PEDESTRIAN WIND ENVIRONMENT STATEMENT

MANDARIN CENTRE, 65 ALBERT AVENUE, CHATSWOOD

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the Mandarin Centre, located at 65 Albert Avenue, Chatswood, on the local wind environment at the critical outdoor areas within and around the subject site. The effect of wind activity has been examined for the three predominant wind directions for the region, namely the north-easterly, southerly, and westerly winds. The analysis of the wind effects relating to the proposed development have been carried out in the context of the local wind climate, building morphology and land topography.

The conclusions of this report are drawn from our extensive experience in this field and are based on an examination of the latest architectural drawings. No wind tunnel testing has been undertaken for the subject development, and hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection of the architectural drawings provided (received January 2021). Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

The results of this assessment indicate that the development has incorporated several design features and wind mitigating strategies and is expected to be suitable for the intended use for the majority of the outdoor trafficable areas. However, there are some areas that are likely to be exposed to stronger winds. It is expected that the wind effects identified in the report can be ameliorated with the consideration of the following treatment strategies into the design of the development:

- Ground level trafficable areas:
    - Retention of the densely foliating street trees along the Victor Street and Albert Avenue frontages of the site.
    - Impermeable awnings along the Victor Street and Albert Avenue frontages of the site.
- Podium Level 2 Entrance:
    - Localised wind mitigating devices such as densely foliating vegetation in the form of trees or shrubs/hedge planting (live or artificial) or screening around the entrance.
- Podium Level 5 Communal/Childcare Open Spaces:
    - The proposed planter areas along the perimeter edge of the childcare and communal open space as indicated in the architectural drawings to be populated with densely foliating vegetation such as trees or shrubs/hedge planting. In particular between the proposed towers and along the southern and western boundaries.
    - High impermeable balustrades along the proposed perimeter edge of the outdoor communal open space; in particular along then northern, southern and western boundaries.
    - Impermeable awnings along the proposed tower facades; in particular on the southern façade of the childcare centre where the prevailing winds are likely to be down-washed onto the podium rooftop than side-stream along the tower.

- Areas intended for short duration stationary activities such as outdoor seating are recommended to be restricted/situated away from the corners of the proposed towers as these areas highly susceptibility to adverse wind conditions such as accelerating flows around the building; in particular the outdoor areas exposed to the prevailing southerly winds which are the strongest for the region.

- Localised wind mitigating devices such as densely foliating vegetation in the form of trees or shrubs/hedge planting (live or artificial), screening or pergolas within and around areas intended for short duration stationary activities such as outdoor seating etc.

- Private Balconies:

    - Full-height blade walls or louver screens along the short perimeter edges and an impermeable balustrade on the long perimeter edges of the corner balconies.

    - Full-height privacy screen between southern private corner balconies.

    - Impermeable balustrades along the perimeter edge of the remaining single aspect private balconies.

With the inclusion of the abovementioned recommendations in the final design, it is expected that wind conditions for the various trafficable outdoor areas within and around the development will be suitable for their intended uses, and that the wind speeds will satisfy the applicable criteria for pedestrian comfort and safety. Nonetheless, due to the overall massing of the subject development and the complexity of the building form, wind tunnel testing is recommended to be undertaken as part of the detailed design phase. This will provide a quantitative analysis of the wind conditions and determine the requirement for wind mitigation measures; including the optimisation of the size and extent of the treatments required to ensure suitable wind conditions are achieved at all outdoor pedestrian accessible locations within and around the development.

As a general note, the use of loose glass-tops and light-weight sheets or covers (including loose BBQ lids) is not appropriate on high-rise outdoor balconies or terraces. Lightweight furniture is not recommended unless it is securely attached to the balcony or terrace floor slab.

CONTENTS

1 INTRODUCTION

An opinion on the likely impact of the proposed design on the local wind environment affecting pedestrians within the critical outdoor areas within and around the subject development is presented in this report. The analysis of wind effects relating to the proposed development has been carried out in the context of the predominant wind directions for the region, building morphology of the development and nearby buildings, and local land topography. The conclusions of this report are drawn from our extensive experience in the field of wind engineering and studies of wind environment effects.

