849, 853, and 859 Pacific Highway and 2 and 8 Wilson Street, Chatswood

Environmental Wind Tunnel Study

BB Wilson Property Pty Ltd
Billbergia
Locked Bag 1400
Meadowbank NSW 2114

Prepared by:

SLR Consulting Australia

SLR Project No.: 610.031413.00001

Revision: R01-v1.3

12 March 2026

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
R01-v1.3	12 March 2026	Dr Farzin Ghanadi	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy
	Click to enter a date.			
	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with BB Wilson Property Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Basis of Report i

1.0 INTRODUCTION 4

1.1 Location and Context of the Development Site 4

1.2 Development Description 5

1.3 Surrounding Built Environment 7

2.0 SYDNEY'S WIND CLIMATE 8

2.1 Annual and Seasonal Variations 8

2.2 Wind Exposure at the Site – the "Local"' Wind Environment 8

3.0 DESIGN WIND SPEEDS 9

3.1 Reference Height Annual Mean Wind Speeds 9

4.0 WIND ACCEPTABILITY CRITERIA 10

4.1 Practical Application of Wind Criteria 11

4.2 Significance Criteria – Comfort 12

4.3 Comments on the Application of the Acceptability Criteria 13

5.0 WIND TUNNEL TEST METHODOLOGY 15

5.1 Simulation of Natural Wind 15

5.2 Proposed Development Models and Proximity Model 16

5.3 Data Processing 17

5.4 Test Method – Sensor Locations 17

5.5 Sample Test Result 22

5.6 Lawson (2001) and Melbourne (1978) Calculation Methodology 23

5.7 Wind Tunnel Test Data - All Scenarios 23

6.0 TEST RESULTS 23

6.1 Predicted Melbourne (1978) Safety Criteria Levels 23

6.2 Predicted Lawson Comfort Criteria Levels 23

6.2.1 Impact of the Proposed Development on Existing Wind Conditions 28

6.2.2 Impact of the Proposed Development Relative to Target Comfort Levels 28

7.0 WIND MITIGATION OPTIONS 30

7.1 Windbreaks Suited to Mitigating Vertical/Oblique Winds 30

7.2 Windbreaks Suited to Mitigating Horizontal Winds 30

7.3 Horizontal Windbreak Examples 31

7.4 Vertical Windbreak Examples 32

8.0 MITIGATION AND TREATMENT RECOMMENDATIONS 33

8.1 Wind Mitigation Recommendations 33

9.0 Conclusion 39

10.0 Feedback 42

Tables in Text

Table 1 Standard Local Government Wind Acceptability Criteria ... 10
Table 2 Lawson Wind Acceptability Criteria – COMFORT ... 11
Table 3 Melbourne (1978) Wind Acceptability Criteria – SAFETY ... 12
Table 4 Significance Criteria Related to Lawson Acceptability Criteria ... 12
Table 5 Assessment of Impacts – Wind Tunnel Predicted Comfort Level of “Baseline” and “Proposed” Scenarios Relative to Target Comfort Level ... 29

