PEDESTRIAN WIND ENVIRONMENT STATEMENT

845 PACIFIC HIGHWAY, CHATSWOOD

WF454-04F02(REV0)- WS REPORT

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Prepared for:

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30 YEARS OF EXCELLENCE IN WIND ENGINEERING

DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the proposed development located at 845 Pacific Highway, 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 2 September 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:

- Retention of the proposed awning structure around the northern and southern aspects of the development (extending from the Level 1 slab). It Is recommended that the awning be <u>no more</u> than 35% porous.

- Recommended extension of the awning structure at the northern corner, western building aspect and south-eastern building aspect, to be <u>no more</u> than 35% porous.

- Retention of the existing and the planned trees as well as inclusion of an additional tree at the south-western corner of the subject development to mitigate the effect of direct prevailing winds reaching the pedestrian footpaths, external seating areas and building entrances. The trees should be of an evergreen species with densely foliating 3-5m wide canopies capable of growing to a height of 3-5m.

Note that for the densely foliating planting to be effective in wind mitigation throughout the year, they are recommended to be of an evergreen species. Wind tunnel testing is recommended to be undertaken at a later detailed design stage to verify the wind conditions and enable a more detailed feedback and design of the proposal and potential wind mitigation measures. This will provide a quantitative analysis of the wind conditions and determine the requirement for wind mitigation measures, including the optimum size and extent of treatments to ensure suitable conditions are provided for the trafficable areas throughout the development. Note that the inclusion of any additional landscaping or planting within and around the building is expected to be effective in improving local wind conditions.

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 845 Pacific Highway, Chatswood, and is bounded by Railway Street to the north-east, Day Street to the south-east and Pacific highway to the north-west. The buildings surrounding the subject development within 'southwest – northwest – northeast' 180-degree sector are predominately low-rise residential and commercial buildings, with a few mid-rise apartment buildings to the south-west. The 'southwest – southeast- northeast' 180-degree sector consists of number of high right developments, including the 25-storey Altura Tower (11 Railway Street) and the 31 storey Epica Tower (9 Railway Street) located to the northeast as well as the 24-storey Zenith Towers located to the southeast (821 Pacific Highway).

The existing site consists of a 6-storey office building, and the proposed development is a 38-storey high commercial tower.

A survey of the land topography indicates a gradual downward slope towards the junction of Day Street and Railway Street, however, there are no major elevation changes in the area immediately surrounding the site. An aerial image of the subject site and the local surroundings is shown in Figure 1.

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

- Pedestrian footpaths around the proposed development.
- Building entrances along Pacific Highway and Railway Street.
- Public seating areas located at the northern and southwestern corners of development at Ground Level.

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.

