PEDESTRIAN WIND ENVIRONMENT STATEMENT

601 PACIFIC HIGHWAY, ST LEONARDS

WD859-04F02(REV2)- WS REPORT

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Prepared for:

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EXECUTIVE SUMMARY

Windtech has prepared this Pedestrian Wind Environment Statement on behalf of Stockland Development Pty Ltd to support a Planning Proposal to amend the statutory planning controls that apply to 601 Pacific Highway, St Leonards (Lot 71 in Deposited Plan 749690) (the site) under North Sydney Local Environmental Plan 2013 (LEP).

This report presents an opinion on the likely impact of the reference building massing for the development, located at 601 Pacific Highway, St Leonards, 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 building envelope 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 21 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 majority of ground level pedestrian trafficable areas are exposed to the prevailing southerly and westerly winds due to the alignment of the development site and adjacent roads to the prevailing winds. It is noted that the high-rise developments directly to the south of the site will provide significant shielding to the direct prevailing southerly winds. Furthermore, the prevailing north-easterly winds are expected to impact the development tower and down-wash down onto the surrounding trafficable areas to the north-east. Significant funnelling is also expected along Atchison Street and Pacific Highway and also between the development tower and the adjacent tower to the west which is to be constructed. The following treatment strategies are recommended to assist with the wind effects identified in the report:

- Ground level trafficable areas:
    - Impermeable awning along the northern and eastern aspects of the podium façade.
    - Localised baffle screens or densely foliating evergreen planting within and around seating areas along the Atchison and Mitchell Streets.
    - Densely foliating evergreen planting along the Pacific Highway, Atchison and Mitchell Streets.
- Elevated Outdoor Areas:
    - Impermeable balustrades around the terrace areas.
    - Impermeable canopies over the terrace areas.
    - Densely foliating landscaping throughout the terrace areas.

With the consideration of the abovementioned recommendations at a future Development Application stage, it is expected that wind conditions for the various trafficable outdoor areas within and around the reference

building massing can be made suitable for their intended uses, with the wind speeds satisfying the applicable criteria for pedestrian comfort and safety. Due to the building massing size, exposure and height exceeding the stipulated 45m as per the North Sydney Development Control Plan 2013, a comprehensive assessment including wind tunnel testing of the pedestrian wind environment associated with a detailed development proposal will be required as part of a future development application for the site.

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1 INTRODUCTION

Windtech Consultants has prepared this Pedestrian Wind Environment Statement on behalf of Stockland Development Pty Ltd to support a Planning Proposal to amend the statutory planning controls that apply to 601 Pacific Highway, St Leonards (Lot 71 in Deposited Plan 749690) (the site) under North Sydney Local Environmental Plan 2013 (LEP).

The intended outcome of this Planning Proposal is to amend the LEP planning controls as follows:

- Establish a site-specific building height control, with maximum building height of RL276.5; and
- Establish a site-specific floor space ratio (FSR) control, with a maximum FSR of 20:1.

The Planning Proposal does not amend the site's existing B3 Commercial Core zoning. Future development aligned with the Planning Proposal is consistent with the permissible land uses and objectives of Zone B3.

The new planning controls seek to unlock the potential of a strategically-located landholding within the St Leonards centre and facilitate a new commercial building in a precinct earmarked for density uplift.

This Planning Proposal will deliver strategic planning merits commensurate with State and Local government policy and align with the St Leonards and Crows Nest 2036 Plan adopted by NSW Department of Planning, Industry and Environment (DPIE) (August 2020). Future development of the site will generate substantial public benefit and make a significant contribution to the evolving character of St Leonards town centre.

This report presents an opinion on the likely impact of the indicative concept proposal on the local wind environment affecting pedestrians within the subject development's critical outdoor areas. The analysis of wind effects relating to the proposed building envelope 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. A comprehensive assessment including wind tunnel testing of the pedestrian wind environment associated with a detailed development proposal will be required as part of a future development application for the site. 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

2.1 Site Description

The site to which this Planning Proposal relates is 601 Pacific Highway, St Leonards, within the North Sydney Local Government Area (LGA). The site is located approximately 4.5 km north of the Sydney CBD and within close proximity to the commercial centres of St Leonards, Chatswood, and Macquarie Park.

