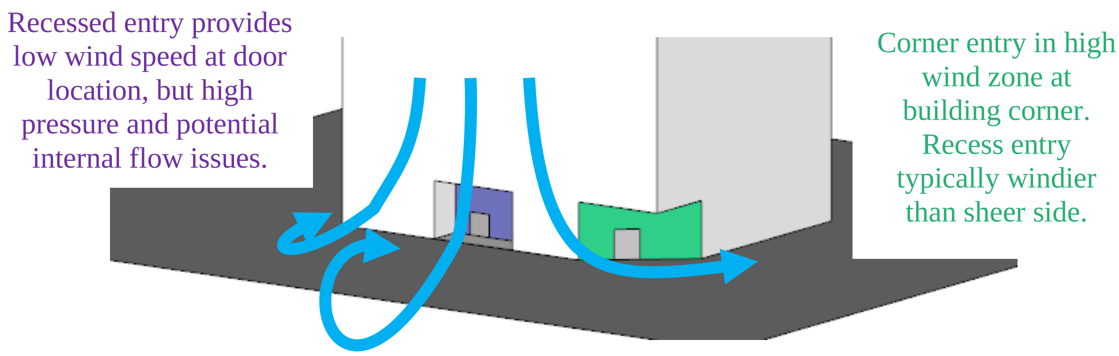


Figure 10: Schematic of flow patterns around isolated building with ground articulation

Multiple building

When a building is located in a city environment, depending on upwind buildings, the interference effects may be positive or negative, Figure 11. 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.

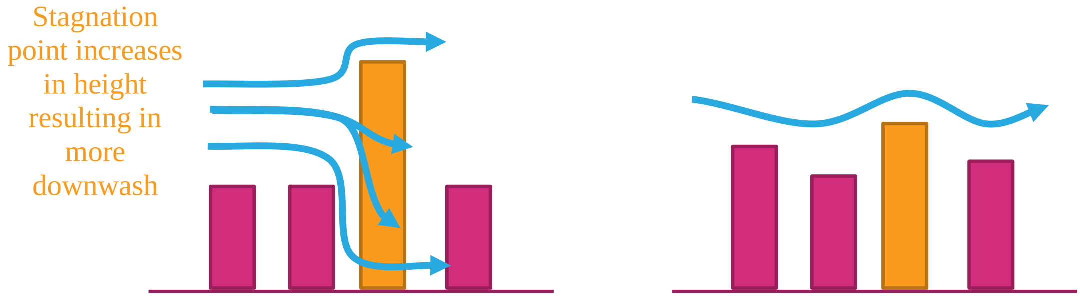


Figure 11: Schematic of flow pattern interference from surrounding buildings

The above discussion becomes more complex when three-dimensional effects are considered, both with orientation and staggering of buildings, and incident wind direction, Figure 12.

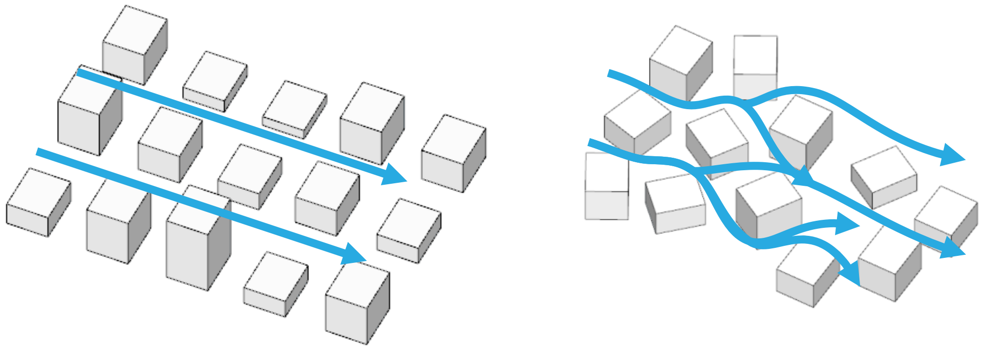


Figure 12 Schematic of flow patterns through a grid and random street layout

On the fringe of a city, the compound shape of neighbouring buildings instigates the flow pattern through the city. The overall massing causes an obstruction to the flow causing a slowing of the incident flow and increasing the windward pressure. Pressure driven flow is produced between the buildings, Figure 13. The vertical component in pressure driven flow is lower than downwash flow.