Figures in Text

Figure 1 Aerial View of Development Site ... 4
Figure 2 Elevation Views of the Proposed Development ... 6
Figure 3 Project Site Surrounds ... 7
Figure 4 Annual Wind Roses for Sydney (KS) Airport and Bankstown Airport (BoM Data) ... 8
Figure 5 Reference Height (200 m) Annual Recurrence Mean Wind Speed at Project Site ... 9
Figure 6 Wind Tunnel Test Profiles of Mean Wind and Turbulence Intensity ... 15
Figure 7 1:400 Scale Model of the Proposed Development (View from Southwest) ... 16
Figure 8 Sensor Locations on ground level - Baseline Scenario ... 18
Figure 9 Sensor Locations on ground level - Proposed Scenario ... 18
Figure 10 Sensor Locations on level 1- Proposed Scenario ... 19
Figure 11 Sensor Locations on level 2- Proposed Scenario ... 19
Figure 12 Sensor Locations on level 34 - Proposed Scenario ... 20
Figure 13 Sensor Locations on level 38 - Proposed Scenario ... 20
Figure 14 Sensor Locations on level 57 - Proposed Scenario ... 21
Figure 15 Sensor Locations on level 61- Proposed Scenario ... 21
Figure 16 Sample Polar Plot Test Result – Location 7 ... 22
Figure 17 Predicted Lawson Comfort Levels - “Baseline” Scenario – Ground Level ... 24
Figure 18 Predicted Lawson Comfort Levels - “Proposed” Scenario – Ground Level ... 24
Figure 19 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 1 ... 25
Figure 20 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 2 ... 25
Figure 21 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 34 ... 26
Figure 22 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 38 ... 26
Figure 23 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 57 ... 27
Figure 24 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 61 ... 27
Figure 25 Common Built Environment Windflow Patterns ... 30
Figure 26 Horizontal Windbreak Options ... 31
Figure 27 Vertical Windbreak Options ... 32

Figure 28 Wind Mitigation for the Development – Ground level 35
Figure 29 Wind Mitigation for the Development – Level 1 36
Figure 30 Wind Mitigation for the Development – Level 2 36
Figure 31 Wind Mitigation for the Development – Level 34 37
Figure 32 Wind Mitigation for the Development – Level 38 37
Figure 33 Wind Mitigation for the Development – Level 57 38
Figure 34 Wind Mitigation for the Development – Level 61 38

Appendices

Appendix A Seasonal Wind Roses for Bureau of Meteorology Met Stations at Sydney (Kingsford Smith) Airport and Bankstown Airport

Appendix B Wind Tunnel Test Data (Polar Plots) – BASELINE Scenario

Appendix C Wind Tunnel Test Data (Polar Plots) – PROPOSED Scenario

1.0 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged by BB Wilson Property Pty Ltd to perform a quantitative wind assessment of the proposed development at 849, 853, and 859 Pacific Highway and 2 and 8 Wilson Street, Chatswood, via an Environmental Wind Tunnel Study. Following an initial wind tunnel tests conducted in December 2023 and November 2024, the design has now been revised to increase the height. Consequently, an additional wind tunnel test has been conducted to evaluate the impact of these changes.

The assessment has been carried out via a Discrete Sensor Environmental Wind Tunnel Study whereby wind tunnel measurements were made to investigate wind conditions throughout and around the proposed development (simulated via a 1:400 scale model) at areas to be used by visitors and occupants of the development itself.

1.1 Location and Context of the Development Site

The proposed mixed-use development consists of two towers of 60 and 56 storeys, each incorporating roof terraces. The site is situated between Pacific Hwy to the west, Wilson Street to the north/northeast, Railway to the east, and O'Brien Street to the south -refer **Figure 1**.