No wind tunnel testing has been undertaken for this assessment. Hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection, and any recommendations in this report are made only in-principle.

2 DESCRIPTION OF DEVELOPMENT AND SURROUNDINGS

The site is located at 65 Albert Avenue, Chatswood, and is bounded by Albert Avenue to the south, Victor Street to the east and the high rise Sebel Building to the north and a laneway separating the site and the high-rise Sage Building to the west. The development site is located along the edge of the Chatswood CBD with predominantly low-rise residential with intermittent mid-rise buildings along the southern boundary and mid to high-rise commercial and retail buildings along the remaining boundaries. A survey of the land topography indicates a gradual rise west towards the Chatswood railway station.

An aerial image of the subject site and the local surroundings is shown in Figure 1, with the frequency and magnitude of the prevailing winds is superimposed for each wind direction.

The existing site consists of 5-storey commercial/retail buildings to be redeveloped into a 29-storey high rise building; comprised of two towers atop of a 5-storey high podium.

The critical outdoor trafficable areas associated with the proposed development, which are the focus of this assessment with regards to wind effects, are listed as follows:

- Ground Level pedestrian footpaths along Victor Street, Albert Avenue and the laneway adjacent to the Sage Building.
- Podium Level 2 entrance from the public green plaza.
- Podium Level 5 communal/childcare open space
- Private balconies and terraces.

