WIND ENGINEERING CONSULTANTS

QUALITATIVE WIND ASSESSMENT
CPP PROJECT 21170
3 MARCH 2026

Campbelltown Arts Centre Expansion

Campbelltown, NSW

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Executive Summary

A qualitative assessment was conducted to determine the impact of the proposed Campbelltown Arts Centre Expansion development on the surrounding pedestrian wind environment. The assessment was based on the local wind climate, CPP's experience in the region and comparable projects, and the characteristics of the proposed development.

For most locations around the site, wind conditions are expected to remain similar to existing wind conditions. Qualitatively, integrating the expected directional wind conditions around the site with the wind climate, it is considered that with the Lawson wind criteria that the wind conditions would be generally classified as suitable for pedestrian standing. These pedestrian comfort levels are considered acceptable for the intended use. All locations would be expected to satisfy the safety/distress limiting annual maximum gust criterion.

The articulated nature of the building is a benefit to create some areas of calm conditions regardless of the incident wind direction.

This report is a high-level qualitative assessment based on basic features of the local wind climate and proposed built environment. To quantify the qualitative advice provided in this report, numerical or physical modelling of the development would be required, but is not considered necessary for this redevelopment.

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Document Tracking and Version Control

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Contents

1. Introduction

This environmental wind assessment report prepared by Cermak Peterka Petersen Pty. Ltd. on behalf of Campbelltown City Council is submitted to the Department of Planning, Housing and Infrastructure (DPHI) in support of a State Significant Development Application (SSDA) for the expansion of the existing Campbelltown Arts Centre (CAC) on land at 1 Art Gallery Road, Campbelltown (the site).

This SSDA seeks approval for:

- Demolition of parts of the existing buildings and structures on site.
- Expansion and redesign of the existing CAC, including the following elements:
  - Reorientation of the building towards Queen Street in the north to create a more substantial, welcoming and visible connection to the City Centre.
  - Addition of a new 350 seat theatre with back of house facilities.
  - Providing rehearsal spaces, creative and educational workshop areas, and community facilities.
  - Provision of ancillary artists' residences.
  - Provision of commercial spaces including a café/restaurant, retail, and conference facilities.
  - Provision of expanded gallery spaces for the exhibition of artists' collections and dedicated storage for loaned artworks and collections.
- Landscaping works including provision of feature planting and paving.
- Expansion and reconfiguration of at grade car parking.
- Extension and augmentation of services and infrastructure as required.

For a further detailed project description, please refer to the Environmental Impact Statement prepared by Colliers Urban Planning, the Architectural Drawings prepared by fjcstudio, and the other accompanying technical documents that form part of the State Significant Development Application.

THE SITE

The site is located at 1 Art Gallery Road, Campbelltown and is legally identified as Lot 500 DP777387, Lot B DP157318, Lot 1 DP1038779, Lot 2 DP259807 and Lot 3 DP259807, as illustrated in the Site Aerial at Figure 1. It is situated within the Campbelltown local government area (LGA) immediately southwest of the Campbelltown City Centre and railway station. The existing development on site consists of the current Campbelltown Arts Centre, characterised by a double storey built form with open space and an at-grade carpark.

The site is bounded by Art Gallery Road to the west, Narellan Road to the south, Oxley Street to the east and Camden Road to the north. The northern part of the site is separated from the southern portion by Art Gallery Road as shown in Figure 1. The site comprises a total site area of approximately 18,877 m^2.

The Site (1) LOT 500/DP 777387 (2) LOT B/DP 157318 (3) LOT 1/DP 1038779 (4) LOT 2/DP 259807 (5) LOT 3/DP 259807 NOT TO SCALE

Figure 1:Site Aerial (Source: Nearmap / Colliers Urban Planning)

RELEVANT SEAR TO THIS REPORT

This environmental wind assessment has been prepared in response to the Secretary's Environmental Assessment Requirements (SEARs) for the proposed development dated 7 August 2024 for SSD-74509208. Specifically, this report has been prepared to respond to those SEARs outlined in *Table 1*.

Table 1 Secretary's Environmental Assessment Requirements relevant to this Report

SEAR	SEAR Description	Section this is addressed and summary of response
5. Environmental amenity	Assess amenity impacts on the surrounding locality, including lighting impacts, solar access, visual privacy, visual amenity, view loss and view sharing, overshadowing and **wind** impacts. A high level of environmental amenity for any surrounding residential or other sensitive land uses must be demonstrated.	*Pedestrian-level environmental wind report – entire document.*

2. Wind Assessment

WIND CLIMATE

The proposed redevelopment lies approximately 11 km to the south-east of the Camden Airport Bureau of Meteorology anemometer, which provides the best source of historical wind data for the project. The wind rose is shown in Figure 2. The arms point in the direction from where the wind is blowing, the width and colour of the arm represent the wind speed, and the length of the arm indicates the percent of the time that the wind blows for that combination of speed and direction. It is evident from Figure 2 that prevailing winds come from the south-west quadrant, with stronger winds from the west quadrant. This wind assessment is structured around these prevailing wind directions.

