WINDTECH

PEDESTRIAN WIND ENVIRONMENT STATEMENT

STAGE 1, ONE CITY HILL, CANBERRA

WF869-01F02(REV1)- WS REPORT.DOCX

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Prepared for:

MPG Constructions Canberra Pty Ltd

Ground Floor, 50 Blackall Street, Barton, ACT 2600

DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the One City Hill development, located in Canberra, 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 northerly, north-westerly 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 23 June 2020). 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:

<u>Ground Level:</u>

- Retention of the proposed densely foliating trees (at least 3-5m high with 3-5m wide canopy) along the western and southern boundaries of the subject building.
- Retention of the proposed impermeable awning (extending out from Level 1 slab) along the western boundary of the subject building.
- Retention of the proposed impermeable canopy (extending out from Level 2 slab) above the western entry public foyer.

<u>Level 1:</u>

- Retention of the proposed densely foliating trees (at least 3-5m high with 3-5m wide canopy) along the eastern boundary of the subject building.
- Inclusion of additional densely foliating trees (at least 3-5m high with 3-5m wide canopy) along the eastern boundary of the subject building. We understand that that these additional trees have now been added to the landscape layout following the issuance of our initial report.
- Retention of the proposed densely foliating trees (at least 3-5m height with 3-5m wide canopy) within the proposed secure terrace.
- Retention of the proposed glass fence along the eastern boundary of the secure terrace (maximum porosity = 35%).

- Retention of the proposed impermeable awning (extending out from Level 2 slab) along the eastern boundary of the subject building.

- Inclusion of an impermeable awning structure above the footpath located along the northern boundary of the subject development.

Level 6:

- Inclusion of a 1.2m high impermeable balustrade along the western and northern boundaries of the north-east corner terrace.

- Inclusion of a 1.2m high impermeable balustrade along the western boundary of the south terrace.

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.

Wind tunnel testing will be undertaken to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

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 subject site located in Canberra (One City Hill development), and is bounded by Knowles Place to the west, Edinburgh Avenue to the south, Vernon Circle to the east and The Supreme Court of the ACT building to the north. For the purpose of this assessment, it is assumed that the site located to the west is vacant. Future plans for the lot involve the development of two office buildings, which are expected to be taller than the subject development. The timing of this future construction is not yet known.

A survey of the land topography indicates a gradual slope towards the south-west.

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 superimposed for each wind direction.

The existing site is vacant, with excavation works underway for the subject development. Prior to this, the site consisted of an open public carpark (ground only). The proposed development is a 7 storey high office development, consisting of two towers separated by a secure outdoor terrace on Level 1, aligned in the east-west orientation.

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 areas and pedestrian footpath
- The secure outdoor terrace between the north and south towers.
- Communal Open Spaces at Level 6 (north and south).

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

3 REGIONAL WIND

The Canberra region is governed by three principal wind directions that can potentially affect the subject development. These winds prevail from the north, north-west 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 Canberra Airport by the Bureau of Meteorology (recorded from 1939 to 2002). 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.

