Health Infrastructure NSW

Children's Hospital Westmead (CHW) Paediatric Services Building (PSB) & Multi-storey Car Park (MSCP)

Environmental Wind Assessment

Wind

Revision 01 | 11 February 2021

Job number 271985-91

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Executive summary

Arup have been commissioned by the Health Infrastructure NSW to provide a quantitative wind impact assessment of the proposed development, the Children's Hospital Westmead (CHW) Paediatric Services Building (PSB) & Multi-storey Car Park (MSCP), on the pedestrian level wind conditions for comfort and safety in and around the site.

Arup have provided quantitative advice for the impact of the proposed development on the pedestrian level wind comfort in the proposed configuration, including surrounding buildings. Wind conditions are function of the flow around all surroundings rather than individual buildings. The inclusion of large buildings generally has an impact on the wind environment making some areas windier and others calmer depending on the incident wind direction.

From a pedestrian safety perspective, all locations pass the safety conditions for the proposed development.

In terms of pedestrian comfort, the wind conditions around the site are generally classified as suitable for pedestrian standing and sitting, with some smaller localised areas suitable for pedestrian walking.

All pedestrian accessways along the surrounding streets meet the walking criteria and are therefore considered suitable for the intended use of the space. The wind conditions at all the entries are calm and suitable for the intended use.

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1 Introduction

Health Infrastructure NSW have engaged Arup to provide a quantitative environmental wind assessment for the proposed Children's Hospital Westmead (CHW) Paediatric Services Building (PSB) & Multi-storey Car Park (MSCP) development. This report outlines the assessment and recommendations relating to the pedestrian wind comfort and safety on the ground level in and around the site.

Arup have provided quantitative advice for the impact of the proposed development on the pedestrian level wind comfort in the proposed configuration, including surrounding buildings.

2 Proposed development

The proposal seeks consent for the construction of a new PSB to be located adjacent to the Central Acute Service Building (CASB), and on the site of the decommissioned P17 car park, including development of the Hawkesbury Road forecourt and access links. This includes works associated with CHW forecourt on Hawkesbury Road to provide improved community amenity in the form of a new front entry, improved street frontage and enable a more cohesive main entrance connecting existing CHW, adjoining research facilities, and the PSB.

The scope of the proposed works the subject of this SSD application includes the following:

- Construction of the PSB:
  - The PSB may contain the following uses: perioperative and interventional services, neonatal and paediatric intensive care units, cancer centre, acute inpatient beds, back of house and parent facilities; and
  - Alterations and additions to existing CHW, KR and CASB buildings adjoining the PSB site area to accommodate floor realignment and movement corridors.
- Extension of the existing CHW medical gas compound,
- Construction of a new pedestrian canopy link through KR, connecting the PSB with the Hawkesbury Road forecourt and existing hospital entrance,
- The canopy link is to be lifted above the CHW forecourt,
- A new ground plane / forecourt landscaped area extending from Hawkesbury Road to the proposed PSB,
- Tree removal to accommodate the construction of the PSB, and
- Pathology expansion and refurbishment.

3 Site description

3.1 PSB (SSD application number SSD-10349252)

The proposed development is located between Hawkesbury and Redbank Roads in Westmead, Figure 1. The site is surrounded by low- to medium-rise buildings in all directions, with the exception of the south-west where the adjacent CASB is of similar height.

The proposed development consists of the 14-storey (excluding the helipad) PSB and the CHW Forecourt (courtyard) development to the east of the site, Figure 1. The local topography is essentially flat from a wind perspective.

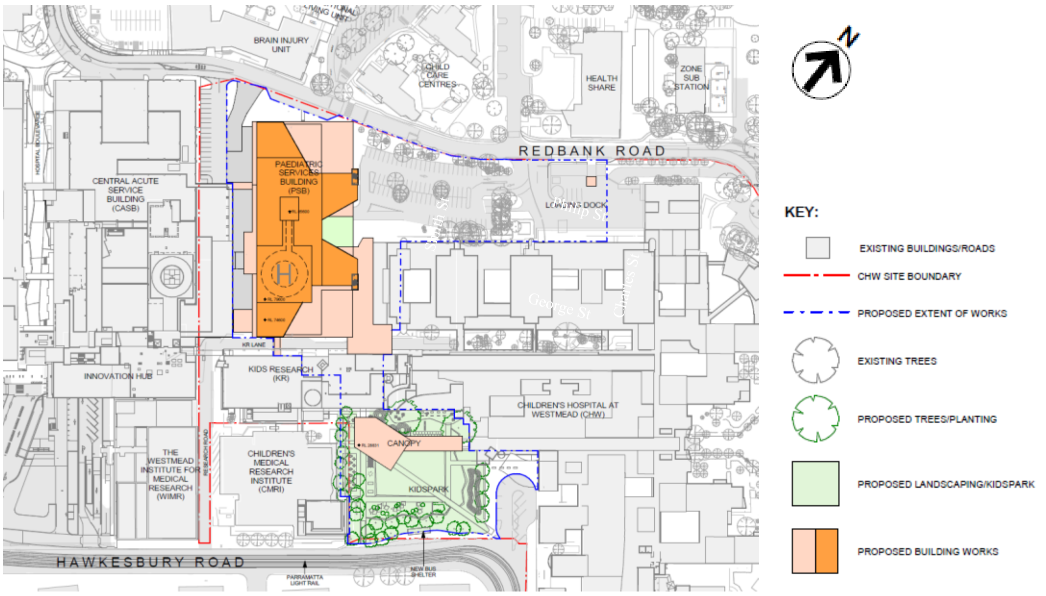

Figure 1: Site location

The PSB consists of a single building consisting of a 4-storey podium (including carpark) and 10-storey tower, rising to a maximum height of about 69 m above local ground level, Figure 2. The building tower is setback on the north-east aspect, creating two wings and two outdoor corner terraces on Level 6 on the north and east corners, Figure 3. There are various semi-outdoor areas around the perimeter of the building on Level 3 and Levels 6 to 13. The PSB is connected to the adjacent buildings and precincts via various enclosed links, including to the CHW Forecourt development via an enclosed link on Level 2. A rooftop helipad is proposed to the south of the roof.

It is understood that the main pedestrian entry to the PSB is via the CHW Forecourt (courtyard) and KIDSWAY, along the indoor link between the courtyard and PSB, Figure 4. An overhead canopy is proposed above the airlock entry from the courtyard.

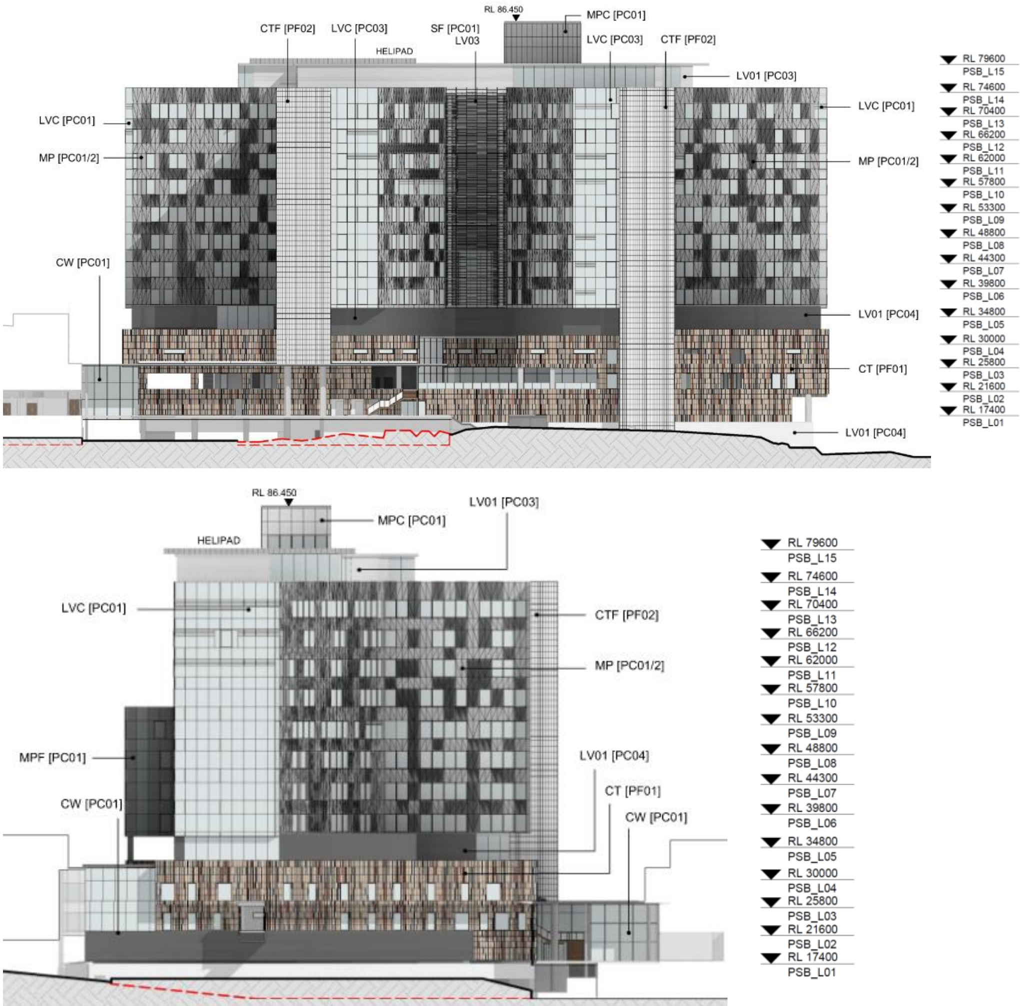

Figure 2: View from north-east (T) and south-east (B)

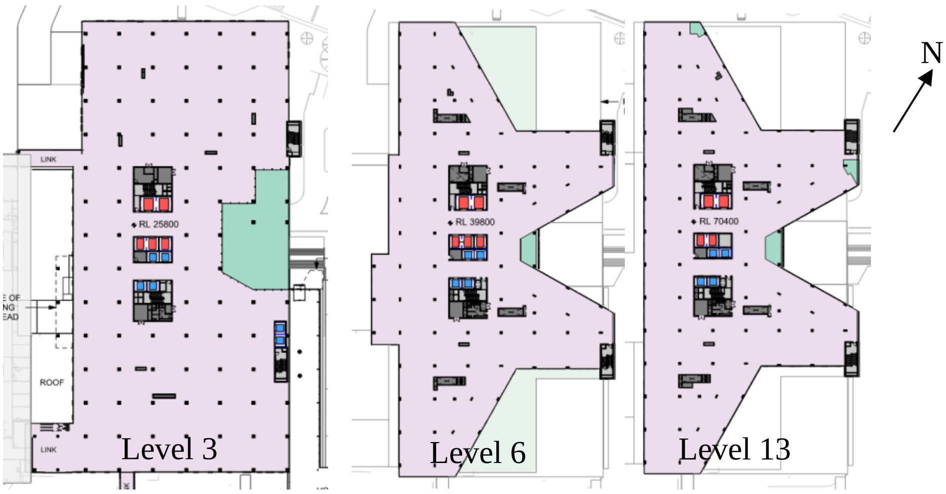

Figure 3: Various floor plans

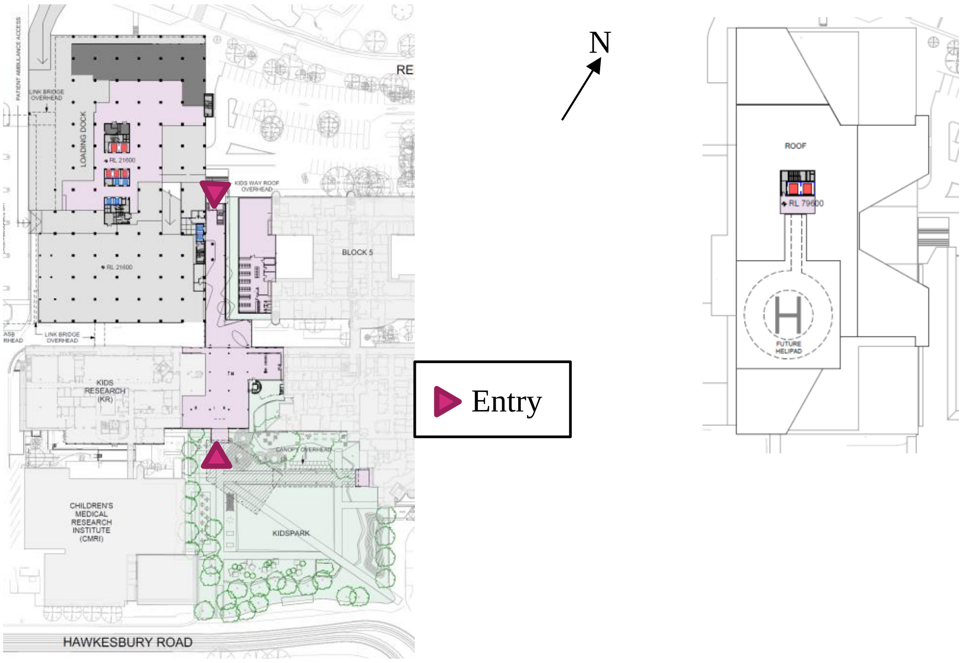

Figure 4: Level 2 plan (L) showing link between PSB and CHW Forecourt, Level 15 (R)

3.2 MCSP (SSD application number SSD-10434896)

The proposed MSCP is located on the corner of Redbank Road and Labyrinth Way in Westmead, Figure 5. The MSCP will have vehicular entry from Redbank Road and exit to Labyrinth Way. The proposed car park is approximately 8 car parking storeys (approximately 28 m high above the ground), Figure 6.

