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WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report

Qualitative Wind Assessment for:

St Leonards South,

St Leonards, NSW

Prepared for:

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Evergreen to provide a qualitative assessment of the impact of the proposed St Leonards South, development on the local wind environment.

The proposed development is located approximately 6 km to the north of the Sydney CBD, with low-rise suburban development to the south and the mid-rise developments of St Leonards business district and train station to the north, Figure 1. The proposed development will comprise 3 medium-rise structures, reaching a maximum height of 62 m above ground level, Figure 5. Addition of the proposed development is expected to have some impact on the local wind conditions, and the extents are broadly discussed in this report.

Figure 1: Aerial view of the proposed development site (Google Earth, 2022).

2 SYDNEY WIND CLIMATE

The proposed development lies approximately 14 km to the north of the Sydney Airport Bureau of Meteorology anemometer. To enable a qualitative assessment of the wind environment, the wind frequency and direction information measured by the Bureau of Meteorology at a standard height of 10m at Sydney Airport from 1995 to 2019 have been used in this analysis. The wind rose for Sydney Airport is shown in Figure 2 and is generally representative of prevailing winds at the site. Strong prevailing winds are organised into three main groups which centre at about north-east (expected to be marginally reduced in velocity compared to Sydney airport), south, and west. This wind assessment is focused on these prevailing strong wind directions.

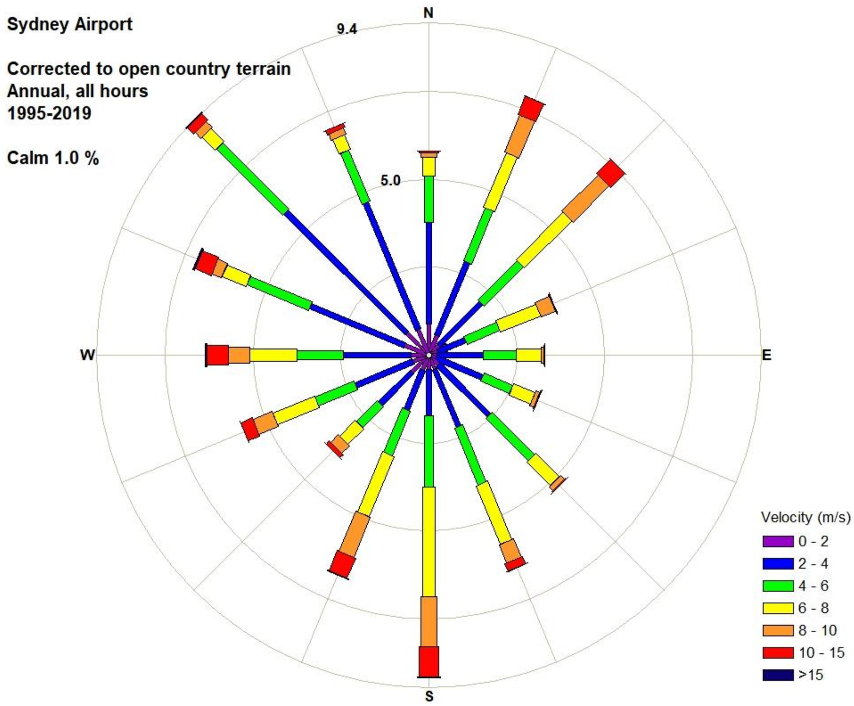

Figure 2: Wind rose for Sydney Airport.

3 ENVIRONMENTAL WIND CRITERIA

It is generally accepted that wind speed and the rate of change of wind velocity are the primary parameters that should be used in the assessment of how wind affects pedestrians. Local wind effects can be assessed with respect to a number of environmental wind speed criteria established by various researchers. 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 remarkably good agreement.

Lane Cove Council DCP (2013) specifies that developments should not result in wind speeds exceeding 13 m/s along major streets and public places and 16 m/s in all other streets. It is assumed that this is a once per year (0.1% of the time) 3 second gust wind speed, and is intended to be interpreted as a comfort, rather than a distress requirement, with the 13 m/s requirement seen as generally acceptable for short-term stationary activities (e.g. café dining) and the 16 m/s requirement as generally acceptable for pedestrian walking in public accessways (Melbourne, 1978). Assessment using the Lawson criteria (1990) provides a similar classification as using once per annum gust criteria (0.022% of the time), however also provides significantly more information regarding the serviceability wind climate.

