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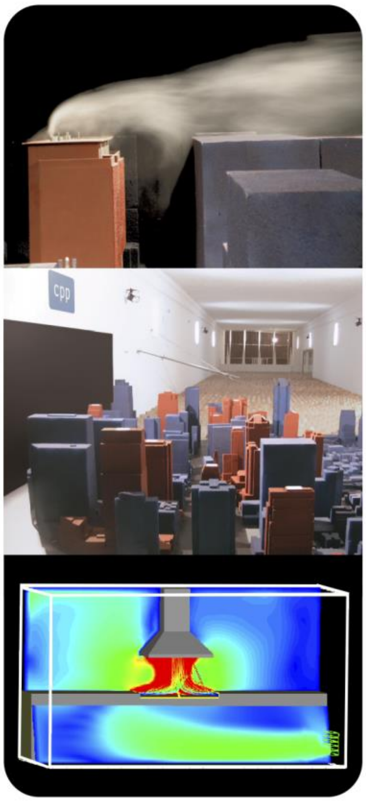
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:

Wagga Wagga Base Hospital Stage 3

Lewis Drive, Wagga Wagga, NSW 2650

Prepared for:

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Martin & Ollmann to provide a qualitative assessment of the impact of the proposed Wagga Wagga Base Hospital Stage 3 development on the wind environment in and around the development site. The development site is located approximately 1 km to the west of the Wagga Wagga train station within a region of low-rise suburban development, Figure 1, and is bounded by Edward and Docker Streets, and Rawson Lane. 3D renders of the proposed development are shown in Figure 2.

1.1 Proposed Development (client provided)

The Wagga Wagga Base Hospital Stage 3 consists of a six storey Ambulatory Care Building, including a rooftop Plant Room, all above an undercroft parking level. The Ambulatory Care Building will provide the following Units:

- 28 flexible Aged Care Beds, including 4 dedicated beds for Acute Delirium.
- 24 Rehabilitation beds, including inpatient therapy and ADL facilities shared with the Aged Care and Older Persons Health inpatient units.
- A 24 bed Older Person's Mental Health Inpatient Unit, including 8 T-BASIS beds.
- A 20 chair Renal Dialysis Unit plus 4 training chairs (2 x HD and 2 x peritoneal) collocated with other Extended Hours Services.
- Ambulatory Clinics, Rehabilitation and Allied Health, comprising 60 bookable (electronic patient flow management system) Interview / Consult rooms and Gym / Allied Health treatment spaces. Services accessing this area will include Primary and Community Health, Outpatients, Prosthetics and Orthotics, Mental Health, Drug and Alcohol, and Oral Health services (8 Dental Chairs).
- An education area including library, conference rooms (60 seats total) and a lecture theatre (100 seats).
- Extended Hours Services including Hospital in the Home, Integrated Care, Rapid Assessment Clinic, After Hours GP, and Infusions using 10 treatment spaces and 6 consultation rooms and shared support areas with renal dialysis.
- Workforce and office accommodation will be provided for staff associated with Stage 3, refined through New Ways of Working (NWW).

The NWW assessment will be also extended to Support Services staff, including Patient Flow, IT, Health Share, Health Information Services, Pastoral Care and Volunteer Services.

Figure 1: Aerial view of overall site plan (Google Earth, 2016).

