WINDTECH

PEDESTRIAN WIND ENVIRONMENT STATEMENT

153-157 WALKER STREET, NORTH SYDNEY

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Prepared for:

Strata Plan 50411

153 Walkers Street,
North Sydney, NSW 2060

DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report presents an opinion on the likely impact of the proposed 153-157 Walker Street development, located in North Sydney, 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 December 2, 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 areas and pedestrian footpaths:

- Dense tree planting, capable of growing up to 4m in height, to be included in the following locations along the Ground Level plane:
    - South-western corner.
    - South-eastern corner
    - Western end of the through-site link, adjacent to the proposed seating areas.
- Localised impermeable screening to be placed adjacent to the seating areas. Screens are to be connected to the façade and placed in a north-south direction. Structural elements may be used in lieu of screening.

Level 05 terrace area (to be included in the design of the development only if pedestrian trafficable):

- Tall, impermeable end screens.
- An impermeable awning to be placed along the Level 06 floor slab and extend the entire length of the terrace.

Rooftop terraces:

- Retention of dense planter box/planting design with a recommended minimum effective height of 1.5m.

- Inclusion of full-height impermeable end screens. The end screens can be designed such that they match the slope of the sun access plane.

- Inclusion of full-height impermeable dividers at the centre of each of the rooftop terraces. The dividers can be designed such that they match the slope of the sun access plane.

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, wind tunnel testing is recommended to be undertaken at a later design stage to assess the wind conditions within and around the subject development. This will provide a quantitative analysis of the wind conditions and determine the extent of the abovementioned wind mitigation treatments, in order to ensure suitable wind conditions are achieved for the various outdoor trafficable areas within and around the subject development.

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 153-157 Walker Street, North Sydney and is bounded by Walker Street to the west, Little Walker Street to the east and mid-rise towers to the north and south. The development is located near the eastern boundary of the North Sydney central business district. Buildings to the west of the site consist of mid to high-rise towers whereas to the east lies residential housing, apartments, and the Warringah Freeway/Bradfield Highway.

The existing site consists of 16-storey tall commercial building. The proposed development is 45 storeys high. The tower primarily consists of commercial tenancies with retail and lobby areas along the street levels. The tower is predominantly rectangular in planform with sloped sun access plane at the rooftop levels.

A survey of the land topography indicates a gradual slope towards 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 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 footpaths.
- Level 05 terrace area.
- Rooftop terraces.