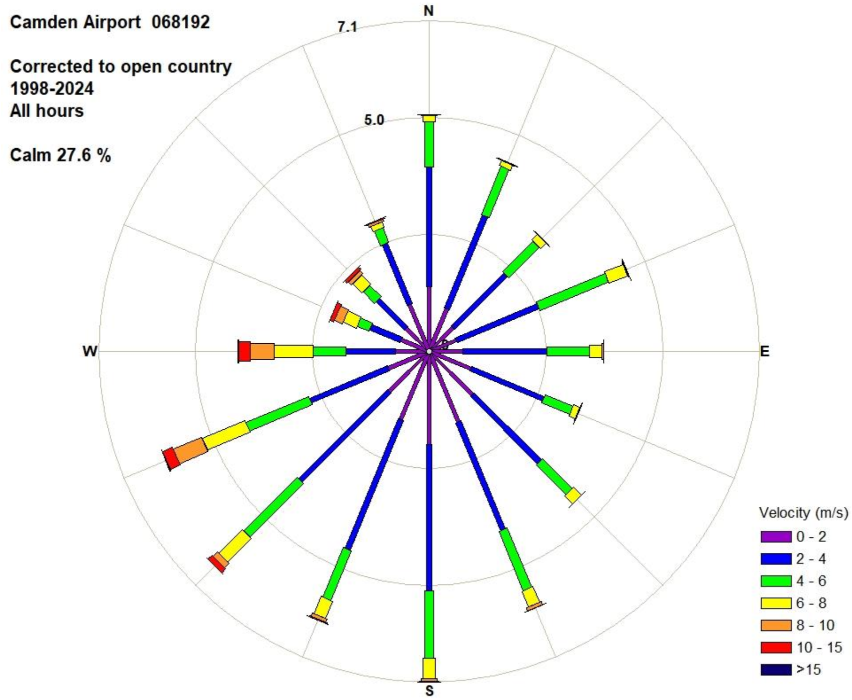

Figure 2: Wind rose for Camden Airport

WIND ASSESSMENT CRITERIA

A number of researchers have suggested quantitative methods for assessing wind comfort and safety based on estimated wind speeds and local climate statistics. These criteria provide a means of evaluating the wind amenity of location based on the frequency of threshold wind speeds, noting that pedestrians will tolerate higher wind speeds for a shorter time period than lower speeds. The comfort criteria allows planners to assess the usability, with respect to the wind environment, of different locations for various purposes. A discussion on various criteria is presented in Appendix B.

The SEARs requirements do not specify a method of assessing wind comfort or safety for this site. CPP uses a modified form of the widely-accepted pedestrian-level wind criteria developed by Lawson (1990). Lawson's criteria are divided into separate categories of comfort and safety.

Lawson's comfort criteria are based on wind speeds exceeded 5% of the time, and are described as categories for comfort ranging from 'Pedestrian Sitting' to 'Business Walking', allowing planners to judge the usability of locations for various intended purposes, Table 2. The criteria include a safety rating, which is based on occasional (once or twice per year) wind speeds, to identify locations where wind speeds may be hazardous to pedestrians.

Table 2: Wind Comfort and Safety criteria (after Lawson, 1990)

COMFORT RATING	U_{EQUIV}*	DESCRIPTION
Dining**	≤2 m/s	outdoor restaurant uses, semi-enclosed spaces.
Sitting	>2-4 m/s	long duration seating areas, café areas, and other amenities.
Standing	>4-6 m/s	main entrances and bus stops where pedestrians may linger, recreational parks, and sitting for shorter periods.
Pedestrian Walking	>6-8 m/s	window shopping and strolling along a downtown street, or park.
Business Walking	>8-10 m/s	less frequented areas, areas with objective walking, or running.
Uncomfortable	>10 m/s	unacceptable for all pedestrian activities; wind mitigation is typically required.

*U_{Equiv} = Max (U_{Mean}, U_{Gust} / 1.85). Criterion based on an annual exceedance of 5% (~8 hours / week) assessed over all hours.
** For regular outdoor dining, commercial tenancies, and in semi-enclosed spaces, it has been the experience of CPP that the comfort rating of Sitting may be windier than desired and a comfort criterion of 2 m/s or less may be more applicable.

SAFETY RATING	U_{EQUIV}*	DESCRIPTION
Pass	≤15 m/s	Meets wind safety criterion.
Able-Bodied	>15-20 m/s	Acceptable where only able-bodied people would be expected; not acceptable for frail persons or cyclists
Fail	>20 m/s	Excessive wind speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation required.

* U_{Equiv} = Max (U_{Mean}, U_{Gust} / 1.85). Criterion based on an annual exceedance of 0.022% (~2 / year or 1 / season) assessed over all hours.

In general, wind conditions comfortable for Sitting and Standing are considered appropriate for areas such as entrances where pedestrians are likely to gather for longer durations, while wind conditions comfortable for Casual Walking and Business Walking are more appropriate for sidewalks where pedestrians are actively in transit. Locations rated as Uncomfortable are generally less suitable for most pedestrian activities and wind control solutions are often sought. Whether mitigation is needed at a location depends upon the intended pedestrian use of the location.

Satisfaction of the safety rating is generally required for areas accessible to the general public. A rating of 'Able-Bodied' may be acceptable for areas with managed access or where pedestrians are unlikely to be present under adverse conditions.

Assessment using the Lawson criteria is preferred to methods based on once per annum gust speeds such as Melbourne (1978) as it is based on more regularly occurring wind speeds relevant to perception by pedestrians and uses a combined probability integrated over all directions. In addition, it is less susceptible to variations in turbulence levels in urban environments while still considering the impact of short-duration gusts.