The site has a primary (south-facing) frontage to the Pacific Highway and secondary frontages to Mitchell Street (to the east) and Atchison Street (to the north). 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 site comprises a single allotment (Lot 71 in DP 749690) with a total area of 2,840 sqm (approximate).

The site is currently occupied by a 14-storey commercial office building, with ground and plaza level retail land uses, and four basement parking levels (accommodating 158 spaces).

2.2 Surrounding Context

The site occupies a prominent location on the corner of the Pacific Highway and Mitchell Street, with a secondary frontage to Atchison Street. The site is located in the heart of St Leonards within convenient walking distance of the facilities and services available within the St Leonards rail precinct.

The area is well advanced in its transition from an older style commercial precinct to a thriving mixed-use area incorporating commercial and residential land uses, in tall tower building forms. This transition is facilitated by ongoing construction activity, recent development approvals, and further planning proposals.

The immediate surroundings include a range of building forms which are predominantly medium and high rise commercial and multi-storey mixed-use residential buildings. A mid-rise residential and commercial building is currently abutting the subject site to the west, and has been approved for a 180m high tower development.

Further to the north, west and east are the residential suburbs including Willoughby, Lane Cove and Crows Nest. To the south of the site is the residential suburb of Greenwich and Sydney harbour. The local land topography is relatively significant with a fall across the site from east to west along the Pacific Highway and Atchison Street frontages.

The existing site is the "IBM" building and is a 14 storey office tower. The proposed building envelope is 42 storeys high.

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

- Ground Level areas and pedestrian footpaths.
- Elevated outdoor areas.