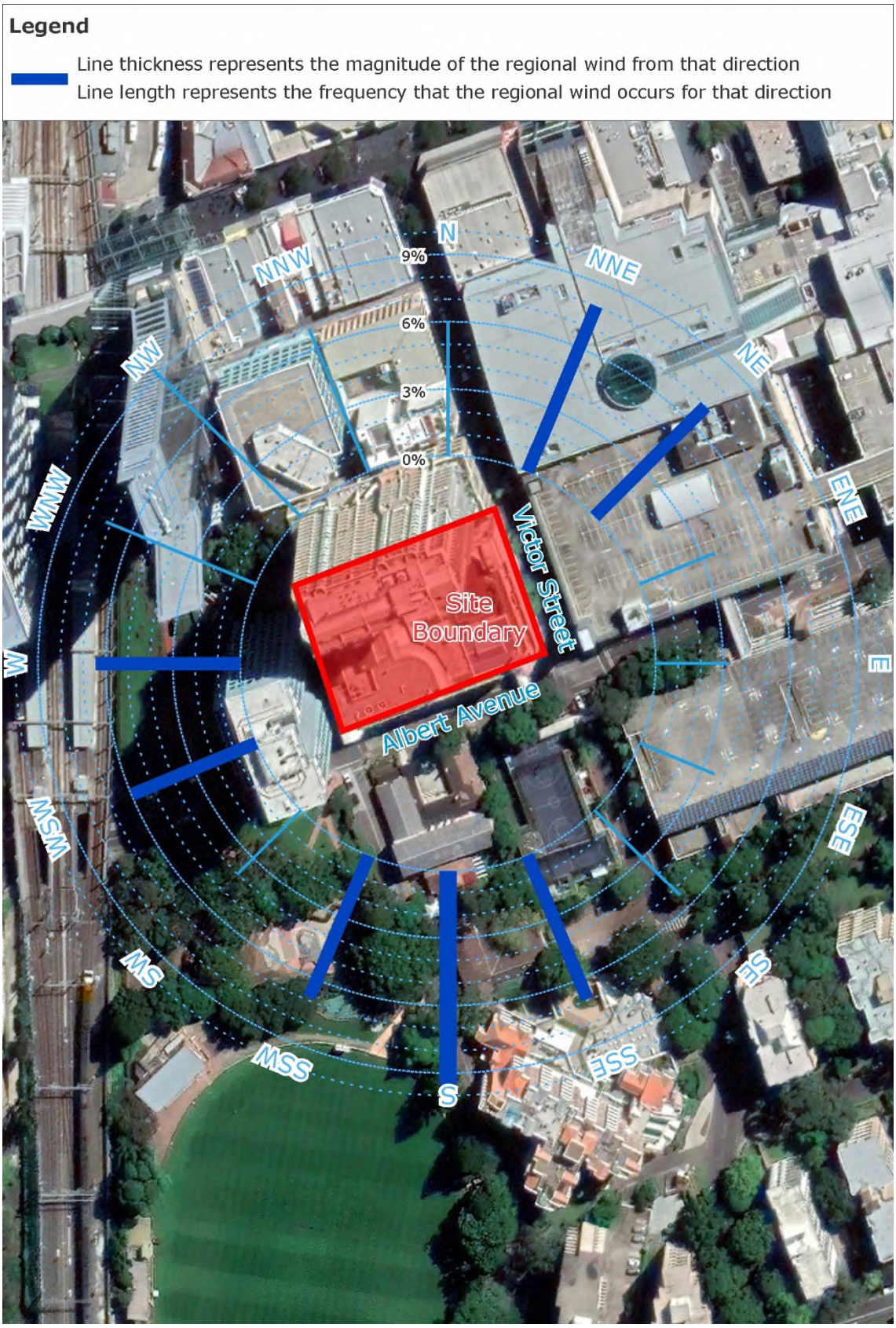

Figure 1: Aerial Image of the Site Location and Prevailing Wind Directions

3 REGIONAL WIND

The Sydney region is governed by three principal wind directions that can potentially affect the subject development. These winds prevail from the north-east, south, and west. These wind directions were determined from an analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained from the meteorological station located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1995 to 2016). The data has been corrected to represent winds over standard open terrain at a height of 10m above ground level. The results of this analysis are presented in Figure 2 in the form of a directional plot of the annual and 5% exceedance mean winds for the region. The frequency of occurrence of these winds is also shown in Figure 2.