A once per annum gust wind speed may not be representative of the day-to-day pedestrian wind conditions around the site from a comfort perspective. To address this limitation, the criteria of Lawson used in this study provides a similar comfort classification as the criterion of Melbourne assumed to be referenced by the Lane Cove DCP but gives significantly more information regarding serviceability wind climate. The criteria of Lawson are described in Table 1 for both pedestrian comfort and distress/safety. The benefits of these criteria over many in the field are that they use both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations. The criteria based on the mean wind speeds define when the steady component of the wind causes discomfort, whereas the GEM wind speeds define when the wind gusts cause discomfort. The level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment for all wind directions is recommended when evaluating with Lawson ratings. Another benefit of these from a comfort perspective is that the 5% of the time event is appropriate for a precinct to develop a reputation from the general public.

Table 1: Pedestrian comfort criteria for various activities.

Comfort (max. wind speed exceeded 5% of the time)	
<2 m/s	Outdoor dining
2 - 4 m/s	Pedestrian sitting (considered to be of long duration)
4 - 6 m/s	Pedestrian standing (or sitting for a short time or exposure)
6 - 8 m/s	Pedestrian walking
8 - 10 m/s	Business walking (objective walking from A to B or for cycling)
> 10 m/s	Uncomfortable

Distress/Safety (max. wind speed exceeded 0.022% of the time, twice per annum)	
<15 m/s	General access area
15 - 20 m/s	Acceptable only where able-bodied people would be expected; no frail people or cyclists expected
>20 m/s	Unacceptable

The wind speed is either an hourly mean wind speed or a gust equivalent mean (GEM) wind speed. The GEM wind speed is equal to the 3 s gust wind speed divided by 1.85.

4 ENVIRONMENTAL WIND ASSESSMENT

The development site is surrounded by low-rise buildings to the south, and low- to mid-rise commercial developments to the north. Topography immediately surrounding the site is relatively flat from a wind perspective although the general fall in terrain to the south-west will provide some increase in wind speeds from those directions. Noteworthy is 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 1, and the effectiveness of some common wind mitigation measures are described in Appendix 2.

The subject site is located on a block bounded by Holdsworth Avenue to the west and Canberra Avenue to the east. The proposed development consists of three prismatic towers with near rectangular planforms. A ground floor plan is shown in Figure 3, and a Level 6 floor plan is shown in Figure 4.