The perception of wind is subjective and varies depending on regional difference in wind climate and thermal conditions, as well as by individual. Calibration to the local wind environment should be taken into account when evaluating predicted wind comfort conditions. Note that the ratings of 'Uncomfortable' and 'Safety' are the words of the published wind criteria and applicability may vary by project and location.

Converting the wind climate to the site location, the mean wind speed at pedestrian level exceeded 5% of the time would be approximately 4.5 m/s, which would be classified as suitable for pedestrian standing activities. From knowledge of the site, this is considered representative of the area.

SITE DESCRIPTION

The site is located on the block bounded by Camden Road, Oxley Street, Art Gallery Road, and Old Menangle Road, Campbelltown, Figure 3. The surrounding area consists of low-rise suburbia with discrete open areas in all directions. Gently undulating topography surrounds the site, which is essentially flat from a wind perspective.

Winds in such surrounds tend to experience less channelling than areas with many tall structures, with local effects instead being dictated by exposed buildings and their relation to prevailing strong wind directions. Several wind flow mechanisms such as downwash and channelling flow are described in Appendix A including the effectiveness of some common wind mitigation measures.

The existing building and proposed redevelopment are irregular in form, Figure 4, rising to a maximum height of about 8 m above local ground level, Figure 5. As the proposed building massing is larger in plan and of similar height to the existing building, and surrounded by mature trees that are larger than the building, it is expected to have a minimal impact on the local wind conditions, as discussed in this report.

Figure 3: Site location (Google Earth, 2024)

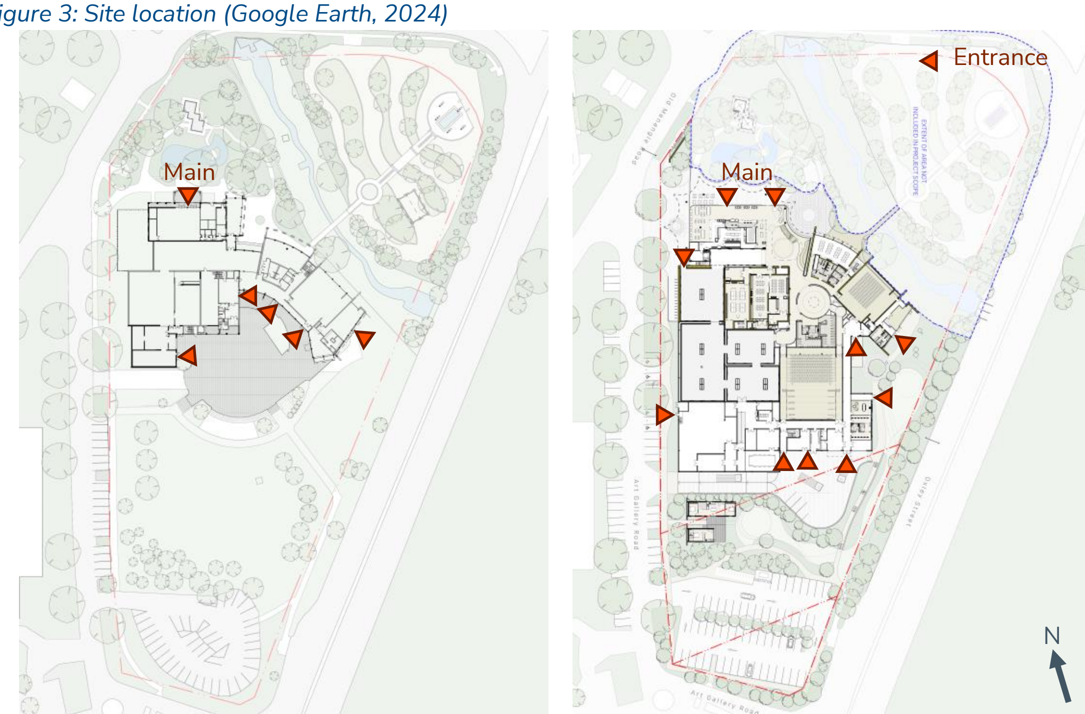

Figure 4: Site plan existing (L), proposed (R)

Figure 5: North (T) and west (B) elevations of the redevelopment

PREDICTED WIND CONDITIONS ON THE GROUND PLANE

The following sections of the report outline 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 Western Sydney are generally moderate, with strong winds coming from the west.

The change in massing of the proposed redevelopment is minimal compared with the existing building from a wind perspective, and would therefore be expected to have a minor impact on the local wind conditions.

WINDS FROM THE NORTH

The site is relatively exposed to winds from the north approaching over low-rise buildings and open land. The mature trees to the north would lift the incident flow over the building. Without the upwind trees the wind conditions on the ground floor outdoor seating area under the sculpted overhang would be relatively windy, Figure 6.