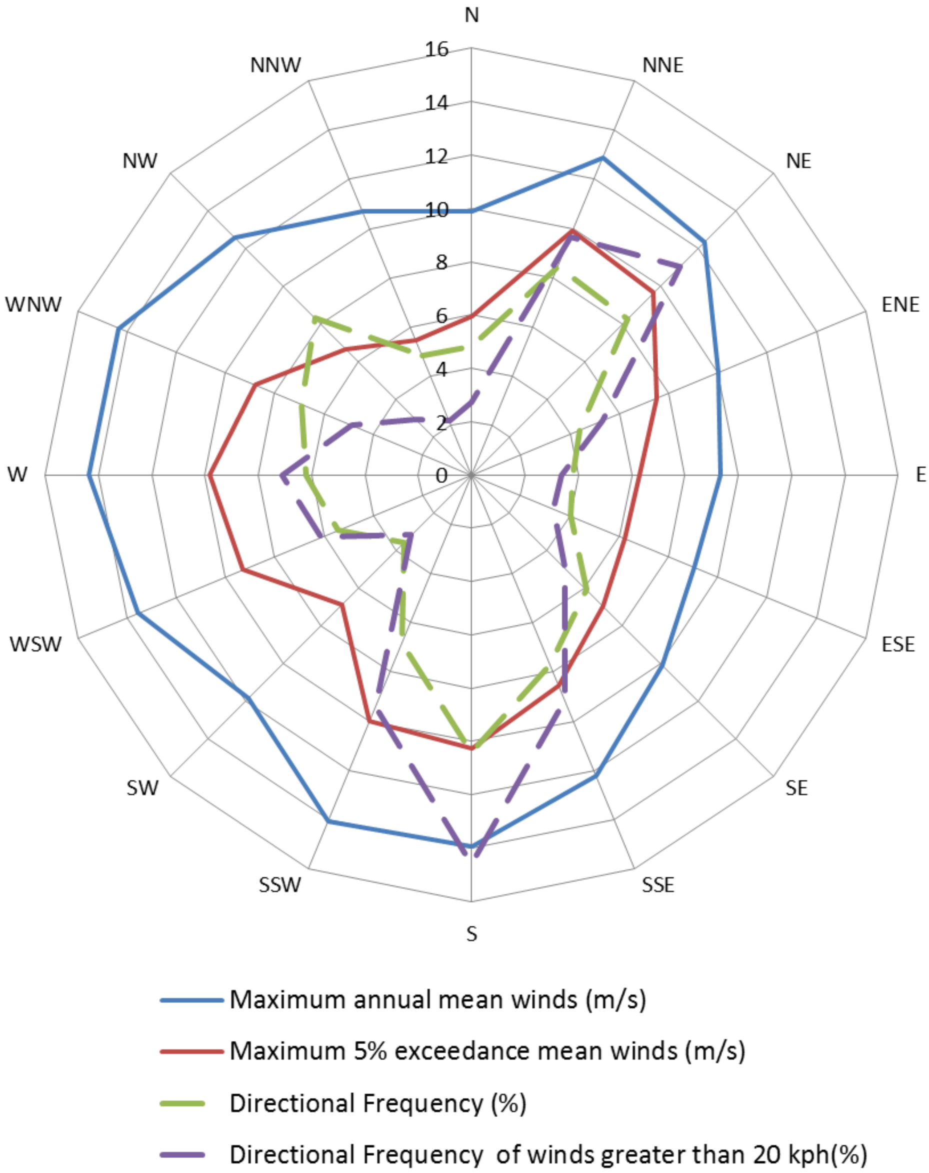

Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Sydney Region

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 to 8m/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 to 6m/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 to 4m/s with a 5% probability of exceedance)
  for stationary activities longer than an hour, e.g. outdoor cinemas, outdoor fine dining etc.

Note that the lower end of the above ranges reflect the Davenport (1972) criteria and the upper end of these ranges reflect a modified Lawson (1975) criteria. 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 Discussion

The proposed chamfered/curved corners of the building façade and the inclusion of awning features in the design are expected to aid in reducing potential corner acceleration effects as well as down-wash effects from the façade.

The pedestrian footpath as well as the building entrance along Railway Street are primarily exposed to the north-easterly prevailing winds. The building façade along Railway Street is set back at the Ground Level compared to the upper levels, however because this has been achieved via a gradual sloped façade, it is expected to lead down-washing north-easterly winds towards the proposed communal seating areas as well as the building entrance along this aspect. Prevailing westerly winds caught by the building façade along Pacific Highway are expected be down-washed on to the pedestrian areas along this aspect, while also impacting the main building entrance leading to the lobby. Prevailing southerly winds as well as westerly winds may accelerate around the south western corner of the development, causing adverse wind effects within and around the food and beverage seating area located at this corner at Ground Level. The seating area located at the northern corner is expected to experience more adverse corner acceleration effect from westerly winds and, to some extent, north easterly winds due to the smaller extent of the chamfer at this corner.

We recommend that the following treatment measures be implemented in the design to mitigate the effects of the prevailing winds on the pedestrian trafficable areas of the subject development (refer to Figure 3).