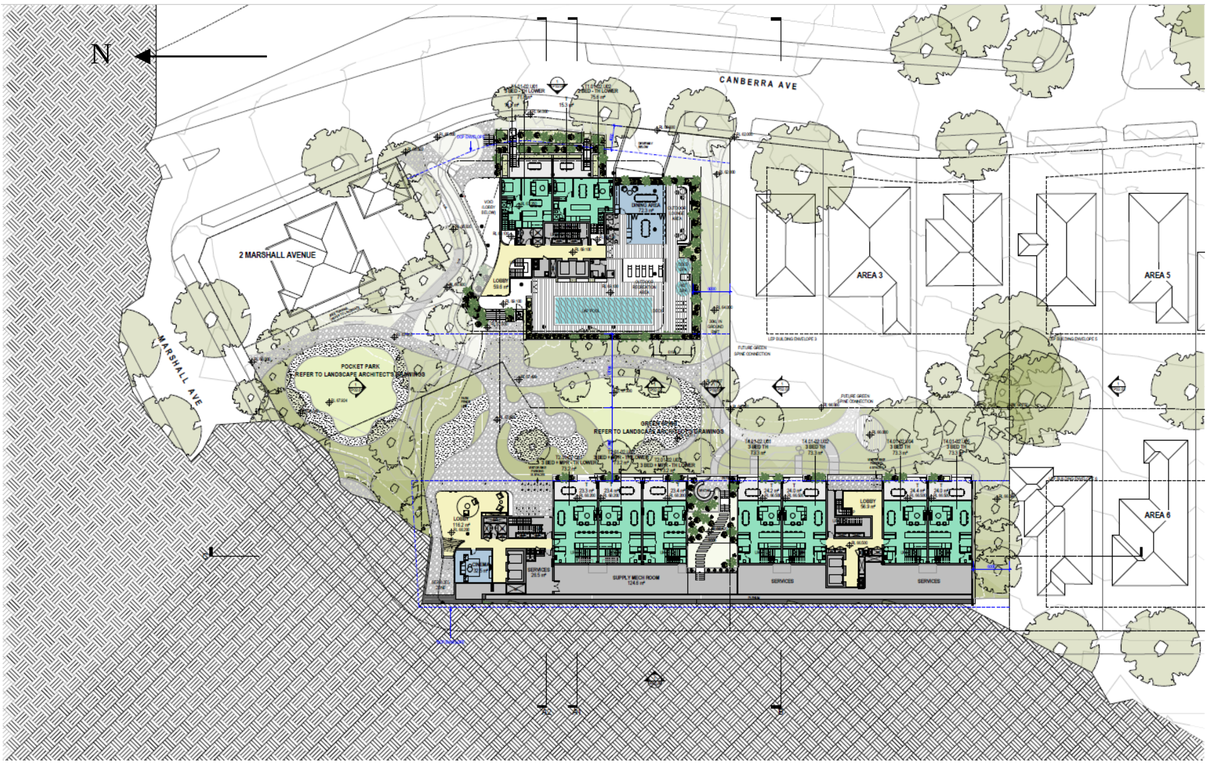

Figure 3: Ground floor of the proposed development.

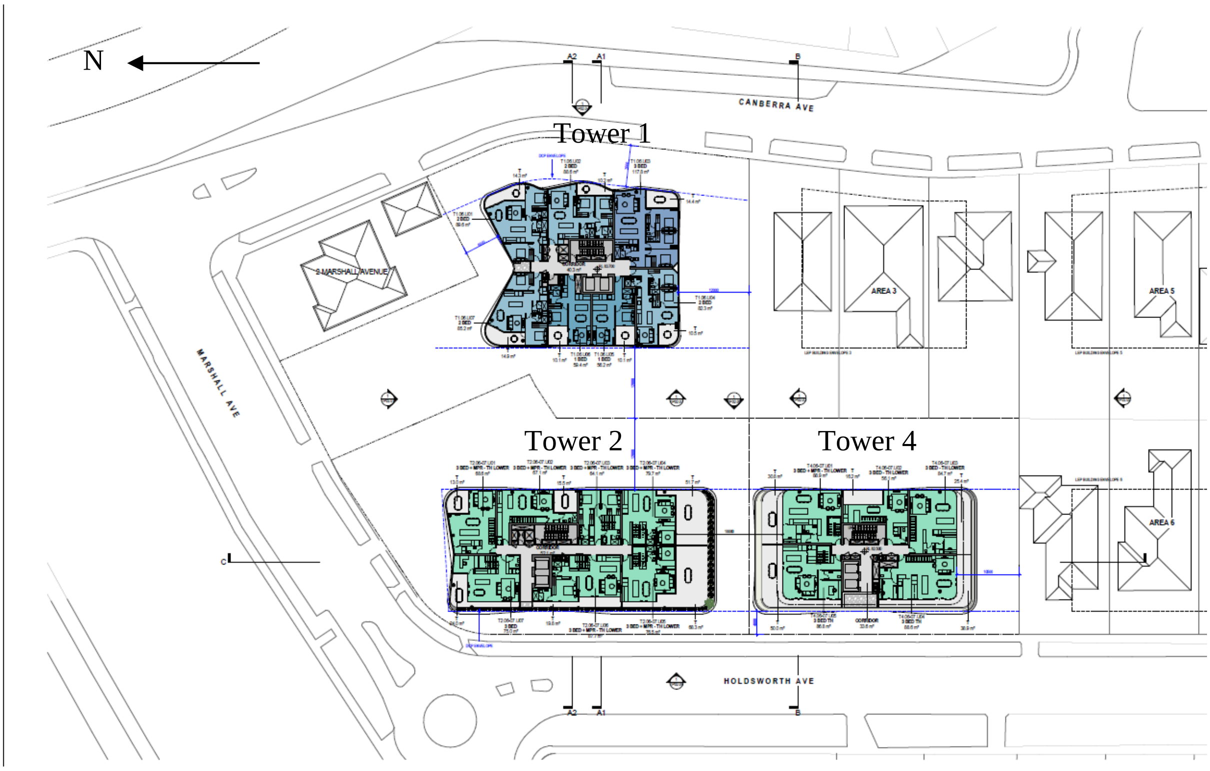

Figure 4: Level 6 floor plan of the proposed development.