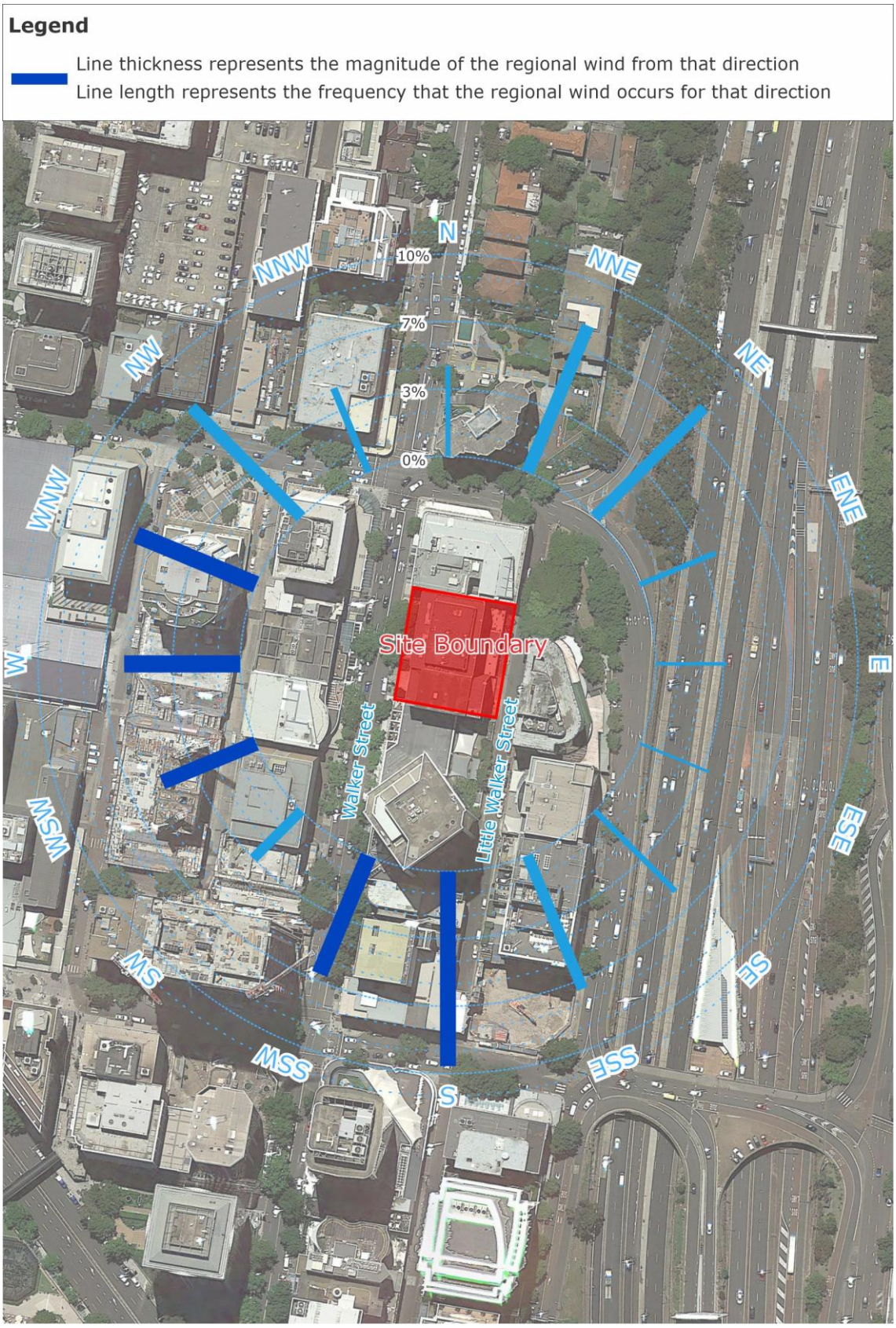

Figure 1: Aerial Image of the Site Location and Prevailing Wind Directions

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.

