

Health Infrastructure

New Rouse Hill Hospital

Environmental Wind Assessment Report

Reference: Report

Revision 04 | 28 October 2025

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 286539-01

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Document Verification

Project title New Rouse Hill Hospital
Document title Environmental Wind Assessment Report
Job number 286539-01
Document ref Report
File reference

Revision	Date	Filename	Rouse Hill Hospital_Arup wind_REP_20250702.docx		
Initial release	02 Jul 2025	Description	Initial release		
			Prepared by	Checked by	Approved by
		Name	Lauren Boysen	Sina Hassanli	Lauren Boysen
Rev. 01	16 Jul 2025	Filename	Rouse Hill Hospital_Arup wind_REP_20250716.docx		
		Description	Minor updates		
			Prepared by	Checked by	Approved by
Name	Lauren Boysen	-	-		
Rev. 02	14 Aug 2025	Filename	Rouse Hill Hospital_Arup wind_REP_20250814.docx		
		Description	Minor updates to standard description & site plan		
			Prepared by	Checked by	Approved by
Name	Lauren Boysen	-	-		
Rev. 03	23 Sep 2025	Filename	Rouse Hill Hospital_Arup wind_REP_20250923.docx		
		Description	Updated to include future surrounds potential impacts		
			Prepared by	Checked by	Approved by
Name	Lauren Boysen	-	-		
Rev. 04	28 Oct 2025	Filename	Rouse Hill Hospital_Arup wind_REP_20251028.docx		
		Description	Revised SSD/SEARs references.		
			Prepared by		
Name	Lauren Boysen	-	-		

Issue Document Verification with Document



Executive Summary

Health Infrastructure have commissioned Arup to prepare an environmental wind impact assessment report to support the State Significant Development Application (SSDA) for the New Rouse Hill Hospital. This report details the impact of the 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 wind conditions in and around the site with some areas becoming 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 comfort conditions at the majority of locations around the site would be classified as suitable for pedestrian standing, increasing to pedestrian walking around the outer corners of the development. These wind conditions would be considered acceptable for the intended use of pedestrian access in and around the site.

Winds from multiple directions would create a differential pressure across the Care Arcade, which would accelerate wind flow within the space, likely rendering conditions suitable for walking.

It is Arup's opinion that all locations within the proposed development would 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.

Given the hospital setting, where patients, visitors, and staff may include frail or mobility-impaired individuals, careful consideration of wind conditions is particularly important. Ensuring a high level of amenity in outdoor spaces—especially at entrances, waiting areas, and key open paths—is essential to support comfort, accessibility, and the functional use of these areas throughout the year. Numerical modelling is recommended to be undertaken for the Care Arcade, which can be conducted during design development, to support refinement of nominated areas for seating and key pedestrian entrances located within this outdoor space.

The proposed future surrounds to the north, east and south of the site would likely assist with shielding the site for key prevailing winds from the north-east and south only (and not for south-west to west), which would provide some improvement overall for wind conditions at the site when these winds occur.

Contents

1.	Introduction	1
1.1	Site Location	2
2.	Wind assessment	3
2.1	Local wind climate	3
2.2	Specific wind controls	5
2.3	Site description	6
2.4	Predicted wind conditions on ground plane	10

Tables

Table 1: SEARs requirements	2
Table 2. Pedestrian comfort criteria for various activities	5
Table 3: Summary of wind effects on pedestrians	20

Figures

Figure 1: Aerial site photo showing site location and local context (Source: HDR SSDA Architectural Design Statement)	2
Figure 2: Site plan proposed	3
Figure 3: Wind rose showing probability of time of wind direction and speed	4
Figure 4: Wind rose showing probability of time of wind direction and speed; for temperatures < 18°C (top-left), between 18 – 28°C (top-right), and above 28°C (bottom-left).	5
Figure 5: Site location (source: Google Earth 2024)	6
Figure 6: Various floor plans for Main Hospital	7
Figure 7: Main Hospital Level 01 plan with key pedestrian entries noted	8
Figure 8: East elevation	8
Figure 9: North-south section, looking east	9
Figure 10: Rouse Hill future development - built form (source: The Hills Shire Council, Precinct Plan Rouse Hill Strategic Centre, November 2023)	9
Figure 11: Northern Frame building envelope (currently under assessment; source: Planning proposal 2/2025/PLP, Reference Design Architectural Plans, July 2024)	10
Figure 12: Wind flow patterns for winds from the north-east	11
Figure 13: Wind flow patterns for winds from the south quadrant	12
Figure 14: Wind flow patterns for winds from the west	13
Figure 15: Schematic wind flow around tall isolated building	15
Figure 16: Schematic flow pattern around building with podium	16
Figure 17: Schematic flow pattern around building with podium	16
Figure 18: Schematic of flow patterns around isolated building with undercroft	17
Figure 19: Schematic of flow patterns around isolated building with ground articulation	17
Figure 20: Schematic of flow pattern interference from surrounding buildings	17
Figure 21 Schematic of flow patterns through a grid and random street layout	18
Figure 22: General flow pattern around multiple buildings	18
Figure 23: Sketch of the flow pattern over an isolated structure	19

Figure 24: Probabilistic comparison between wind criteria based on mean wind speed	21
Figure 25: Probabilistic comparison between wind criteria based on 3 s gust wind speed	22

Appendices

A.1	Wind flow mechanisms	15
A.2	Wind speed criteria	20
A.3	Reference documents	23

Disclaimer

This qualitative 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 by Arup to support a State Significant Development Application (SSDA) for the construction and operation of a new hospital campus at the Corner of Commercial Road and Windsor Road, Rouse Hill (SSD-96248991).

The proposed development comprises:

- Site preparation including earthworks and tree removal;
- Construction of internal roads with connection to Commercial Road;
- Incoming electrical and communications services
- Construction of hospital buildings up to eleven storeys;
- Construction of a ten storey above-ground car park;
- Pedestrian and cycle pathway connections;
- Landscaping; and
- Ancillary works to Commercial Road, comprising:
 - minor works (including realignment of existing median strip, kerb and gutter, footpath and lane marking) to provide access from Commercial Road into Hospital Road; and
 - associated tree removal along Commercial Road.

The scope of the proposed works includes:

- An emergency department and primary access clinic
- Comprehensive birthing services including birthing rooms and a maternity inpatient unit
- Inpatient beds and day surgery services
- Short stay medical assessment services
- Pathology, pharmacy, and medical imaging services
- Outpatient and ambulatory care services including paediatrics and renal dialysis and antenatal and postnatal services
- Virtual care and hospital in the home services
- Prehabilitation, rehabilitation and lifestyle medicine.
- Administration, staff support, loading dock and back-of-house services; and
- Ancillary commercial uses to support the hospital, including retail.

This report has addressed the following matters within the Secretary's Environmental Assessment Requirements (SEARs) issued for the SSDA on 16 October 2025 (see Table 1).

Table 1: SEARs requirements

Item	SEARS Requirement Reference	Relevant Section of Report
5	<p>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.</p>	This entire report forms the required documentation for the Pedestrian Wind Environment Assessment, in particular Section 2.

1.1 Site Location

RHH is proposed to be constructed on a greenfield site on the corner of Commercial Road and Windsor Road, Figure 1. It is within The Hills Shire Local Government Area (LGA) and closely adjacent to Blacktown LGA. The site is well connected to the public transport network, being serviced by rail (Sydney Metro Northwest station at Rouse Hill) and bus rapid transit (North West T-way) with Rouse Hill interchange within a 600 m walk from the site.

A planning proposal has been submitted to council to develop the land immediately west and south of the hospital site, known as the Rouse Hill Northern Frame Precinct. The proposal includes redevelopment of the land as a high-density mixed-use precinct.