The site is surrounded by low- to medium-rise buildings in all directions, Figure 7. The main hospital buildings, which are taller, are located to the south-west and are remote from the site. Some of the adjacent buildings are medium-rise, although the MSCP is slightly higher.

The local topography is essentially flat from a wind perspective.

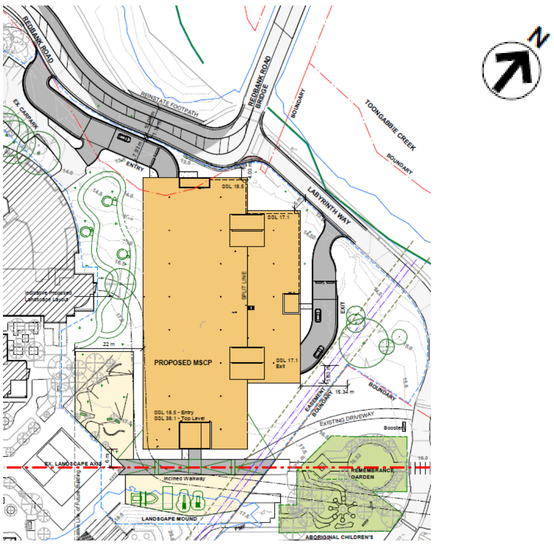

Figure 5: Site location of MSCP

The MSCP is prismatic in shape, with a consistent floor plate across the levels, Figure 8. The main pedestrian entry is from the south-east, which connects with a pedestrian link towards the main hospital buildings, Figure 9.

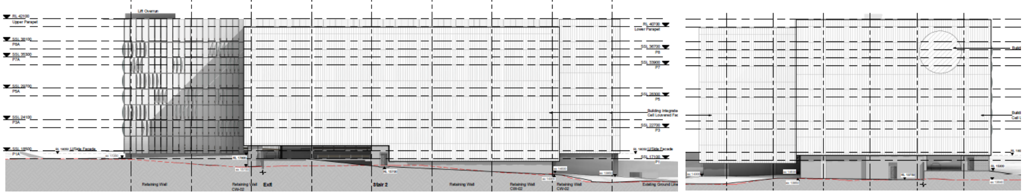

Figure 6: View from east (L) and north (R)

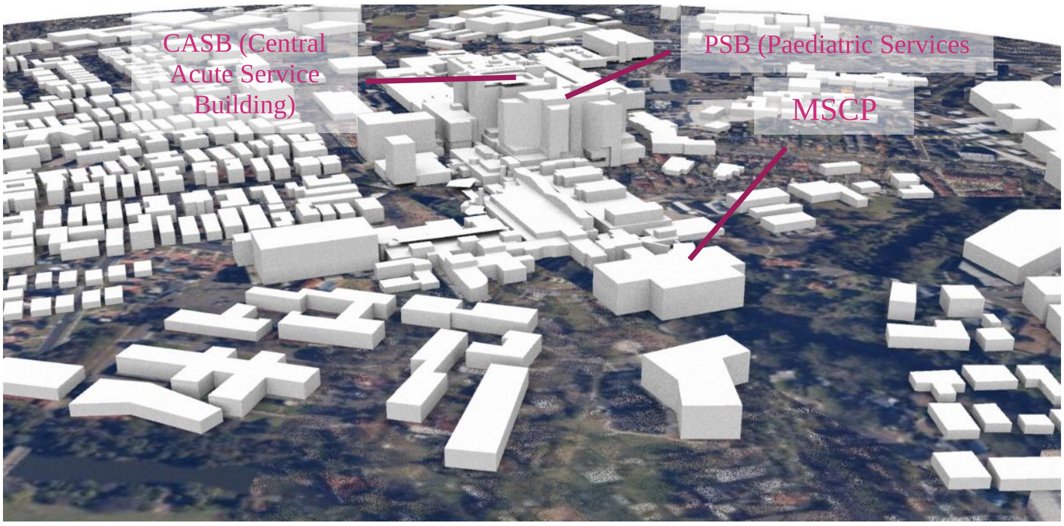

Figure 7: View of the 3D model from the north-east

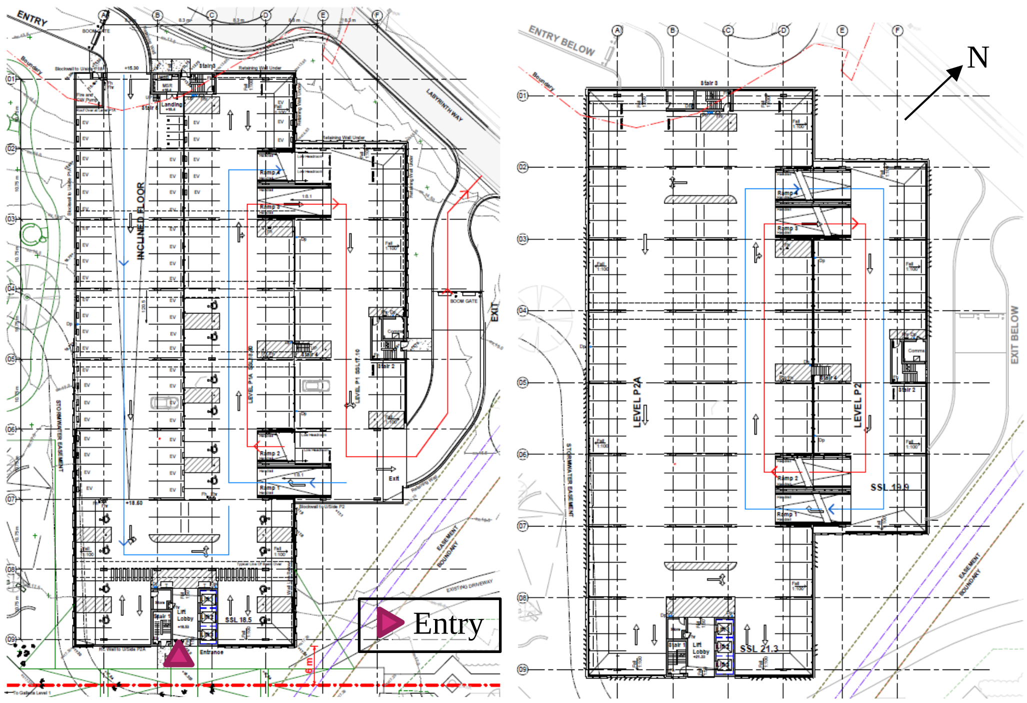

Figure 8: Level P1 (L) and typical floor plan (R)

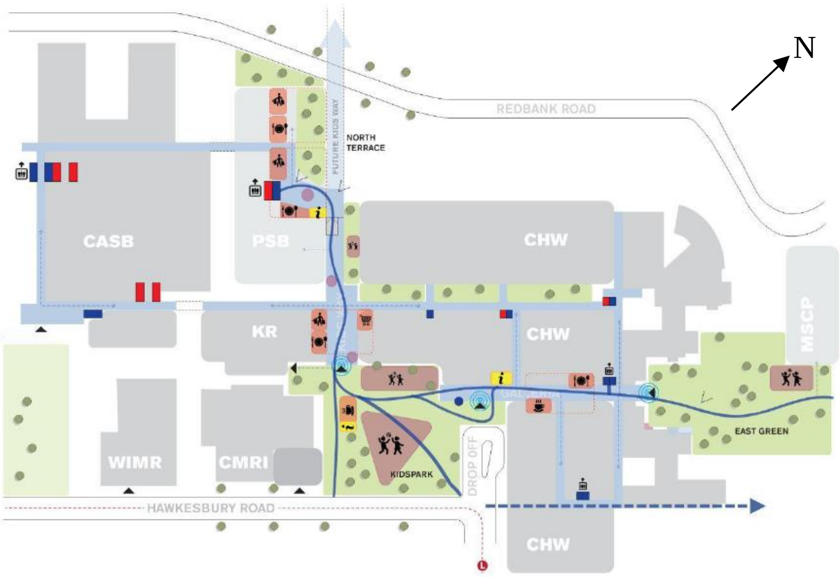

Figure 9: Key pedestrian routes (blue line)

The façade comprises a series of slab to slab aluminium panels. There are two types of panels, one being a regular 50% open area perforated panel, and the other having a 3D punched and fold perforation, Figure 10. It is understood that the entire façade comprises these panels and is therefore generally porous, aside from exceptions such as stairs, entry, and/or lift shafts.

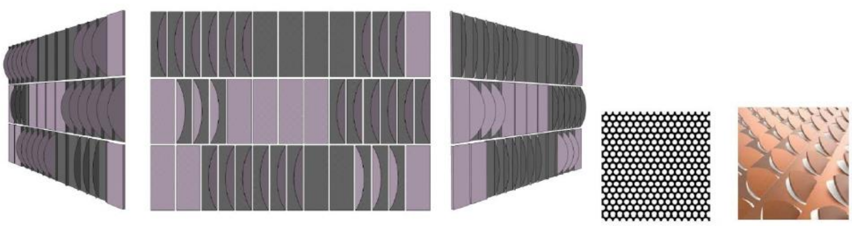

Figure 10: Proposed façade panels

4 Local wind climate

Weather data recorded at Bankstown Airport by the Bureau of Meteorology at a standard height of 10 m above ground level has been analysed for this project, Figure 11. The arms of the wind rose point in the direction from where the wind is coming from. The anemometer is located about 13 km to the south of the site and is a similar distance from the coast to the east, and mountains to the west. The directional wind speeds measured here are considered representative of the incident wind conditions at the site.

Cold and hot winds tend to come from the west and east quadrants respectively. Typically, mornings tend to have lighter winds increasing in intensity through the day.

A general description on flow patterns around buildings is given in Appendix 2.

