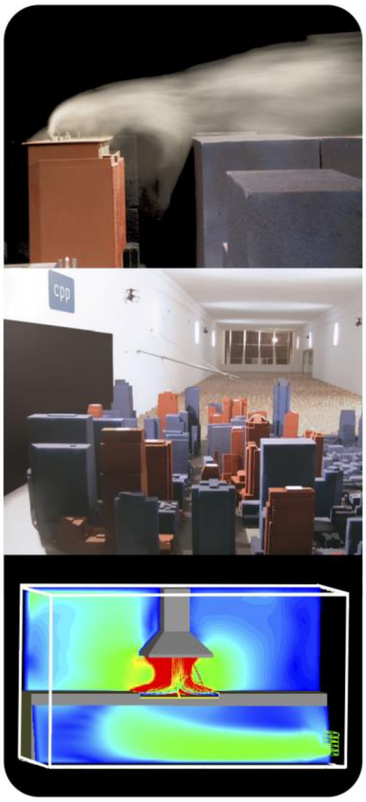
CERMAK
PETERKA
PETERSEN

WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:
The Sutherland Hospital Operating Theatre Upgrade
Sutherland NSW

Prepared for:
Health Infrastructure
1 Reserve Road
St Leonards NSW
Australia

January 2021

CPP Project: 15090

Prepared by:
Thomas Evans, Project Engineer
Matthew Glanville, VP of Business Development

CPP
Unit 2, 500 Princes Highway
St. Peters, NSW 2044, Australia
info-syd@cppwind.com
www.cppwind.com

DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
21/01/21	Draft report	TXE	MG	MG
27/01/21	Final Report	TXE		MG

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Health Infrastructure to provide a qualitative assessment of the impact of pedestrian-level winds around the Sutherland Hospital Operating Theatres Upgrade Project (TSHOTUP), with particular focus on a proposed under croft area on the western side of the site which will form an outdoor breakout space for staff and patients.

The proposed development is located in Caringbah, approximately 20 km to the south-south west of the Sydney CBD, in a region of primarily low-rise suburban development, Figure 1. The proposed upgrade project includes refurbishment and addition of new structure, including a four-level extension to the west of the existing building, Figure 2. At ground level, this extension will form an under-croft area that interfaces with secondary building entries. The interaction of the modified building massing with prevailing winds will determine the local wind environment at this location, and considerations for pedestrian comfort and safety are discussed in this report.

Figure 1: Aerial view of the proposed development site (Google Earth, 2018).

Figure 2: Render of proposed development, viewed from the north

2 SYDNEY WIND CLIMATE

The proposed development lies approximately 11 km to the south-west 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 10 m at Sydney Airport from 1995 to 2019 have been used in this analysis. The wind rose for Sydney Airport is shown in Figure 3 and is considered to be representative of prevailing winds at the site. In addition, wind roses are winter and summer months are provided. Strong prevailing winds are organised into three main groups which centre at about north-east, south, and west. Strong north easterly winds are generally more frequent during summer, as are strong winds from the south, which are often associated with cold frontal systems. Westerly winds occur throughout the year however are more frequent during cooler months. This wind assessment is focused on these prevailing strong wind directions.