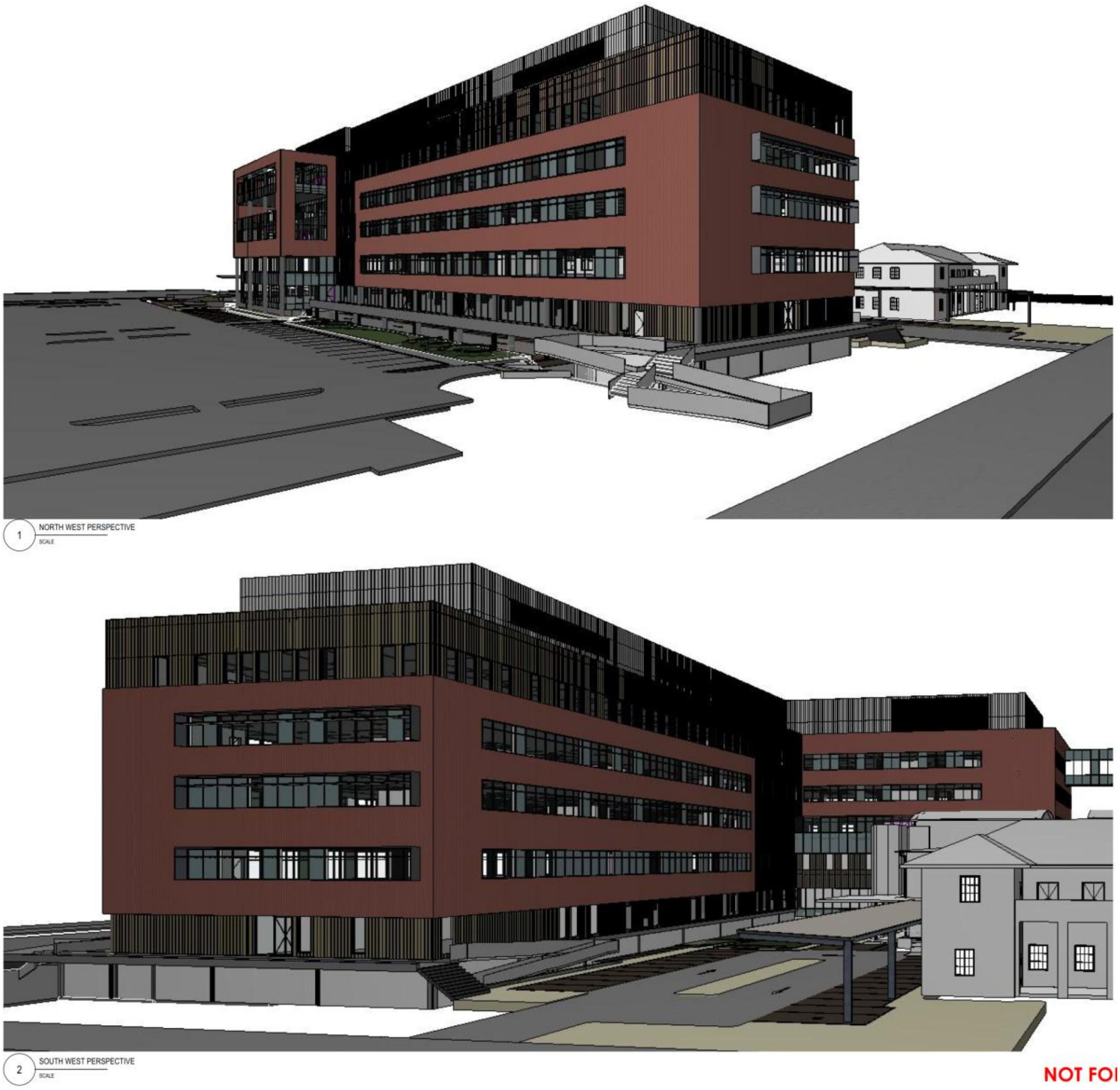

Figure 2: 3D renders of proposed development viewed from the north-west (top) and south-west (bottom), (Martin & Ollmann, 2018).

2 WAGGA WAGGA WIND CLIMATE

The proposed development lies approximately 10 km to the north-west of the Wagga Wagga 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 10 m at Wagga Wagga Airport from 2004 to 2017 have been used in this analysis. The corresponding wind rose for Wagga Wagga Airport is shown in Figure 3 and is considered to be representative of prevailing winds at the site due to proximity from development site and topography. It is noted from Figure 3 that strong prevailing winds typically originate from the east quadrant, with strong winds from the west quadrant occurring less often. This wind assessment is focused on winds from these directions.