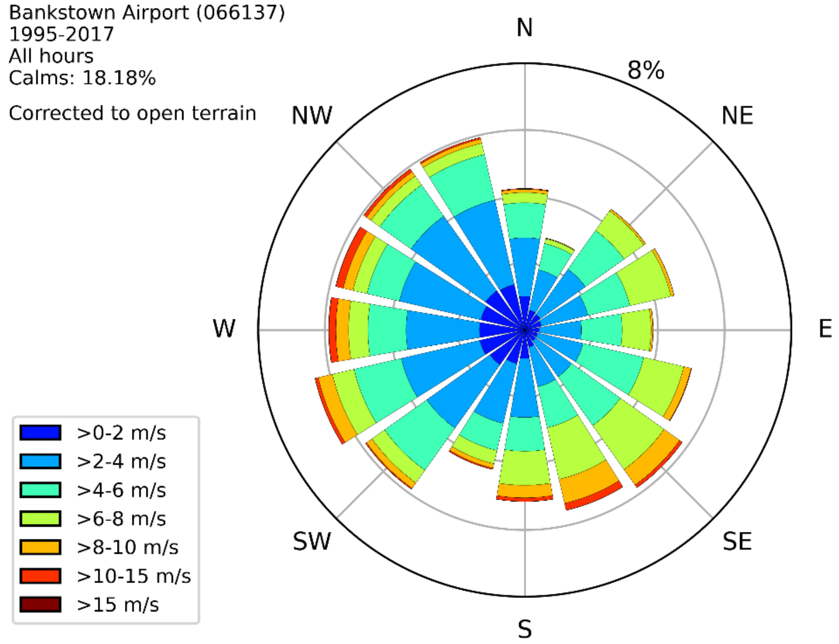

Figure 11: Wind rose showing probability of time of wind direction and speed

5 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 3. The current wind criteria in the City of Parramatta Council DCP 2011 are:

'To ensure public safety and comfort the following maximum wind criteria are to be met by new buildings:

- 10 m/s in retail streets
- 13 m/s along major pedestrian streets, parks and public places
- 16 m/s in all other streets'

These wind criteria do not include the duration of the wind event, nor the probability of time that they occur. These criteria are considered to be based on the work of Melbourne (1978), which represent a peak 3 s gust event occurring in an hour for 0.1% of time from any wind direction. The applicable 13 m/s limit for this site, is a comfort criterion appropriate for pedestrian standing activities. With reference to the wind rose for mean wind speed in Figure 11, there are few exposed locations in Parramatta that would meet this criterion without additional shielding to improve the wind conditions. This wind speed criterion is used as an estimator of the general wind conditions at a site, which may be more relevant.

To combat this limitation, as well as the once per annum gust wind speed, the wind controls used in this wind assessment are based on the work of Lawson (1990) as described in Figure 24 and Table 1. These have both a comfort and safety component and tend to better describe the usage of the space from a comfort perspective.

Table 1 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)

Converting the wind climate to the site location, the mean wind speed exceeded 5% of the time would be approximately 4 m/s at pedestrian level. With reference to Table 1, this wind speed is on the boundary of pedestrian sitting and standing conditions. From our knowledge of the local environs, this assessment would be considered realistic and appropriate.

6 CFD assessment

6.1 Methodology and modelling

The numerical CFD simulations were conducted for the proposed development using steady-state Reynolds-Averaged Navier-Stokes (RANS) method. The implemented CFD methodology has been benchmarked against wind-tunnel testing results on several projects. CFD modelling was selected over wind-tunnel testing as CFD modelling assesses the wind conditions through the entire volume rather than at discreet measurement points.

The urban context including surrounding buildings within a radius of 600 m around the site was explicitly modelled, Figure 12 and Figure 13. Topography surrounding the site is included in the model. The context is placed in a much larger domain based on best practice guideline for the CFD simulation of flows in urban environment, Figure 14.

Due to modelling constraints, the MSCP was modelled as a solid façade, which is a slightly conservative approach.

A computational mesh was constructed comprising of approximately 15 million hexahedral elements. The grid resolution is finest around the proposed building where greater resolution is required. The computational mesh size increases with distance from the regions of most interest. Other mesh sizing controls including varying the level of mesh refinement were used to more accurately capture the effects of important surrounding buildings from an aerodynamic perspective.

Mesh sensitivity study was conducted to reduce the effect of mesh size on the solution.

The effect of terrain outside the 1.2 km diameter urban context was implicitly modelled using rough wall functions reproducing the roughness characteristics corresponding to suburban, Terrain Category 3 (TC3) as defined in Standards Australia (2011). The wind speed and turbulence profiles corresponding to TC3 were employed at the inlet boundary. Simulations were conducted for 16 wind directions at 22.5° increments.

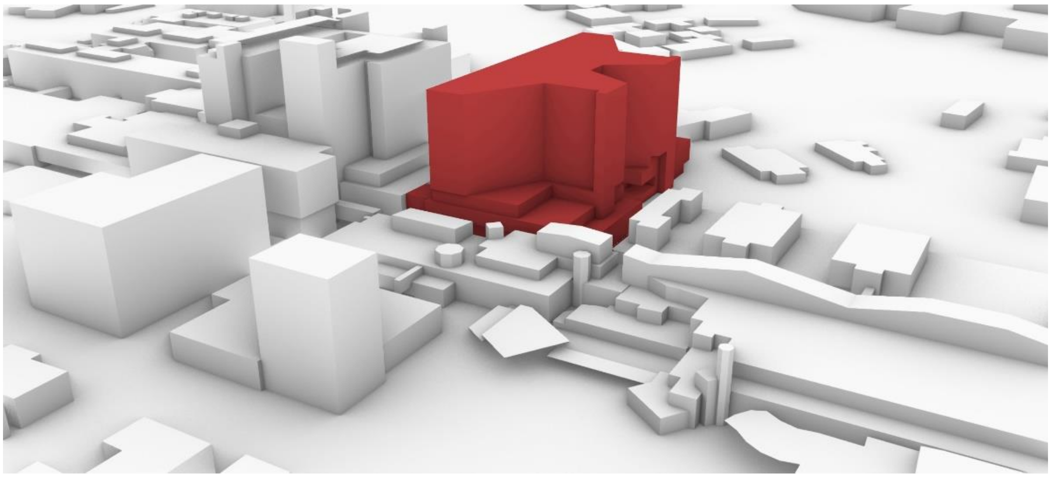

Figure 12: 3d model of the PSB, viewed from the east

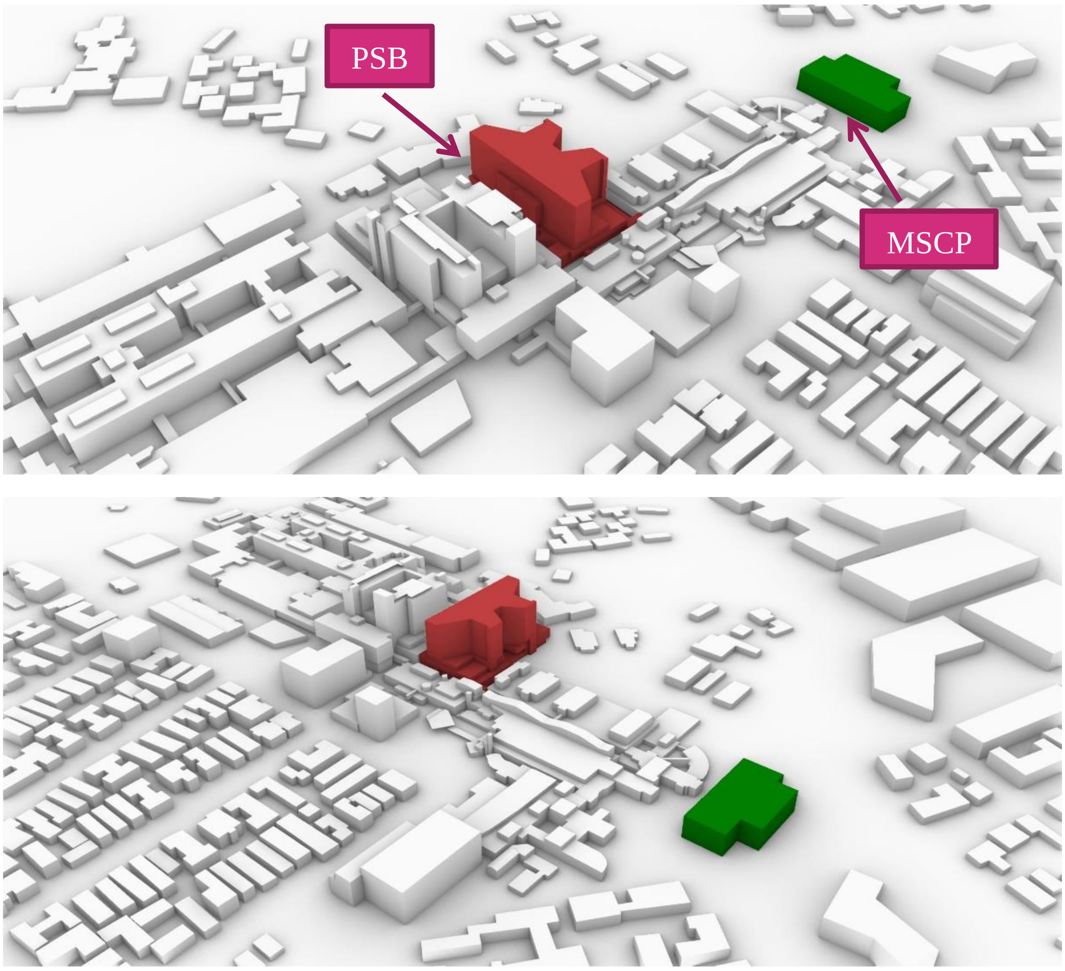

Figure 13: 3d models of the PSB and MSCP, viewed from the south (T), and from the east (B)

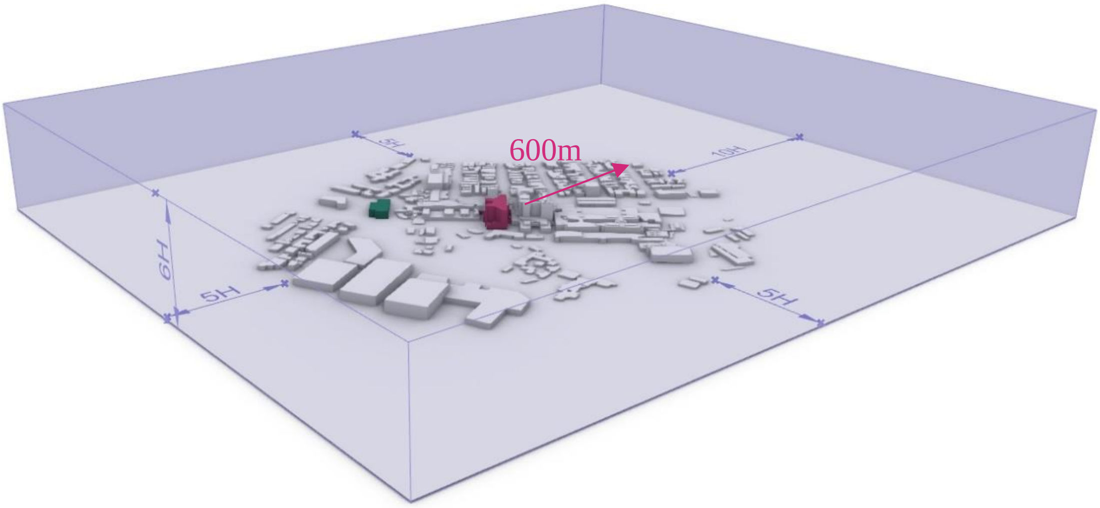

Figure 14: Simulation domain (dimensions in metres; 'H' represents maximum subject building height)

The CFD setup followed the best practices and guidelines for simulating flow in urban environments (Franke, 2011). Probes at different locations around the site and parameter residuals were used to monitor the convergence of the results and ensure the solution reached a steady state solution.

6.2 Wind conditions on ground level

Contour maps of wind speed ratio at pedestrian level at pedestrian height of 1.5 m above the local ground level for 16 wind directions are presented in Appendix 1. The extension of the assessed area around the site is aligned with guidelines for pedestrian wind effects criteria, AWES (2014). The wind speeds over the entire surface are integrated with the local wind climate data presented in Section 2 for assessment against the Lawson criteria for pedestrian comfort and safety. For assessment against the criteria, the Gust Equivalent Mean (GEM) is calculated based on measured turbulent kinetic energy. Considering isotropic turbulence, standard deviation of wind speed would can be calculated using:

$$\sigma = (2/3k)^{0.5}$$

where k is turbulent kinetic energy. Using mean wind speed and standard deviation, GEM can be determined based the equation in Appendix 3. The maximum of GEM and mean wind speed is statistically analysed to provide the site safety, and comfort classification based on 0.022% and 5% of the time exceedance respectively in accordance with the Lawson wind criteria. Contour maps showing the directionally integrated safety and comfort classifications are presented in Figure 15 and Figure 16 respectively.