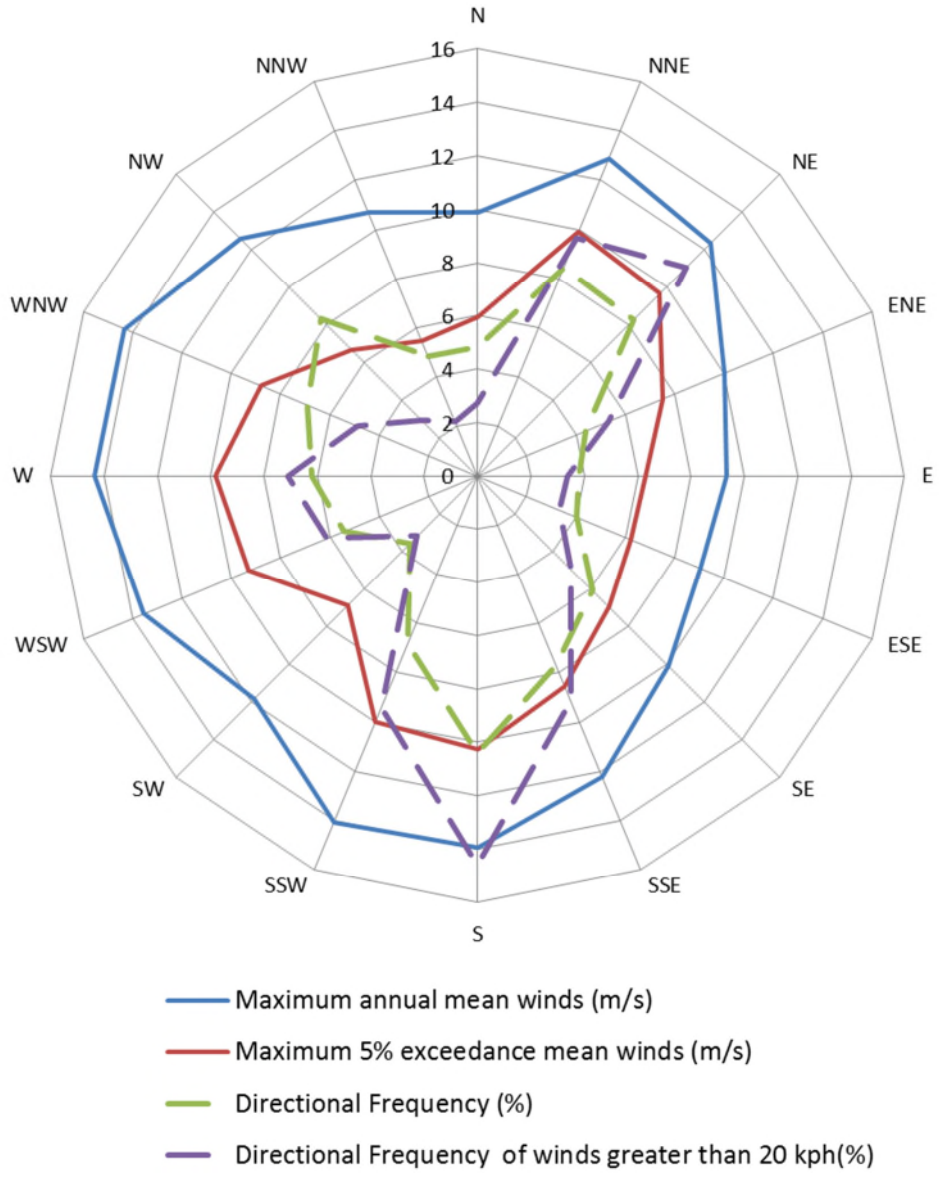

Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Sydney Region

4 WIND EFFECTS ON PEOPLE

The acceptability of wind in any area is dependent upon its use. For example, people walking, or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. Various other researchers, such as A.G. Davenport, T.V. Lawson, W.H. Melbourne, and A.D. Penwarden, have published criteria for pedestrian comfort for pedestrians in outdoor spaces for various types of activities. Some Councils and Local Government Authorities have adopted elements of some of these into their planning control requirements.

For example, A.D. Penwarden (1973) developed a modified version of the Beaufort scale which describes the effects of various wind intensities on people. Table 1 presents the modified Beaufort scale. Note that the effects listed in this table refers to wind conditions occurring frequently over the averaging time (a probability of occurrence exceeding 5%). Higher ranges of wind speeds can be tolerated for rarer events.

Table 1: Summary of Wind Effects on People (A.D. Penwarden, 1973)

Type of Winds	Beaufort Number	Mean Wind Speed (m/s)	Effects
Calm	0	Less than 0.3	Negligible.
Calm, light air	1	0.3 – 1.6	No noticeable wind.
Light breeze	2	1.6 – 3.4	Wind felt on face.
Gentle breeze	3	3.4 – 5.5	Hair is disturbed, clothing flaps, newspapers difficult to read.
Moderate breeze	4	5.5 – 8.0	Raises dust, dry soil and loose paper, hair disarranged.
Fresh breeze	5	8.0 – 10.8	Force of wind felt on body, danger of stumbling
Strong breeze	6	10.8 – 13.9	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, wind noise on ears unpleasant.
Near gale	7	13.9 – 17.2	Inconvenience felt when walking.
Gale	8	17.2 – 20.8	Generally impedes progress, difficulty balancing in gusts.
Strong gale	9	Greater than 20.8	People blown over.

It should be noted that wind speeds affecting this particular development can only be accurately quantified with a wind tunnel study. This assessment addresses only the general wind effects and any localised effects that are identifiable by visual inspection and the acceptability of the conditions for outdoor areas are determined based on their intended use. Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

5 RESULTS AND DISCUSSION

The expected wind conditions affecting the development are discussed in the following sub-sections of this report for the various outdoor areas within and around the subject development. The interaction between the wind and the building morphology in the area is considered and important features taken into account including the distances between the surrounding buildings and the proposed building form, as well as the surrounding landform. Note that only the potentially critical wind effects are discussed in this report. A glossary of the different wind effects described in this report included in Appendix A.