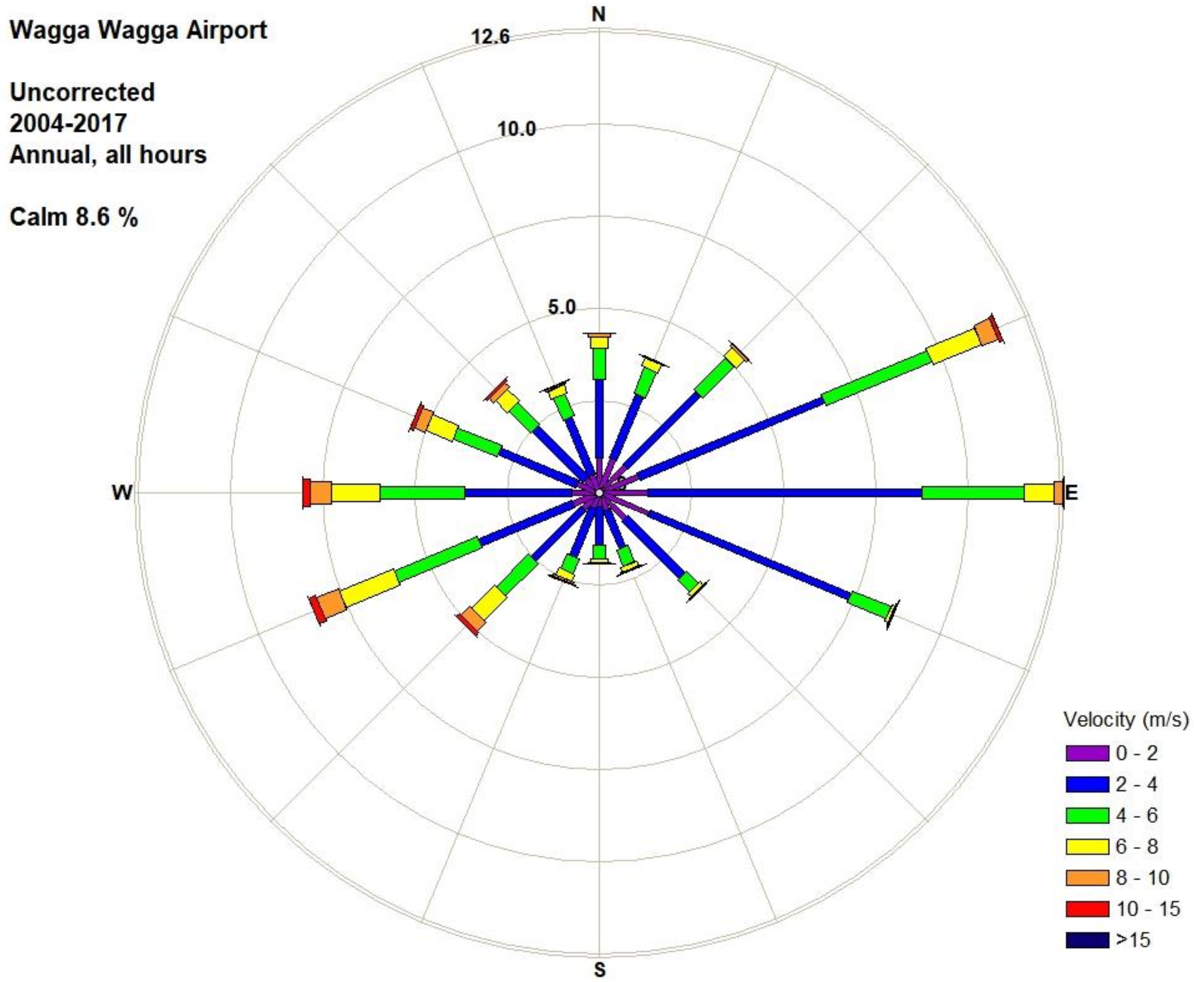

Figure 3: Wind rose for Wagga Wagga Airport.

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.

CPP have not sighted specific wind criteria in the Wagga Wagga City Council DCP (2010) for new developments in the region. Notwithstanding, this study is based upon the industry accepted criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress/safety. The benefits 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. The limiting criteria are defined for both a mean and gust equivalent mean (GEM) wind speed; 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.

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 in most directions and topography surrounding the site is relatively flat from a wind perspective. A site plan is provided in Figure 4. Winds in such surrounds tend to experience less channelling than areas with many tall structures and undulating topography, with local effects instead dictated by the proposed building and its exposure to prevailing strong wind directions, as it is relatively taller than its surrounds. 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.