4.1 Winds from the north-east

Winds from the north quadrant will approach over the mid- and high-rise buildings of St Leonards CBD. The proposed development receives some more immediate shielding from winds from the north by the similarly sized tower at 13 Marshall Avenue adjacent to the development. For winds from the north-east, flow would be expected to flow downward off the exposed north façade of tower 1 in the form of downwash before accelerating around the base corners of the tower. The undercut of the tower 1 planform from Ground to Level 2, as shown in Figure 5, would be beneficial in keeping some downwash from tower 1 above the ground plane in the Green Link Park between the towers. From a Lawson comfort perspective, wind conditions on the ground plane would be expected to be suitable for pedestrian walking activities.

For winds from the north quadrant, conditions around the proposed development site along Canberra Avenue, Marshall Avenue and Holdsworth Avenue are expected to pass the safety/distress criterion.

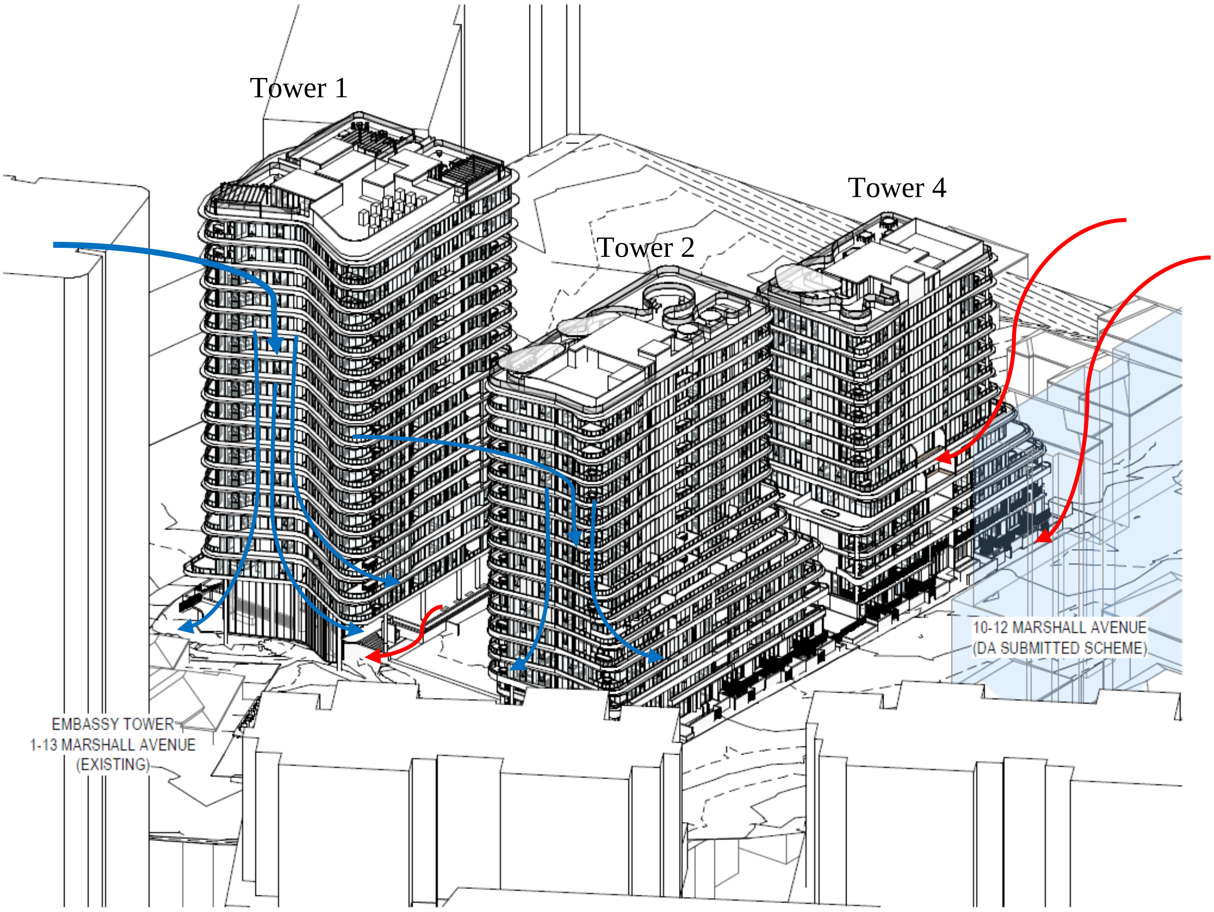

Figure 5: Structures and massing within the proposed development, north-west isometric view.