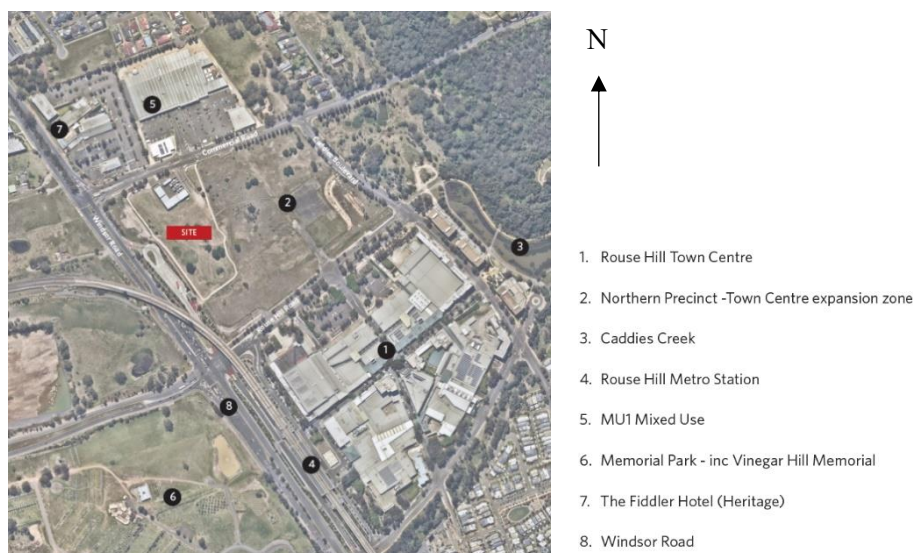


Figure 1: Aerial site photo showing site location and local context (Source: HDR SSSA Architectural Design Statement)

In reference to the site boundary, Figure 2:

- Hospital site boundary (Lots 311 and 312)
- SSSA site will extend to the full extent of works including the hospital site, footpath connection (Part Lot 229), construction compounds (Part Lot 229) and works to Commercial Rd (Lot 2011, DP 1131519 and Lot 101, DP1060353)

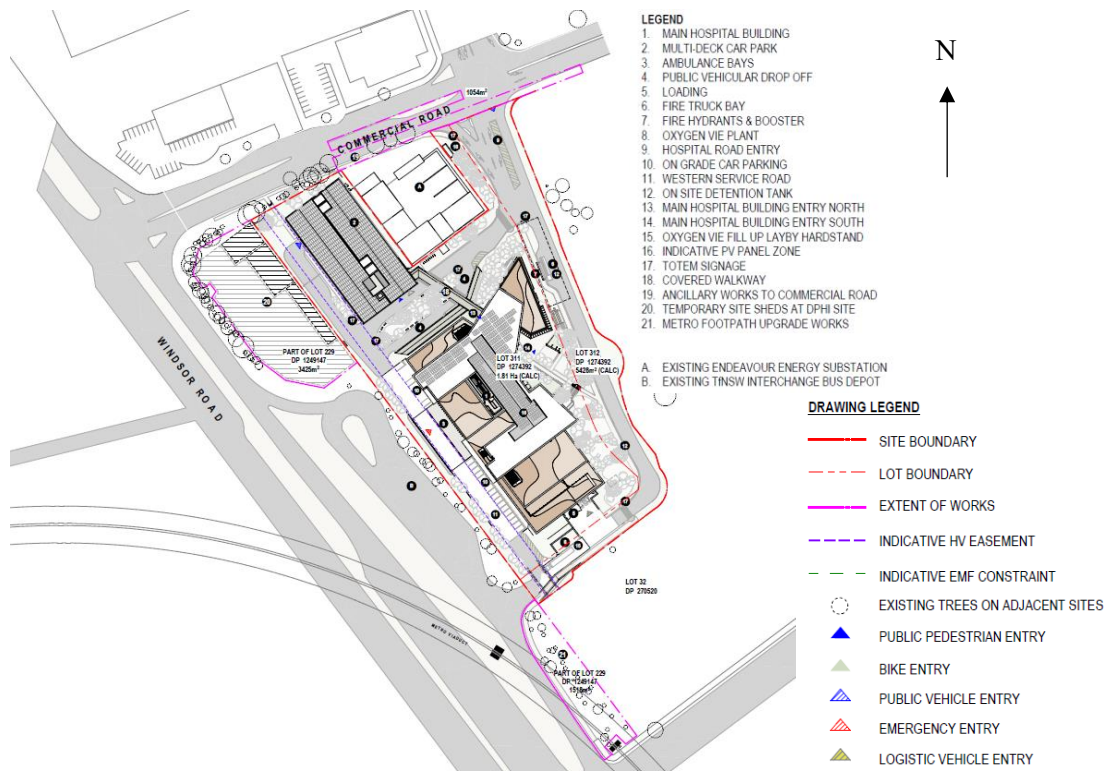


Figure 2: Site plan proposed

2. Wind assessment

2.1 Local wind climate

Weather data recorded at a standard height of 10 m at Richmond have been used in this analysis, Figure 3. The arms of the wind rose point in the direction from where the wind is coming from. The anemometer is located about 16 km to the north-west of the site. The directional wind speeds measured here are generally considered representative of the wind conditions at the site, with the only difference being that the site is further away from the mountains than the anemometer location.

Richmond (067105)
2003-2023
Corrected to open terrain

All hours
Probability: 100% of dataset
Calms: 13.8%

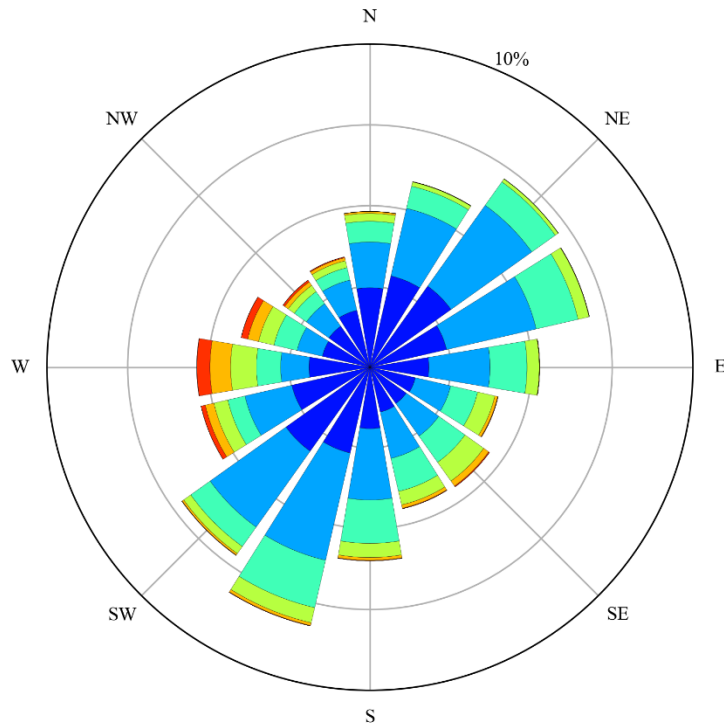
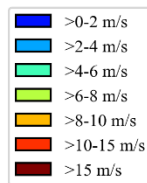


Figure 3: Wind rose showing probability of time of wind direction and speed

It is evident from Figure 3 that the wind climate is omni-directional with fewer winds from the north-west. Winds from the north-east tend to be light, with stronger winds from the south-east and west quadrants. The measured mean (50th percentile) wind speed at the anemometer is approximately 2.5 m/s, and the 5% exceedance mean wind speed at the anemometer is approximately 7.5 m/s. Converting the 5% of the time mean wind speed from the anemometer location (10 m height in exposed terrain) to the site at pedestrian level would result in a wind speed of about 4.8 m/s.

The variation of temperature and wind conditions based on temperature intervals has also been considered:

- Cold temperatures (< 18°C; Figure 4-top left);
- moderate temperatures (18 – 28°C; Figure 4-top right);
- Hot temperatures (> 28°C; Figure 4-bottom right).

Cold temperatures below 18°C constitute approximately 54% of the time and winds are more prevalent from the south-west and north-east quadrants. Moderate temperatures between 18-28°C constitute approximately 40% of the time and the prevalent winds are most commonly from the north-east, east, south-east, south sectors. Hot temperatures above 28°C comprise approximately 5.7% of the time and are predominantly from the north-east, west quadrants. In all temperature bands the strong winds come from the west quadrant.