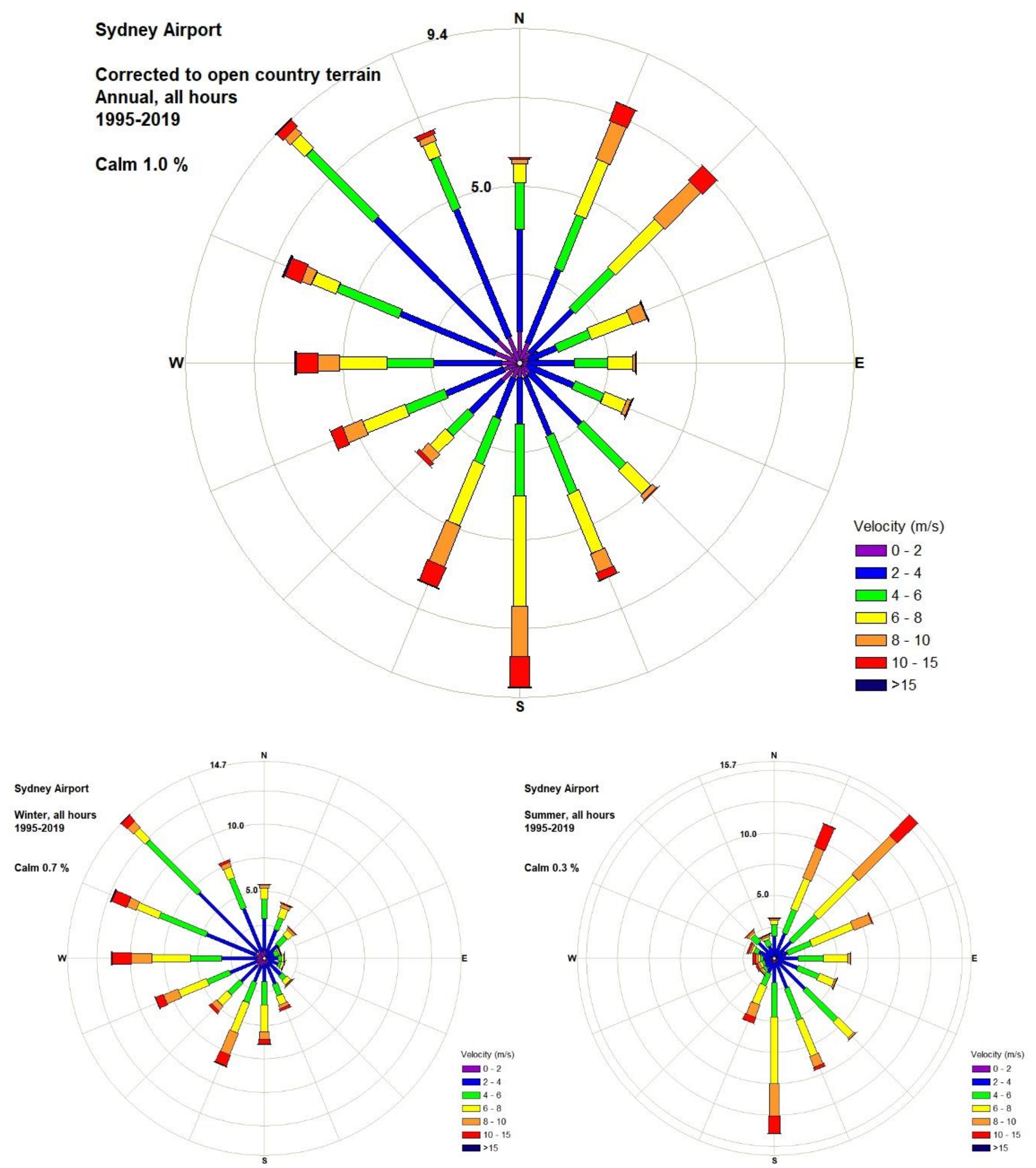


Figure 3: Wind roses for Sydney Airport – all hours, all months (Top), Winter (Bottom left), Summer (Bottom right)

3 ENVIRONMENTAL WIND CRITERIA

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.

The Sutherland Shire DCP (2015) has no specific wind assessment criteria or controls. The SEAR's applicable to this project include the following reference:

> *5. Environmental Amenity*
> • *Assess amenity impacts on the surrounding locality, including solar access, visual privacy, visual amenity, overshadowing, wind impacts and acoustic impacts. A high level of environmental amenity for any surrounding residential land uses must be demonstrated.*

However, do not specify any particular target criteria for wind amenity.

The wind assessment criteria that will be used in this study will be based upon the criteria of Lawson (1990), which 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 (Lawson, 1990)

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 in most directions by low-rise buildings, with sections of Botany Bay, Port Hacking, and Bate Bay located further afield to the north, east, and south respectively. Topography surrounding the site is mildly undulating, but from a wind perspective unlikely to significantly distort the wind climate at the site from that described in Section 2. Winds in such surrounds tend to experience less channelling flow than areas with many tall structures, with local effects instead being dictated by exposed buildings or less protected areas 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 Sutherland Hospital site is located on a block bounded by the Cronulla rail line to the south and The Kingsway road to the north. The upgrade works are focussed on the western side of the site adjacent to Kareena Road, where a portion of the existing building is being extended over an internal roadway to form an under-croft, Figure 4.