4.2 Winds from the south

Winds from the south quadrant will pass over upstream residential housing of St Leonards and Wollstonecraft. Slightly stronger conditions resulting from downwash off the south façades of Tower 1 and Tower 4 would be anticipated close to building corners at ground level on the windward side and would contribute to channelled flow through the Green Link Park which is in alignment with southerly winds. The undercut in Tower 1, along with dense foliage and landscaping in the Green Link Park will assist in dispersing stronger gusts that reach the ground plane. For winds from the south, conditions the Green Link Park would be expected to be suitable for pedestrian walking style activities under the Lawson criteria, in line with expected use as a public accessway.

Wind conditions along Canberra Avenue, Marshall Avenue and Holdsworth Avenue are expected to be suitable for use as pedestrian accessways and below the safety criterion. The undercut terrace and amenity level on Tower 1 would see increased wind speeds as flow downward from the south façade of these tower accelerates through the space, with conditions expected to be suitable for pedestrian walking style activities from a comfort perspective. Mitigation in the form of an awning around the south-west tower corner could assist to redirect downwash flow horizontally around the tower would be recommended if this space is to be used for longer term stationary activities such as outdoor dining. For winds from the south quadrant, wind conditions at most locations around the site are expected to pass the safety/distress criterion.

4.3 Winds from the west

Winds from the west quadrant will pass over the residential housing of St Leonards and are relatively unimpeded upon reaching the proposed development site. These winds have the potential to impact upper levels of the broad western facades of Towers 2 and 4, flow downward in the form of downwash. The tapered west façade will provide some dispersion to downwash flow and ground-level pedestrian wind conditions along Holdsworth Avenue are expected to be suitable only for pedestrian walking from a Lawson comfort perspective.

Wind conditions on the ground plane of the Green Link Park and along Canberra Avenue will receive some shielding from the Towers 2 and 4 massing.

Strong wind conditions would exist on ground level between Towers 2 and 4 as winds impinging on the western facades of the towers are accelerated through the gap between them. If this area is intended for stationary type activities, amelioration in the form of tall vertical screening on the western and eastern sides of the gap would be recommended.

For winds from the west quadrant, ground level wind conditions around the proposed development site are expected to pass the safety/distress criterion.