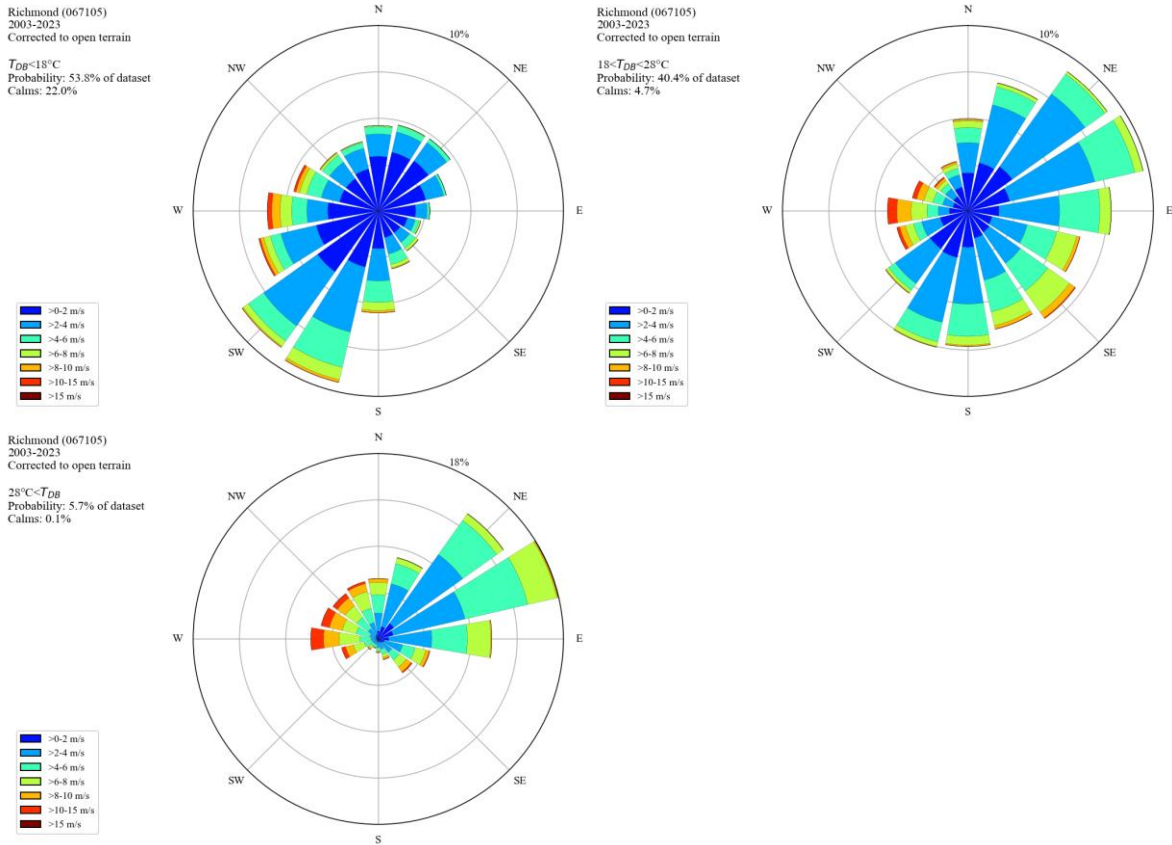


Figure 4: Wind rose showing probability of time of wind direction and speed; for temperatures $< 18^{\circ}\text{C}$ (top-left), between $18 - 28^{\circ}\text{C}$ (top-right), and above 28°C (bottom-left).

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.

There are no known wind speed criteria for the site. The wind speed criteria used in this assessment are based on the work of Lawson (1990) described in Table 2.

Table 2. Pedestrian comfort criteria for various activities

Comfort (max. of mean or GEM wind speed exceeded 5% of the time)	
<2 m/s	Dining
2-4 m/s	Sitting
4-6 m/s	Standing
6-8 m/s	Walking
8-10 m/s	Objective walking or cycling
>10 m/s	Uncomfortable
Safety (max. of mean or GEM wind speed exceeded 0.022% of the time)	
<15 m/s	General access
<20 m/s	Able-bodied people (less mobile or cyclists not expected)

2.3 Site description

The proposed Rouse Hill Hospital site is located to the north-west of the block bounded by Commercial Road, Caddies Boulevard, Rouse Hill Drive, and Windsor Road, Figure 5. The site is surrounded by open terrain and low-rise buildings in all directions. Topography surrounding the site is generally flat, dropping gently to the east and rising to the west.



Figure 5: Site location (source: Google Earth 2024)

The proposed design for the hospital consists of a main hospital building and multi-storey car park, Figure 2 and Figure 6 to Figure 9. The main hospital building rises to a maximum height of approximately 50.7 m above finished ground level, and the multi-storey carpark, approximately 30.3 m above finished ground level, Figure 8 and Figure 9.