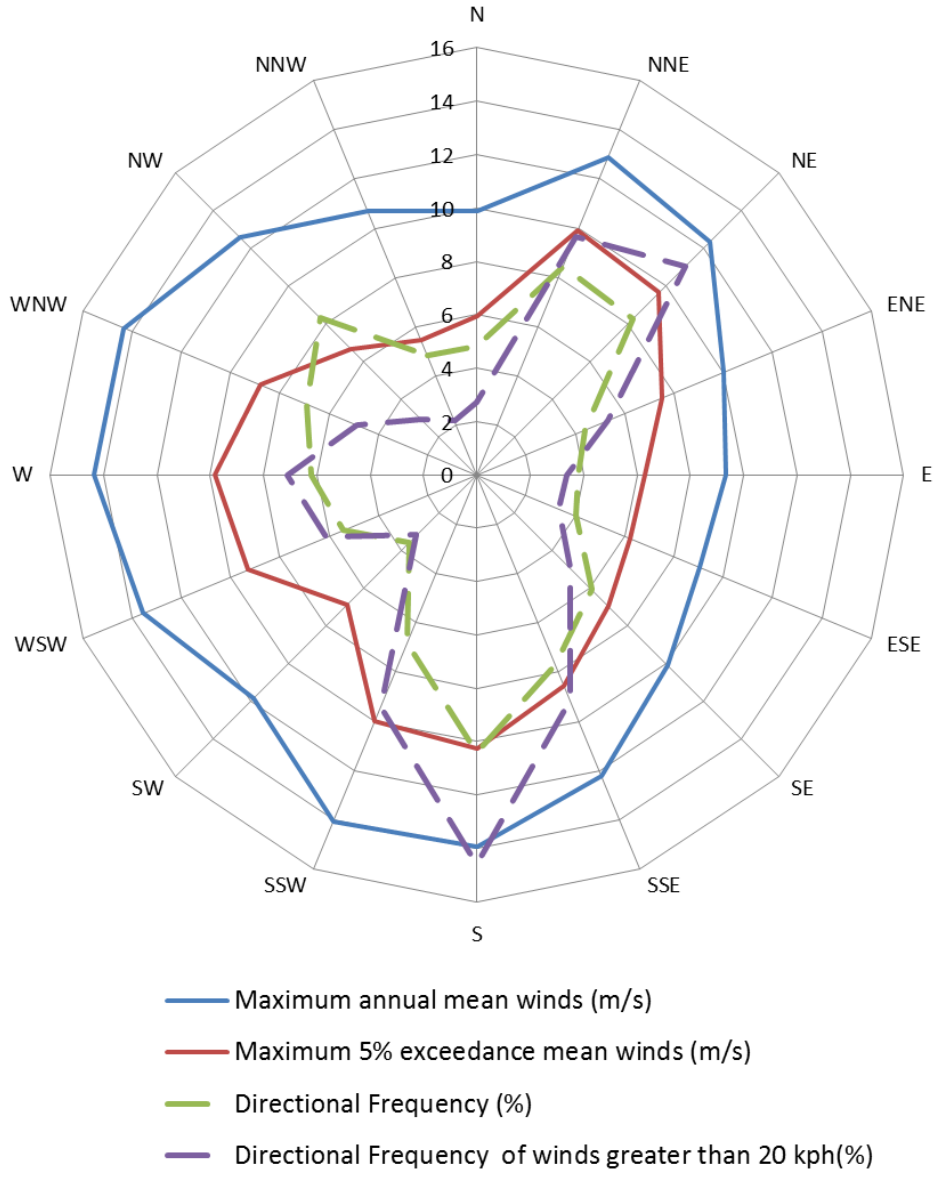

Figure 2: Directional Annual and 5% Exceedance Hourly Mean Wind Speeds (referenced to 10m height in standard open terrain), and Frequencies of Occurrence, for the Sydney Region

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 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 24m/s for the annual maximum gust.

5.1 Ground Level Areas and Pedestrian Footpaths

The pedestrian footpath area along the Little Walker Street frontage is exposed to the prevailing north-easterly wind. It is not expected that downwashing will occur due to the alignment of the development with the prevailing wind as well as the proposed building set-back at the podium levels.

Dense tree planting is located upstream of the subject development site and is expected to reduce the impact of low-level wind side-streaming effects from the north-east by providing direct shielding to the site. It is expected the direct shielding provided by the tree planting will only apply to the northern portion of Little Walker Street frontage. It is likely that the south-eastern corner of the development, the eastern entrance of the through site link, will experience adverse wind conditions in the form of corner accelerated flow. It is recommended that dense tree planting be included along the eastern aspect slightly north of the through-site link entrance. In addition, any proposed tree planting is to be retained. Planting should be densely foliating with interlocking canopies and at least 4m high (refer to Figure 3a).

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The pedestrian footpath area along the Walker Street frontage is exposed to the prevailing westerly wind. The Level 05 tower set back is expected to reduce the impact of wind downwashing from the west. Corner accelerated flow is expected along the south-western corner of the development. It is recommended that dense tree planting be included along this corner (refer to Figure 3a).

The MLC building to the south of the site is likely to provide partial shielding to the subject development from prevailing southerly winds. This is expected to reduce the impact of wind downwashing to an extent. Some downwashing may still occur and thus, it is recommended that tree planting be included along the through-site, adjacent to the proposed seating areas.

Wind funnelling is expected from the south and north-east prevailing winds. The Ground Level plane is generally shielded from each of these directions. As a results, it is likely that the impact of wind funnelling will be minor, and the area will be suitable for pedestrian circulation. It is expected that seated areas will require additional protection and thus, it is recommended that localised impermeable screening be included along the seated areas. Screens are to be connected to the façade and placed in a north-south direction. Structural elements may be used in lieu of screening (refer to Figure 3a).

5.2 Level 05 Terrace Area

The Level 05 communal terrace is located along the western aspect of the development and runs along the entire length of the tower. It is likely that this terrace will experience adverse wind conditions in the form of wind downwashing from the west and corner accelerated flow from the south. If the area is trafficable, it is recommended that the following wind mitigation measures be included in the design of the terrace area:

- Tall impermeable end screens, at least 2m in height (refer to Figure 3b).
- An impermeable awning to be placed along the Level 06 floor slab and extend the entire length of the terrace (refer to Figure 3b).