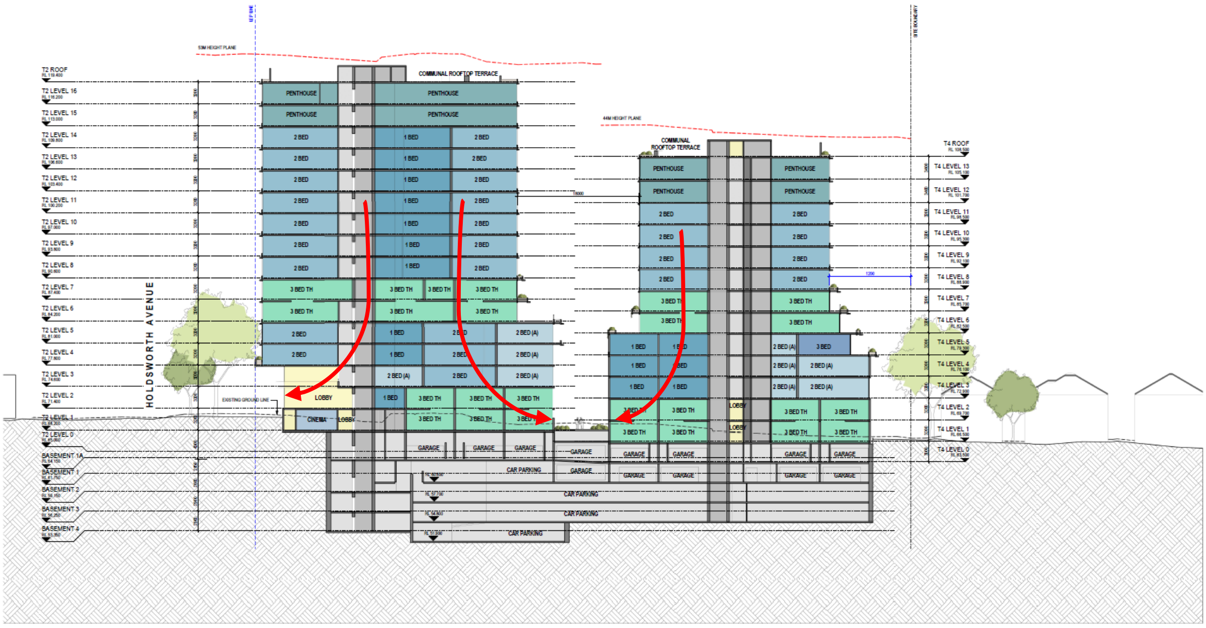

Figure 6: Flow paths through tower gap and undercroft, Towers 2 and 4, west elevation

4.4 Summary

From a pedestrian comfort perspective, the wind environment around the proposed development site is likely to be classified as acceptable for pedestrian walking under Lawson criteria. Localised amelioration measures would be suggested if calmer wind comfort conditions in these areas are desired. All locations would be expected to satisfy the safety/distress criterion.

4.5 Balcony Wind Conditions

Private balcony terraces are located throughout the development. Wind conditions within the recessed balcony spaces are expected to be mostly calm given the wind shielding they receive from the building massing. Balconies located on building corners or protruding from the façade are more exposed, and can experience strong cross flows. For exposed balcony areas it would be recommended to include vertical screening, to allow calm areas to exist for a greater period of time. Over time residents tend to learn the usability of their balconies based on the seasonal weather conditions.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed St Leonards South, project on the local wind environment in and around the development site. Being slightly larger than most surrounding structures, the proposed development will have some effect on the local wind environment.

Pedestrian wind comfort levels surrounding the site at ground level would be suitable for public accessways. Local amelioration would likely be necessary for areas intended for long-term stationary activities such as outdoor café-style dining.

Wind conditions at the Lawson walking criterion are expected throughout the building gaps between the towers due to a combination of downwash and channelling wind flows. Localised amelioration measures would be suggested if calmer wind comfort conditions in these areas are desired.

All locations would be expected to satisfy the safety/distress criterion. To quantify the wind conditions around the site, a wind-tunnel test would be recommended during detailed design.

6 REFERENCES

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, Journal of Wind Engineering and Industrial Aerodynamics, Vol.3, No.2-3, pp.241-249.

Standards Australia (2011), Australian/New Zealand Standard, Structural Design Actions, Part 2: Wind Actions (AS/NZS1170 Pt.2).

Lane Cove Council (2010), "Lane Cove Development Control Plan 2010"

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 7; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward corners and sides of the building. In Figure 7, smoke is being released into the wind flow to allow the wind speed, turbulence, and direction to be visualised. The image on the left shows smoke being released across the windward face, and the image on the right shows smoke being released into the flow at about third height in the centre of the face.

Techniques to mitigate the effects of downwash winds on pedestrians include the provision of horizontal elements, the most effective being a podium to divert the flow away from pavements and building entrances. Awnings along street frontages perform a similar function, and the larger the horizontal element, the more effective it will be in diverting the flow.

Channelling occurs when the wind is accelerated between two buildings or along straight streets with buildings on either side.

Figure 8 shows the wind at mid and upper levels on a building being accelerated substantially around the corners of the building. When balconies are located on these corners, they are likely to be breezy, and will be used less by the owner due to the regularity of stronger winds. Owners quickly become familiar with when and how to use their balconies. If the corner balconies are deep enough, articulated, or have regular partition privacy fins, then local calmer conditions can exist.