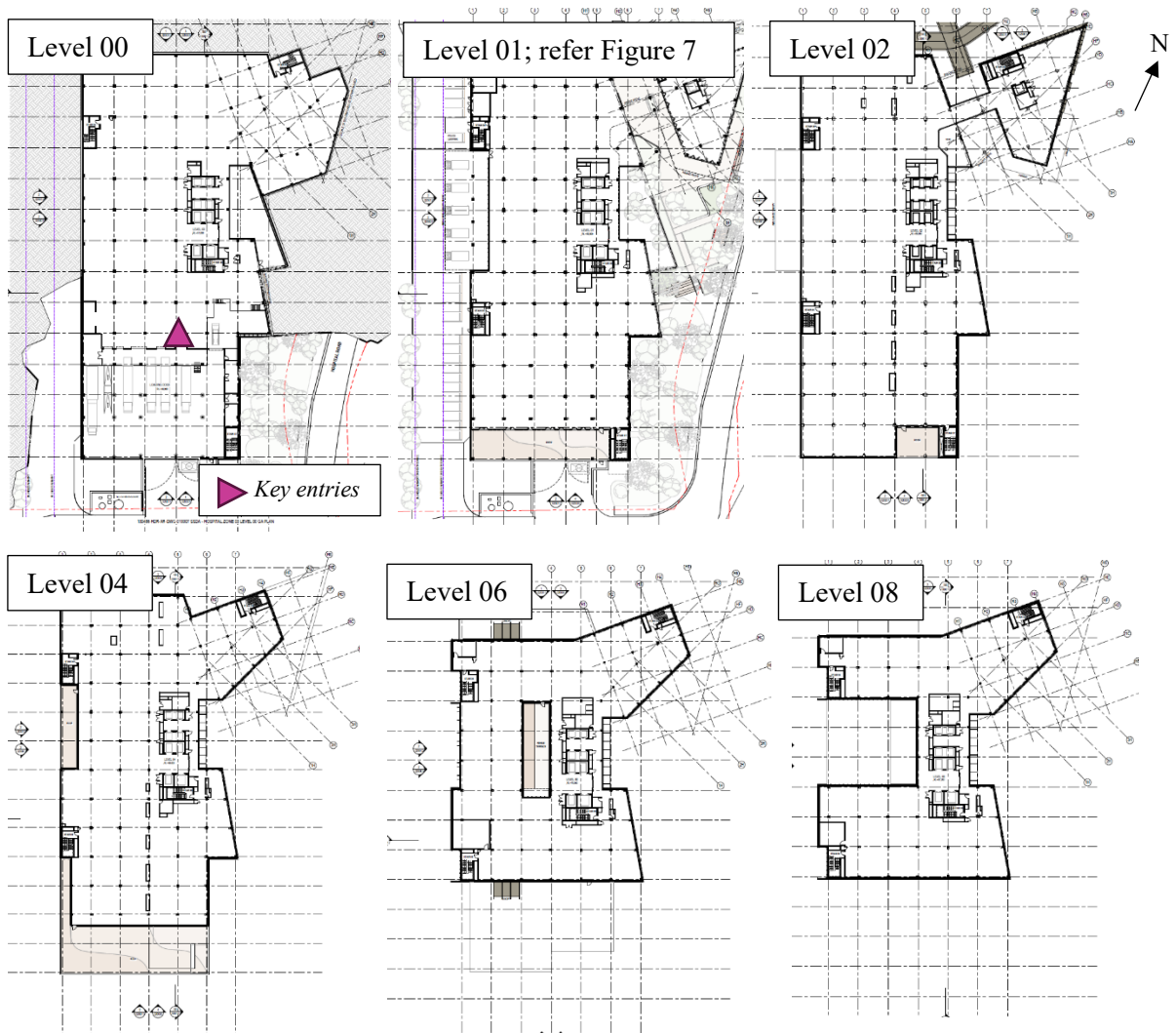


Figure 6: Various floor plans for Main Hospital

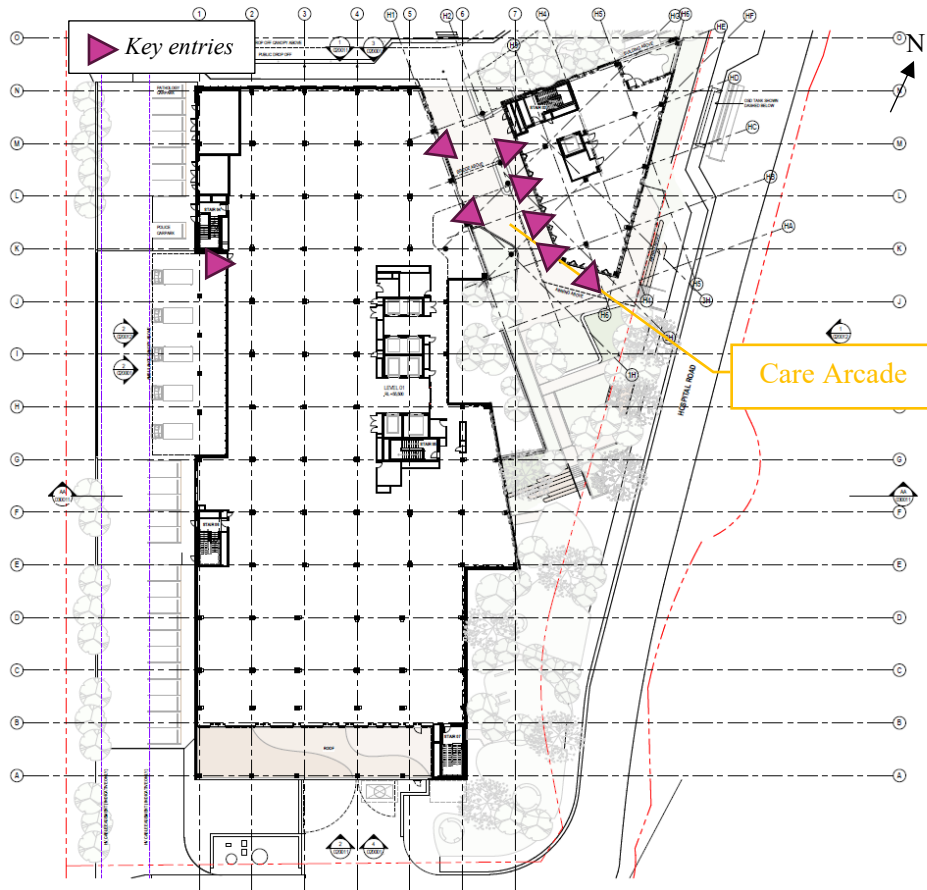


Figure 7: Main Hospital Level 01 plan with key pedestrian entries noted



Figure 8: East elevation



Figure 9: North-south section, looking east

2.3.1 Future surrounds

The Hills Shire Council Precinct Plan for Rouse Hill Strategic Centre, Figure 10, outlines the proposed building heights for future development surrounding the site. Immediately to the north, there is development of 8-10 storeys proposed. To the east and south-east, a mix of development heights is proposed, ranging from 14-20 storeys; refer to further details regarding the Northern Frame below, Figure 11.



Figure 10: Rouse Hill future development - built form (source: The Hills Shire Council, Precinct Plan Rouse Hill Strategic Centre, November 2023)

To the immediate east and south of the site is the proposed Northern Frame, which is currently under assessment and is currently zoned for mixed-use with developments up to 32 m, Figure 11.

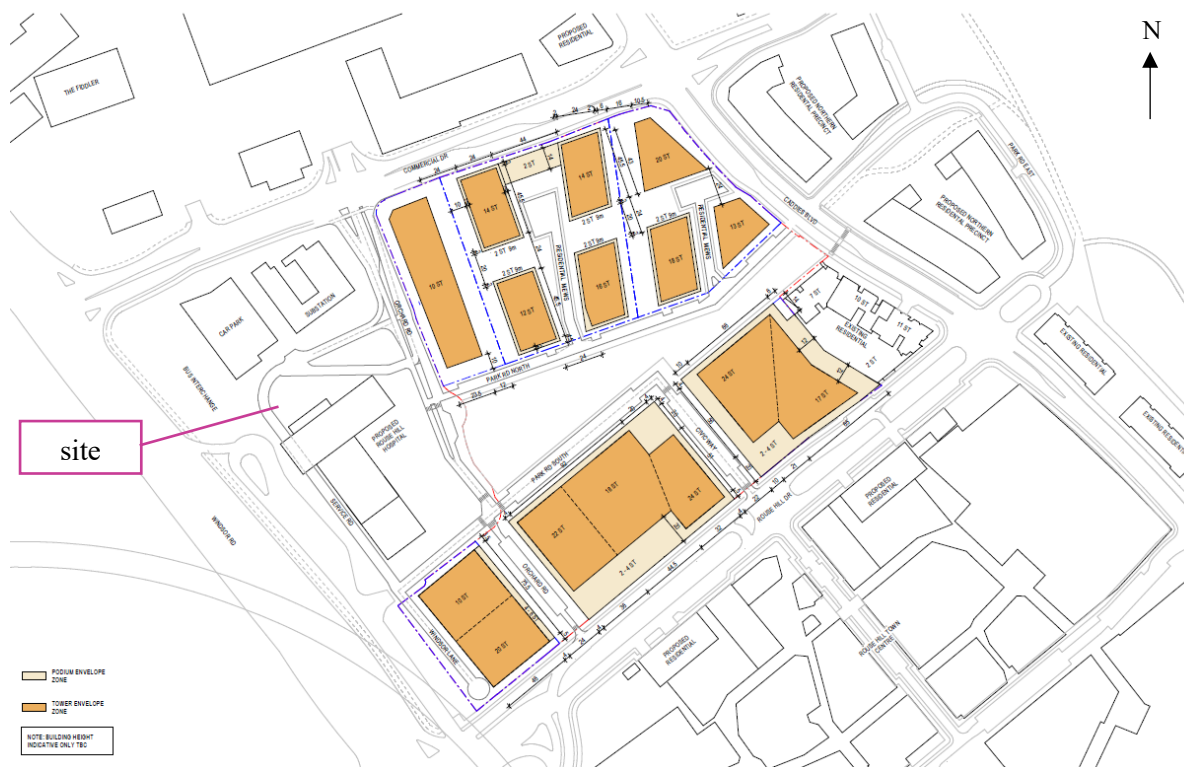


Figure 11: Northern Frame building envelope (currently under assessment; source: Planning proposal 2/2025/PLP, Reference Design Architectural Plans, July 2024)

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

The inclusion of an approximately 50 m tall building (and multi-storey carpark) will impact the wind conditions in around the site, with some areas getting windier, and others calmer depending on incident wind direction.

Winds from the north-east

Winds from the north-east are relatively light, yet undisturbed on reaching the site, due to the open nature of the adjacent land and low-rise residential houses further out to the north-east. Development of the neighbouring site to the north-east would reduce the wind speeds. The flow accelerations around the windward corners (i.e., north-east corners) would be expected to be small with increased wind speeds around the north-west and south-east corners. Calmer conditions would be experienced in the centre of the building facades and on the leeward side, Figure 12. The irregular shaped main hospital building, with stepped massing including a podium to the north-east, will assist with protecting the ground plane and reducing the impact of the proposed development amongst open surrounds. There is going to be accelerated channelled flow between the buildings which provide favourable breeze in warmer months of the year where the prevalent wind direction is from the north-east

There is the potential for pressure driven and/or channelled flow through the Care Arcade space on Level 01, Figure 7.

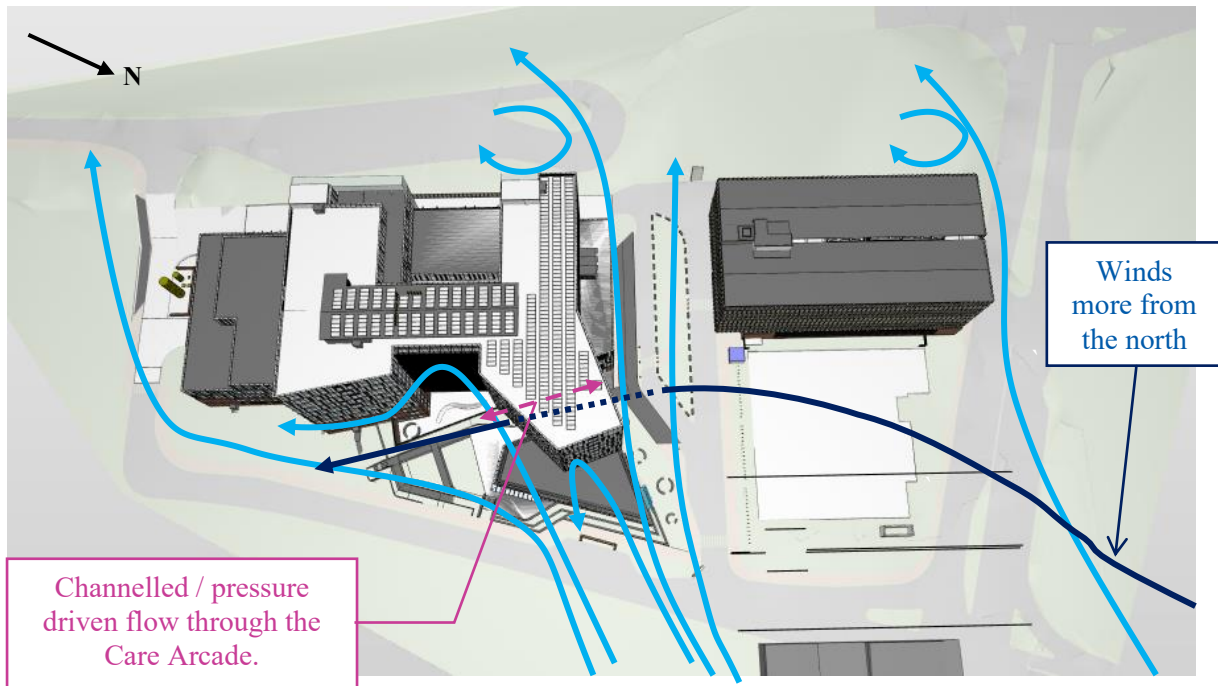


Figure 12: Wind flow patterns for winds from the north-east

Future proposed development to the north and east of the site will assist with shielding the site for winds from the north-east, likely improving local wind conditions.