5.3 Rooftop Terraces

The rooftop terraces are located along the southern aspect of the development and run across the entire length of the terrace. The terraces are likely exposed to corner accelerated flow from the north-east and west. It is recommended that full-height impermeable end screens be included at each of the proposed rooftop terraces. The screening can be designed such that they match the slope of the sun access plane (refer to Figure 3c).

It is expected that wind side-streaming will occur at the terraces along the south. Planter box planting is proposed along the southern boundary of the terrace and is expected to reduce wind side-streaming effects from the south. This design feature should be retained. It is also recommended that the effective height of the planter box/planting be at least 1.5m. Due to the large overall length of the terrace area, it is likely that additional measure will need to be introduced to mitigate the wind side-streaming from the south. It is recommended that a full-height impermeable divider screens be included at the centre of the terrace area for each of the proposed rooftop terraces. The dividers can be designed such that they match the slope of the sun access plane (refer to Figure 3c).

Wind tunnel testing is recommended to be undertaken at a later design stage to assess the wind conditions within and around the subject development. This will provide a quantitative analysis of the wind conditions and determine the extent of the abovementioned wind mitigation treatments, in order to ensure suitable wind conditions are achieved for the various outdoor trafficable areas within and around the subject development.

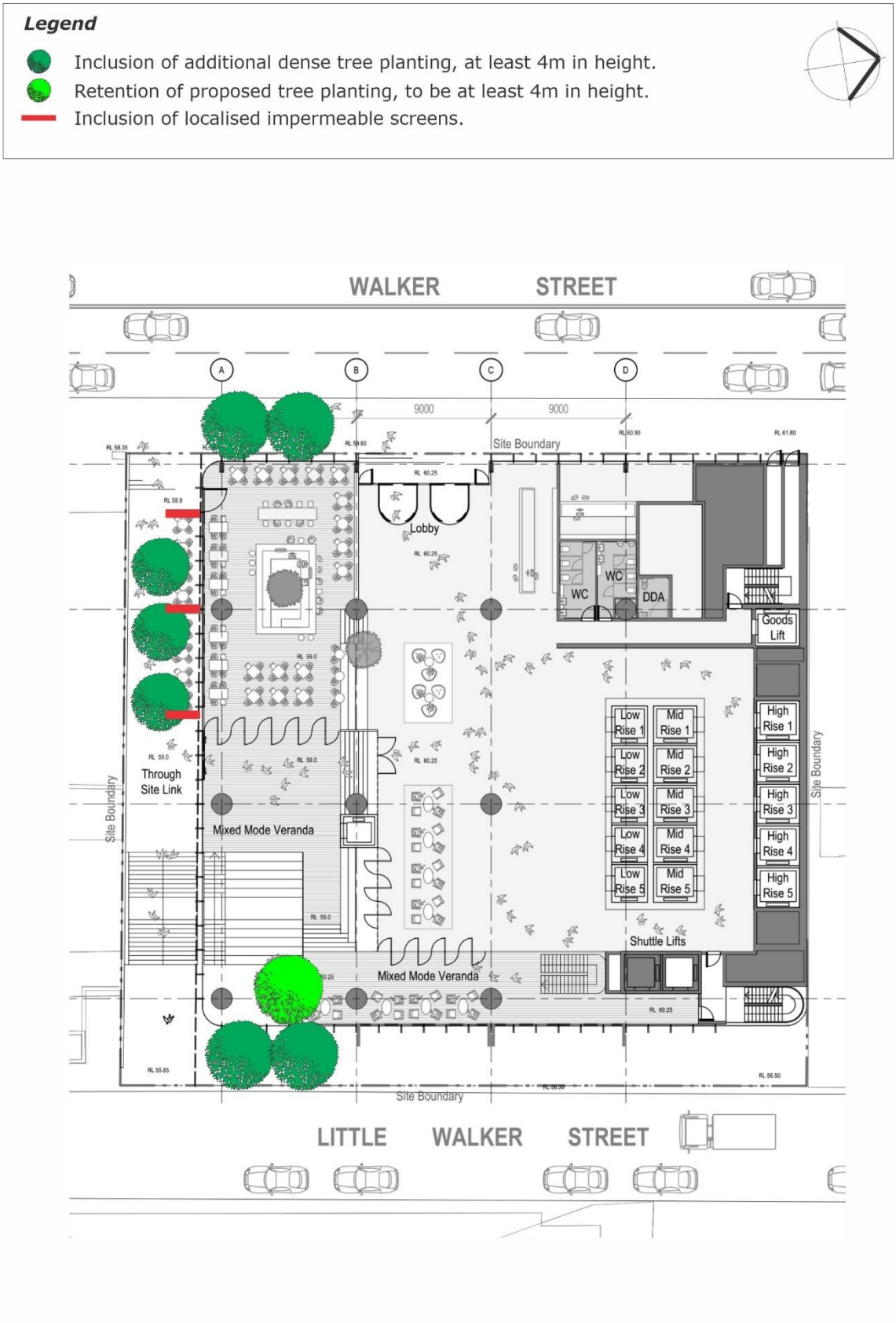

Figure 3a: Recommended Treatment for the Ground Level