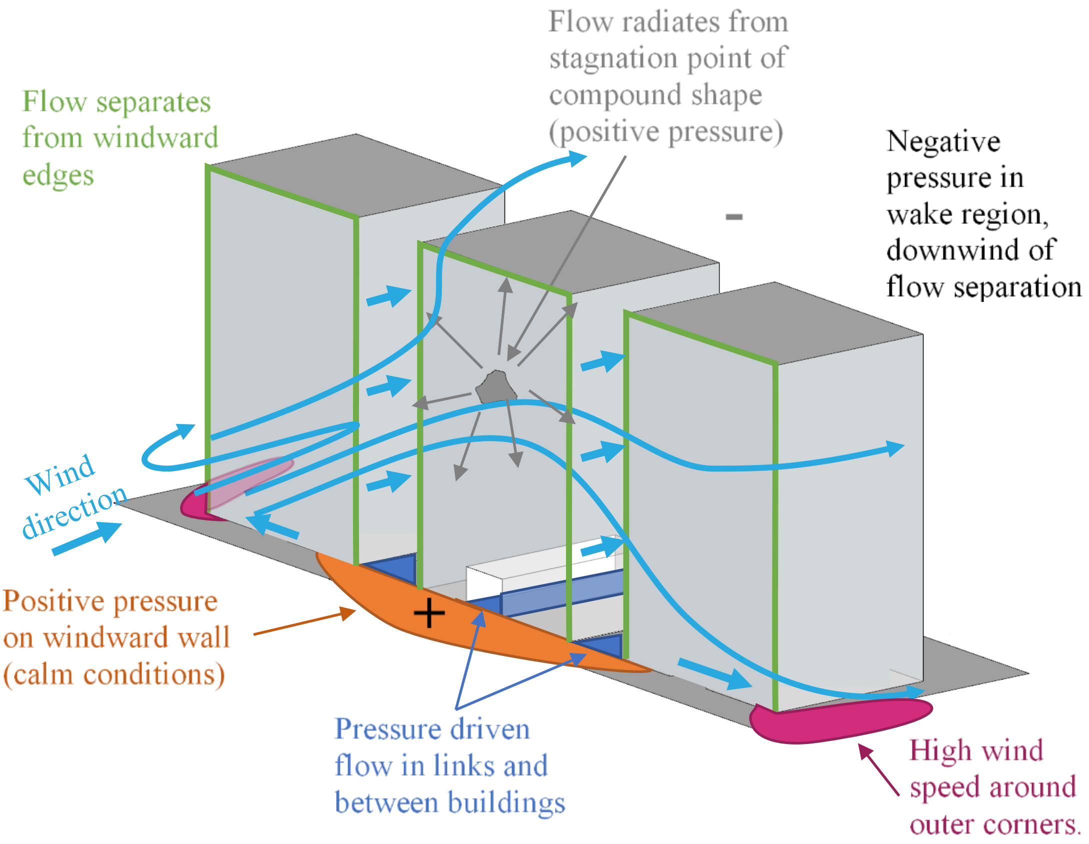


Figure 13: General flow pattern around multiple buildings

Channelling is instigated when pressure driven flow accelerates between two buildings, and continues along straight streets with buildings on either side, Figure 12(L). This occurs on the edge of large built-up areas where the approaching flow is diverted around the overall massing and channelled along the fringe by a relatively continuous wall of building facades. This is generally the primary mechanism producing strong wind conditions on the perimeter of a built-up area, particularly on corners, which can be exposed to multiple prevailing 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 12(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 14, 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 14. 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.