Winds from the south quadrant

Winds from the south quadrant are undisturbed on reaching the site, due to the undeveloped nature of the neighbouring land, Figure 5. Winds from the south-east and south would impinge on the narrow façade, or on the corner of the main building, which would encourage horizontal flow around the building rather than inducing downwash, Figure 13. The stepped nature of the building is beneficial to lift the flow over the roof away from ground level. The multi-storey car park is in the wake of the main building and would experience relatively calm conditions.

Winds from the south-west would impinge on the broad face of the main building and car park, Figure 13. The relatively low height to width ratio, and stepped nature to the south-east would encourage flow over the roof rather than induce downwash resulting in slightly windier conditions around the windward corners. There would be some channelled wind flow between the two buildings which would be accelerated around the leading corners.

The same comments apply for the Care Arcade as per winds from the north-east.

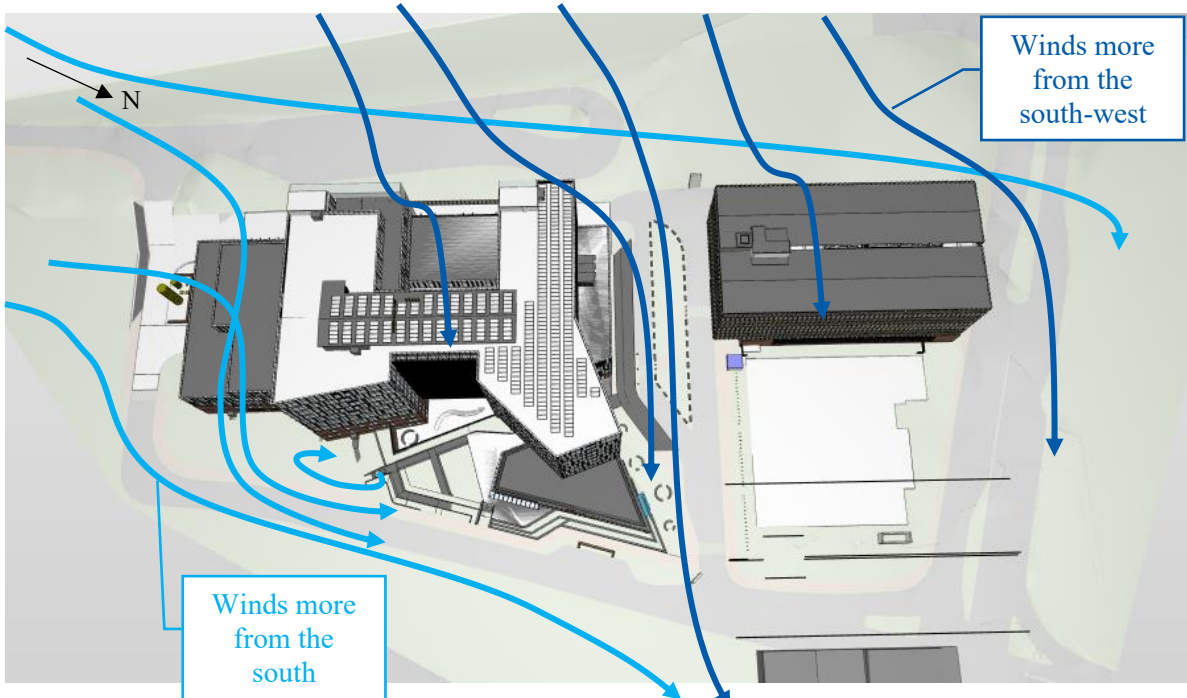


Figure 13: Wind flow patterns for winds from the south quadrant

Winds from the south quadrant are unlikely to be impacted by the future surrounds outlined in Section 2.3.1, given they are predominantly from the south-west. Winds from the south might see a slight reduction in wind speeds at the site based on the proposed development immediately to the south.

Wind from the west

Winds from the west would impinge on the western corner of the multi-storey car park and main building causing the flow to accelerate along the long faces of these buildings with a small amount of flow directed between the buildings. The flow patterns are illustrated in Figure 14.

Given the differential pressure across the Care Arcade, the channelled flow between the two buildings would enter and accelerate in the Care Arcade.

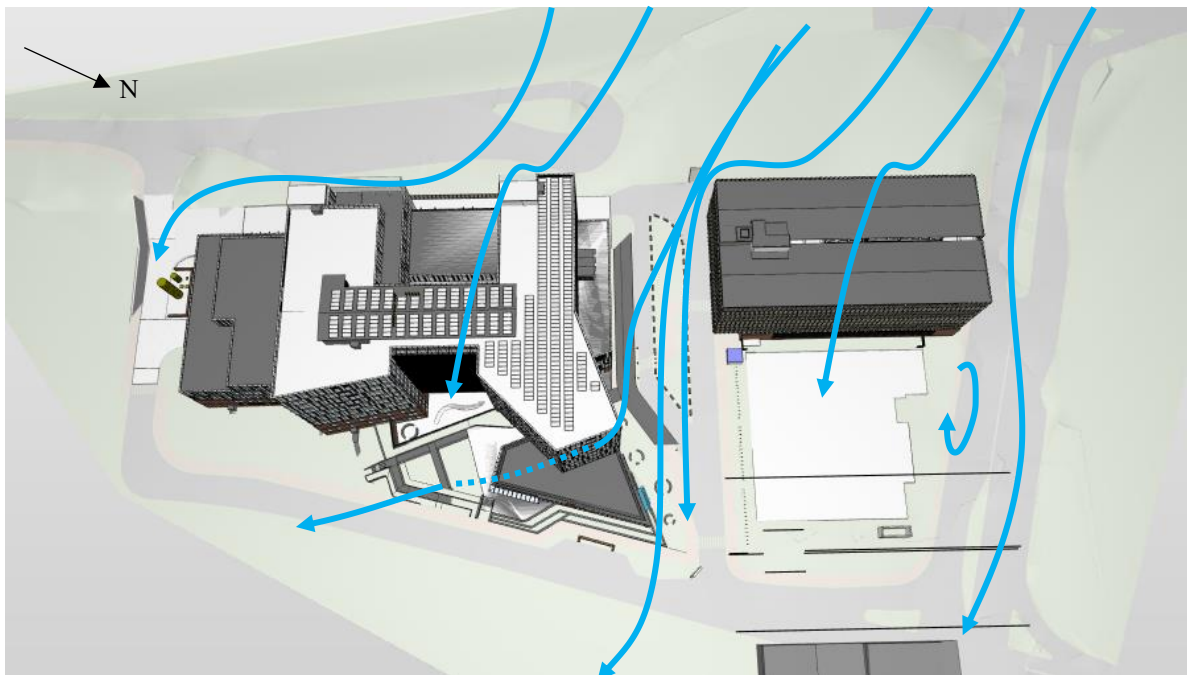


Figure 14: Wind flow patterns for winds from the west

Winds from the west quadrant are unlikely to be impacted by the future surrounds outlined in Section 2.3.1.

Discussion

The height and massing of the proposed buildings is significant relative to the surrounding buildings so will influence the local wind environment. Integrating the expected directional wind conditions with the wind climate, it is considered that wind comfort conditions at the majority of locations around the site would be classified as suitable for pedestrian standing, increasing to pedestrian walking around the outer corners of the development. These wind conditions would be considered acceptable for the intended use of pedestrian access in and around the site.

Given the differential pressure across the Care Arcade, for winds from the north-east and north-west and south-west quadrants, the wind flow would be expected to accelerate within the Care Arcade, likely rendering wind comfort conditions suitable for walking; seated areas would likely require local mitigation measures.

It is Arup's opinion that all locations within the proposed development would meet the safety criterion.

To quantify the qualitative advice provided in this report, numerical or physical modelling of the development would be required.