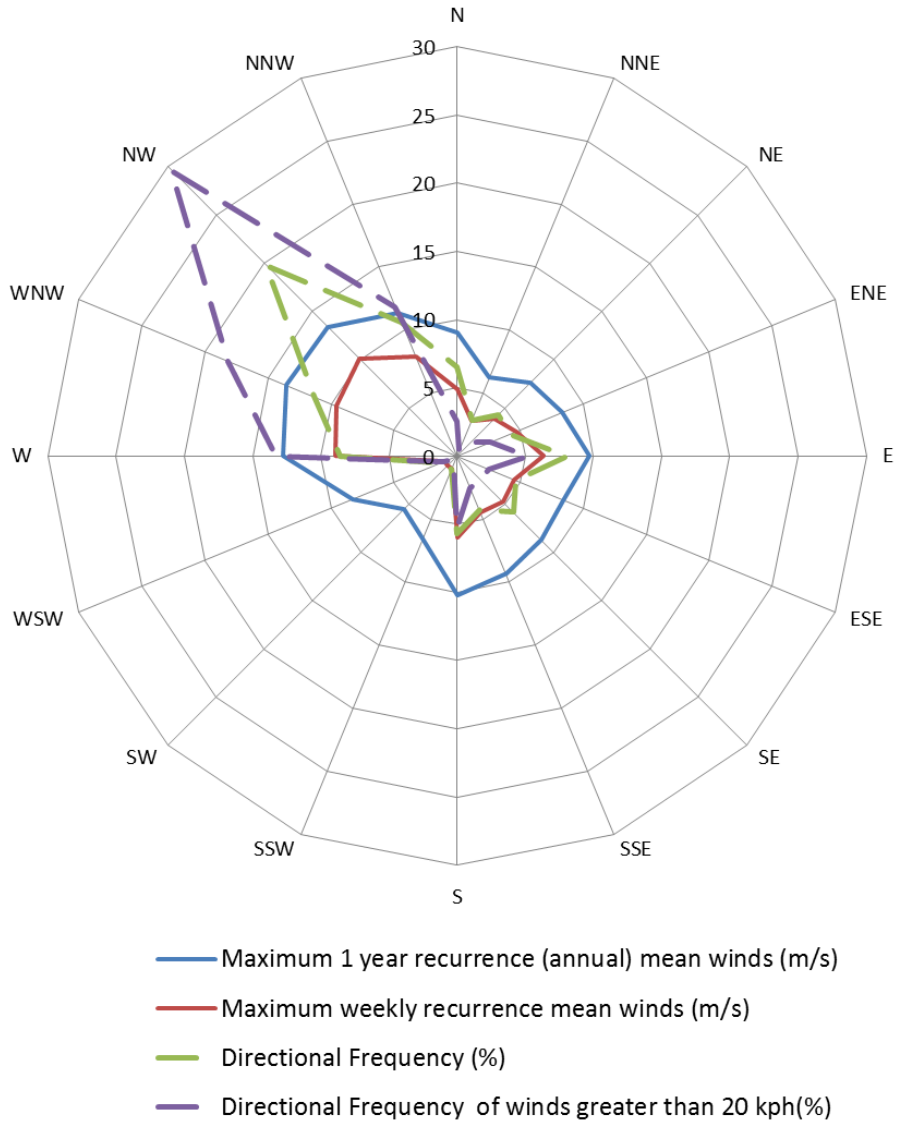

Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Canberra Region

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 (Includes Level 1)

The proposed development consists of several design features that are beneficial in regards to wind mitigation, such as the strategic inclusion of awnings, canopies and screens as well as the Ground Level form being recessed in relation to the upper levels. These features are expected to help reduce the impact of prevailing winds for the region on the pedestrians within and around the subject development. The impact of the prevailing westerly, north-westerly and northerly winds on the subject development is discussed below, with in principle mitigation measures recommended to ameliorate any potential undesirable wind conditions within and around the various pedestrian trafficable areas. For the purpose of this assessment, it is assumed that the site located to the west is vacant. Future plans for the lot involve the development of two office buildings, which are expected to be taller than the subject development. The timing of this future construction is not yet known.

The direct impact of the prevailing westerly and north-westerly winds on the western aspect of development may result in winds being down-washed off the western façade and being directed on to the footpath areas below. The westerly winds also have the potential for being funnelled through the east-west aligned separation between the north and south towers. However, the 2 storey high public foyer/atrium section located at the western end is expected to reduce the effect of wind funnelling at the Ground Level. This public foyer/atrium is also expected to partially shield the secure terrace located at Level 1 from direct westerly winds, although winds that travel above the atrium roof may reattach within the eastern half of the said secure terrace.

Furthermore, the westerly winds may have direct impact on the footpath and colonnade located along the southern perimeter of the southern end of the building, although the acceleration of winds around the south-west corner is expected to be reduced by curved nature of this corner.

Direct impact of northerly winds on the northern boundary at the Ground Level is expected to be minimal due to the shielding provided by the existing Supreme Court of the ACT building located to the north. While the alignment of the eastern boundary of the subject development aligns with the prevailing northerly winds, the said Supreme Court of the ACT building bounding Vernon Circle is likely to prevent direct northerly winds from side streaming along the eastern boundary. However the top half of the subject building is exposed to northerly winds, which may be down washed into the footpath located along the northern boundary. The northerly winds may also side stream along the northern façade, wrap around the north-east corner and downwash onto the pedestrian footpath areas located around the north-east corner.