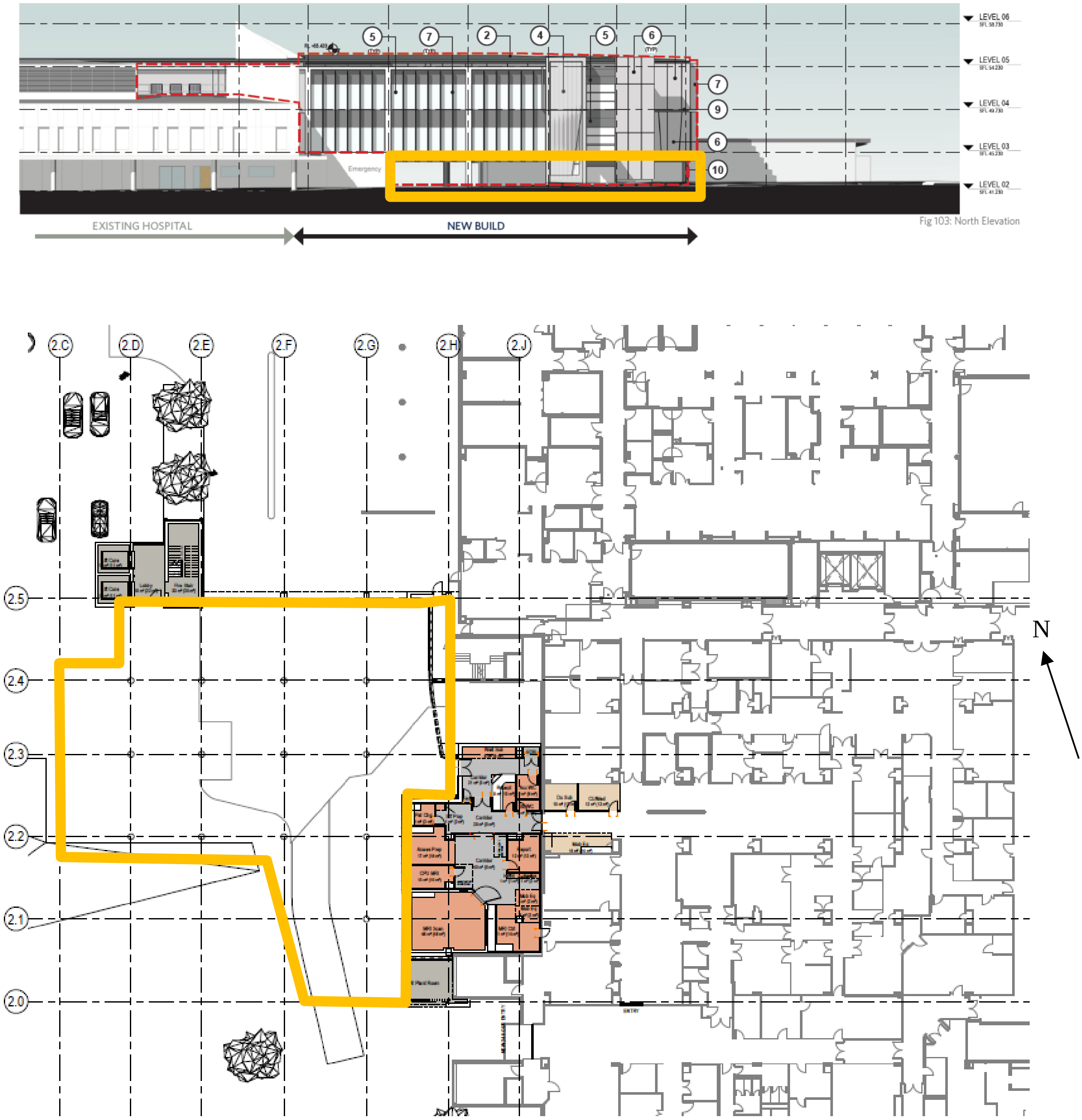


Figure 4: North elevation of upgrade works with under croft area highlighted (Top) Ground floor plan of proposed development with under croft area highlighted (Bottom)

4.1 Winds from the north-east

Wind from the north-east approach the site over a section of low-rise suburban development. The upgrade works are located on the downwind side of the hospital site, meaning the massing of the existing buildings will offer some shielding from north-easterly winds. The new build additions do not represent a significant height increase relative to the existing, therefore no major impact on ground level wind speeds is foreseen as a result of downwash flow during winds from this direction. Wind conditions throughout the under-croft area on ground level and most locations on the western side of the site are expected to remain reasonably calm during winds from the north-east.