The site is taller than the surrounding buildings for all wind directions, with the exception of the south-west where the adjacent CASB is of similar height. The proposed PSB development would therefore be expected to have an impact on the local wind conditions making some areas windier and others calmer depending on the incident wind direction. The main pedestrian areas around the site are internal with little external accessibility in the immediate vicinity of the building massing.

All locations pass the safety criterion, Figure 15.

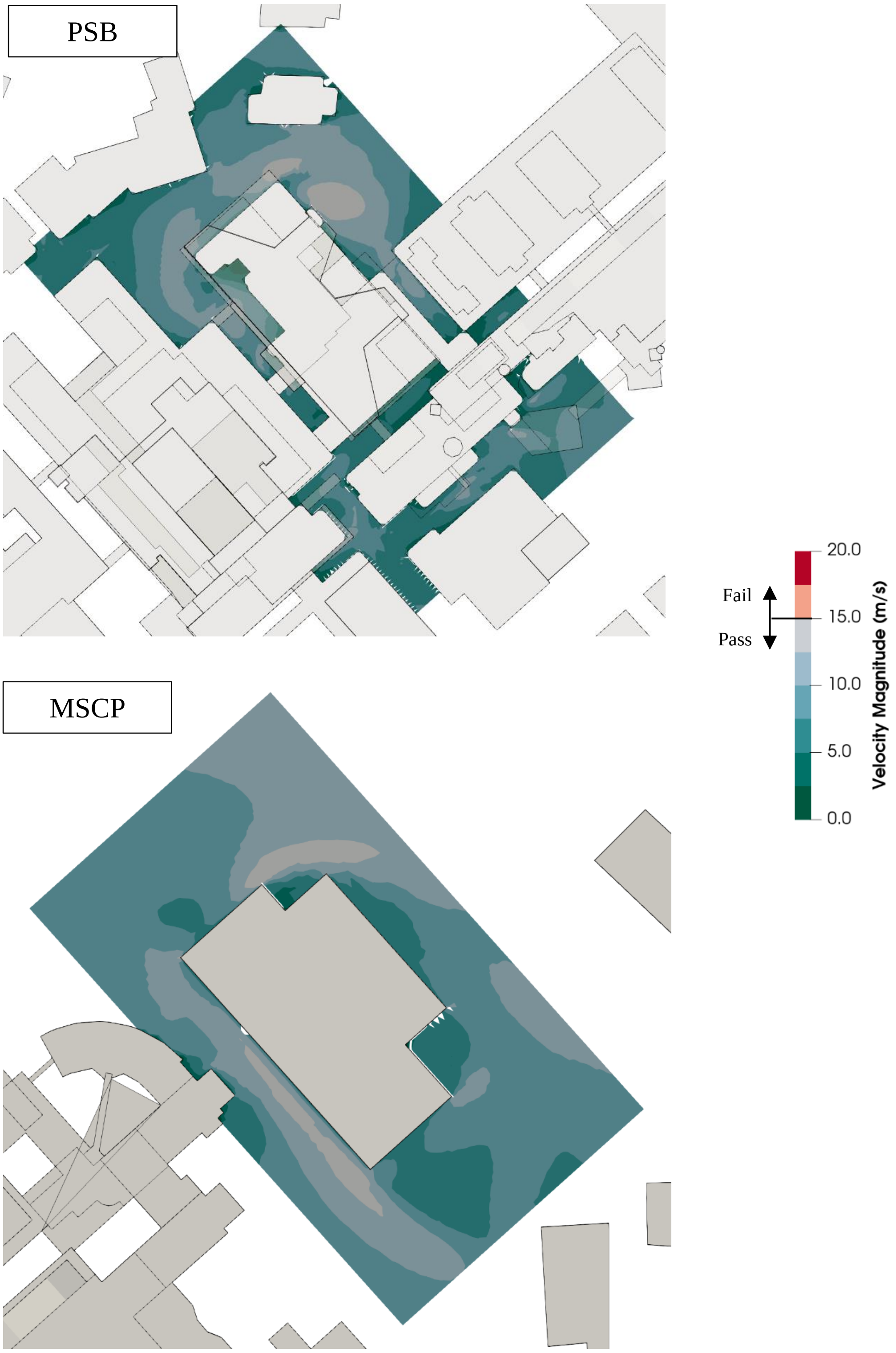

Figure 15: Classification of wind safety at 1.5 m above local ground level

The contour map of wind comfort classification is presented in Figure 16. The directional results (Appendix 1) have been integrated with the wind climate and colour coded to match the criteria classification categories.

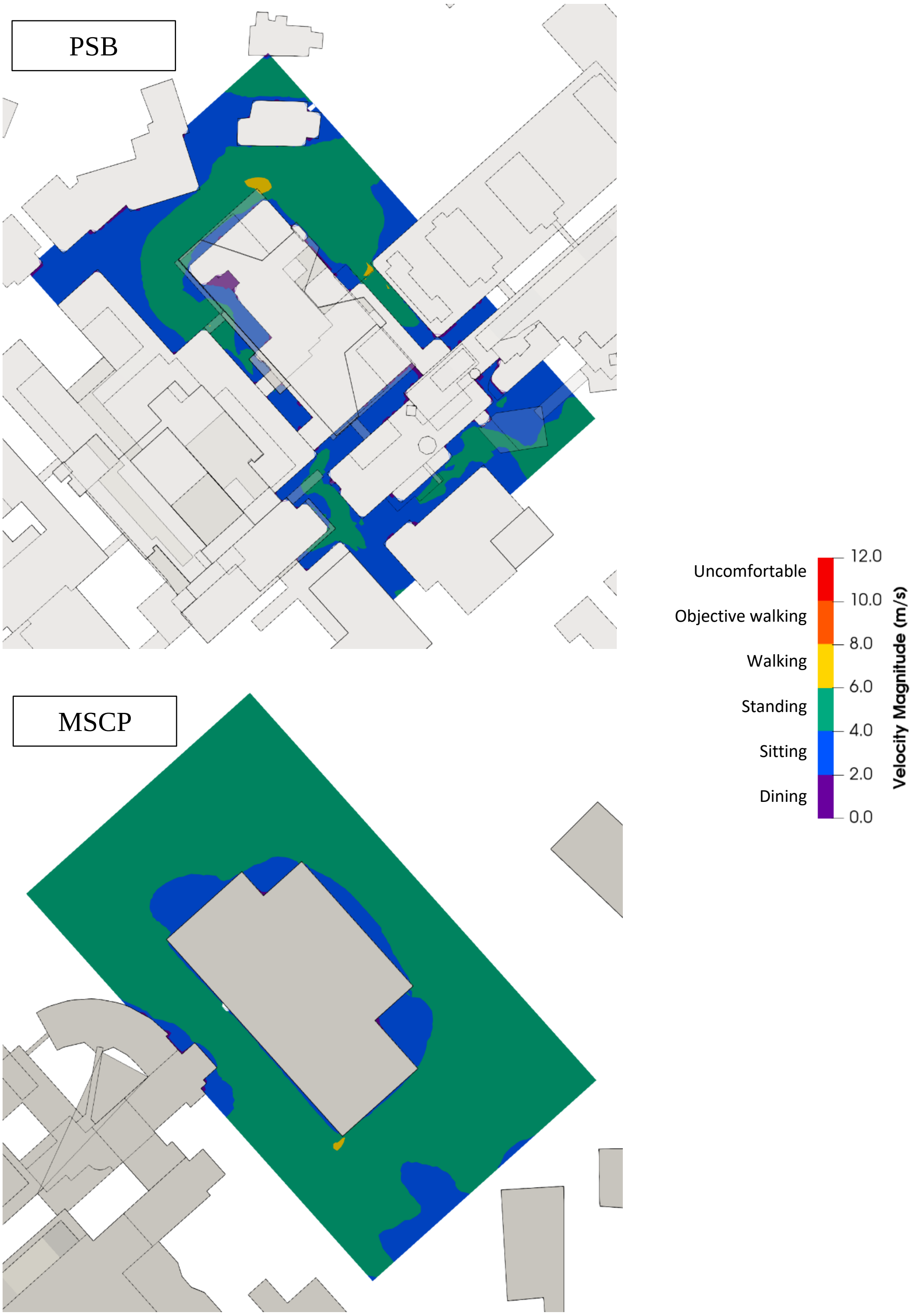

Figure 16: Classification of wind comfort at 1.5 m above local ground level

It is evident from Figure 16 that the wind conditions across the site are generally classified as suitable for sitting and standing activities, with walking conditions experienced in small localised locations at the north corner of the PSB, slightly to the east of the north ground-level pedestrian entrance to the PSB and at the southern corner of the MSCP. These conditions are suitable for the intended use of the spaces.

The wind conditions at the northern entry to the PSB is classified as suitable for sitting. Similarly, the southern entry to the PSB from KIDSWAY is classified as suitable for pedestrian sitting or standing. CHW Forecourt is classified as suitable for pedestrian sitting or standing.

There are a number of local calmer areas close to the building articulations of the PSB that are classified as suitable for sitting, particularly on the south-eastern and south-western façade, where there is ambulance access to the PSB.

The main entry to the MSCP and pedestrian zone to the south-east is classified as suitable for standing.