The following treatment measures are recommended to be included in the design to ameliorate the above discussed undesirable effects of the prevailing winds on the subject site. These treatments are illustrated in Figures 3 and 4.

Ground Level (Figure 3):

- Retention of the proposed densely foliating trees (at least 3-5m high with 3-5m wide canopy) along the western and southern boundaries of the subject building.
- Retention of the proposed impermeable awning (extending out from Level 1 slab) along the western boundary of the subject building.
- Retention of the proposed impermeable canopy (extending out from Level 2 slab) above the western entry public foyer.

Level 1 (Figure 4):

- Retention of the proposed densely foliating trees (at least 3-5m high with 3-5m wide canopy) along the eastern boundary of the subject building.
- Inclusion of additional densely foliating trees (at least 3-5m high with 3-5m wide canopy) along the eastern boundary of the subject building. We understand that that these additional trees have now been added to the landscape layout following the issuance our initial report.
- Retention of the proposed densely foliating trees (at least 3-5m height with 3-5m wide canopy) within the proposed secure terrace.
- Retention of the proposed glass fence along the eastern boundary of the secure terrace (maximum porosity = 35%).
- Retention of the proposed impermeable awning (extending out from Level 2 slab) along the eastern boundary of the subject building.
- Retention of the louvered screen (porous) façade along the northern boundary of the building between Level 1 and Level 2.

5.2 Level 2 Secure Terrace

The secure terrace located at Level 2 of the northern building is expected to be suitable for its intended use due to this terrace being recessed into the northern façade.

5.3 Level 6 Terraces

Due to the relative height and exposure of the upper levels of the subject development, the north-east corner terrace on the north tower at Level 6 may be impacted directly by the prevailing north-westerly and northerly winds. The south terrace on the south tower at Level 6 is likely to receive direct westerly winds, which may also accelerate around the south-west corner and cause undesirable wind effects for patrons using this terrace.

The following treatment measures are recommended to be included in the design to ameliorate the above discussed undesirable effects of the prevailing winds within the Level 6 terraces. These treatments are illustrated in Figure 5.

- Inclusion of a 1.2m high impermeable balustrade along the western and northern boundaries of the north-east corner terrace.
- Inclusion of a 1.2m high impermeable balustrade along the western boundary of the south terrace.

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.

Wind tunnel testing will be undertaken to quantitatively assess the wind conditions and to optimise the size and extent of the treatments required.