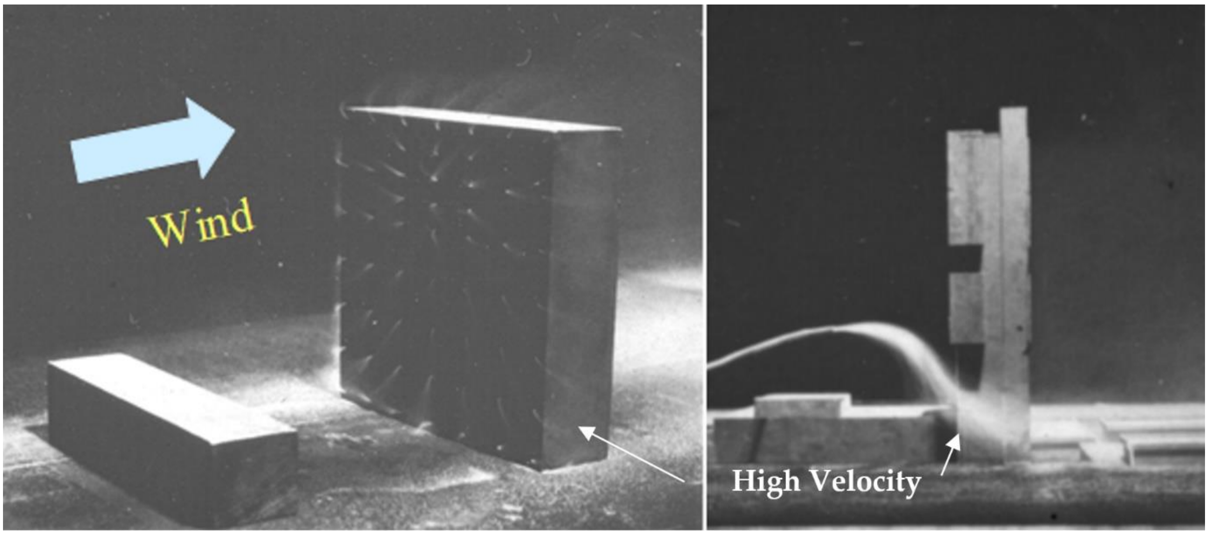

Figure 7: Flow visualisation around a tall building.

Figure 8: Visualisation through corner balconies (L) and channelling between buildings (R).

Appendix 2: Wind Impact Planning Guidelines

It is well known that the design of a building will influence the quality of the ambient wind environment at its base. Below are some suggested wind mitigation strategies that should be adopted into precinct planning guidelines and controls (see also Cochran, 2004).

Building form – Canopies

A large canopy may interrupt the flow as it moves down the windward face of the building. This will protect the entrances and sidewalk area by deflecting the downwash at the second storey level, Figure 9. However, this approach may have the effect of transferring the breezy conditions to the other side of the street. Large canopies are a common feature near the main entrances of large office buildings.

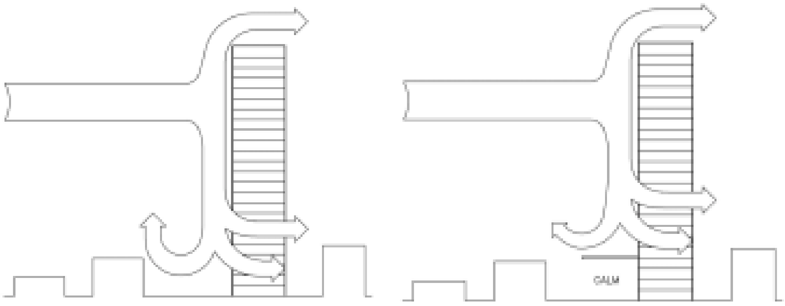

Figure 9: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

Building form – Podiums

The architect may elect to use an extensive podium for the same purpose if there is sufficient land and it complies with the design mandate, Figure 10. This is a common architectural feature for many major projects in recent years, but it may be counterproductive if the architect wishes to use the podium roof for long-term pedestrian activities, such as a pool or tennis court.