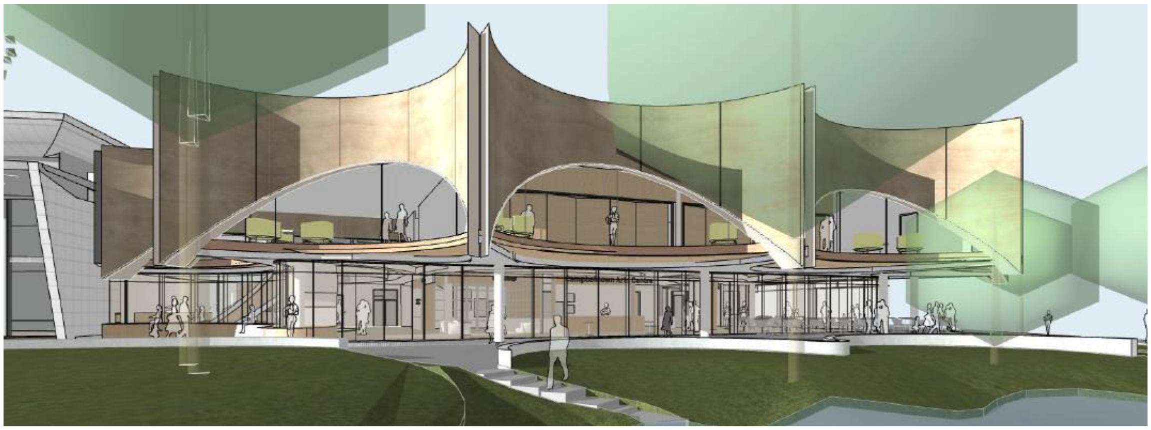

Figure 6: View from the north to the main entry

WINDS FROM THE SOUTH-WEST

Winds from the south-west approach over low-rise buildings of similar height before reaching the site. The majority of incident flow would be expected to pass over the roof of the development. The higher sections of the roof are remote from the building edge, which is a benefit of the design by reducing the amount of flow accelerating around the building at ground level.

The incident flow would impinge on the building corner inducing horizontal flow around the building. The flow would accelerate along the face of the building inducing slightly faster flow around the north-west corner, Figure 7. The pedestrian main access area from the north would be shielded by the building.

As the incident wind direction moves to the west, the amount of flow passing around the north corner would be expected to reduce.

Figure 7: Flow patterns for wind from the south-west

DISCUSSION – PUBLIC DOMAIN

The height and massing of the proposed development is similar to the surrounding buildings and the existing building and therefore would be expected to have a minimal impact impact on the local wind environment. The wind conditions are expected to remain similar to the existing wind conditions with some areas getting windier and others calmer depending on the incident wind direction.

Qualitatively, integrating the expected directional wind conditions around the site with the wind climate, it is considered that wind conditions would be generally classified as suitable for pedestrian standing.

All locations would be expected to satisfy the safety criterion.

The main entrances to the building are well located in the middle of the building face and remote from the high wind speed zones around the corners.

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Appendix A – 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 8, 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 8. 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.

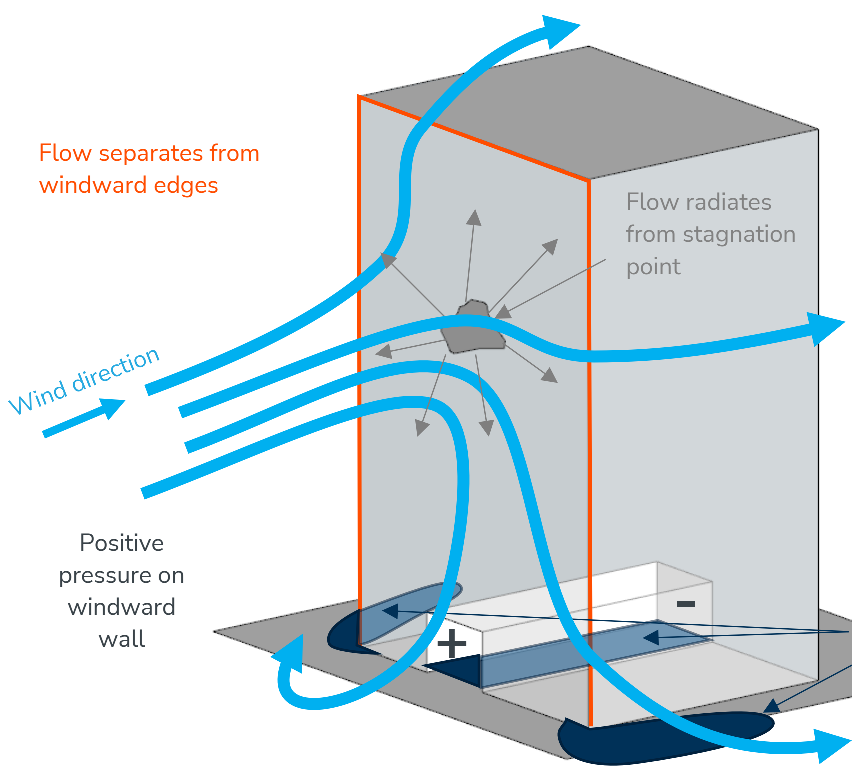

Figure 8: Schematic wind flow around tall, isolated building

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 9. 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.