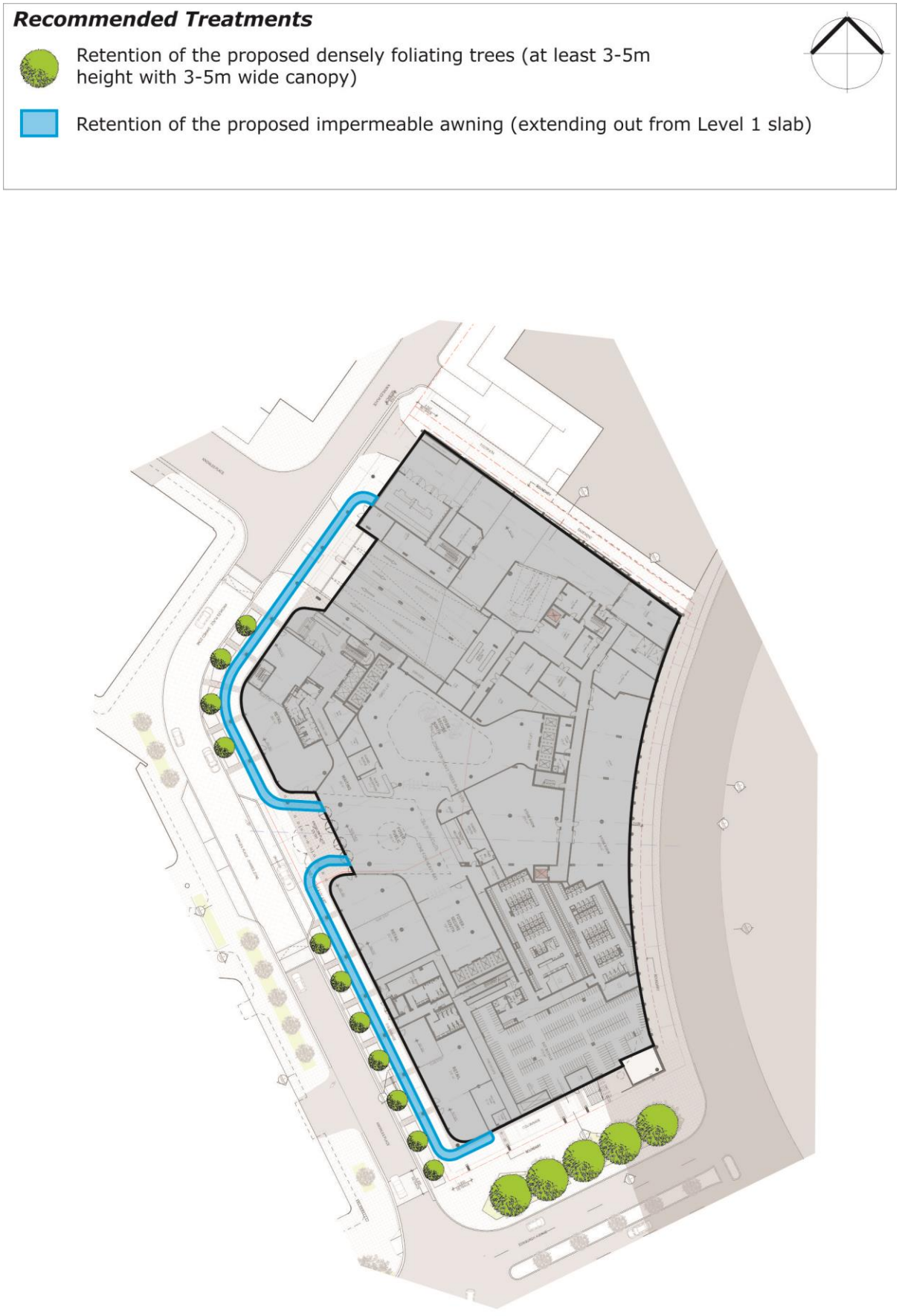

Figure 3: Recommended Treatment (Ground Level)