Figure 1 Aerial View of Development Site

Image: Courtesy Nearmap, September 2025

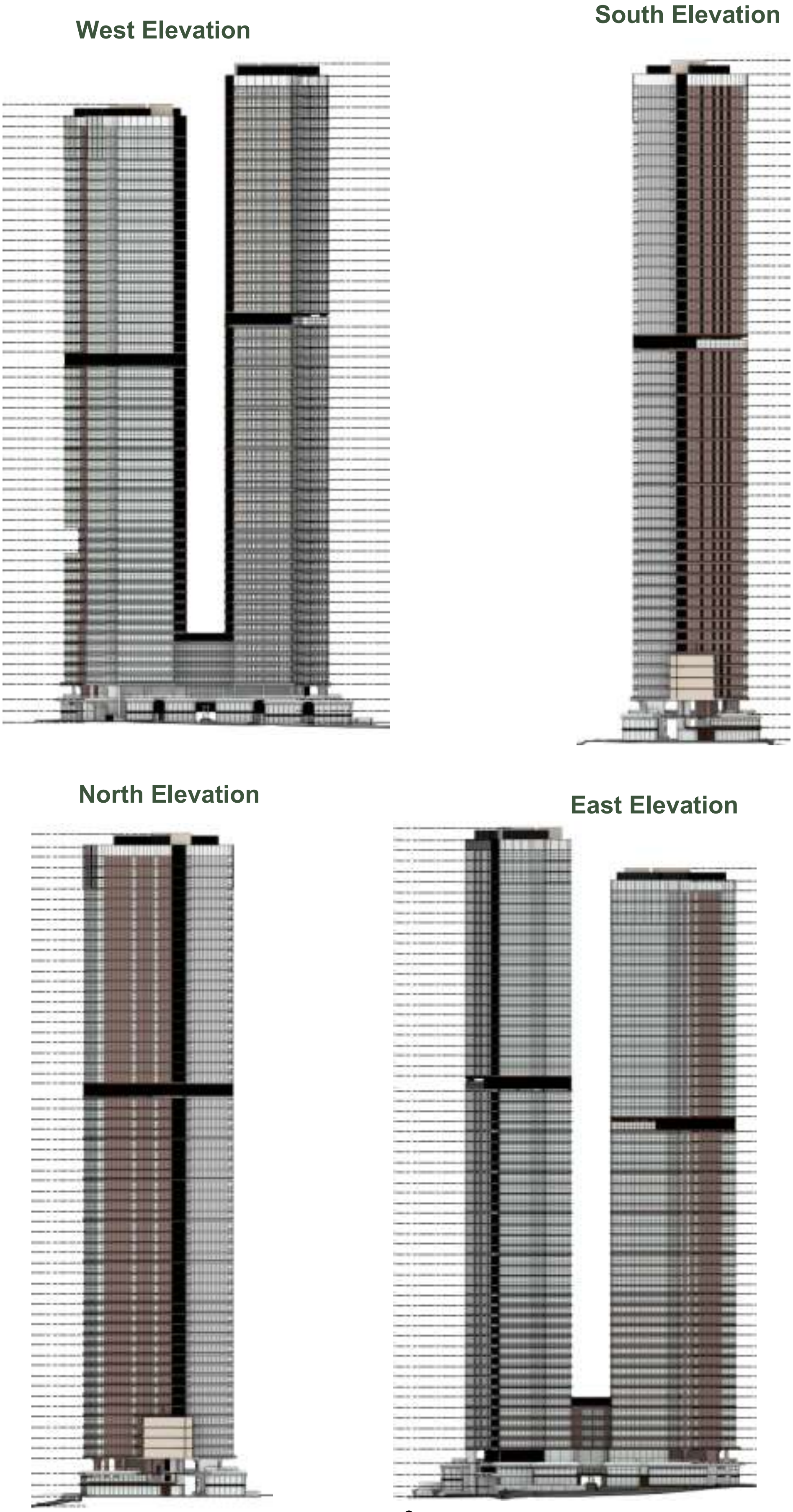
1.2 Development Description

From the plans provided, the proposed development comprises the following components:

- A mixed-use development consisting of two residential towers (A & B) of approximately 60 and 55 storeys, each incorporating roof terraces and upper-level communal areas.
- Residential accommodation distributed within both towers.
- Basement levels (9 storeys) providing parking and building services, with vehicular access from O'Brien Street.
- Podium-level uses, including:
  - Retail and commercial tenancies
  - A childcare centre
- Communal open space areas, including:
  - A shared communal open space and pool area at Level 2, serving Towers A and B
  - Additional communal terraces at Level 34 (Tower B), Level 38 (Tower A), Level 56 (Tower B) and Level 61 rooftop (Tower A).
- Public domain works, comprising landscaping, street tree planting, and publicly accessible open spaces surrounding the development.