4.2 Winds from the south

Winds from the south will tend to be channelled along Kareena Road and the internal access route approaching the under croft. The addition of the new build massing will direct some of this flow towards ground level, where the pressure differential across the north and south entries to the under croft will encourage breezes through the space. It is understood a partial enclosure of the under-croft area is formed where the existing ambulance station building to the south interfaces with the new build. This will help to limit the impact of southerly winds for a large section of the under-croft area, however may encourage stronger flows through the narrow channel created under the new levels (Figure 5). Relatively strong and consistent flows would be anticipated moving through this part of the under croft during moderate to strong winds from the south. The retention of existing and proposed landscaping (Figure 6) together with the shielding effect of the existing adjacent buildings will assist in limiting the impact of southerly winds elsewhere in the under-croft, particularly on the western and north-western boundaries. Further computational modelling could be conducted to quantify any acceleration of southerly winds through the under croft area.

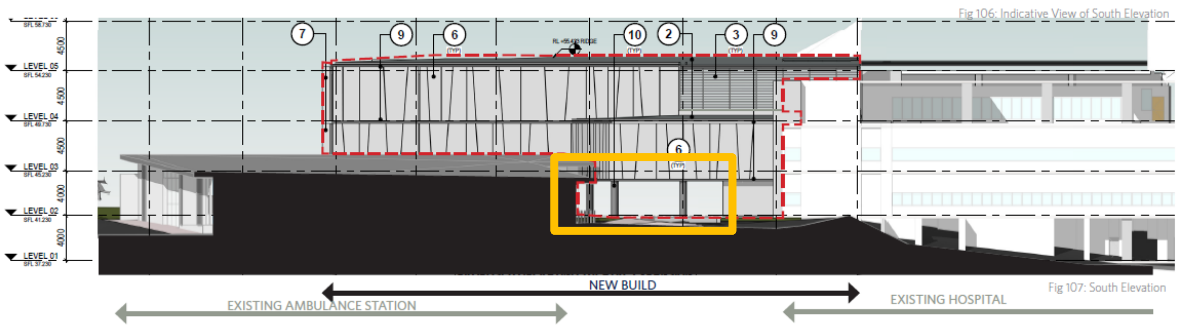


Figure 5: South elevation of new build with under-croft area highlighted)