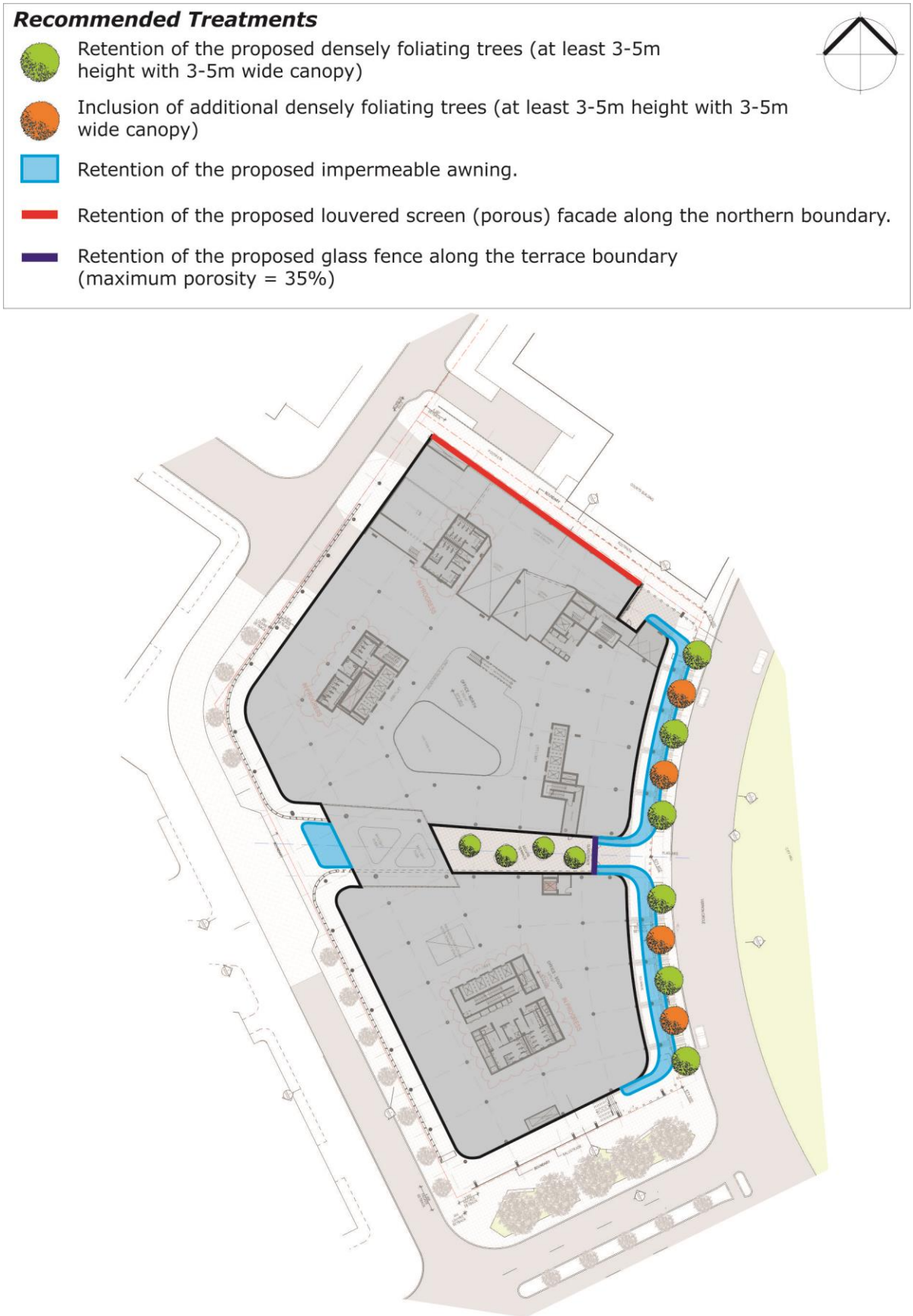

Figure 4: Recommended Treatment (Level 1)