For this assessment, the wind speed criteria for pedestrian comfort that are considered are listed as follows:

- Comfortable Walking Criterion (7.5m/s with a 5% probability of exceedance)
  for general circulation and pedestrian thoroughfares, e.g. footpaths, private balconies/terraces, through-site links etc.

- Short Exposure Criterion (5.5m/s with a 5% probability of exceedance)
  for stationary activities generally less than an hour, e.g. waiting areas, communal terraces, main entries, café seating etc.

- Long Exposure Criterion (3.5m/s with a 5% probability of exceedance)
  for stationary activities longer than an hour, e.g. outdoor cinemas, outdoor fine dining etc.

Although this assessment is qualitative in nature, the abovementioned criteria for pedestrian comfort are considered when assessing the wind environment impacts. However, all areas are also assessed with consideration to a pedestrian safety criterion of 23m/s for the annual maximum gust.

5.1 Ground Level Areas

The wind conditions on the pedestrian footpath along the Victor Street and Albert Avenue frontages of the site is expected to be similar to the existing site conditions. This is due to the similar height of the podium to the existing building and the large setback of the residential tower from the podium edge that is effective in ameliorating the potential down-wash wind effect off the tower façade. On the existing building are impermeable awnings along the Albert Avenue and Victor Street frontages of the site that may be effective in enhancing the local wind conditions along the associated pedestrian footpaths. An impermeable awning along these street frontages is recommended to be considered in the final design of the development to simulate a similar wind conditions to the existing site conditions. The existing densely foliating street trees along street frontages are expected to be effective in wind mitigation, hence they are recommended to be retained in the final design of the development.

Similarly, the wind conditions on the pedestrian footpath along the laneway between the subject building and the neighbouring Sage Building is expected to be similar to the existing site conditions. The pedestrian footpath benefits from the shielding provided by the subject and Sage buildings to the prevailing north-easterly and westerly winds. The footpath is exposed to the direct southerly winds travelling along Orchard Road and funnelling between the subject and Sage building. This is however an existing wind condition for the site and the inclusion of the proposed building is not expected to exacerbate the wind conditions on the footpath.

5.2 Podium Level 2 Entrance

The entrance into the subject development from the public green plaza; located at the north-western corner of the site, benefits from the shielding provided by the subject and neighbouring high-rise buildings to wind effects from the prevailing north-easterly and southerly winds. Due to the alignment of the entrance, it is potentially exposed to the prevailing westerly winds travelling over the public green plaza and funnelled into the entrance. The existing landscaping of the public green plaza in providing some form of wind amelioration of the direct wind effects. The inclusion of effective wind mitigation features such as localised densely foliating vegetation in the form of trees or shrubs/hedge planting (live or artificial) or screening around the entrance is recommended to be considered in the final design to enhance the local wind conditions.

5.3 Podium Level 5 Communal/Childcare Open Space

The proposed towers can provide partial shielding to the communal outdoor areas located downstream of the proposed towers from the prevailing wind directions. There are however wind effects due to the interaction of the prevailing winds with the building morphology that can potentially impact the wind comfort and amenity on the podium rooftop. These are summarised as follows

- Direct wind effects from the prevailing wind directions due to the podium rooftop's elevated position and lack of shielding from the neighbouring low-rise developments along the eastern and southern boundaries.

- Corner wind effects around the corners of the proposed tower; in particular the corner outdoor areas adjacent to the central communal open space.

- Funnelling wind effects between the proposed towers of the subject development and the neighbouring high-rise Sebel and Sage buildings.

- Down-wash wind effects captured off the southern tower façades that are redirected onto the podium rooftop below.

It is expected the following treatment strategies to be effective in mitigating the abovementioned potential wind effects and enhance the local wind conditions on the podium rooftop, hence they are recommended to be considered in the design of the development:

- The proposed planter areas along the perimeter edge of the childcare and communal open space as indicated in the architectural drawings to be populated with densely foliating vegetation such as trees or shrubs/hedge planting. In particular between the proposed towers and along the southern and western boundaries.

- High impermeable balustrades along the proposed perimeter edge of the outdoor communal open space; in particular along then northern, southern and western boundaries.