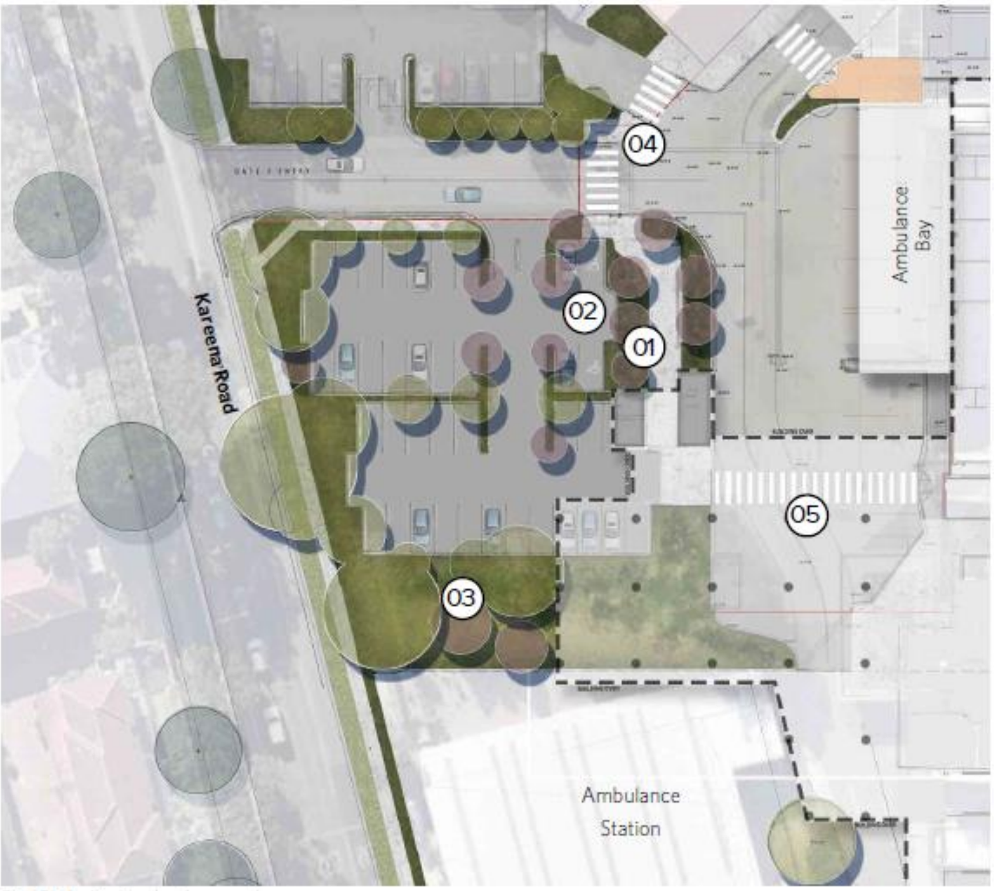


Figure 6: Preliminary landscape plan

4.3 Winds from the west

Winds from the west approach the site over a region of low-rise suburban development, with a small open area formed by a carpark immediately upwind of the new build area. During moderate to strong westerly winds, relatively high velocities would be anticipated for most areas on the western side of the hospital site. The addition of the new structure is not expected to significantly degrade conditions relative to the existing, however wind from the west is likely to affect the under-croft space, particularly at the fringes. Being protected from overhead and with the small benefit of landscape planting at the western edge, severe gusty conditions would not be expected for most of this area during westerly winds, though steady breezes may arise. Calmer conditions are likely to be available on the eastern side of the under-croft near to the building entry. Further computational modelling could be conducted to quantify any acceleration of westerly winds through the under croft area.

4.4 Summary

On average, wind conditions in the under-croft area are expected to be marginally calmer than a typical pedestrian environment in the vicinity of the project site. The configuration of the existing and future building massing relative to prevailing wind directions, along with proposed landscaping, will allow relatively calm conditions to be present for parts of the under-croft area for most of the time. While generally protected from the impact of direct winds, the under-croft area may be affected by steady breezes of moderate velocities as pressure-driven flow is created under certain conditions. From the perspective of pedestrian comfort, the under-croft area is expected to be suitable for Pedestrian Standing to Pedestrian Walking under the Lawson criteria, meaning the space would be generally suitable for pedestrian thoroughfare/transit and short to medium-duration stationary activity. An approximate distribution of windier and calmer conditions over the space is given in Figure 7 – these zones could be refined and quantified through numerical modelling. All areas would be expected to satisfy the Lawson distress/safety criterion.