- Retention of the proposed awning structure around the northern and southern aspects of the development (extending from the Level 1 slab). It Is recommended that the awning be no more than 35% porous.
- Recommended extension of the awning structure at the northern corner, western building aspect and south-eastern building aspect, to be no more than 35% porous.
- Retention of the existing and the planned trees as well as inclusion of an additional tree at the south-western corner of the subject development to mitigate the effect of direct prevailing winds reaching the pedestrian footpaths, external seating areas and building entrances. The trees should be of an evergreen species with densely foliating 3-5m wide canopies capable of growing to a height of 3-5m.

Note that for the densely foliating planting to be effective in wind mitigation throughout the year, they are recommended to be of an evergreen species. Wind tunnel testing is recommended to be undertaken at a later detailed design stage to verify the wind conditions and enable a more detailed feedback and design of the proposal and potential wind mitigation measures. This will provide a quantitative analysis of the wind conditions and determine the requirement for wind mitigation measures, including the optimum size and extent of treatments to ensure suitable conditions are provided for the trafficable areas throughout the development. Note that the inclusion of any additional landscaping or planting within and around the building is expected to be effective in improving local wind conditions.

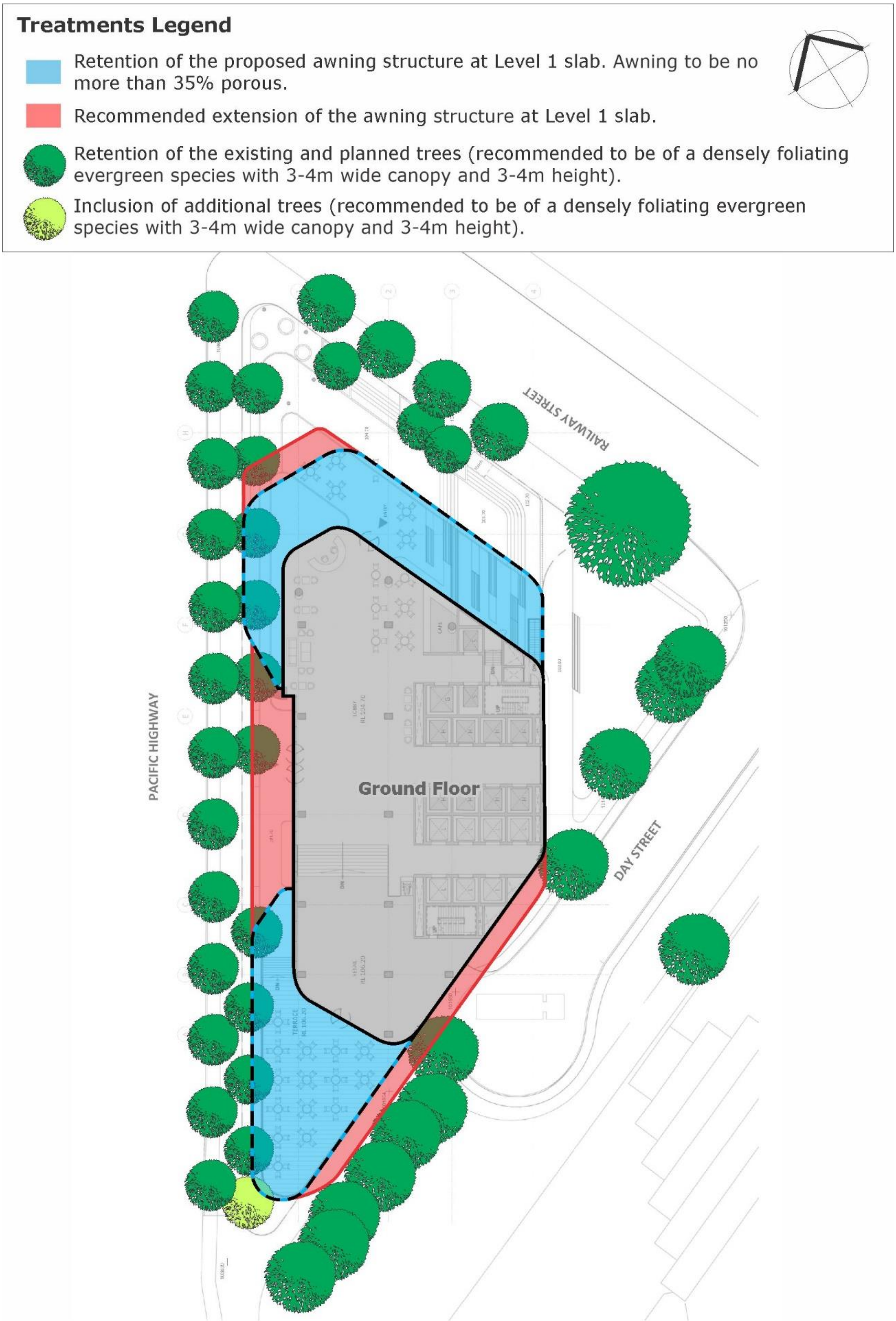

Figure 3: Recommended Treatments - Ground Floor Plan

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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.

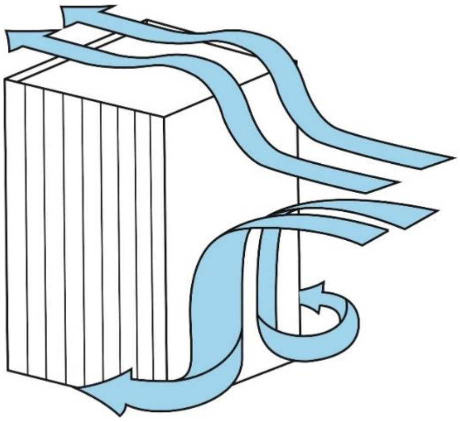

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

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.

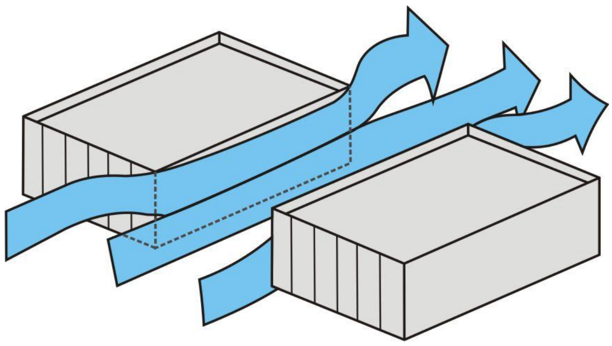

Figure A.2: Funnelling/Venturi Wind Effect

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.

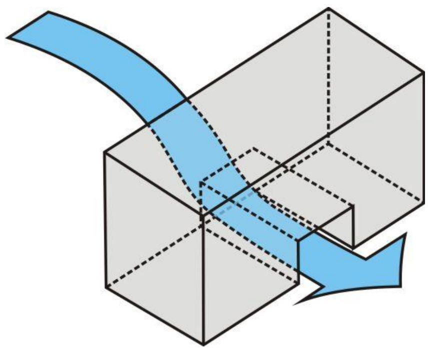

Figure A.3: Gap Wind Effect

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.

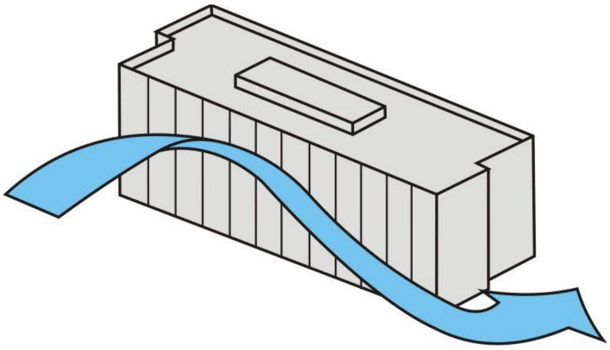

Figure A.4: Sidestream and Corner Wind Effect

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.