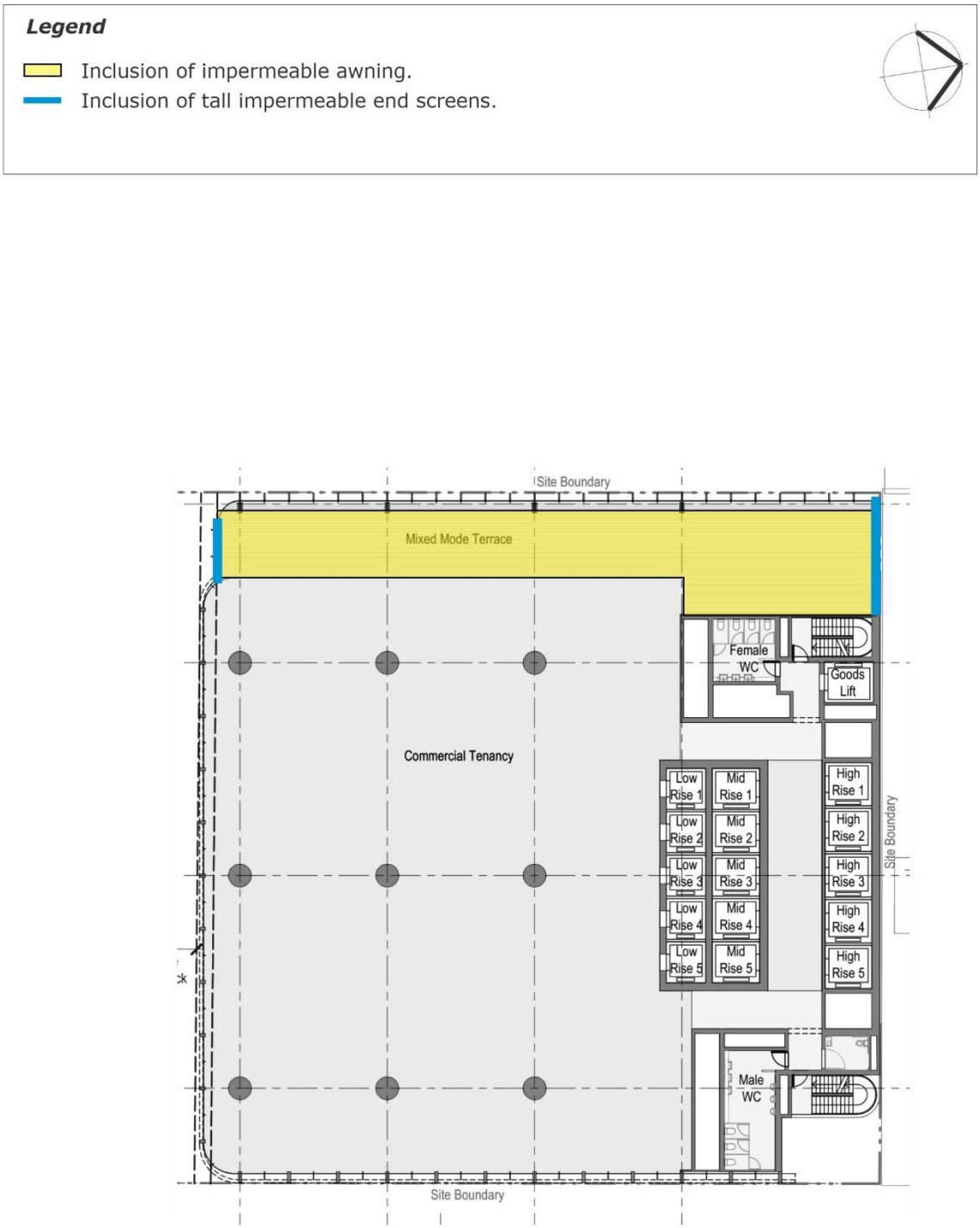

Figure 3b: Recommended Treatment for the Level 05 Terrace Area

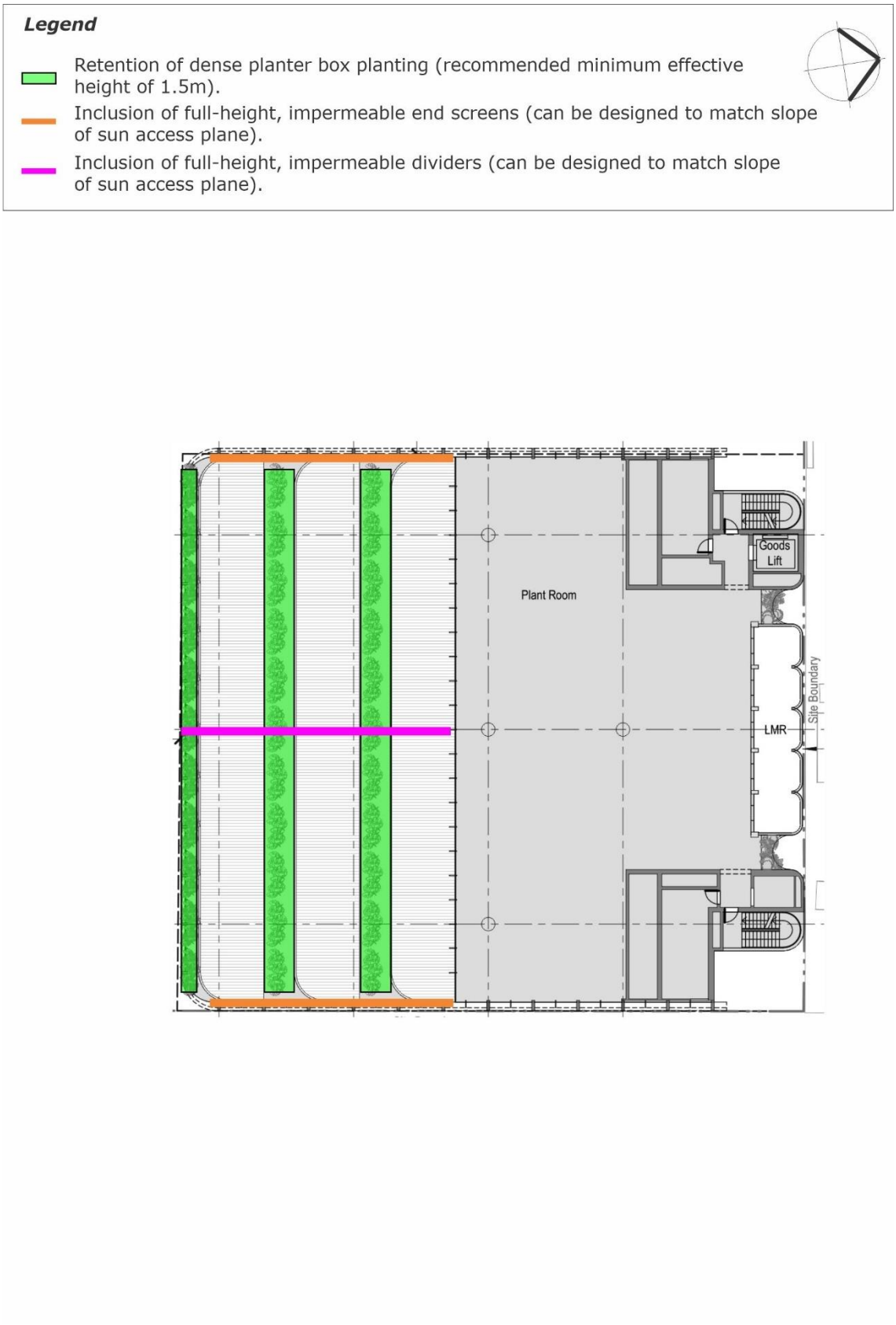

Figure 3c: Recommended Treatment for the Rooftop Terraces

6 REFERENCES

Davenport, A.G., 1972, "An approach to human comfort criteria for environmental conditions". Colloquium on Building Climatology, Stockholm.

Lawson, T.V., 1973, "The wind environment of buildings: a logical approach to the establishment of criteria". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1975, "The determination of the wind environment of a building complex before construction". Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1980, "Wind Effects on Buildings - Volume 1, Design Applications". Applied Science Publishers Ltd, Ripple Road, Barking, Essex, England.

Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions". *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 3, pp241-249.