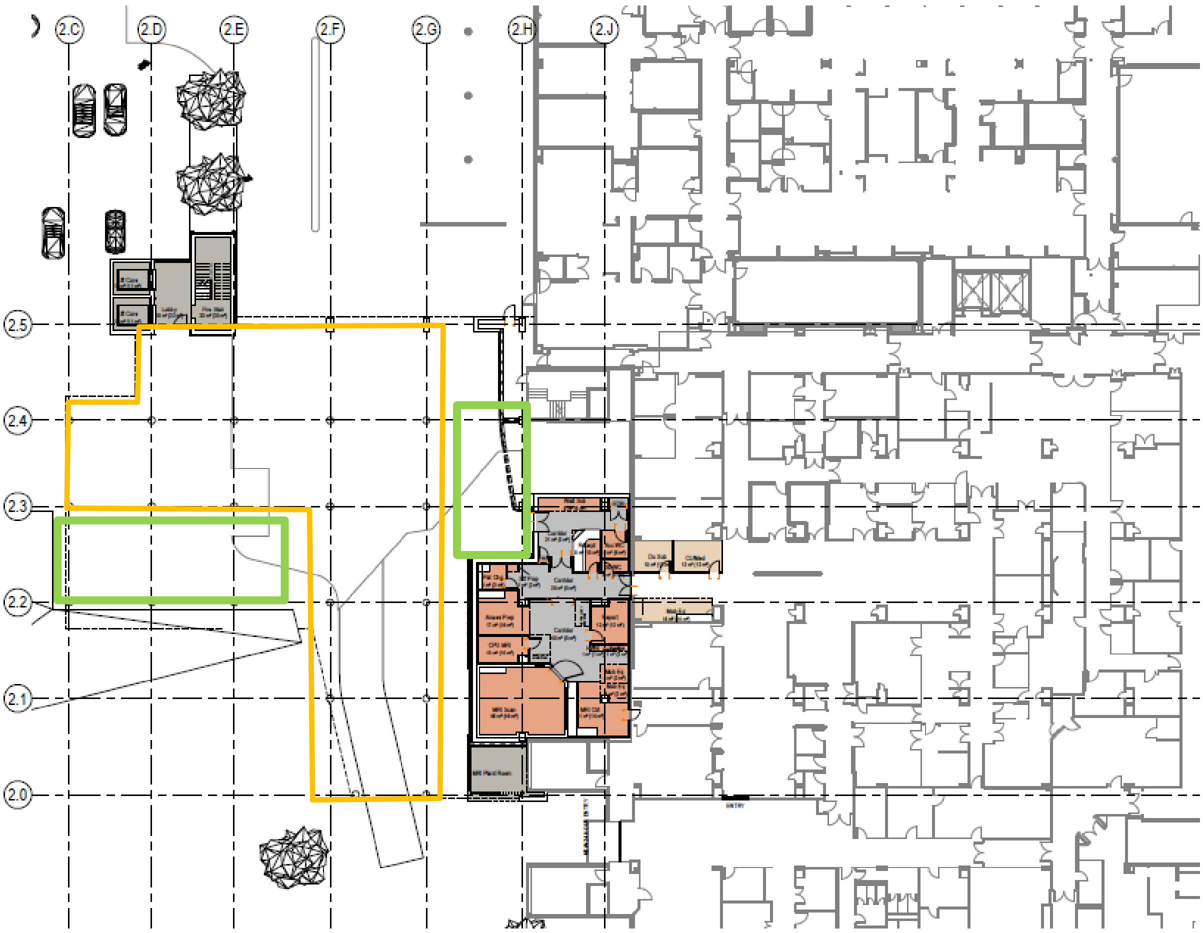


Figure 7: Ground floor plan indicating approximate distribution of calmer (green) and windier (Orange) areas within the under-croft

With reference to the SEAR's for this project, the new build works are not expected to produce any significant wind impacts for surrounding residential areas. The proposed upgrade works are not considered to be of a scale sufficient to measurably affect the wind amenity for neighbouring areas, taking into account the existing built environment and prevailing wind conditions.

CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed Sutherland Hospital Upgrade Project on the local wind environment in and around the development site, with a particular focus on the under-croft area. Considering the scale and massing of the new build component of the upgrade within the existing built context, the impact of the proposed work on the local pedestrian-level wind environmental amenity is expected to be negligible. For the under-croft area, wind conditions are expected to be mostly similar to the adjacent outdoor environment, with some areas well protected and suited for short to medium term stationary use by pedestrians, and others slightly windier and suitable for more transitory use. All areas would pass the Lawson distress/safety criterion.

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.

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 8; 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 8, 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 9 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.