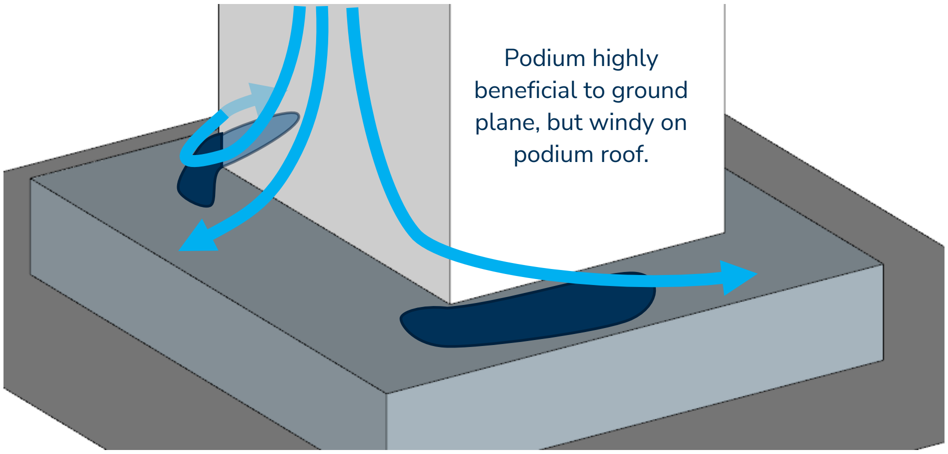

Figure 9: Schematic flow pattern around building with podium

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 10. 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.

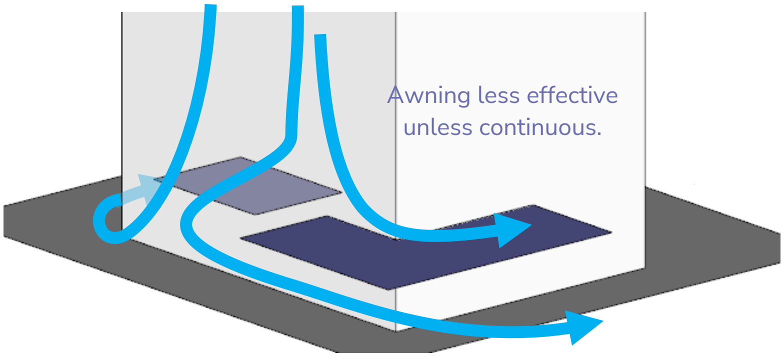

Figure 10: Schematic flow pattern around building with awnings

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 11. 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 8. If the link is blocked, wind conditions will be relatively calm, Figure 12. 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 12.

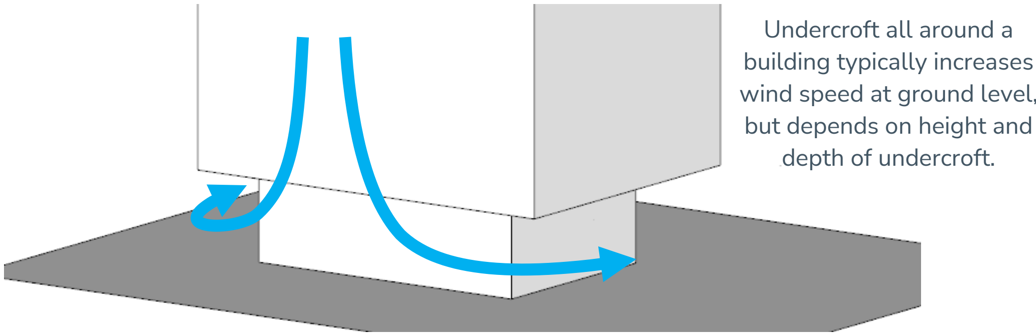

Figure 11: Schematic of flow patterns around isolated building with undercroft

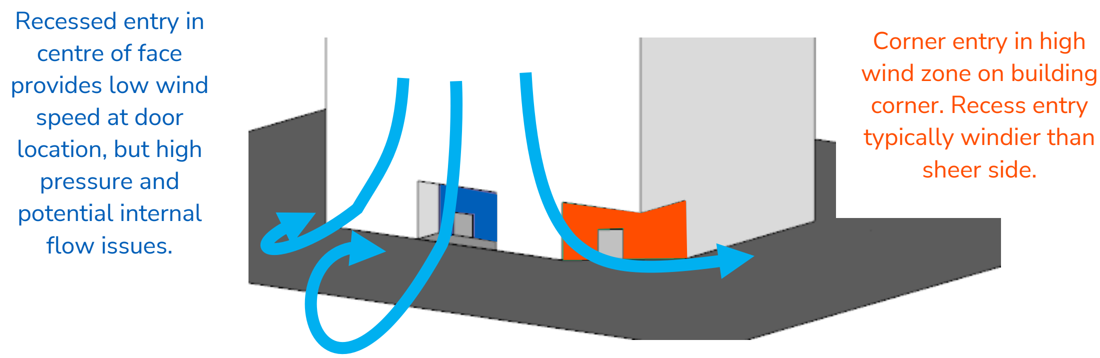

Figure 12: Schematic of flow patterns around isolated building with ground articulation

MULTIPLE BUILDINGS

When a building is located in a city environment, depending on upwind buildings, the interference effects may be positive or negative, Figure 13. 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 by the surrounding buildings. 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.