Given the hospital setting, where patients, visitors, and staff may include frail or mobility-impaired individuals, careful consideration of wind conditions is particularly important. Ensuring a high level of amenity in outdoor spaces—especially at entrances, waiting areas, and key open paths—is essential to support comfort, accessibility, and the functional use of these areas throughout the year. Numerical modelling is recommended to be undertaken for the Care Arcade, which can be conducted during design development, to support refinement of nominated areas for seating and key pedestrian entrances located within this outdoor space.

The proposed future surrounds, as outlined in Section 2.3.1, would likely assist with shielding the site for key prevailing winds from the north-east and south only (and not for south-west to west), which would provide some improvement overall for wind conditions at the site when these winds occur.

References

City of Auckland, (2016), Auckland Unitary Plan Operative.

City of Sydney (2016), Central Sydney Planning Strategy 2016-2036.

City of Melbourne (2017), Melbourne Planning Scheme.

Hunt, J.C.R., Poulton, E.C., and Mumford, J.C., (1976), The effects of wind on people; new criteria based on wind tunnel experiments, *Building and Environment*, Vol.11.

Isyumov, N. and Davenport, A.G., (1975), The ground level wind environment in built-up areas, *Proc. 4th Int. Conf. on Wind Effects on Buildings*, Cambridge University Press, U.K.

Lawson, T.V., and Penwarden, A.D., (1975), The effects of wind on people in the vicinity of buildings, *Proc. 4th Int. Conf. on Wind Effects on Buildings*, Cambridge University Press, U.K.

Lawson, T.V., (1990), The Determination of the wind environment of a building complex before construction, Department of Aerospace Engineering, University of Bristol, Report Number TVL 9025.

Melbourne, W.H., (1978), Criteria for environmental wind conditions, *J. Wind Engineering and Industrial Aerodynamics*, Vol.3, No.2-3, pp.241-249.

Netherlands Standardization Institute, NEN, (2006). Wind comfort and wind danger in the built environment, NEN 8100 (in Dutch) Dutch Standard.

Penwarden, A.D. and Wise, A.F.E. (1975), Wind environment around buildings, Building Research Establishment Report, HMSO.

San Francisco Planning Department, (2015) San Francisco Planning Code Section 148.

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 15, 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 15. 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.

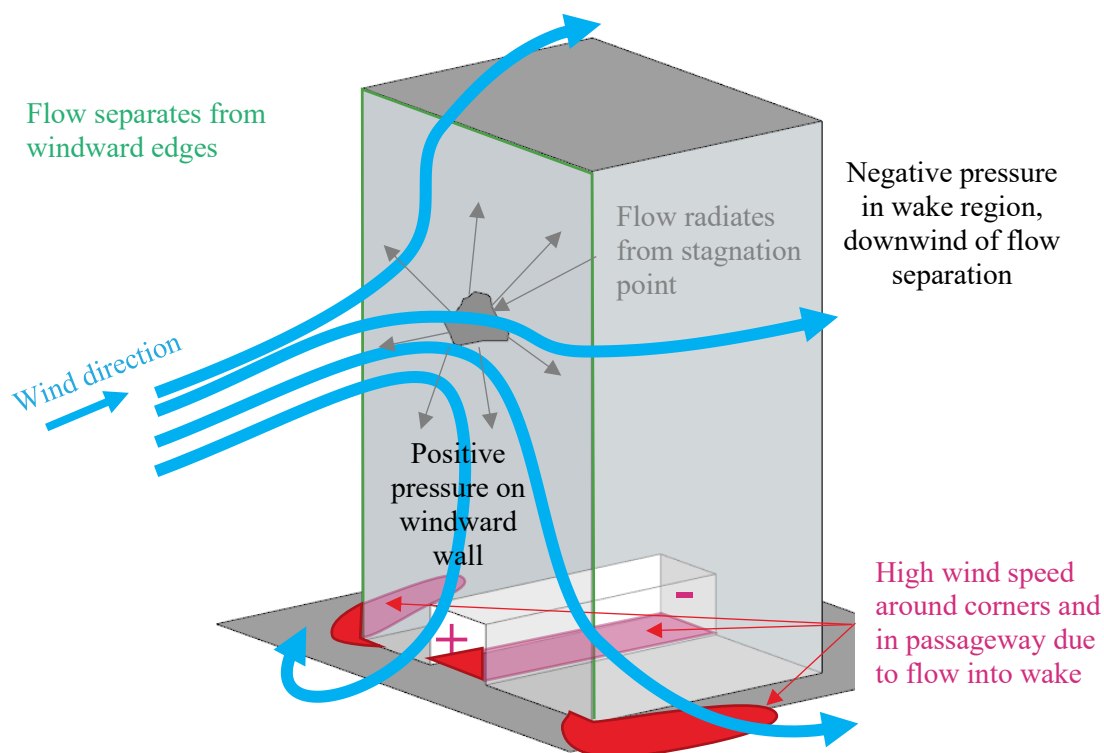


Figure 15: Schematic wind flow around tall isolated building

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 16. 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.

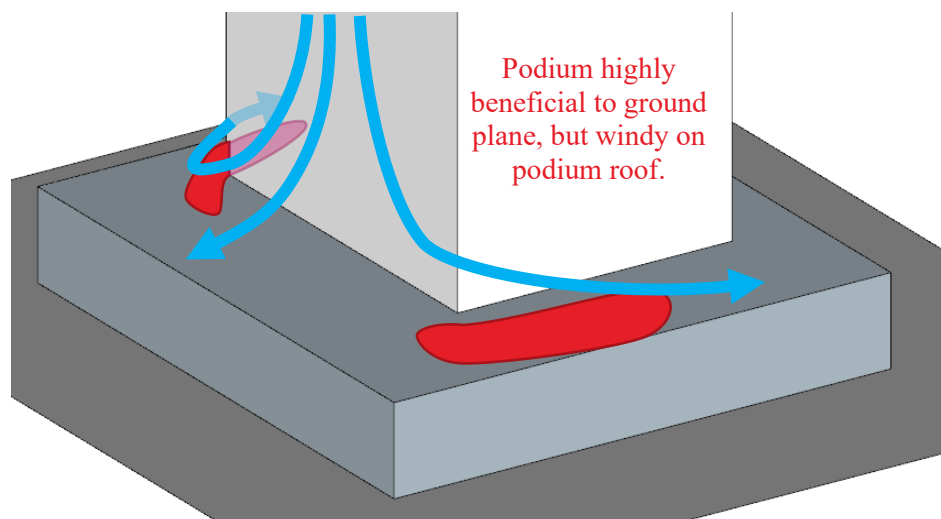


Figure 16: Schematic flow pattern around building with podium

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 17. 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.

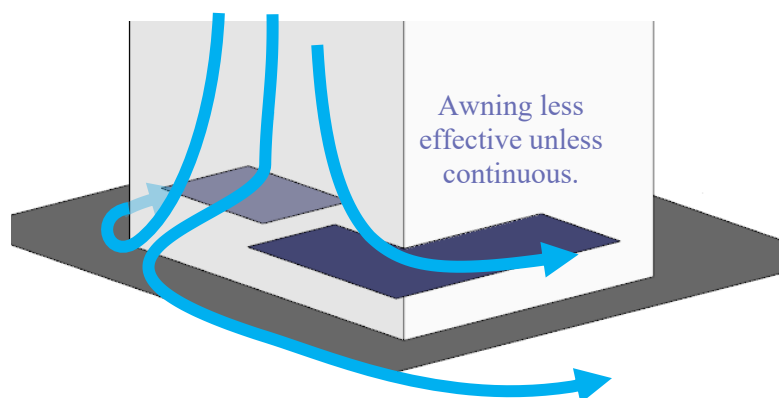


Figure 17: Schematic flow pattern around building with podium

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 18. 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 15. If the link is blocked, wind conditions will be relatively calm, Figure 19. 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 19.