Representative floor plans are shown in in **Figure 2.**

Figure 2 Elevation Views of the Proposed Development



1.3 Surrounding Built Environment

In terms of the surrounding terrain and topography (refer to **Figure 3**):

- The railway is located immediately to the east of the site.
- Several high-rise residential buildings are situated in the south and southeast sides of the site.
- Low-rise developments are present on the west and north sides of the proposed development.
- Moving northwest, you'll find densely forested areas within Blue Gum Park.
- The terrain on the western side of the site undergoes significant elevation changes, impacting the nearby westerly wind patterns and speeds.

Figure 3 Project Site Surrounds

2.0 SYDNEY'S WIND CLIMATE

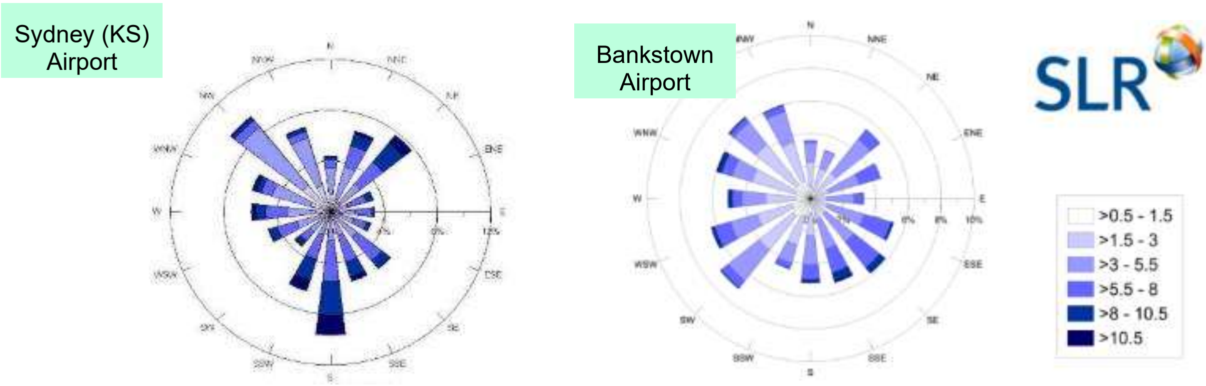
The data of interest in this study are the mean hourly wind speeds and largest gusts experienced throughout the year (especially higher, less frequent winds), how these winds vary with azimuth, and the seasonal break-up of winds into the primary Sydney Region wind seasons.

2.1 Annual and Seasonal Variations

Key characteristics of Sydney's Regional Wind Climate are illustrated in two representative wind roses shown in **Figure 4** taken from Bureau of Meteorology (BoM) data recorded during the period 1999-2017 at Sydney (Kingsford Smith) Airport and Bankstown Airport. A review of the associated seasonal wind roses (refer to **Appendix A**) shows that Sydney is affected by two primary wind seasons with relatively short (1-2 month) transition periods in between:

- Summer winds occur mainly from the northeast, southeast, and south. While northeast winds are the more common prevailing wind direction (occurring typically as offshore land-sea breezes), southeast and southerly winds generally provide the strongest gusts during summer. Both northeast winds (as sea breezes) and stronger southerly winds associated with "Southerly Busters" and "East Coast Lows" typically have a significantly greater impact along the coastline. Inland, these systems lose strength and have altered wind direction characteristics.
- Winter/Early Spring winds occur mainly from west quadrants and to a lesser extent from the south. West quadrant winds provide the strongest winds during winter and in fact for the whole year, particularly at locations away from the coast.

Figure 4 Annual Wind Roses for Sydney (KS) Airport and Bankstown Airport (BoM Data)



2.2 Wind Exposure at the Site – the "Local"' Wind Environment

Close to the ground, the "regional" wind patterns described above are affected by the local terrain, topography and built environment, all of which influence the "local" wind environment.