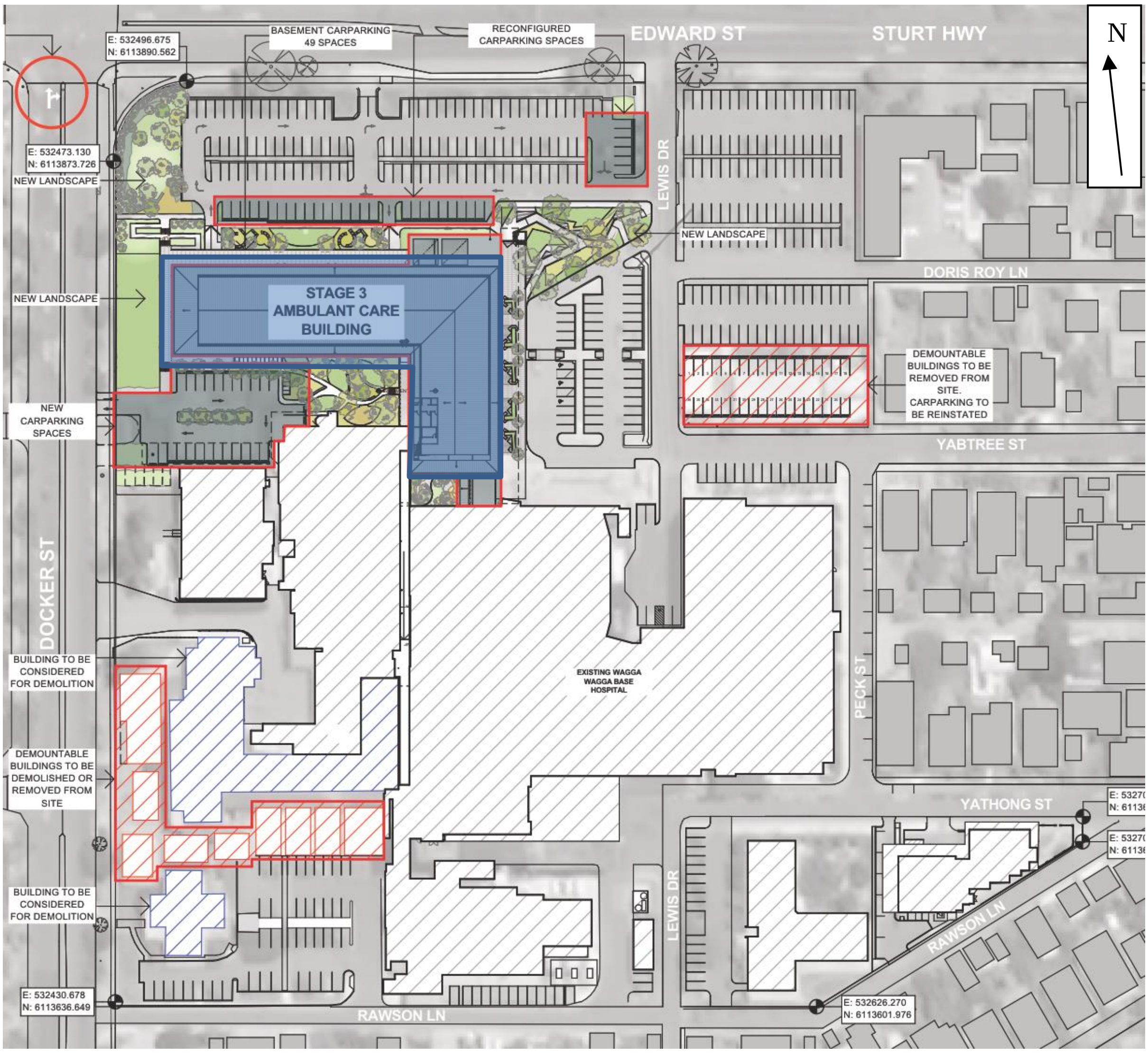

Figure 4: Site plan with Stage 3 highlighted (Martin & Ollmann, 2018).

4.1 Ground Plane

4.1.1 Winds from the East

Winds from the east quadrant will approach the site relatively unimpeded and impinge the eastern façade generating some downwash which would accelerate around the building's north-east corner, and is expected to create slightly windy conditions in this area. Architectural drawings indicate an awning along the eastern façade which will help redirect some downwash away from ground level and shield the area directly beneath it. It would be recommended to extend the northern end of the awning to shield patrons using the pedestrian stairs. The courtyard and eastern frontage along Docker St will be protected from wind events from the east.