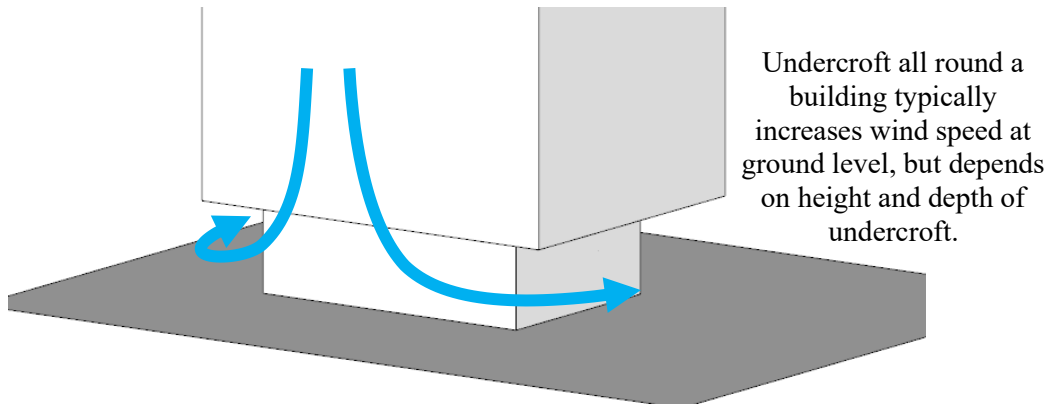


Figure 18: Schematic of flow patterns around isolated building with undercroft

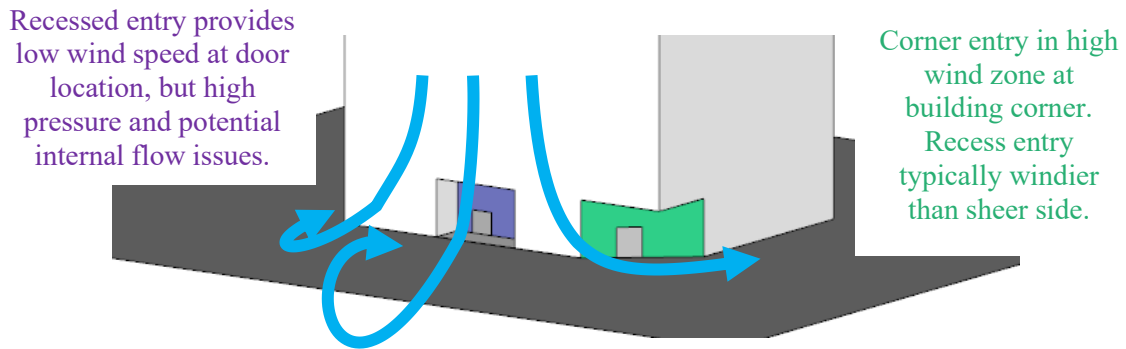


Figure 19: Schematic of flow patterns around isolated building with ground articulation

Multiple building

When a building is located in a city environment, depending on upwind buildings, the interference effects may be positive or negative, Figure 20. 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.

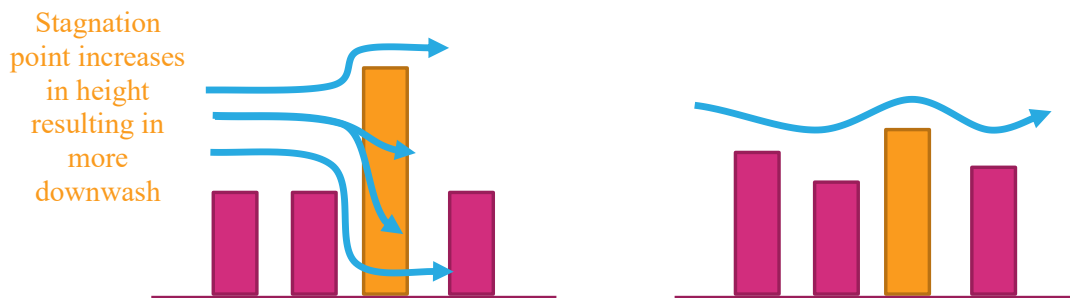


Figure 20: Schematic of flow pattern interference from surrounding buildings

The above discussion becomes more complex when three-dimensional effects are considered, both with orientation and staggering of buildings, and incident wind direction, Figure 21.

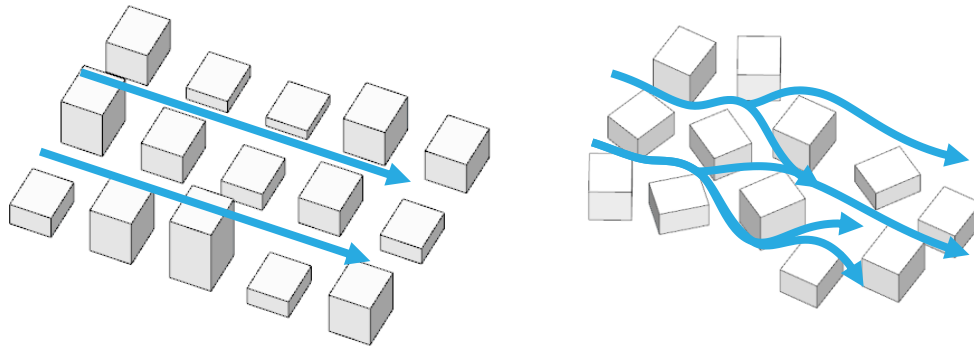


Figure 21 Schematic of flow patterns through a grid and random street layout

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

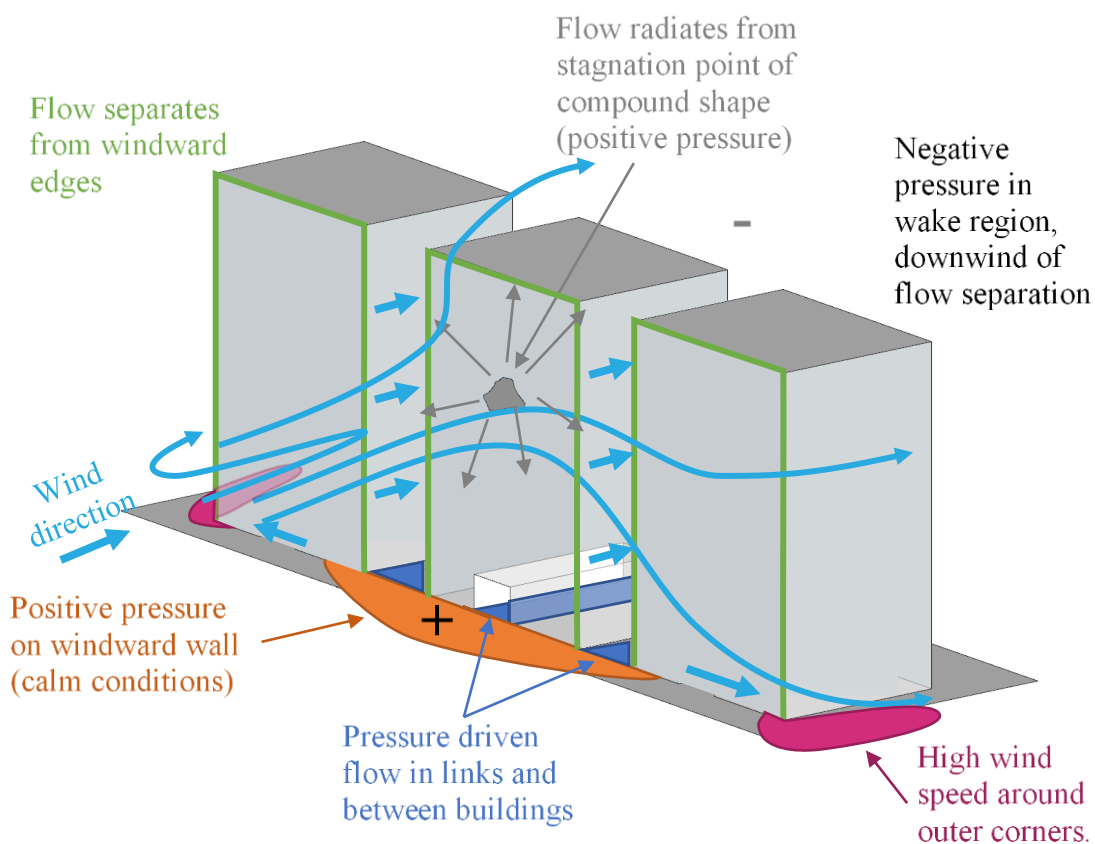


Figure 22: General flow pattern around multiple buildings

Channelling is instigated when pressure driven flow accelerates between two buildings, and continues along straight streets with buildings on either side, Figure 21(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 21(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 23, 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 23. 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.

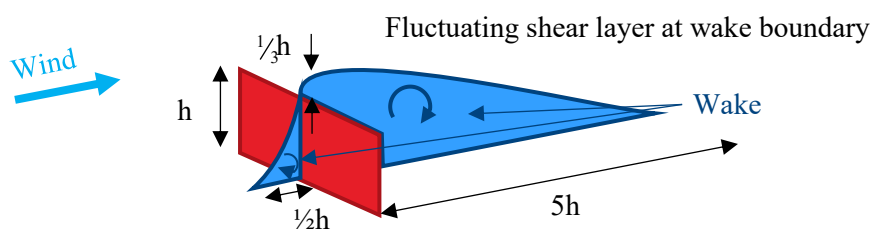


Figure 23: Sketch of the flow pattern over an isolated structure

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 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 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:

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

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 24 and Figure 25. 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 24 with definitions of the intended use of the space categories included in this Figure.