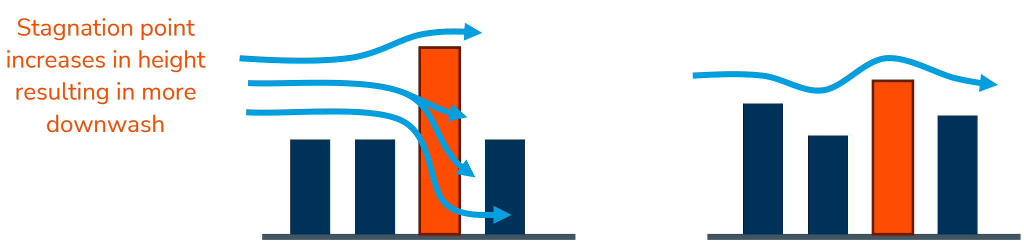

Figure 13: Schematic of flow pattern interference from surrounding buildings

The above discussion becomes more complex when three-dimensional effects are considered, both with orientation and staggering of buildings, and incident wind direction, Figure 14.

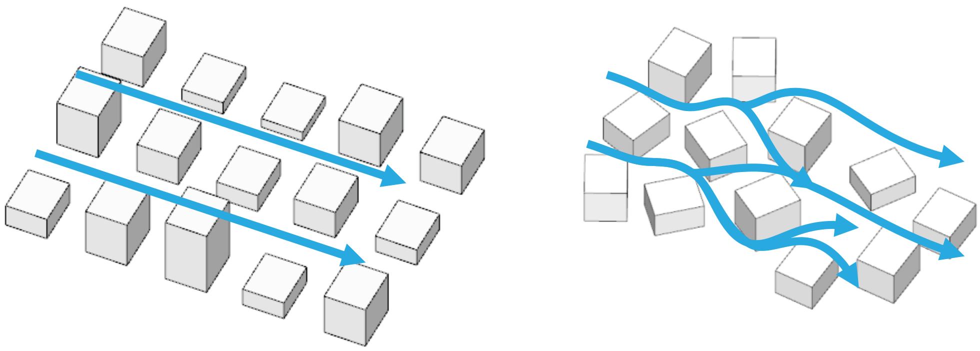

Figure 14 Schematic of flow patterns through a grid and random street layout

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 15. The vertical component in pressure driven flow is lower than downwash flow.

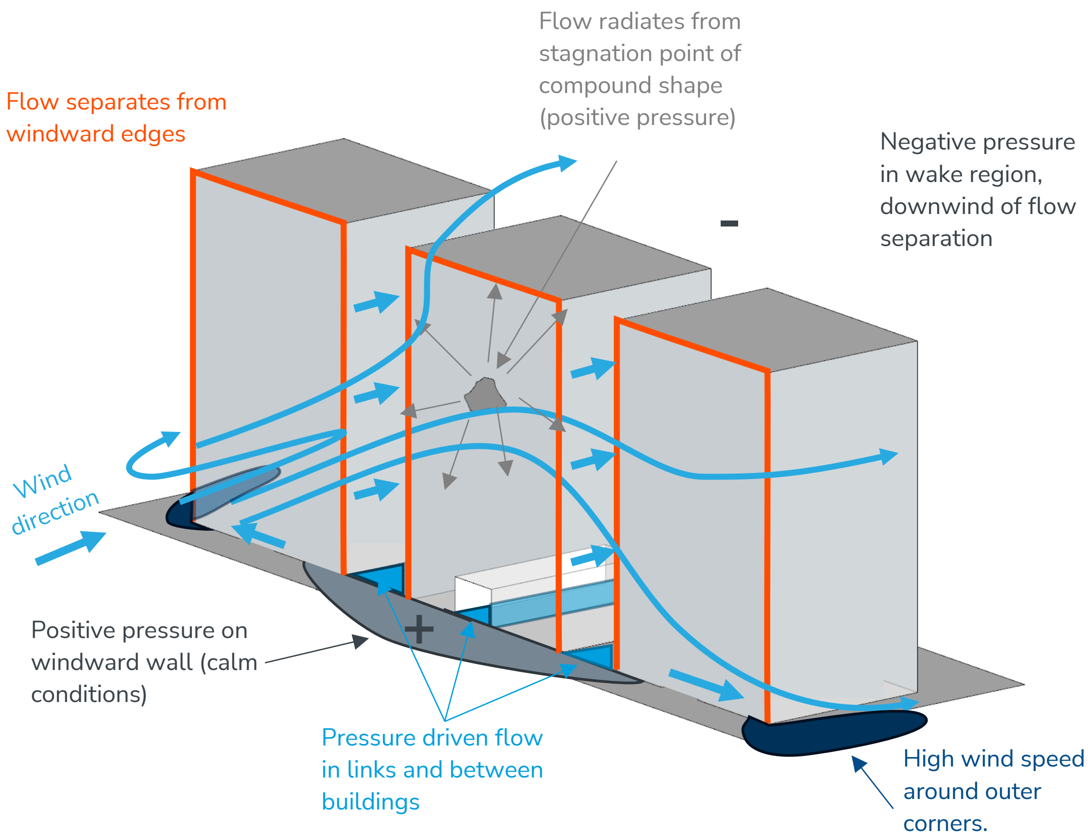

Figure 15: General flow pattern around multiple buildings

Channelling is instigated when pressure driven flow accelerates between two buildings, and continues along straight streets with buildings on either side, Figure 14(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 the 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 14(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.

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.

Multiple barriers offer improved wind conditions between the barriers by preventing the flow from reattaching to the surface.