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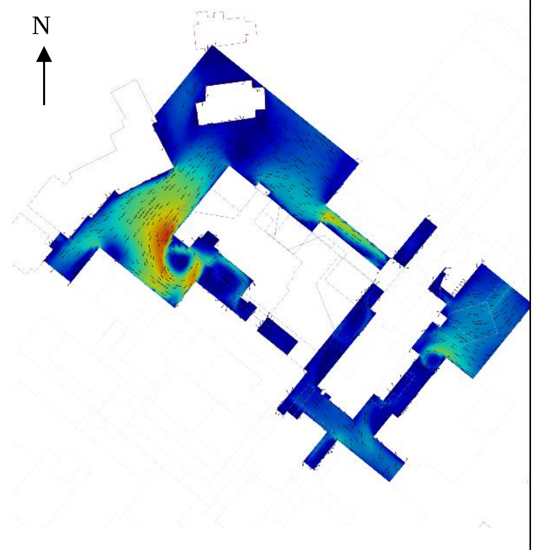
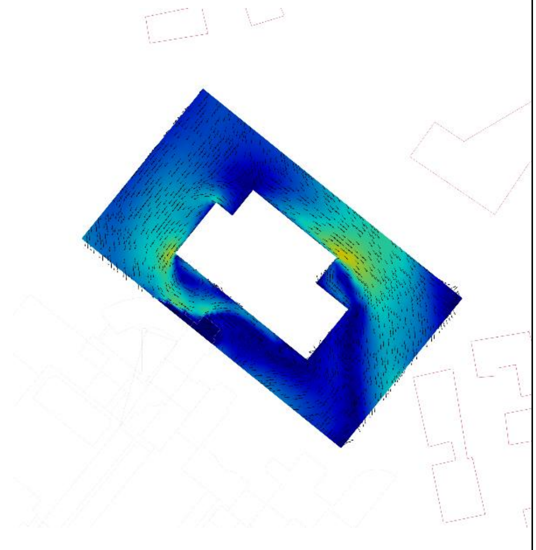
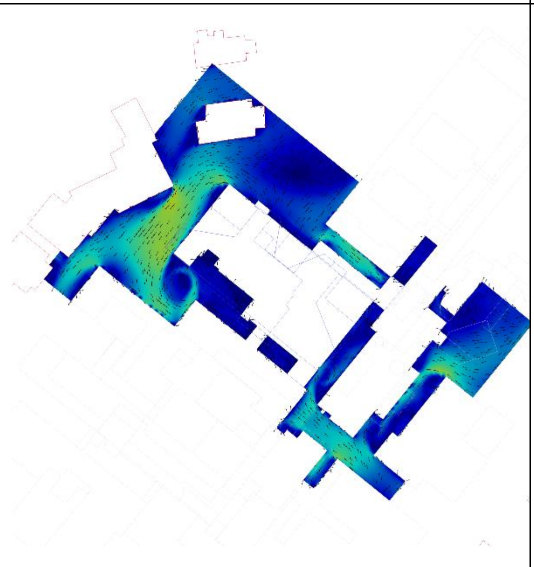
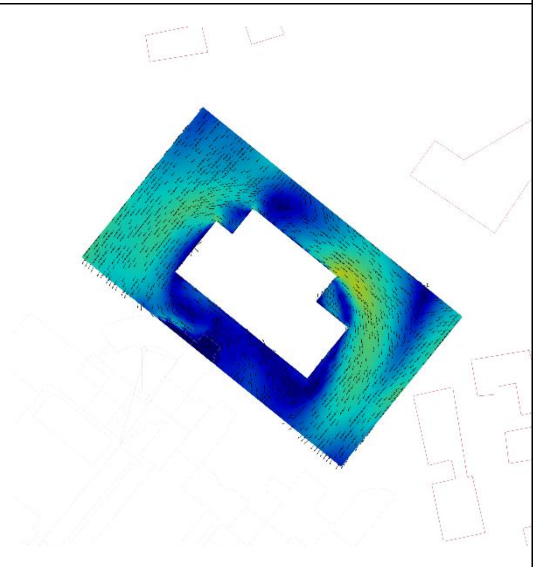
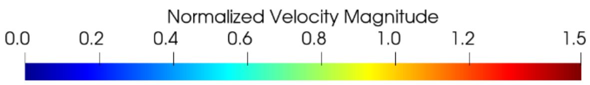
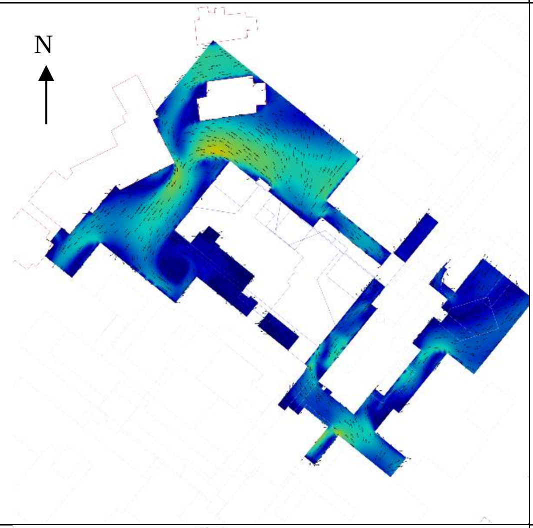
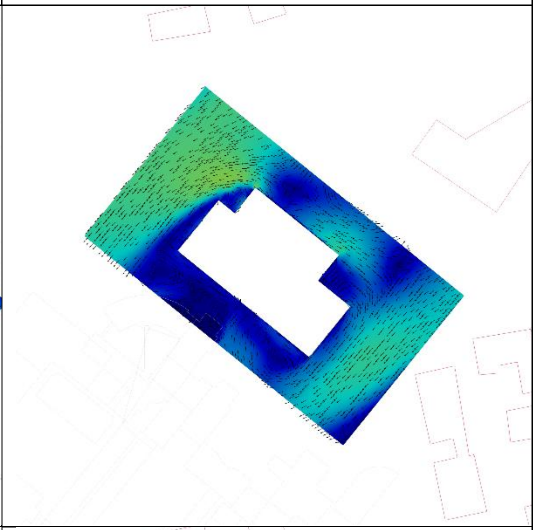
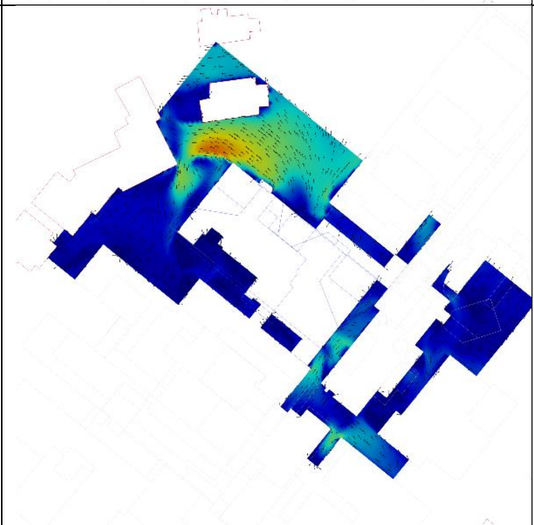
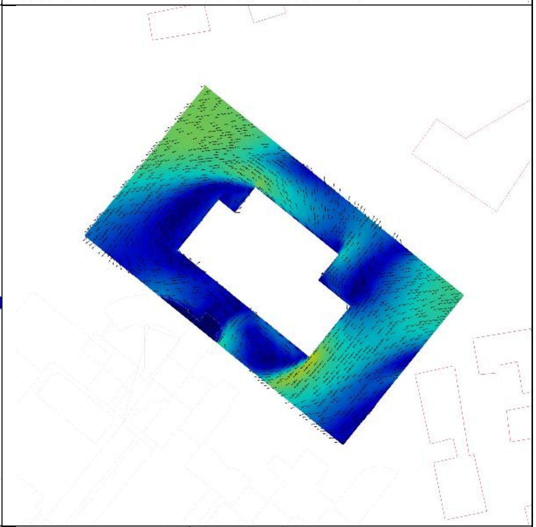
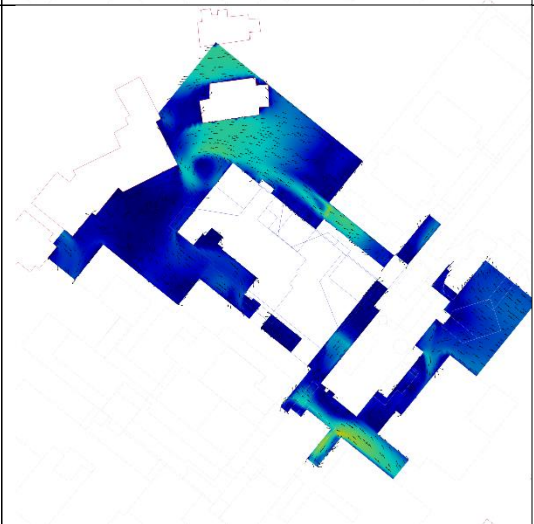
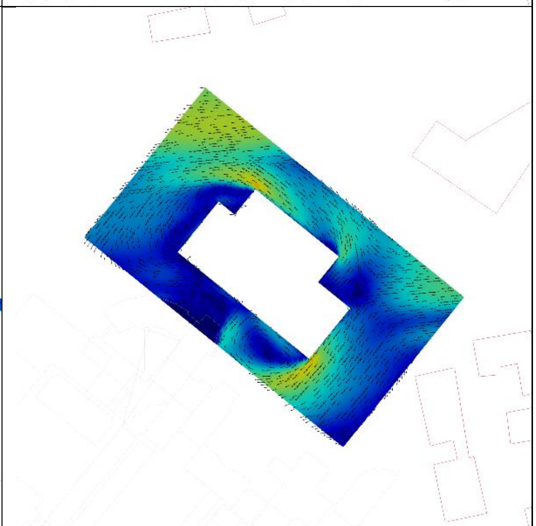
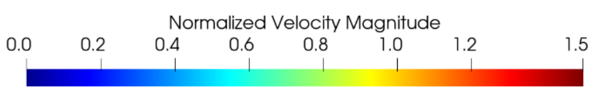
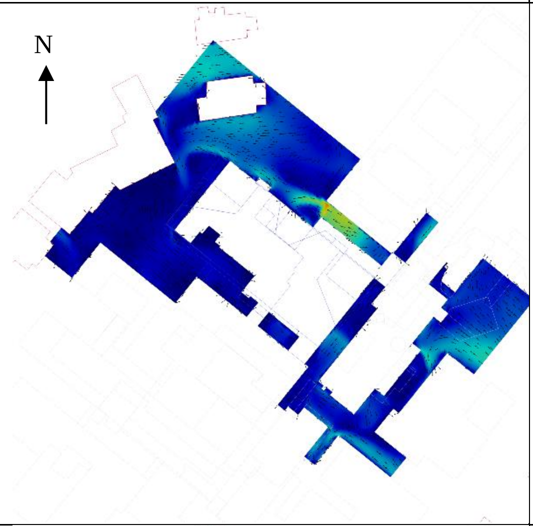
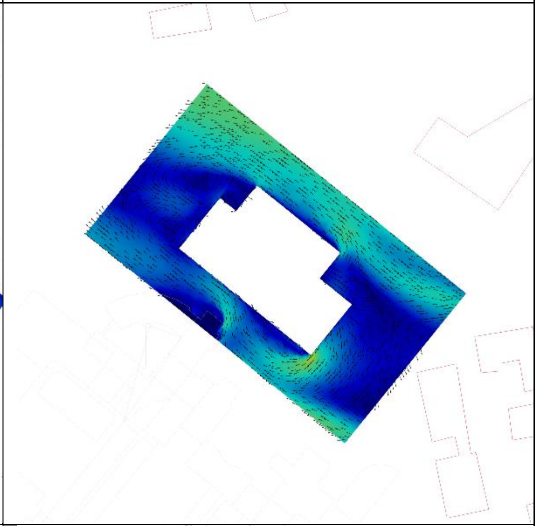
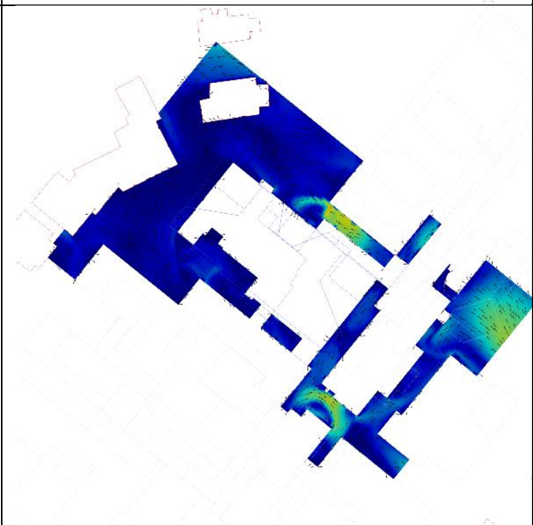
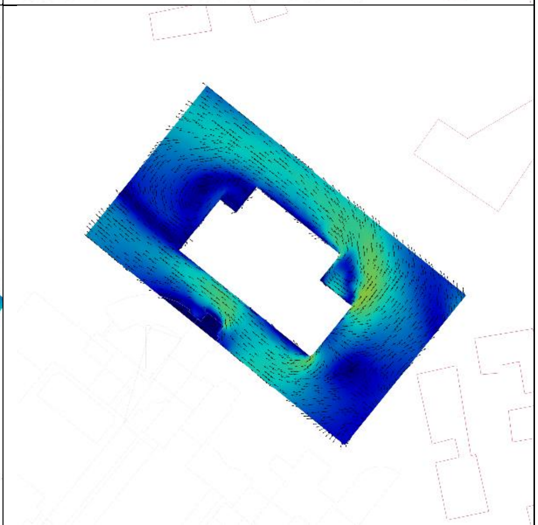
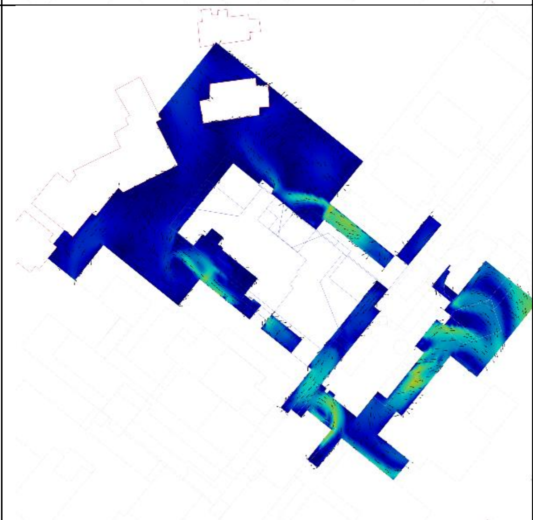
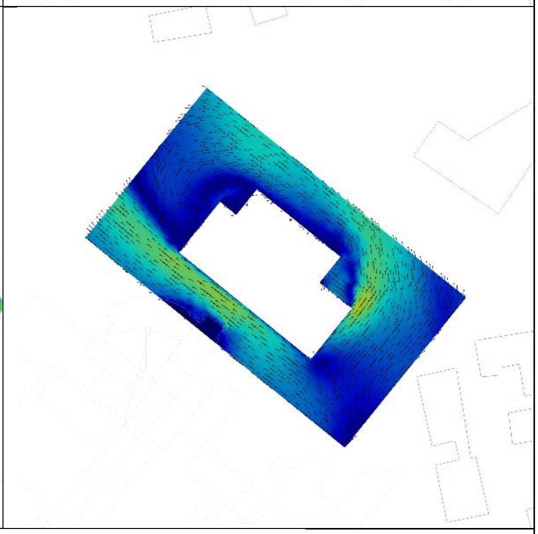
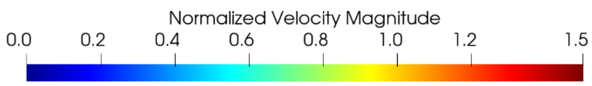
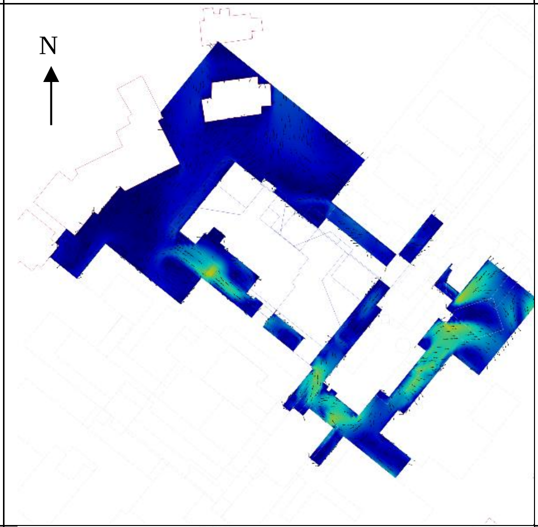
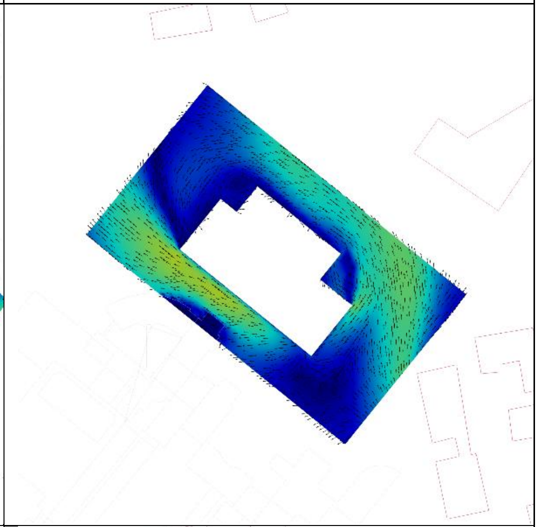
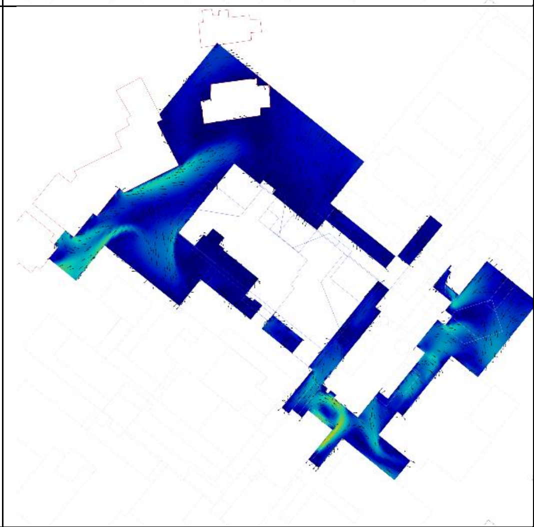
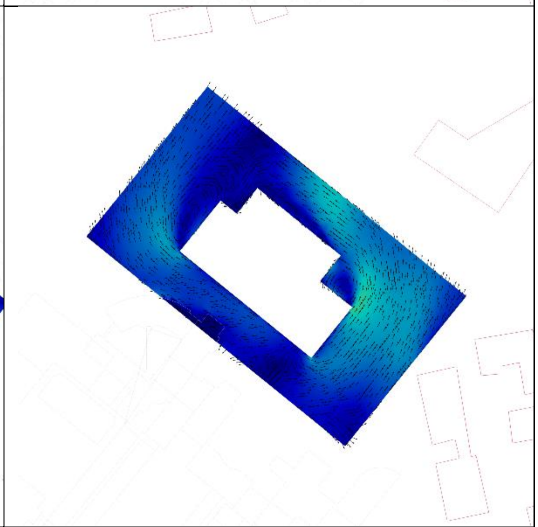
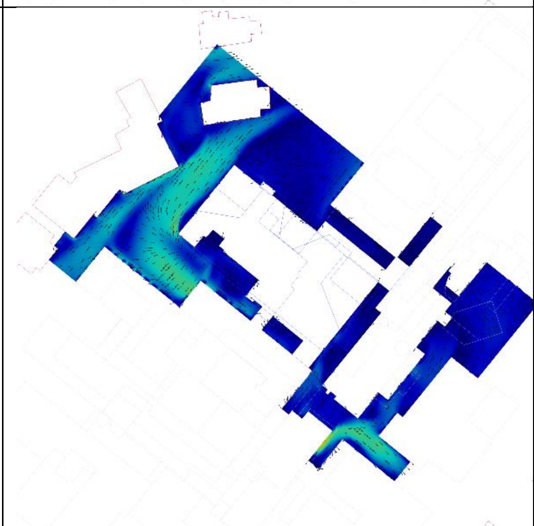
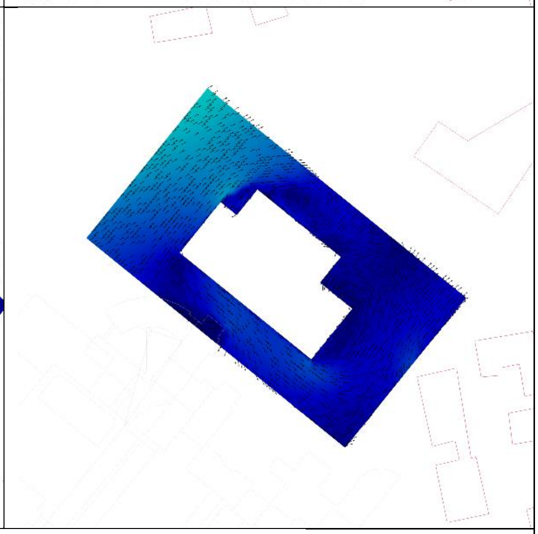
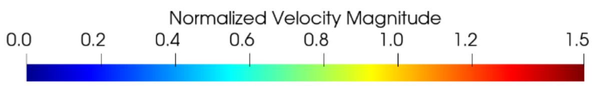
Appendix 1. Directional results at pedestrian level