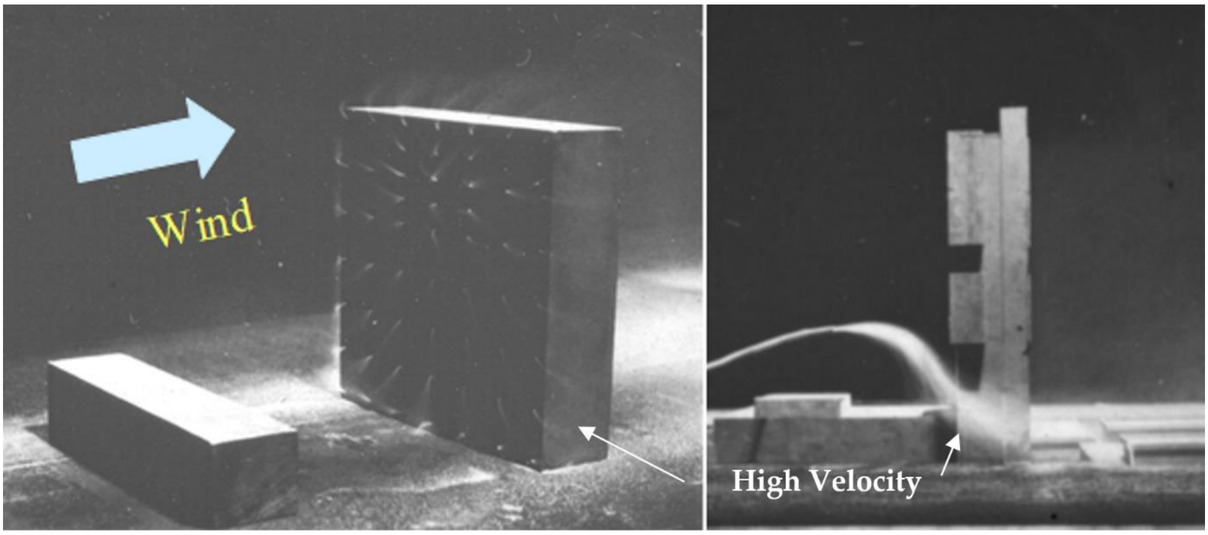


Figure 8: Flow visualisation around a tall building.

Figure 9: 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 10. 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.

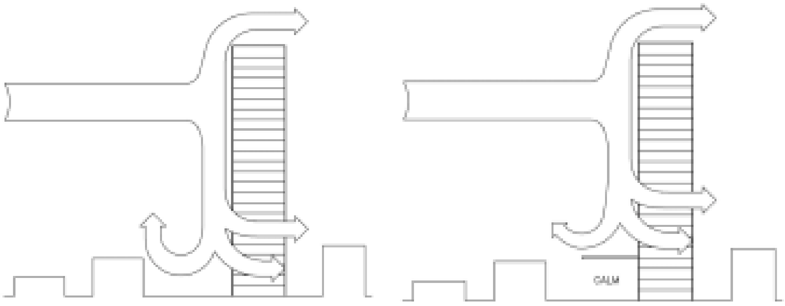


Figure 10: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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 11. 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.

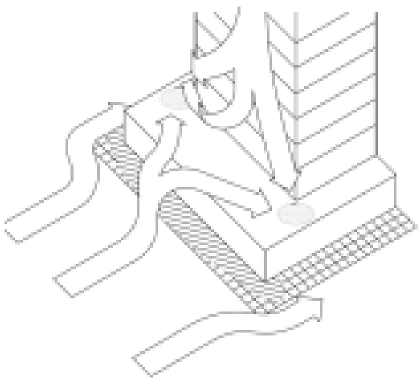


Figure 11: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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

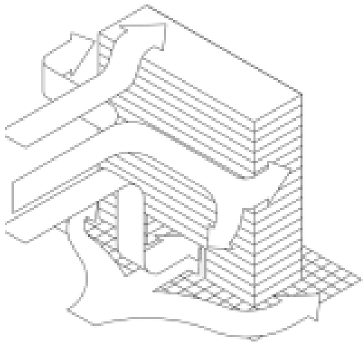


Figure 12: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 13(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 13(R), due to the accelerated flow mechanism described in Figure 8 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.

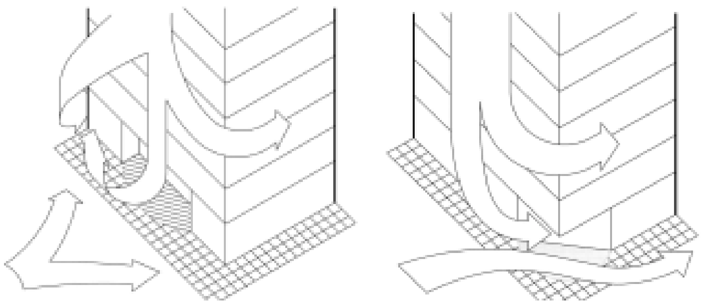


Figure 13: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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 11. 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 9(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.