Penwarden, A.D. (1973). "Acceptable Wind Speeds in Towns", Building Science, vol. 8: pp259–267.

Penwarden, A.D., Wise A.F.E., 1975, "Wind Environment Around Buildings". Building Research Establishment Report, London.

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.

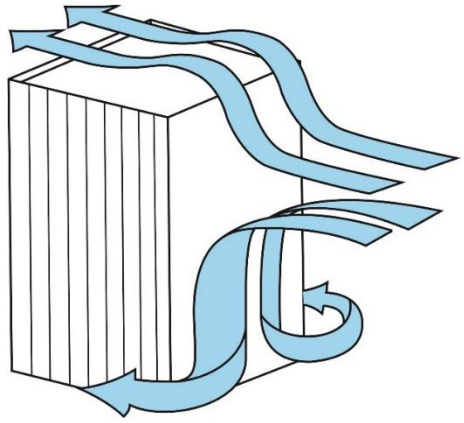

Figure A.1: Downwash Leading to Corner Wind Effect, and Upwash Effects

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.

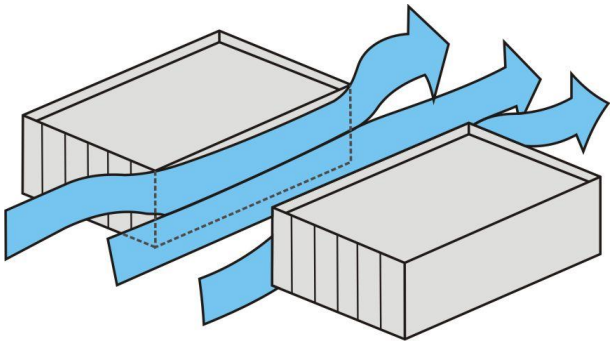

Figure A.2: Funnelling/Venturi Wind Effect

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.

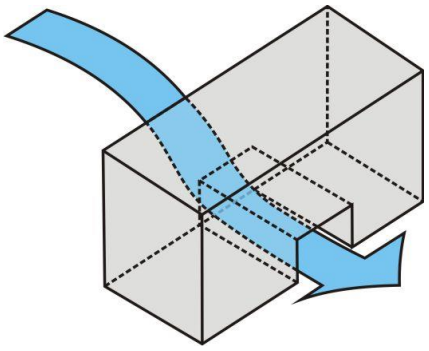

Figure A.3: Gap Wind Effect

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.

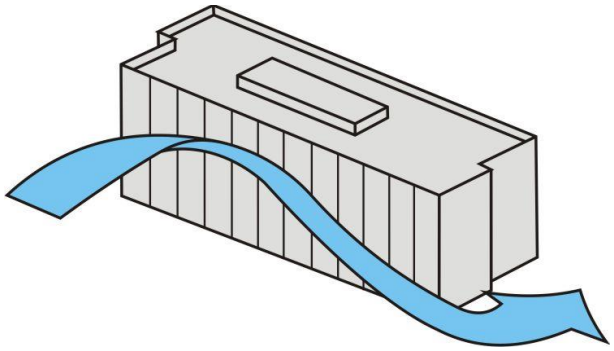

Figure A.4: Sidestream and Corner Wind Effect

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.