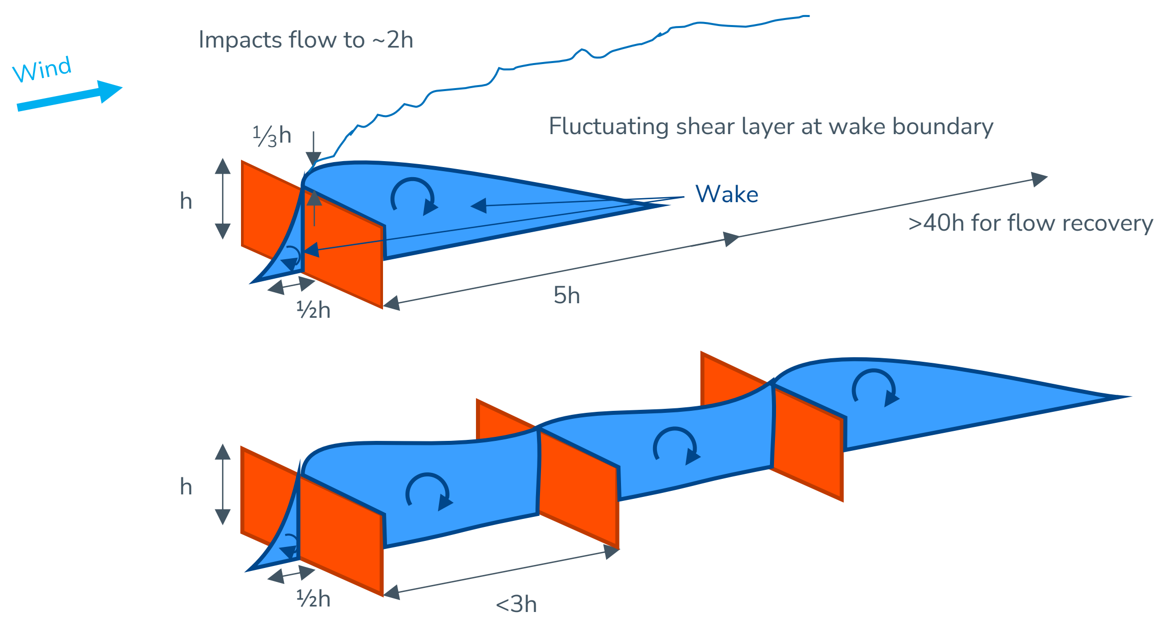

Figure 16: Sketch of the flow pattern over vertical elements

Appendix B – 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 3. 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 3: 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 peak 3 s gust in an hour, 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 less agreement over a wider range of flow conditions. 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 wind speed 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:

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

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 18. 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 included in this Figure.

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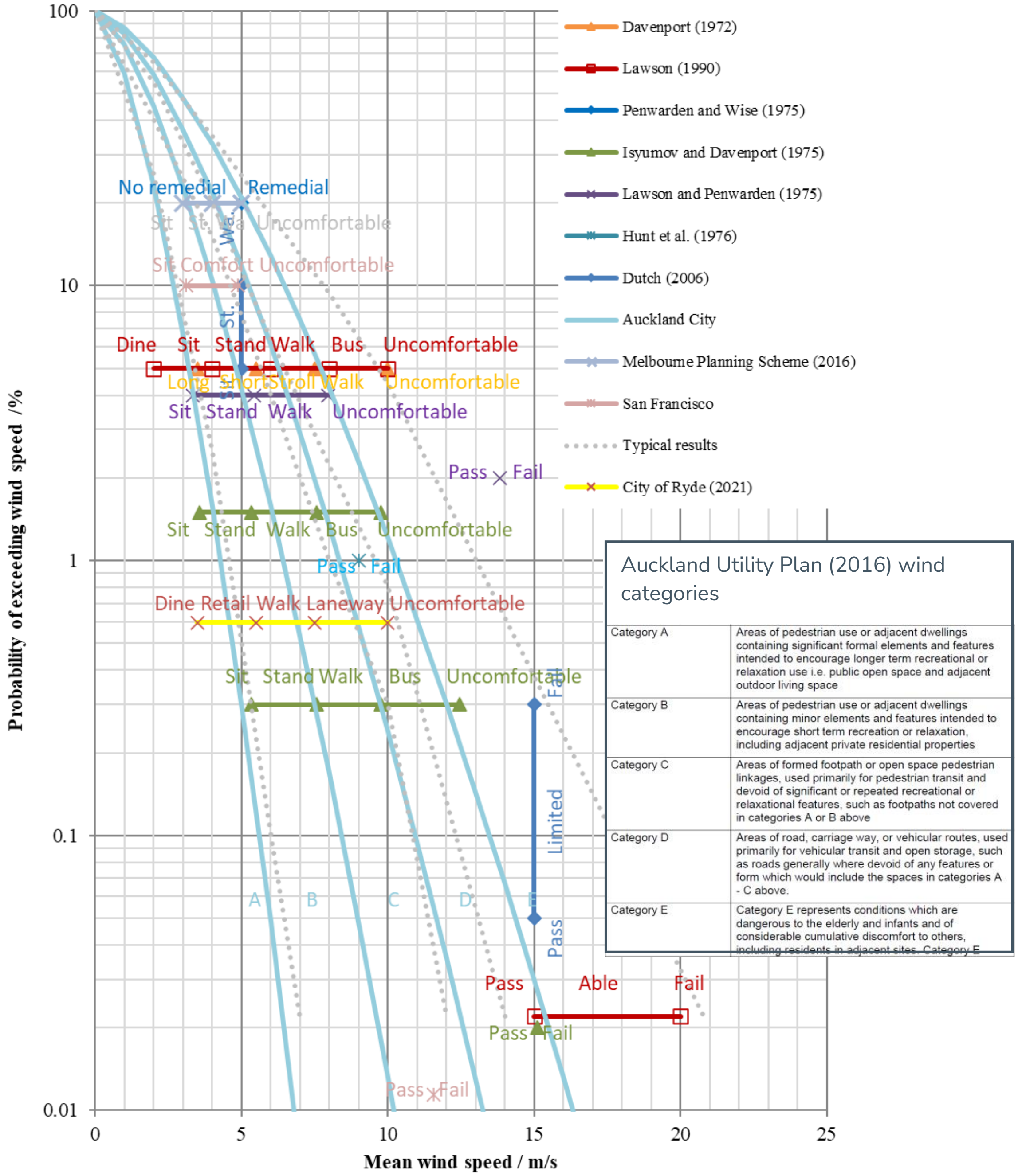