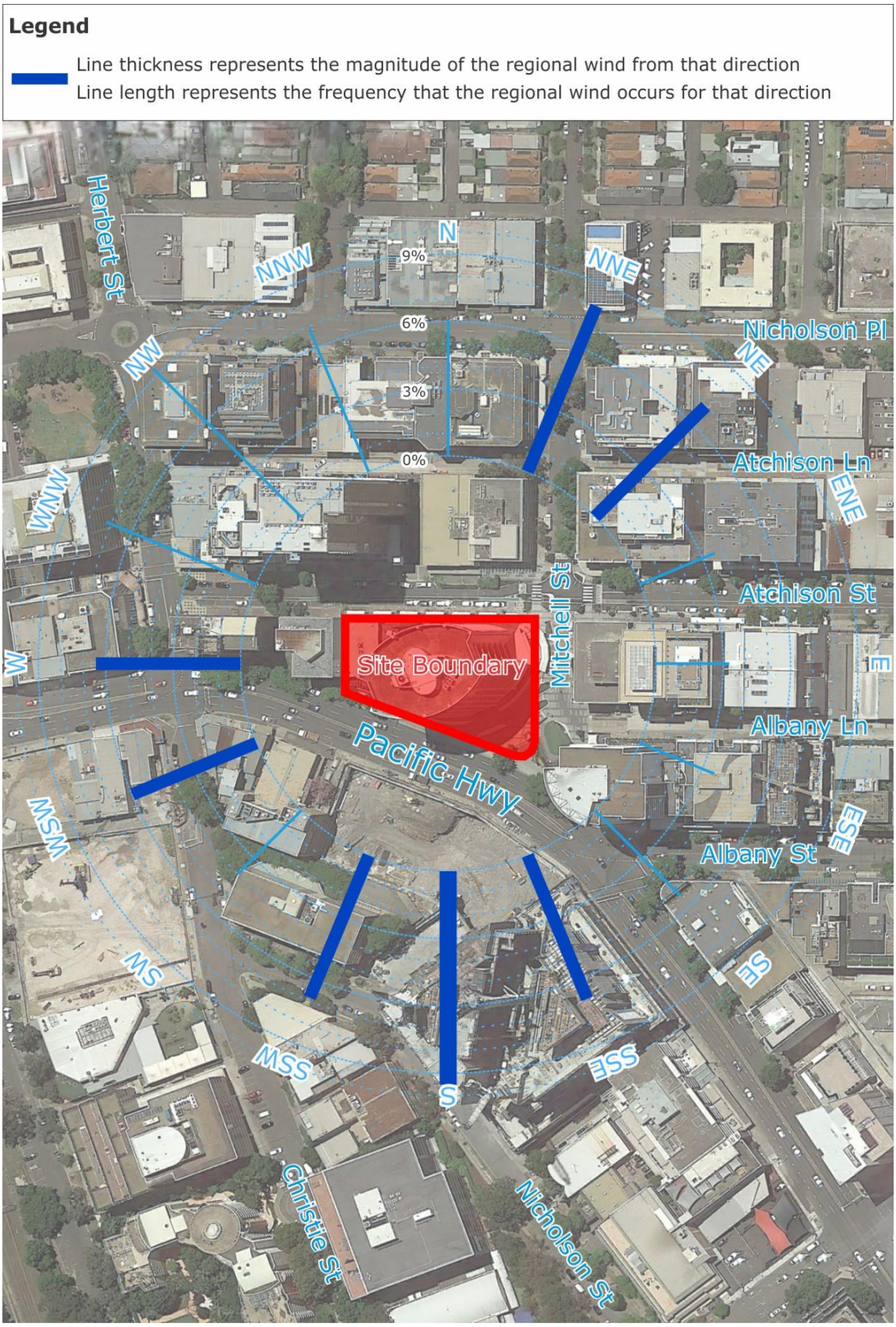

Figure 1: Aerial Image of the Site Location and Prevailing Wind Directions

3 REGIONAL WIND

The Sydney region is governed by three principal wind directions that can potentially affect the indicative concept proposal. 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.