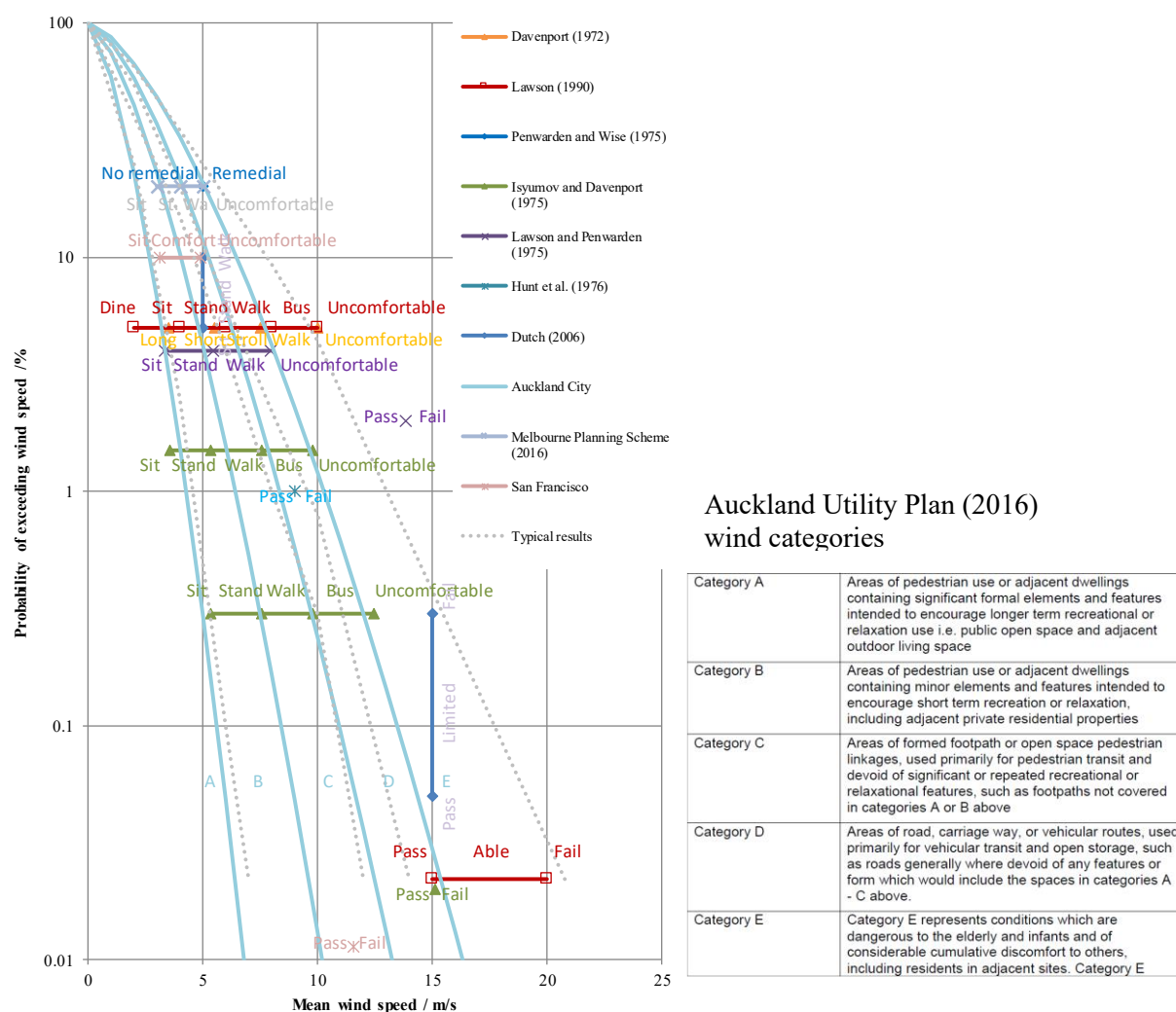


Figure 24: Probabilistic comparison between wind criteria based on mean wind speed

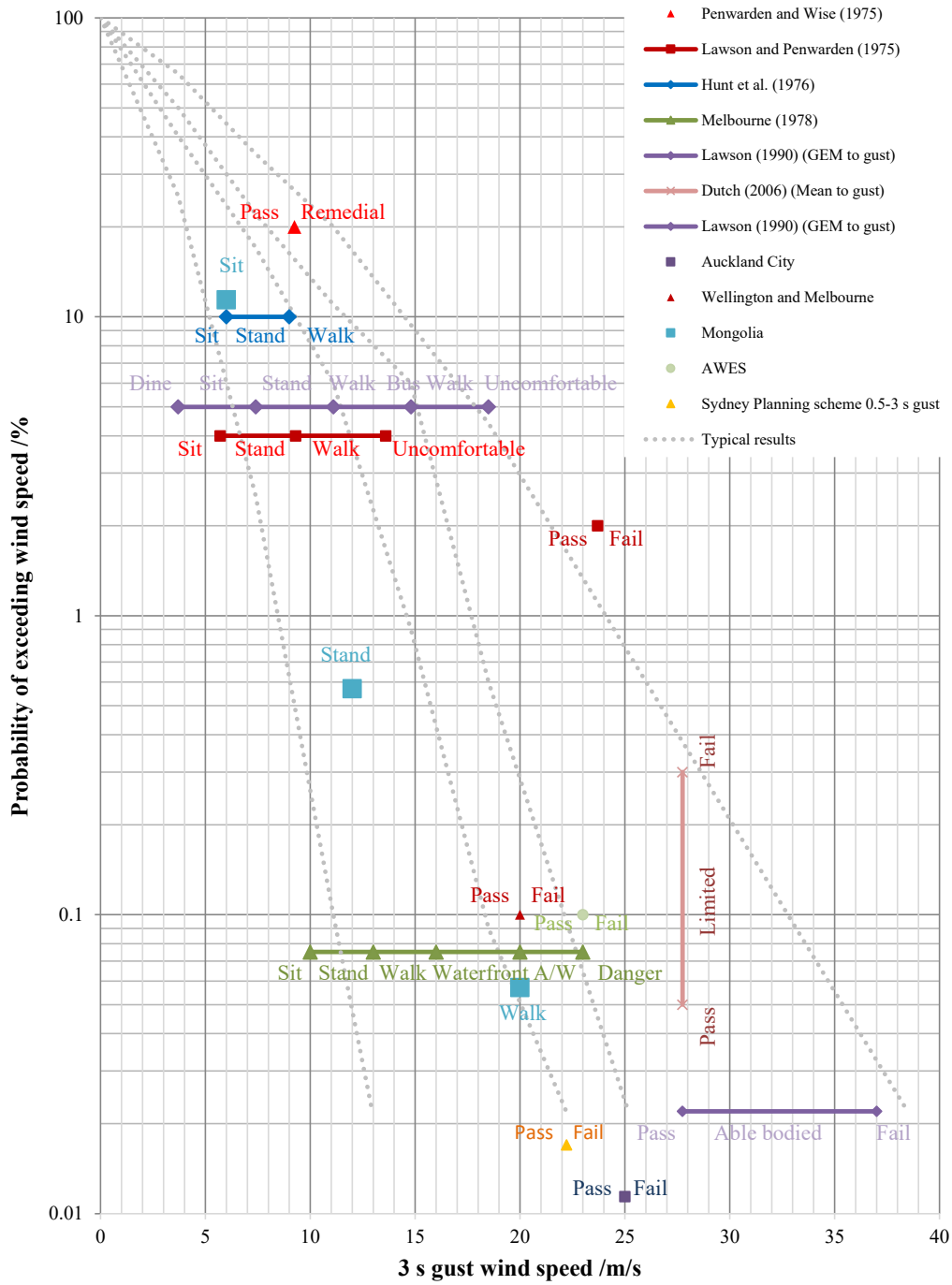


Figure 25: Probabilistic comparison between wind criteria based on 3 s gust wind speed

A.3 Reference documents

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

- Architectural plans, Revision E SSDA, dated 27 June 2025.
- SSDA - Site plan proposed, Revision F SSDA, dated 23 July 2025.
- SSDA Architectural Design Statement, Revision 7, dated 7 August 2025.

Additional documents referenced to consider future surrounds are as follows:

- GPT, Rouse Hill Strategic Centre Northern Precinct, Planning proposal 2/2025/PLP, Reference Design Architectural Plans, July 2024.
- The Hills Shire Council, Precinct Plan Rouse Hill Strategic Centre, November 2023.