4.1.2 Winds from the West

Winds from the west quadrant will also reach the site relatively unimpeded impacting the western façades along Docker St and adjacent to the courtyard. Considering its narrow width, the quantity of downwash from the Docker St façade will be moderate before dispersing into the northern carpark and courtyard. Although, wind conditions in the courtyard is expected to be relatively calmer than the Docker St frontage and northern carpark due to its semi-enclosed location. The retail frontage on the east side of the building is significantly shielded from wind events from the west.

4.2 Upper Level Courtyards

The courtyard on the upper levels may be susceptible to cross-flow winds through the space. To assist with reducing cross-flows, porous screening such as operable vertical slats or a mesh-style screen implemented in the area illustrated in Figure 5 would be recommended.

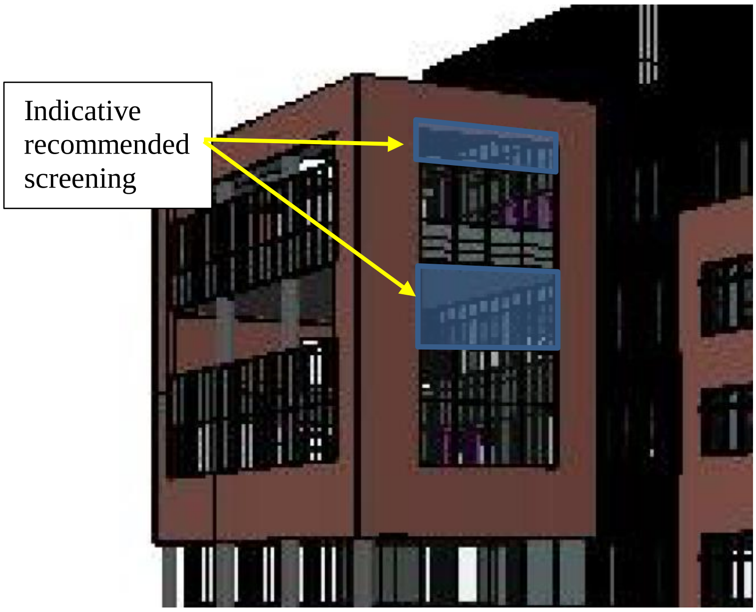

Figure 5: Indicative illustration of recommendation screening for upper level courtyards

4.3 Summary

For most locations, wind conditions in around the development site are expected to remain similar to the existing wind conditions. Due to the relatively low height of the building no major impact of downwash winds would be expected. From a Lawson comfort perspective, the wind conditions are likely to be classified as pedestrian standing, and low pedestrian walking near building corners on the ground plane. These comfort levels would be suitable for public accessways such as building entrances and footpaths. Localised amelioration measures would be suggested if calmer conditions are desired for locations such as outdoor cafes and seated waiting spaces. All locations would be expected to satisfy the safety/distress criterion.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed Wagga Wagga Base Hospital Stage 3 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, though any changes are not expected to be significant from a Lawson pedestrian comfort and safety/distress perspective. Wind conditions at most locations in and around the development are expected to be classified as pedestrian standing with local areas near building corners classified as pedestrian walking rating from a Lawson comfort perspective. Local amelioration would likely be necessary for areas intended for long-term stationary or outdoor dining activities. Wind conditions at all locations in and around the development site are expected to pass the distress/safety criterion.

To quantify the wind conditions in and 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).

City of Wagga Wagga (2010), "Wagga Wagga Development Control Plan 2017", Version 16, 13 July 2017.

Appendix 1: Wind Flow Mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 6; 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 6, 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 7 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.