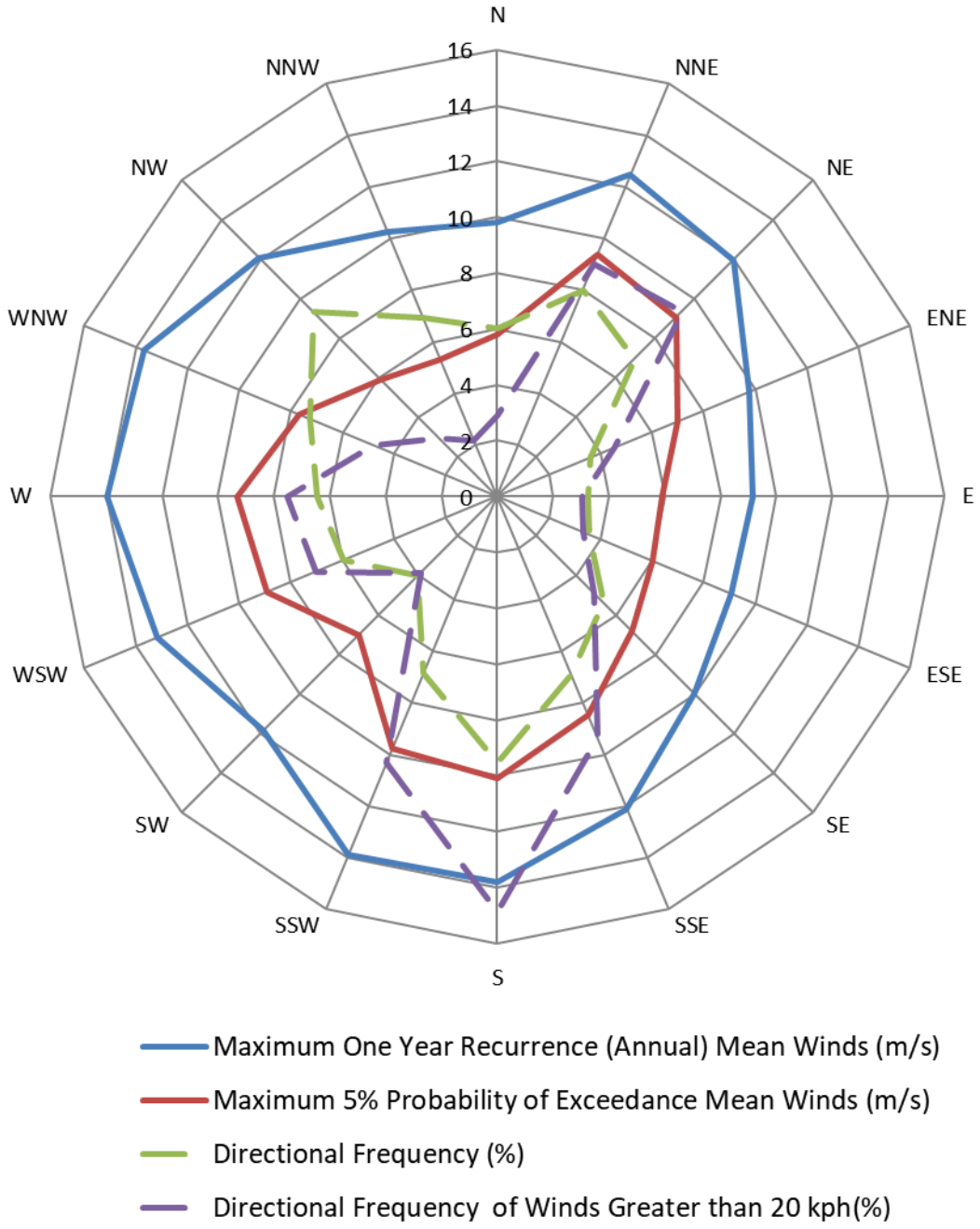

Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Sydney Region

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 reference massing building. 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.

- North Sydney Development Control Plan 2013 Criterion (13m/s with annual maximum gust)
  for all public outdoor trafficable areas on Ground Level.

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 development site is exposed to the prevailing north-easterly and westerly winds. The surrounding high-rise buildings directly adjacent to the west (619-621 Pacific Highway) and south (504 Pacific Highway and St Leonards Square) are expected to provide significant shielding to the direct prevailing southerly winds.

The surrounding high-rise developments, are also expected to cause funnelling of the prevailing westerly winds along Atchison Street and Pacific Highway adversely impacting the pedestrian footpaths, entrances and seating areas along the north of the development site.

Similarly, these high-rise buildings are also expected to direct the prevailing north-easterly winds to funnel through Atchison and Mitchell Streets impacting the entrance at the corner of Atchison and Mitchell Street, the pedestrian footpaths and proposed seating areas along Atchison and Mitchell Streets.

The prevailing southerly winds although shielded by the high-rise developments to the south are expected to flow from the Pacific Highway and around the west of St Leonards Square and to the north funnelling down along Mitchell Street accelerating along the east of the site.

The tower of the proposed envelope has a 3m setback from the podium along the northern, eastern and southern aspects and has a 12m setback from the podium along the western aspect. These setbacks are expected to assist in reducing the effect of downwash onto the ground plane from the prevailing winds are should be retained in the final design. Due to the high-rise building to the south, 504 Pacific Highway, the development is shielded from the prevailing southerly winds and any potential downwash affecting the Pacific Highway from the development itself is expected to be minimal. There is the potential for the prevailing winds to impact the adjacent 619-621 Pacific Highway tower to the west and downwash down into the trafficable areas at the southern perimeter of the site. This is expected to be an existing condition once the adjacent tower is constructed.

The following treatments strategies are expected to assist with the wind effects identified above, hence it is recommended to be considered at the detailed design stage of the development:

- Impermeable awning along the northern and eastern aspects of the podium façade.
- Localised baffle screens or densely foliating evergreen planting within and around seating areas along the Atchison and Mitchell Streets.
- Densely foliating evergreen planting along the Pacific Highway, Atchison and Mitchell Streets.

5.2 Elevated Outdoor Areas

The elevated outdoor area on the podium deck of the proposed envelope is exposed to the prevailing north-easterly and westerly winds. The proposed tower to the west is expected to provide some shielding to this area from the prevailing westerly winds. The prevailing north-easterly winds however are expected to directly impact the elevated outdoor areas to the north and east, side streaming along the tower's northern façade aspect to the western elevated outdoor area and funnelling through the gap towards the south-west. Similarly, the prevailing southerly winds are expected to flow around the adjacent tower to the south and accelerate through the area to the west funnelling through the gap between the development tower and the adjacent tower to the west.