- Impermeable awnings along the proposed tower facades; in particular on the southern façade of the childcare centre where the prevailing winds are likely to be down-washed onto the podium rooftop than side-stream along the tower.

- Areas intended for short duration stationary activities such as outdoor seating are recommended to be restricted/situated away from the corners of the proposed towers as these areas highly susceptibility to adverse wind conditions such as accelerating flows around the building; in particular the outdoor areas exposed to the prevailing southerly winds which are the strongest for the region.

- Localised wind mitigating devices such as densely foliating vegetation in the form of trees or shrubs/hedge planting (live or artificial), screening or pergolas within and around areas intended for short duration stationary activities such as outdoor seating etc.

Densely foliating vegetation is to be of an evergreen species to ensure their effectiveness in wind mitigation throughout the year and the vegetation should be spaced such that the foliage is able to interlock between plants (where possible).

Due to the overall massing of the subject development and the complexity of the building form, wind tunnel testing is recommended to be undertaken as part of the detailed design phase. This will provide a quantitative analysis of the wind conditions and determine the requirement for wind mitigation measures; including the optimisation of the size and extent of the treatments required to ensure suitable wind conditions are achieved at all outdoor pedestrian accessible locations within and around the development.

5.4 Private Balconies

The wind conditions within the proposed single aspect private balconies are expected to be suitable for their intended use due to their overall recessed design into the tower build-form that creates effective wind stagnation zones within the balconies. The inclusion of impermeable balustrades along the exposed perimeter edges of the single aspect private balconies are also effective in further enhancing the local wind conditions.

The proposed corner balconies benefit from some form of shielding from the neighbouring high-rise buildings to the north and west of the tower. However, it is exposed to strong wind effects such as the accelerating flows around the corners of the tower due to the generated pressure differential along the orthogonal aspects, the prevailing winds travelling around the neighbouring high-rise buildings and reattaching onto the corner balconies, or directly over the low-rise buildings along the eastern and southern boundaries that afford minimal shielding to the elevated co It is expected the following treatment strategies to be effective in mitigating the abovementioned potential wind effects and enhance the local wind conditions on the podium rooftop, hence they are recommended to be considered in the design of the development:

- Full-height blade walls or louver screens along the short perimeter edges and an impermeable balustrade on the long perimeter edges of the corner balconies.

- Full-height privacy screen between southern private corner balconies.

As a general note, the use of loose glass-tops and light-weight sheets or covers (including loose BBQ lids) is not appropriate on high-rise outdoor balconies or terraces. Lightweight furniture is not recommended unless it is securely attached to the balcony or terrace floor slab.

6 REFERENCES

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APPENDIX A WIND EFFECTS GLOSSARY

A.1 Downwash and Upwash Effects

The downwash wind effect occurs when wind is deflected down the windward face of a building, causing accelerated winds at pedestrian level. This can lead to other adverse effects as corner acceleration as the wind attempts to flow around the building, as seen in Figure A.1.

This can also lead to recirculating flow in the presence of a shorter upstream building, causing local ground level winds to move back into the prevailing wind.

The upwash effect occurs near upper level edge of a building form as the wind flows over the top of the building. This has the potential to cause acceleration of winds near the leading edge, as well as potentially reattaching onto the roof area. This effect causes wind issues particularly near the leading edges of tall building and on the rooftop areas if there is sufficient depth along the wind direction. Upwash is more apparent in taller towers and podia.

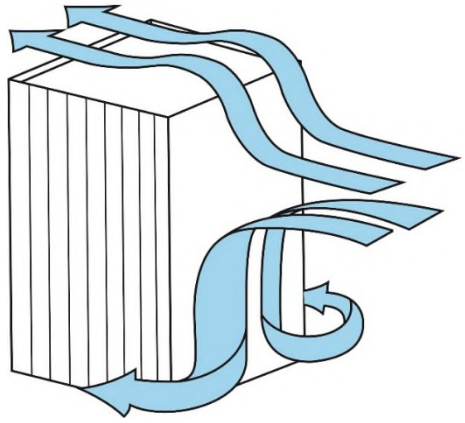

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

A.2 Funnelling/Venturi Effect

Funnelling occurs when the wind interacts with two or more buildings which are located adjacent to each other, which results in a bottleneck, as shown in Figure A.2. This causes the wind to be accelerated through the gap between the buildings, resulting in adverse wind conditions and pedestrian discomfort within the constricted space. Funnelling effects are common along pedestrian links and thoroughfares generally located between neighbouring buildings that have moderate gaps between them.