- As noted in **Section 1.3**, the current surroundings of the site consist of low to medium-rise buildings, ranging in height up to 4 stories, positioned in a clockwise direction from the west to the southeast. To the south, there are areas with high-rise towers.
- The site will therefore receive only modest wind shielding from north, west and east quadrants with increased sheltering (especially at lower levels) from other directions.

3.0 DESIGN WIND SPEEDS

SLR has carried out a detailed study of Sydney Basin wind speeds using continuous records of wind speed and direction measured at the Bureau of Meteorology's (BoM) Sydney weather stations. The above analysis is described in detail in …

- SLR Technical Note: "9300-TN-CW&E-v2.0 Sydney Region Design Winds", March 2018.

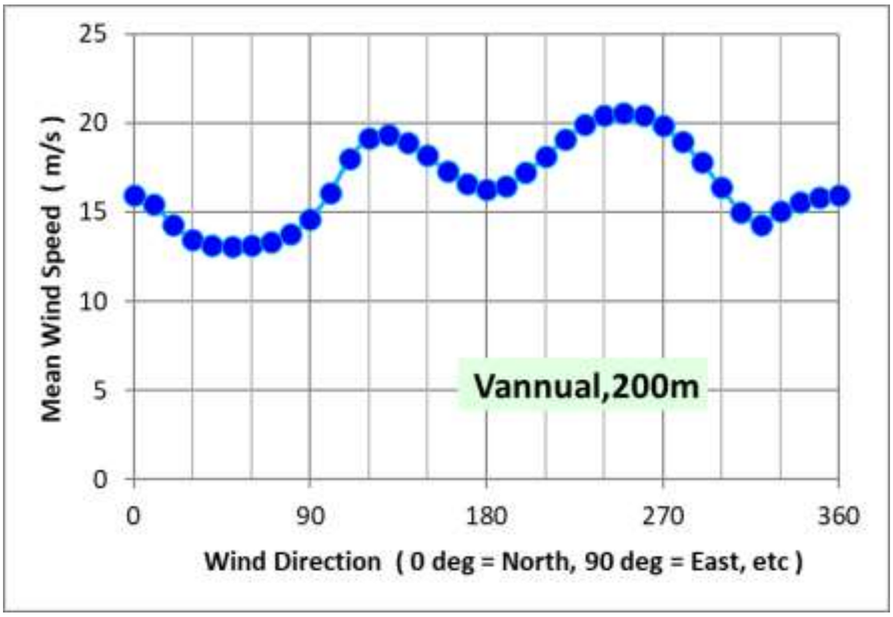
In particular, SLR has determined statistical wind information for locations not situated in close proximity (ie within say approximately a kilometre) of BoM weather stations. Particular emphasis was given to weather stations with a "clean" surrounding exposure, ie stations such as Sydney (Kingsford Smith) Airport and Bankstown Airport, which are relatively free of immediately surrounding obstacles such as buildings, vegetation, trees, etc, which would otherwise distort the winds seen by the weather station anemometer.

For the project site, SLR has concluded that the upper-level winds, influenced by local weather systems, would more closely resemble those at Sydney (Kingsford Smith) Airport than at Bankstown Airport, given the site's proximity to the airport.

3.1 Reference Height Annual Mean Wind Speeds

In the wind tunnel testing, the reference dynamic pressure used to record all wind speed data was measured at an equivalent (full-scale) height of 200 m above ground level (500 mm in the wind tunnel). Accordingly, conversion from wind tunnel speeds to full-scale speeds requires the determination of reference height design mean wind speeds for the site. These are shown in Figure 5 and have been based on the adopted Randwick wind model as described above. The winds shown have a once-per-year exceedance probability. The highest winds occur from the south and west to northwest quadrants with a secondary (more moderate) peak arising from summertime NE breezes.