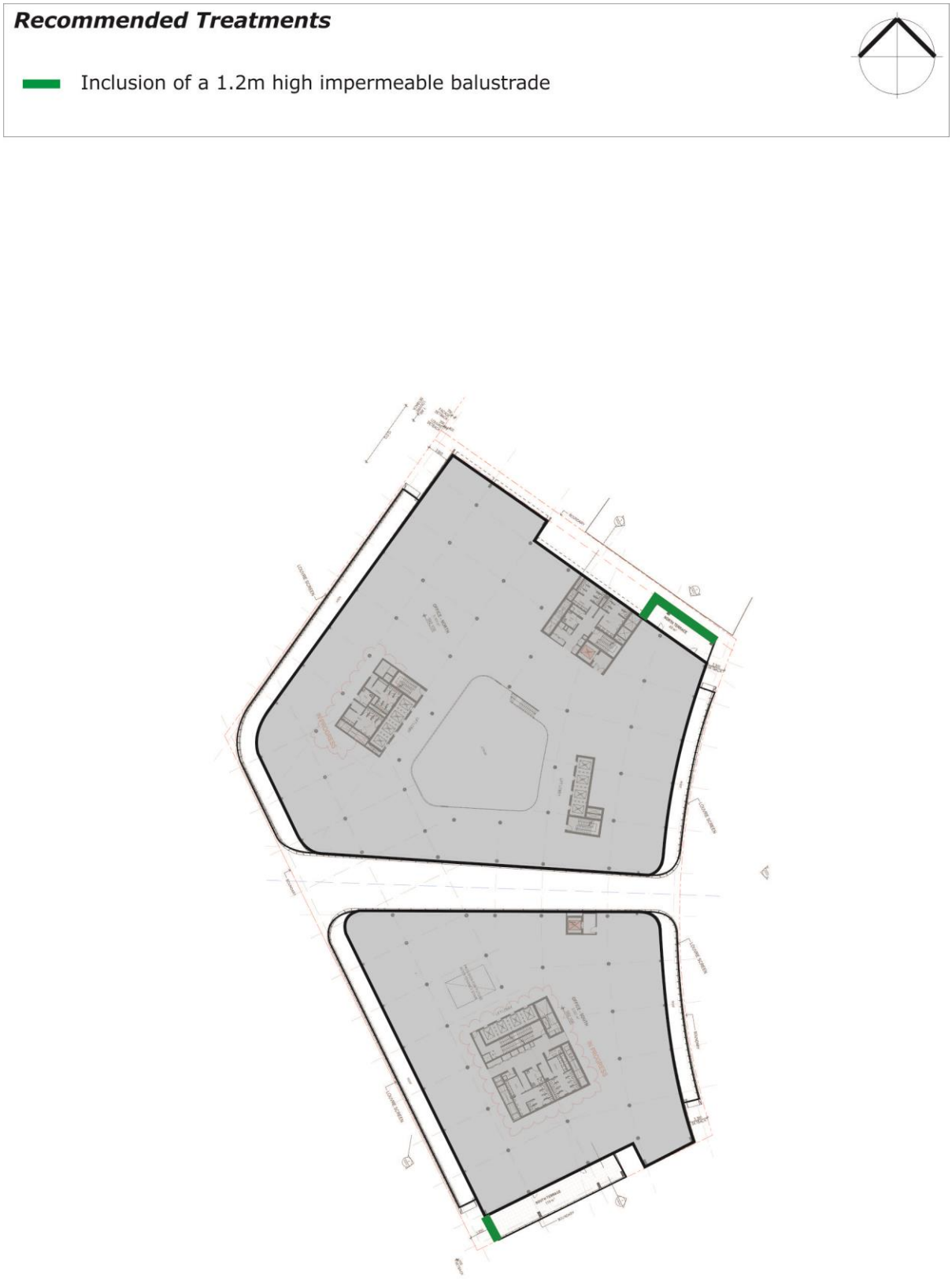

Figure 5: Recommended Treatment (Level 6)

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.

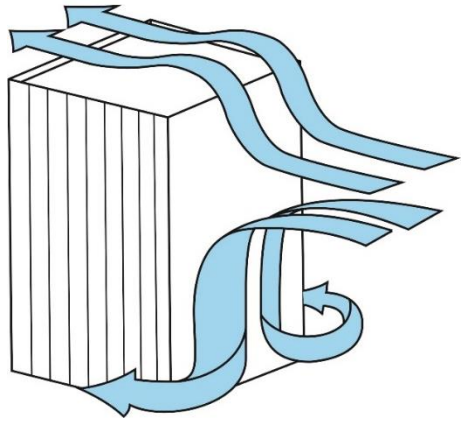

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

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.

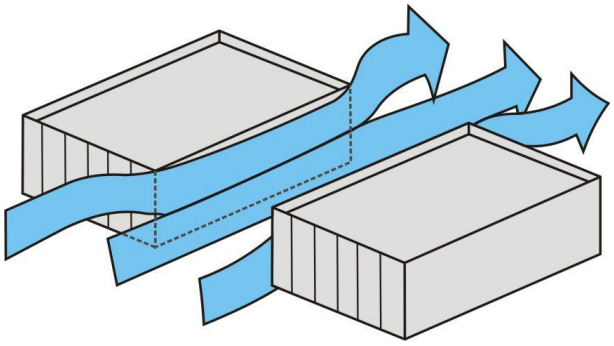

Figure A.2: Funnelling/Venturi Wind Effect

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.

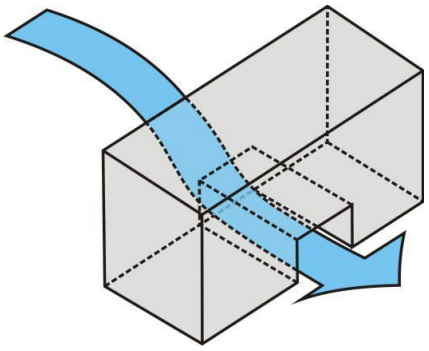

Figure A.3: Gap Wind Effect

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.

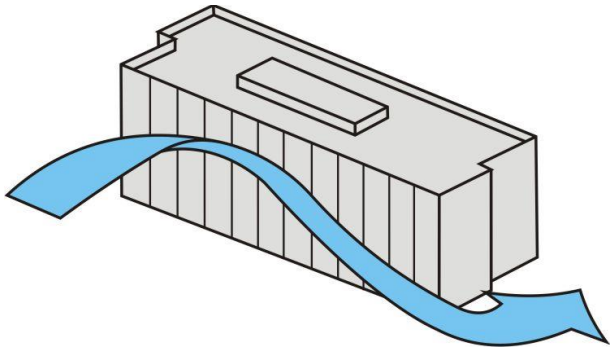

Figure A.4: Sidestream and Corner Wind Effect

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.