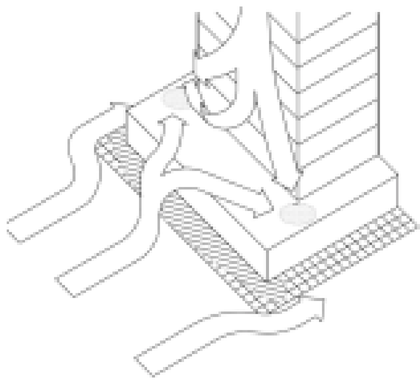

Figure 10: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

Building form – Arcades

Another massing issue, which may be a cause of strong ground-level winds, is an arcade or thoroughfare opening from one side of the building to the other. This effectively connects a positive pressure region on the windward side with a negative pressure region on the lee side; a strong flow through the opening often results, Figure 11. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

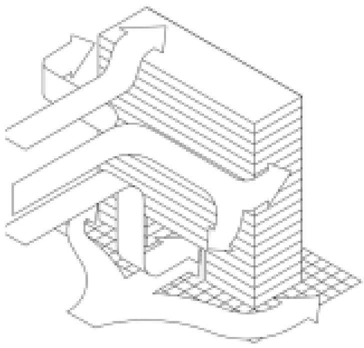

Figure 11: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 12(L). In some cases, a canopy may not be necessary with this scenario, depending on the local geometry and directional wind characteristics. The same undercut design at a building corner is usually quite unsuccessful, Figure 12(R), due to the accelerated flow mechanism described in Figure 7 and the ambient directional wind statistics. If there is a strong directional wind preference, and the corner door is shielded from those common stronger winds, then the corner entrance may work. However, it is more common for a corner entrance to be adversely impacted by this local building geometry. The result can range from simply unpleasant conditions to a frequent inability to open the doors.

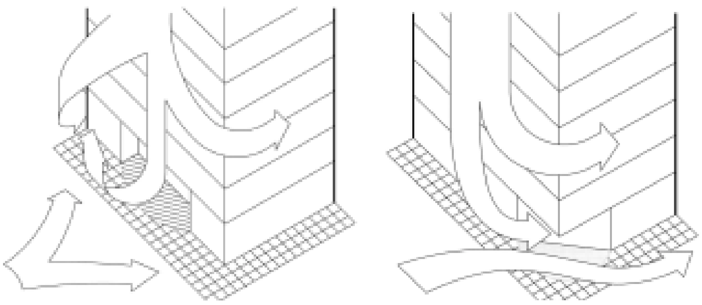

Figure 12: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

Building form – Façade profile and balconies

The way in which a building's vertical line is broken up may also have an impact. For example, if the floor plans have a decreasing area with increased height the flow down the stepped windward face may be greatly diminished. To a lesser extent the presence of many balconies can have a similar impact on ground level winds, although this is far less certain and more geometry dependent. Apartment designs with many elevated balconies and terrace areas near building ends or corners often attract a windy environment to those locations. Mid-building balconies, on the broad face, are usually a lot calmer, especially if they are recessed. Corner balconies are generally a lot windier and so the owner is likely to be selective about when the balcony is used or endeavours to find a protected portion of the balcony that allows more frequent use, even when the wind is blowing.

Use of canopies, trellises, and high canopy foliage

Downwash Mitigation – As noted earlier, downwash off a tower may be deflected away from ground-level pedestrian areas by large canopies or podium blocks. The downwash then effectively impacts the canopy or podium roof rather than the public areas at the base of the tower, Figure 10. Provided that the podium roof area is not intended for long-term recreational use (e.g. swimming pool or tennis court), this massing method is typically quite successful. However, some large recreational areas may need the wind to be deflected away without blocking the sun (e.g. a pool deck), and so a large canopy is not an option. Downwash deflected over expansive decks like these may often be improved by installing elevated trellis structures or a dense network of trees to create a high, bushy canopy over the long-term recreational areas. Various architecturally acceptable ideas may be explored in the wind tunnel prior to any major financial commitment on the project site.

Horizontally accelerated flows between two tall towers, Figure 8(R), may cause an unpleasant, windy, ground-level pedestrian environment, which could also be locally aggravated by ground topography. Horizontally accelerated flows that create a windy environment are best dealt with by using vertical porous screens or substantial landscaping. Large hedges, bushes or other porous media serve to retard the flow and absorb the energy produced by the wind. A solidity ratio (i.e. proportion of solid area to total area) of about 60-70% has been shown to be most effective in reducing the flow's momentum. These physical changes to the pedestrian areas are most easily evaluated by a model study in a boundary-layer wind tunnel.

References

Cochran L., (2004) Design Features to Change and/or Ameliorate Pedestrian Wind Conditions, Proceedings of the ASCE Structures Congress, Nashville, Tennessee, May 2004.