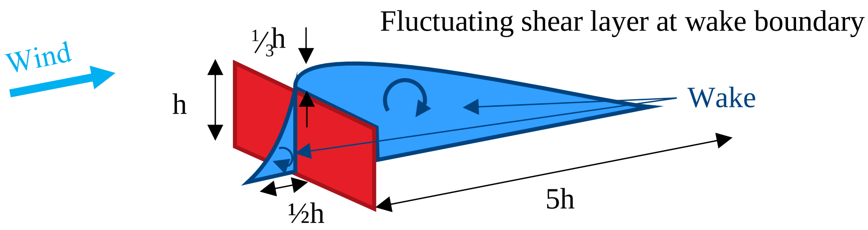


Figure 14: Sketch of the flow pattern over an isolated structure

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.

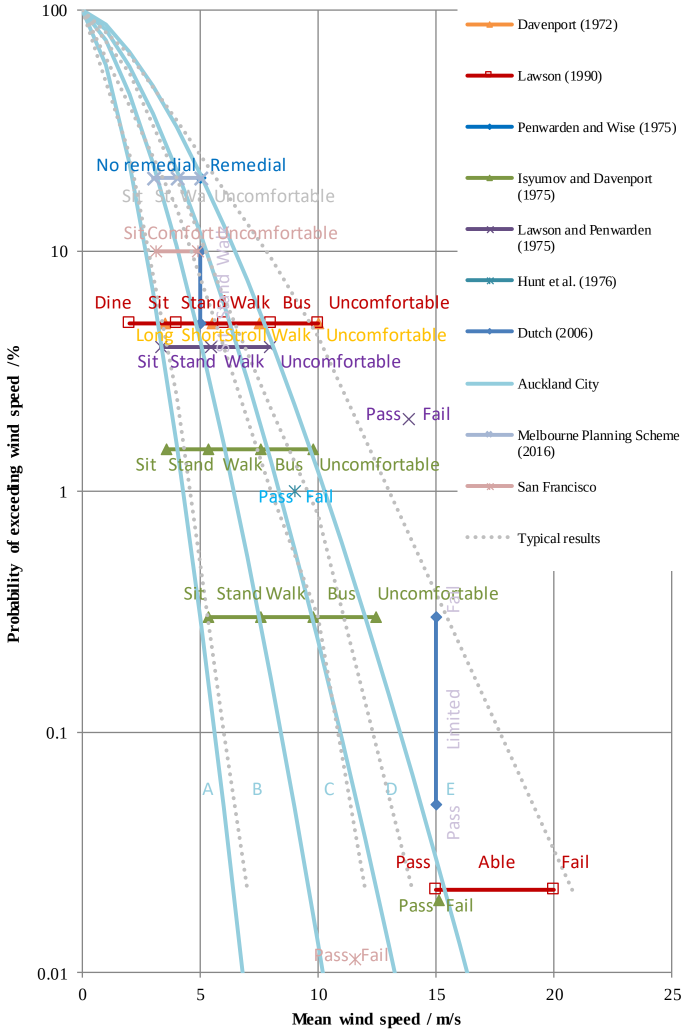
For assessing the effects of wind on pedestrians, neither the random peak gust wind speed (3 s or otherwise), nor the mean wind speed in isolation are adequate. The gust wind speed gives a measure of the extreme nature of the wind, but the mean wind speed indicates the longer duration impact on pedestrians. 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 15 and Figure 16. 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 15 with definitions of the intended use of the space categories included in this Figure.



Auckland Utility Plan (2016) wind categories

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 15: Probabilistic comparison between wind criteria based on mean wind speed