Figure 17: Probabilistic comparison between wind criteria based on mean wind speed

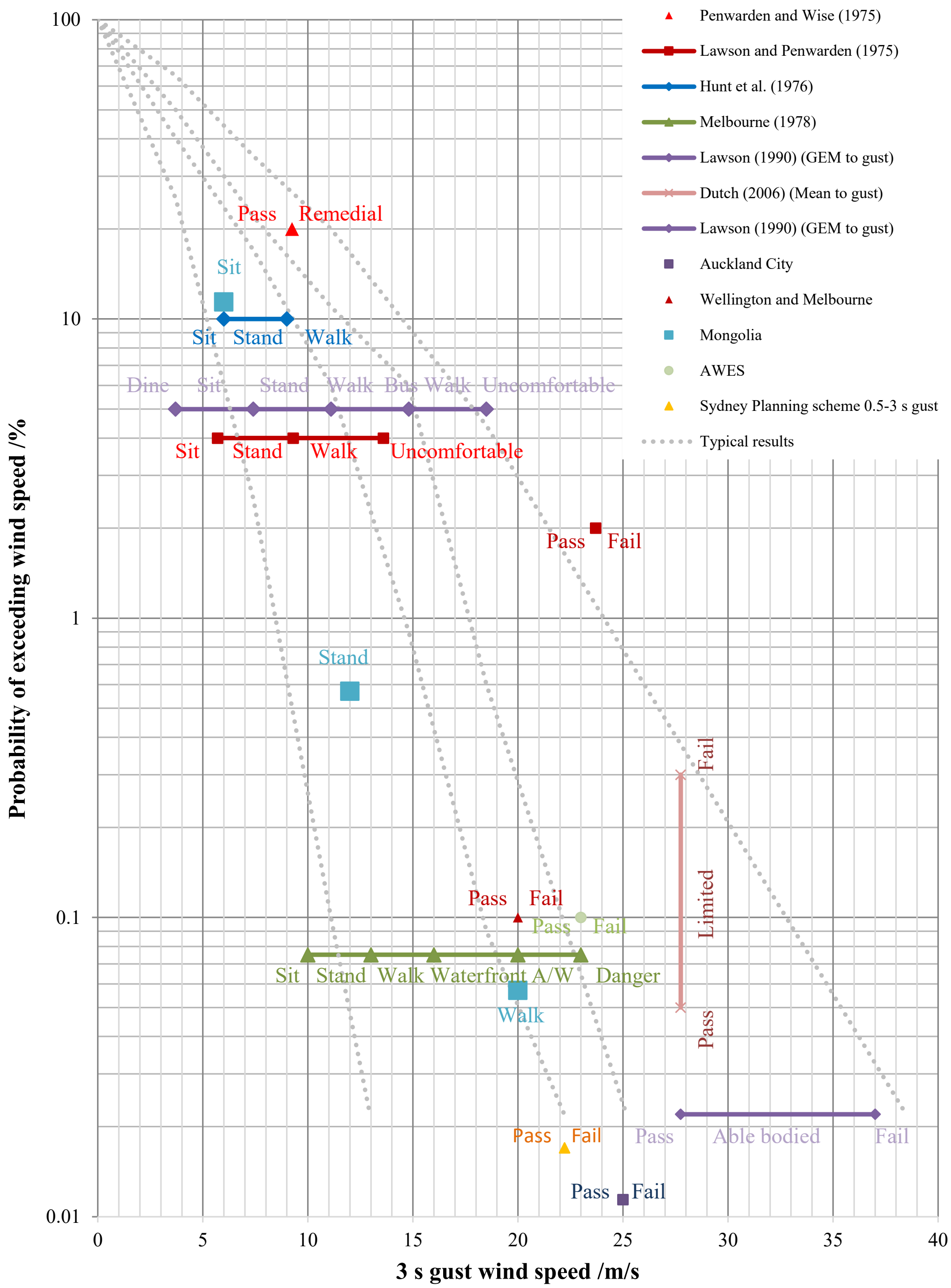

Figure 18: Probabilistic comparison between wind criteria based on 3 s gust wind speed