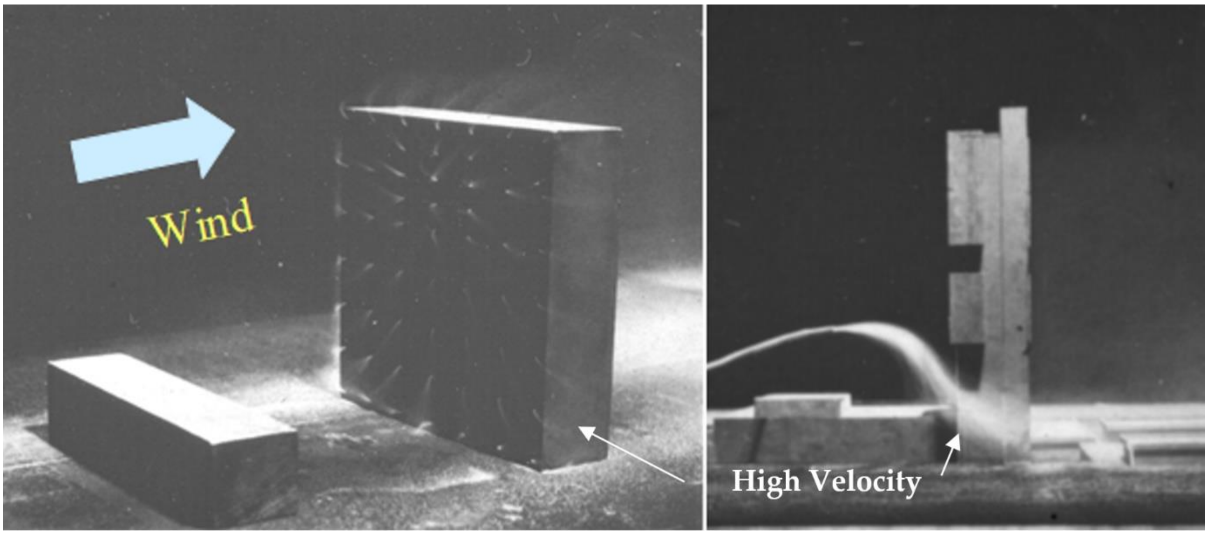

Figure 6: Flow visualisation around a tall building.

Figure 7: 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 8. 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.

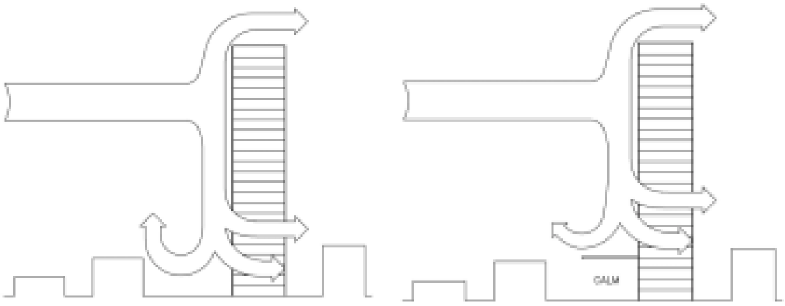

Figure 8: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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 9. 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.

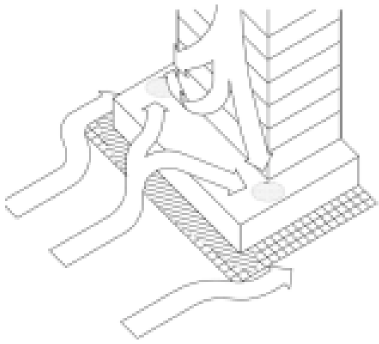

Figure 9: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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 10. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

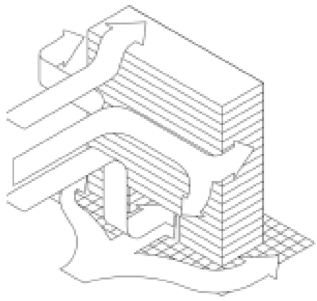

Figure 10: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 11(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 11(R), due to the accelerated flow mechanism described in Figure 6 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.

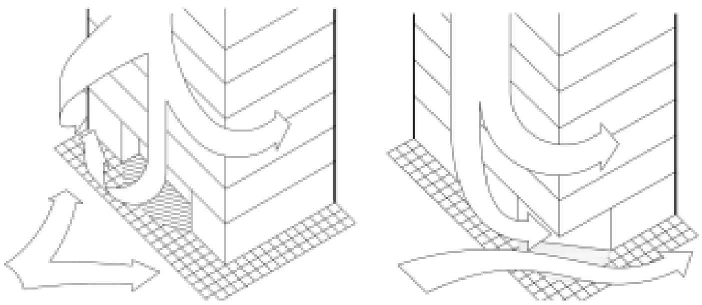

Figure 11: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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 9. 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 7(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.