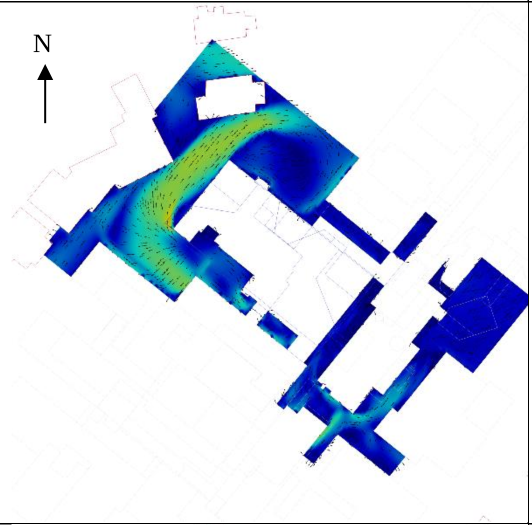
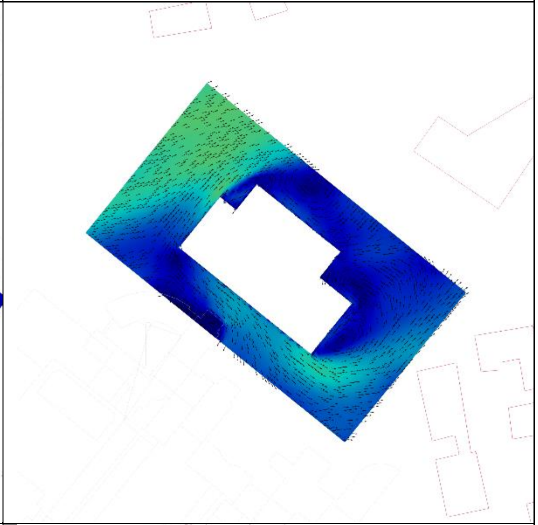
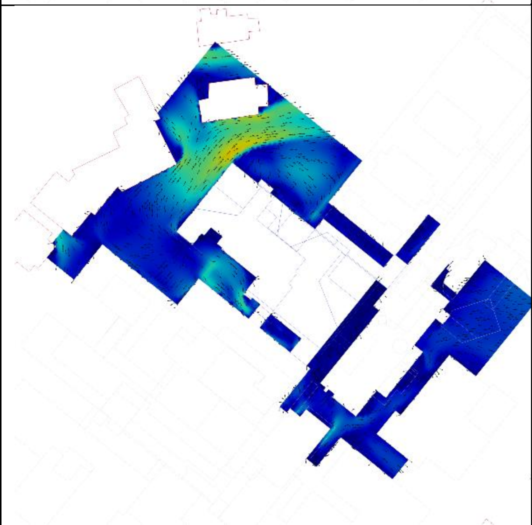
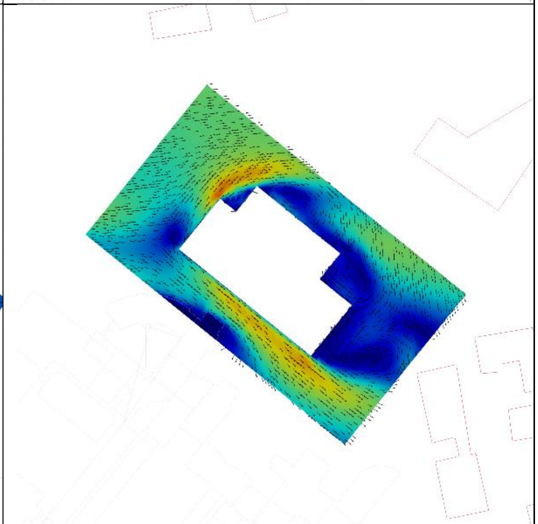
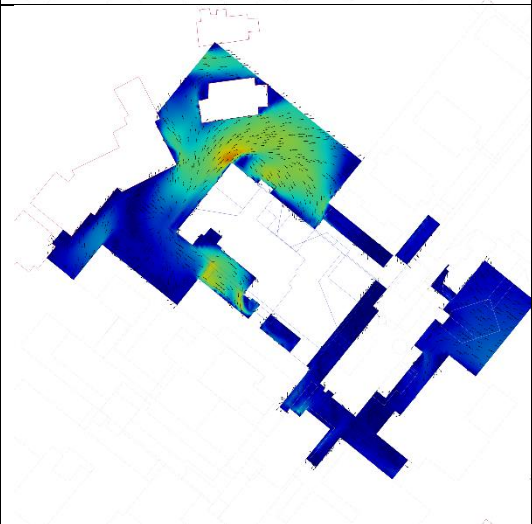
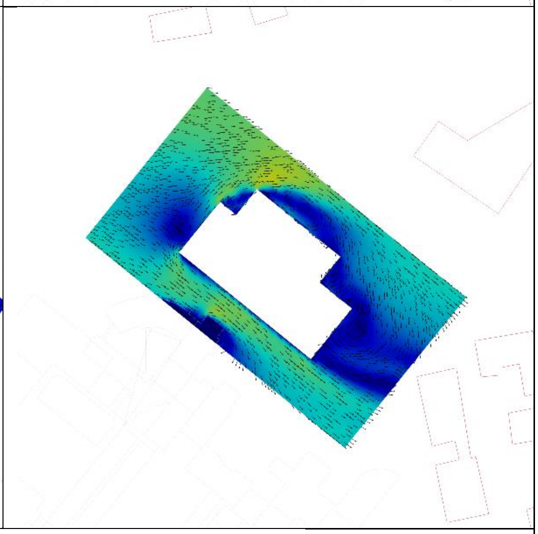
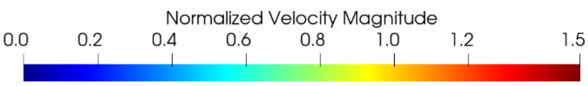
The coloured contour map of mean wind speed ratio 1.5 m above the ground for different wind directions are presented below. The wind speed ratio is calculated as the local wind speed to the reference undisturbed incident mean wind speed at 10 m in suburbia region (TC3). These directional CFD results were integrated with local wind climate data to provide wind speeds occurring 0.022% and 5% of time per annum from all directions for safety (Figure 15) and comfort (Figure 16) respectively.