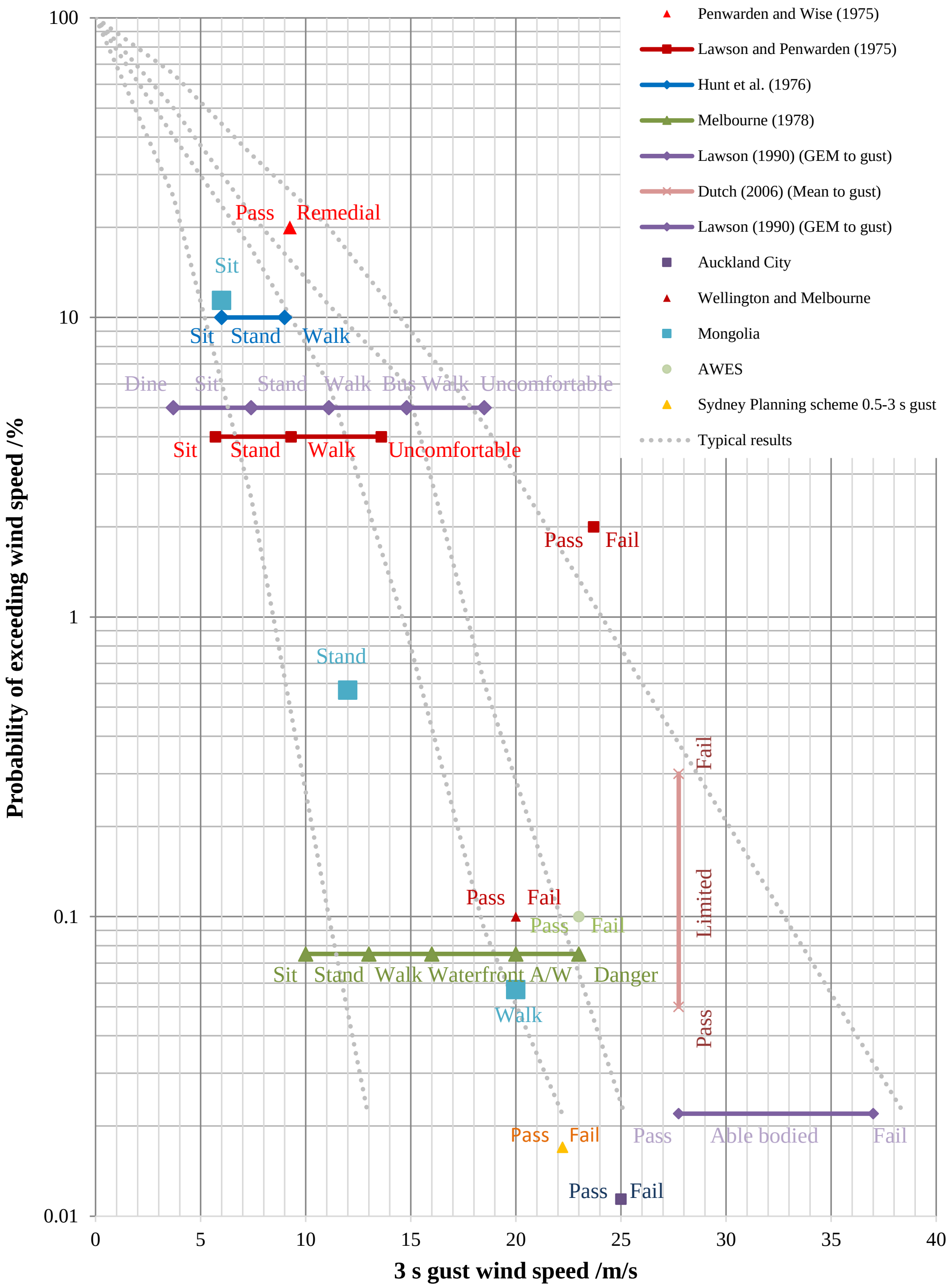


Figure 16: Probabilistic comparison between wind criteria based on 3 s gust wind speed

A.3 Reference documents

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

- 2000 Ground Floor Plan.pdf
- 2001 Level 1 Plan.pdf
- 2002 Level 2 Plan.pdf
- 2003 Level 3 Plan.pdf
- 2004 Level 4-10 Plan.pdf
- 2005 Level 11 Plan.pdf
- 2006 Typical Lower Plan.pdf
- 2007 Typical Upper Plan.pdf
- 2008 Roof Plan.pdf
- 20B1 Basement 1 Plan.pdf
- 20B2 Basement 2 Plan.pdf
- 20B3 Basement 3 Plan _ Railway Platform Level.pdf
- 20B4 Basement 4 Railway Platform (Level 4-7 Similar).pdf