Terrace areas located on the upper levels are exposed to the direct prevailing winds from the north-east, south and west. The adjacent tower to the west is expected to provide some shielding to these terrace areas and reduce the direct impact of the prevailing westerly winds. The prevailing north-easterly and southerly winds however are expected to directly impact these terrace areas and also accelerate around the north-western and south-western corners respectively into the terrace areas.

The following treatments strategies are expected to assist with the wind effects identified above, hence it is recommended to be considered at the detailed design stage of the development:

- Impermeable balustrades around the terrace areas.
- Impermeable canopy over the terrace areas.
- Densely foliating landscaping throughout the terrace areas.

6 CONCLUSION

This report assesses the local wind environment of the indicative concept design scheme prepared by Architectus to inform the Planning Proposal. This Pedestrian Wind Environment Statement demonstrates, that with the consideration of the recommendations outlined in this report, the site is capable of accommodating future development aligned with the proposed planning control changes and the applicable controls pertaining to wind within the North Sydney Development Control Plan 2013.

Due to the building massing size, exposure and height exceeding the stipulated 45m as per the North Sydney Development Control Plan 2013, a comprehensive assessment including wind tunnel testing of the pedestrian wind environment associated with a detailed development proposal will be required as part of a future development application for the site.

7 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.

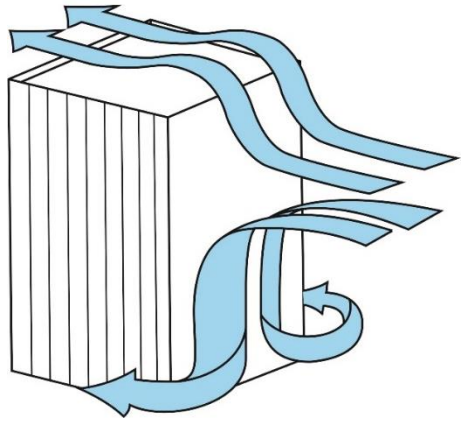

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

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.

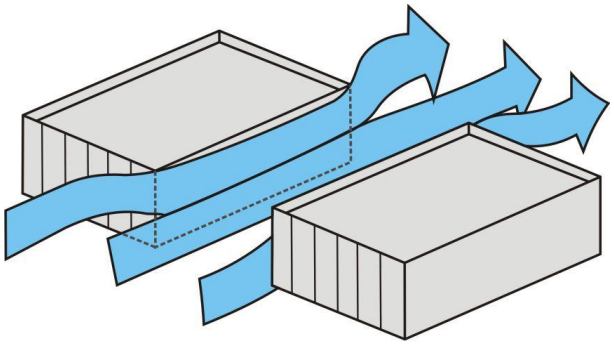

Figure A.2: Funnelling/Venturi Wind Effect

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.

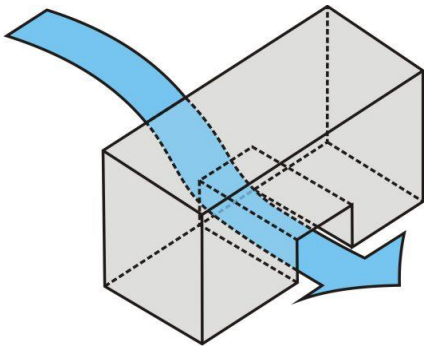

Figure A.3: Gap Wind Effect

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.

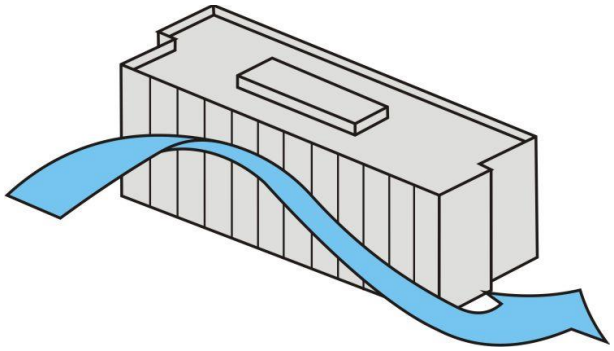

Figure A.4: Sidestream and Corner Wind Effect

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.