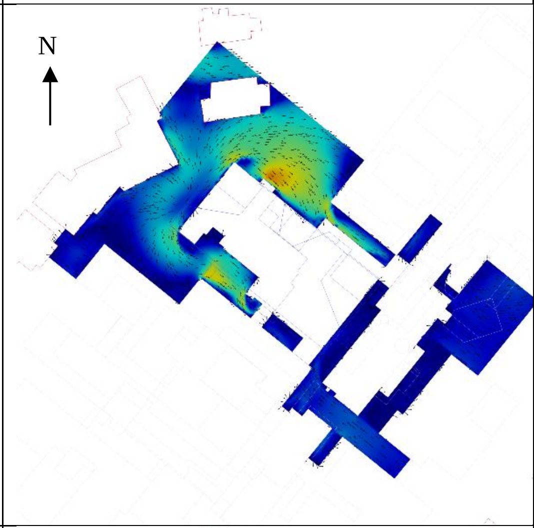
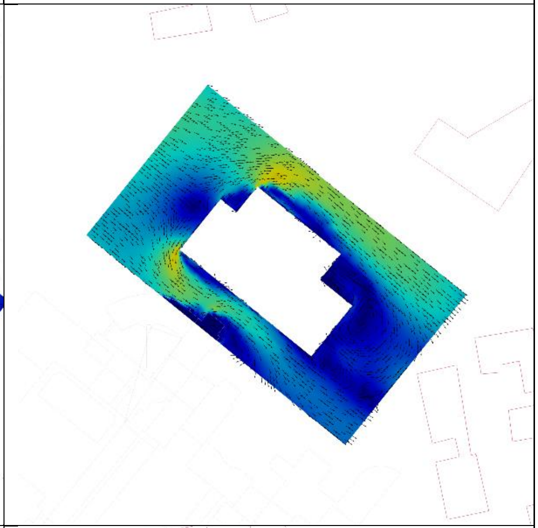
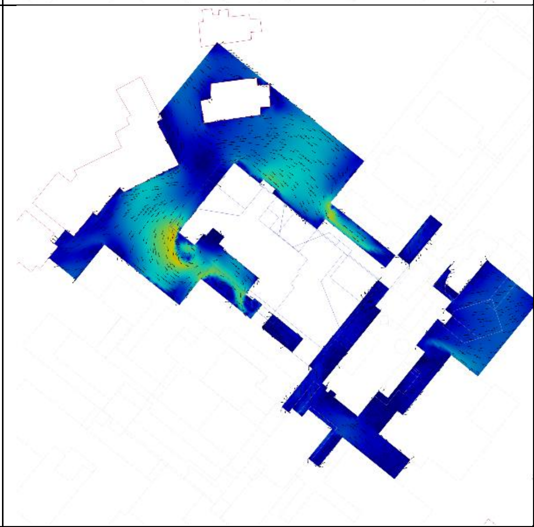
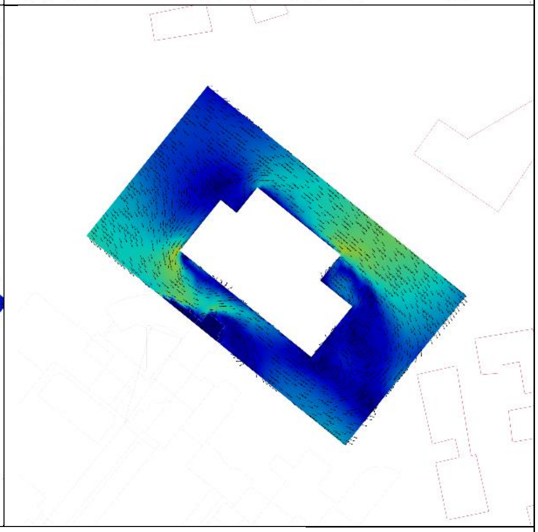
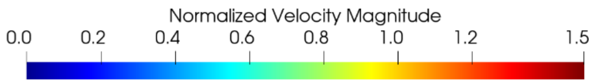
Wind direction	**PSB**	**MSCP**
0º		
22.5º		
		

Wind direction	PSB	MSCP
45º ↙		
67.5º ↙		
90º ←		
		

Wind direction	PSB	MSCP
112.5º		
135º		
157.5º		
		

Wind direction	PSB	MSCP
180º		
202.5º		
225º		
		

Wind direction	PSB	MSCP
247.5º		
270º		
292.5º		
		

Wind direction	PSB	MSCP
315º ↘		
337.5º ↓		
		

Appendix 2. 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 17, 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 17. 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.

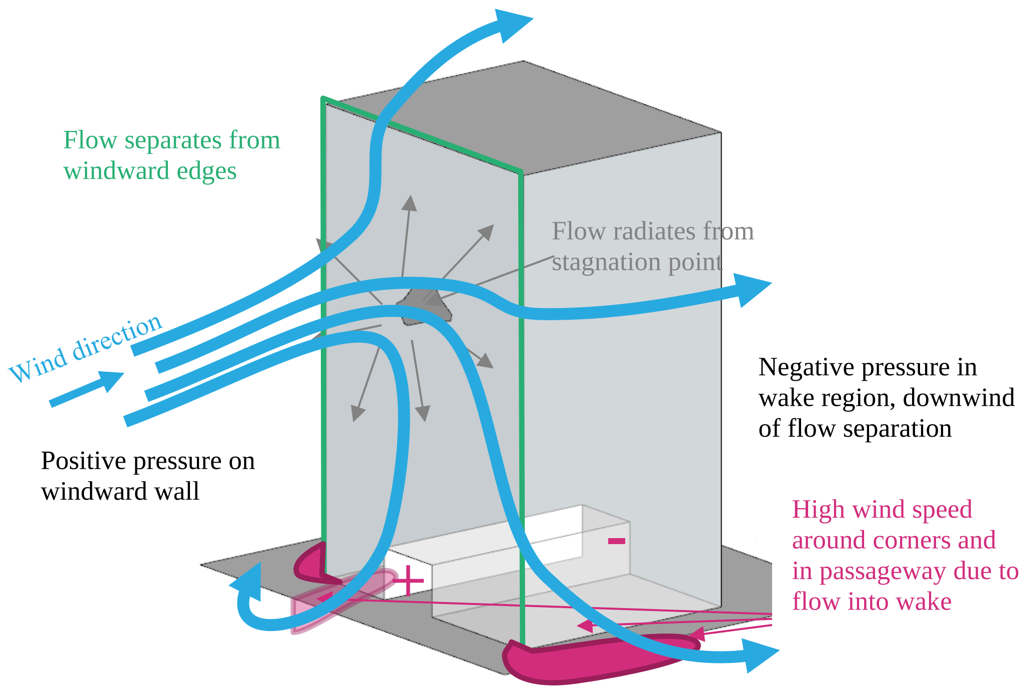


Figure 17. Schematic wind flow around tall isolated building

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

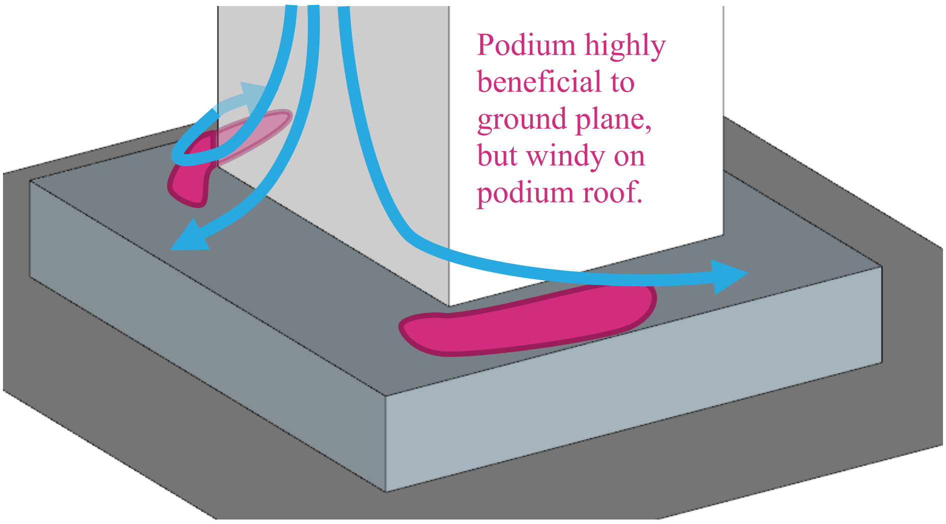


Figure 18. Schematic flow pattern around building with podium

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 19. 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.

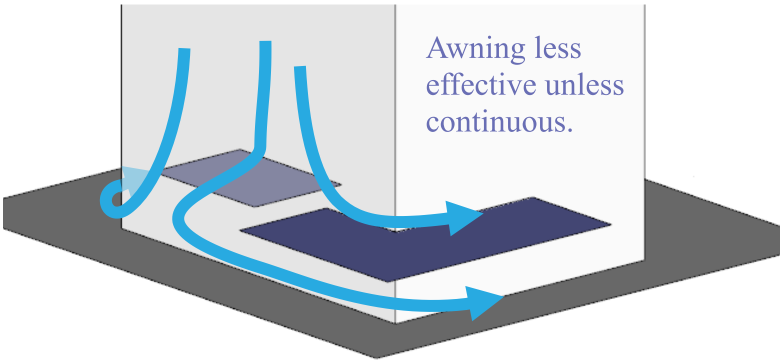


Figure 19. Schematic flow pattern around building with awning

It should be noted that colonnades at the base of a building with no podium generally create augmented windy conditions at the corners due to an increase in the pressure differential, Figure 20. Similarly, open through-site links through a building cause wind issues as the environment tries to equilibrate the pressure generated at the entrances to the link, Figure 17. If the link is blocked, wind conditions will be calm unless there is a flow path through the building, Figure 21. This area is in a region of high pressure and therefore the is the potential for internal flow issues. A ground level recessed corner has a similar effect as an undercroft, resulting in windier conditions, Figure 21.