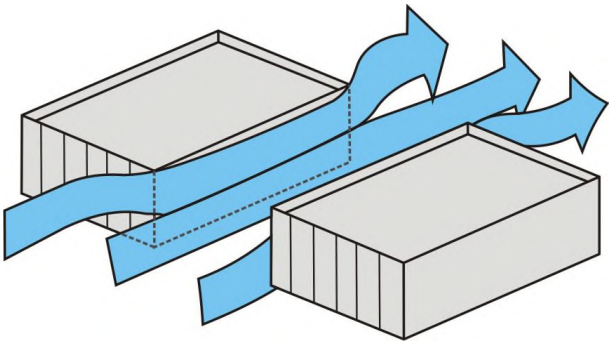

Figure A.2: Funnelling/Venturi Wind Effect

A.3 Gap Effect

The gap effect occurs in small openings in the façade that are open to wind on opposite faces, as seen in Figure A.3. This can involve a combination of funnelling and downwash effects. Presenting a small gap in the façade on the windward aspect as the easiest means through which the wind can flow through can result in wind acceleration through this gap. The pressure difference between the windward façade and the leeward façade also tends to exacerbate the wind flow through this gap.

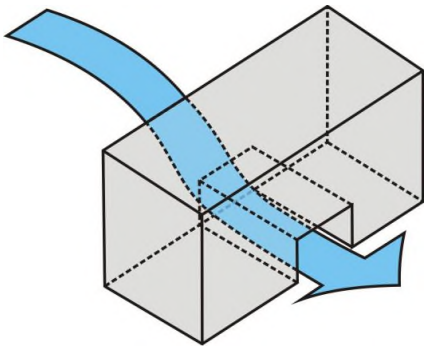

Figure A.3: Gap Wind Effect

A.4 Sidestream and Corner Effects

The sidestream effect is due to a gradual accumulation of wind shearing along the building façade that eventuates in an acceleration corner effect. The flow is parallel to the façade and can be exacerbated by downwash effects as well, or due to corner effect winds reattaching on the façade.

This is shown in Figure A.4. The corner refers to the acceleration of wind at the exterior vertical edge of a building, caused by the interaction of a large building massing with the incident wind, with the flow at the corner being accelerated due to high pressure differentials sets up between the windward façade and the orthogonal aspects. It can be further exacerbated by downwash effects that build up as the flow shears down the façade.

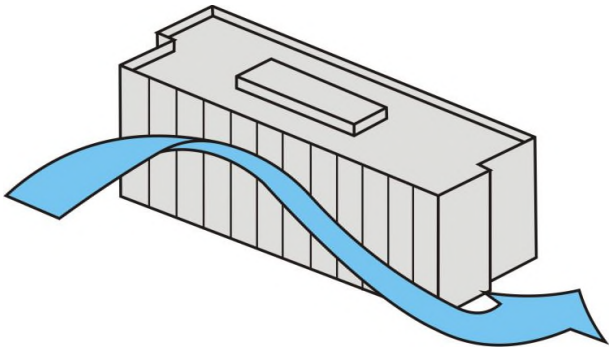

Figure A.4: Sidestream and Corner Wind Effect

A.5 Stagnation

Stagnation in a region refers to an area where the wind velocity is significantly reduced due to the effect of the flow being impeded by the bluff body. For a particular prevailing wind direction, this is typically located near the middle of the windward face of the building form or over a short distance in front of the windward face of a screen or fence. Concave building shapes tend to create an area of stagnation within the cavity, and wind speeds are generally low in these areas.