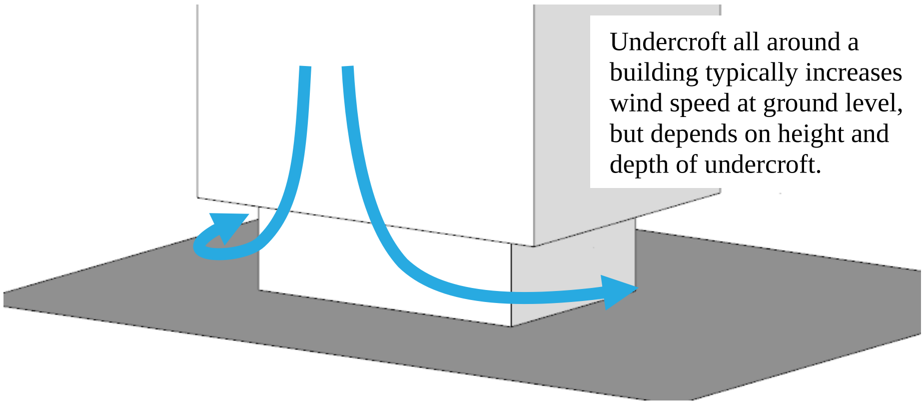


Figure 20. Schematic of flow patterns around isolated building with undercroft

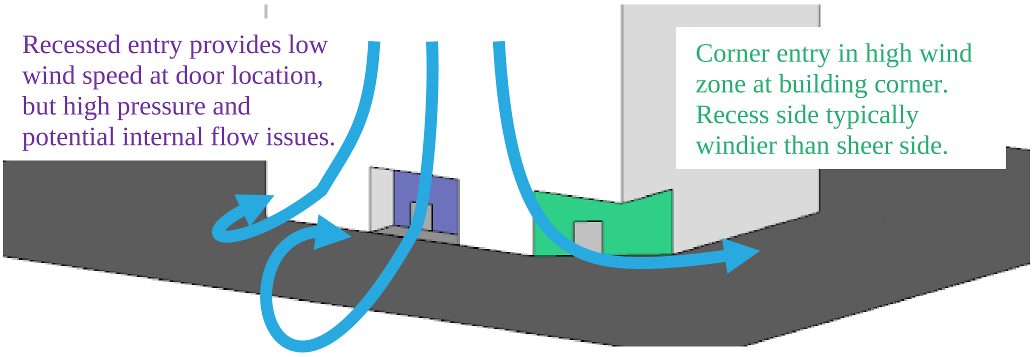


Figure 21. Schematic of flow patterns around isolated building with ground articulation

Multiple buildings

When a building is located in a city environment, depending on upwind buildings, the interference effects may be positive or negative, Figure 22. 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.

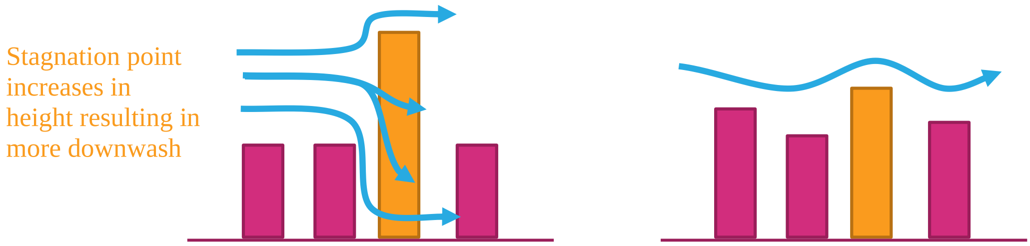


Figure 22. Schematic of flow pattern interference from surrounding buildings

The above discussion becomes more complex when three-dimensional effects are considered, both with orientation and staggering of buildings, and incident wind direction, Figure 23.

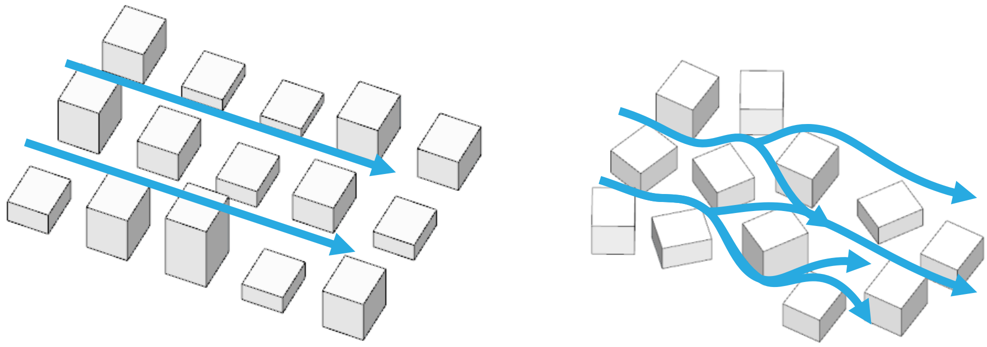


Figure 23. Schematic of flow patterns through a grid and random street layout

Channelling occurs when the wind is accelerated between two buildings, or along straight streets with buildings on either side, Figure 23(L), particularly on the edge of built-up areas where the approaching flow is diverted around the city massing and channelled along the fringe by a relatively continuous wall of building facades. This is generally the primary mechanism driving the wind conditions for this perimeter of a built-up area, particularly on corners, which are exposed to multiple wind directions. The perimeter edge zone in a built-up area is typically about two blocks deep. Downwash is more important flow mechanism for the edge zone of a built-up area with buildings of similar height.

As the city expands, the central section of the city typically becomes calmer, particularly if the grid pattern of the streets is discontinued, Figure 23(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.

Appendix 3. 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:

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

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 26. 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 defined in Figure 25.

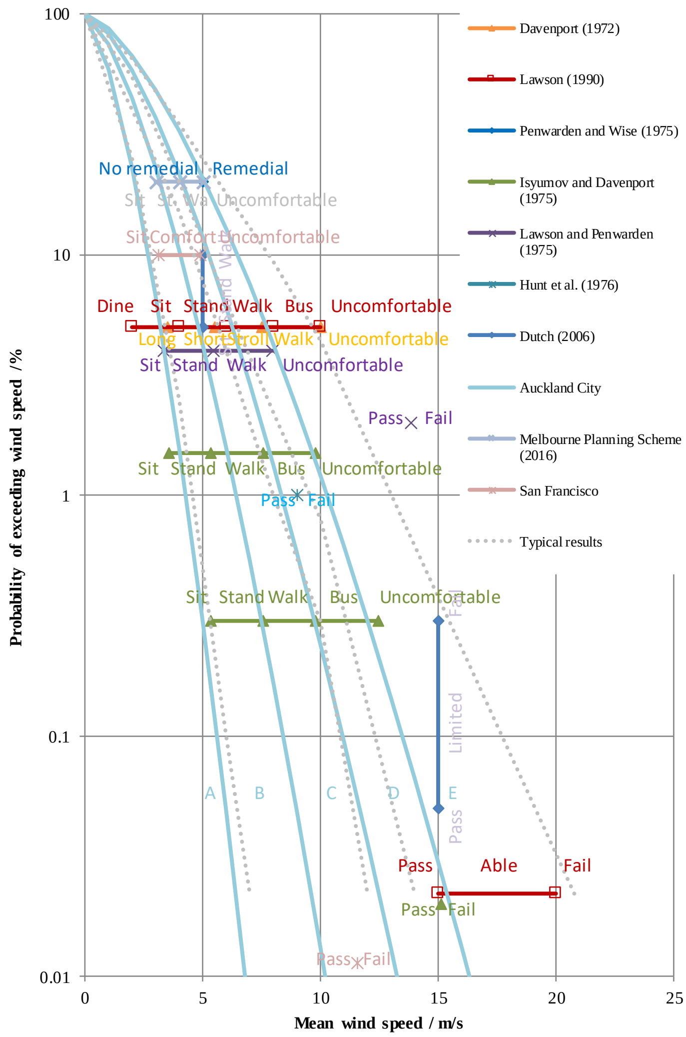


Figure 24. Probabilistic comparison between wind criteria based on mean wind speed

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

Figure 25. Auckland Utility Plan (2016) wind categories

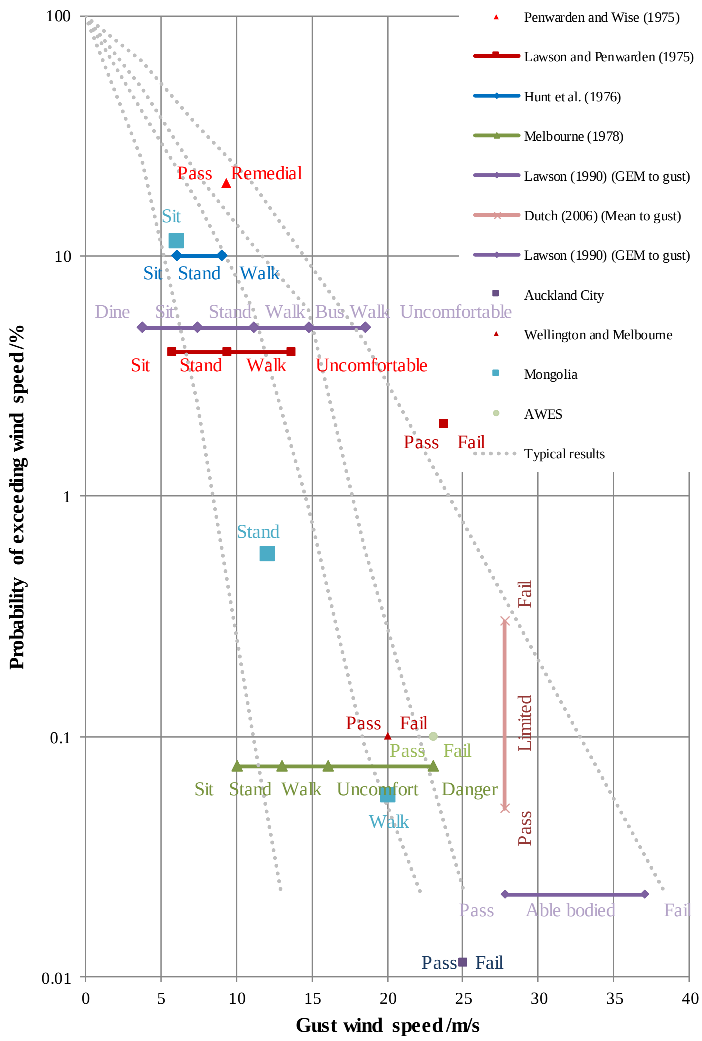


Figure 26. Probabilistic comparison between wind criteria based on 3 s gust wind speed

Appendix 4. Reference documents

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

- ASB-HDR-AR-EM-0002-STR.rvt
- ASB-HDR-AR-EM-0004-FCT.rvt
- ASB-HDR-AR-EM-0005-FAC.rvt
- ASB-HDR-AR-EM-0007_L01.rvt
- ASB-HDR-AR-EM-0008_L02.rvt
- ASB-HDR-AR-EM-0009_L03.rvt
- CHW-BLP-MDL-ARC-BK6-BLD.rvt
- CHW-BLP-MDL-ARC-CHW-XST.rvt
- CHW-BLP-MDL-ARC-CMR-TWR.rvt
- CHW-BLP-MDL-ARC-KRI-BLD.rvt
- CHW-BLP-MDL-ARC-PSB-CORE.rvt
- CHW-BLP-MDL-ARC-PSB-FAC.rvt
- CHW-BLP-MDL-ARC-PSB-KWN.rvt
- CHW-BLP-MDL-ARC-PSB-KWR.rvt
- CHW-BLP-MDL-ARC-PSB-L01_L02_L03.rvt
- CHW-BLP-MDL-ARC-PSB-L04.rvt
- CHW-BLP-MDL-ARC-PSB-L05_L06_L07.rvt
- CHW-BLP-MDL-ARC-PSB-L08_L09.rvt
- CHW-BLP-MDL-ARC-PSB-L10_L11.rvt
- CHW-BLP-MDL-ARC-PSB-L12_L13_L14_L15.rvt
- CHW-BLP-MDL-ARC-STE-CTX.rvt
- CHW-BLP-MDL-ARC-STE-PTP.rvt