Figure 5 Reference Height (200 m) Annual Recurrence Mean Wind Speed at Project Site



4.0 WIND ACCEPTABILITY CRITERIA

The Bayside Council's Planning scheme generally states that the wind effects of a development should be considered, and the development be designed to ameliorate adverse wind conditions. In accordance with regulations detailed in Section 3.14.4 Control C2 of the Bayside Development Control Plan (DCP) 2022 outlines specific maximum wind criteria that new buildings must adhere to in order to guarantee public safety and comfort:

Table 1 Standard Local Government Wind Acceptability Criteria

Type of Criteria	Limiting Gust Wind Speed Occurring Once Per Year	Activity Concerned
Safety	24 m/s	Knockdown in Isolated Areas
	23 m/s	Knockdown in Public Access Areas
Comfort	16 m/s	Comfortable Walking
	13 m/s	Standing, Waiting, Window Shopping
	10 m/s	Dining in Outdoor Restaurant

The primary objectives relating to the above wind impact criteria are as follows:

- The general objective is for annual 3-second gust wind speeds to remain at or below the so-called 16 m/s "Walking Comfort" criterion. Whilst this magnitude may appear somewhat arbitrary, its value represents a level of wind intensity above which the majority of the population would find unacceptable for comfortable walking on a regular basis at any particular location.

- In many urban locations, either because of exposure to open water conditions or because of street "canyon" effects, etc, the 16 m/s "Walking Comfort" level may already be currently exceeded. In such instances a new development should ideally not exacerbate existing adverse wind conditions and, wherever feasible and reasonable, ameliorate such conditions.

- It can be seen in **Table 1** that the recommended limiting wind speeds for spaces designed for long-term exposure activities such as sitting, outdoor dining, etc., are lower (ie more stringent) than for "walking comfort".

- The criteria provided in **Table 1** should not be viewed as "hard" numbers as the limiting values were generally derived from subjective assessments of wind acceptability. Such assessments have been found to vary considerably with the height, strength, age, etc., of the pedestrian concerned.

- A further factor for consideration is the extent of windy conditions, and some relaxation of the above criteria may be acceptable for small areas under investigation provided the general site satisfies the relevant criteria.

- Finally, it is noted that the limiting wind speed criteria in **Table 1** are based on the maximum wind gust occurring (on average) once per year. Winds at all other times, ie monthly winds, weekly winds, etc, would be of lesser magnitude. So, for example, a location with a maximum annual gust of 10 m/s would experience winds throughout the year of a generally very mild nature, conducive to stationary activities (seating, dining, etc).

4.1 Practical Application of Wind Criteria

"COMFORT" Criteria

As noted above, in relation to comfort, the Lawson (2001) criteria used in this report make use of the same Beaufort wind speed ranges to characterise issues of interest in terms of both pedestrian comfort and safety.

- The **Lawson (2001) Comfort** criteria relate a range of typical pedestrian activities such as purpose-walking, strolling, sitting, etc, to the local "GEM" wind speed which is exceeded on average 5% of the time, on an annual return period basis – refer **Table 2**.
- The "GEM" (Gust Equivalent Mean) wind speed used in the criteria is the maximum of the local mean wind speed or the local gust speed divided by 1.85.

Table 2 Lawson Wind Acceptability Criteria – COMFORT

Comfort Level	Beaufort Equivalent	"GEM" Wind Speed 5% Annual Exceedance	Description (see also Notes)
C5	1	2.5 m/sec	Dining
C4	2	4 m/sec	Sitting
C3	3	6 m/sec	Standing
C2	4	8 m/sec	Leisure Walking (Strolling)
C1	5	10 m/sec	Business (Purpose) Walking
CX	> 5	> 10 m/sec	Exceeds Comfort Criteria

Notes: C4 is suitable for promenades, popular recreation areas with seating, reading newspapers, etc

C3 is suitable for locations where pedestrians will likely be waiting for relatively short periods, eg at building entrances, at pedestrian crossings, bus stops, etc

C2 is suitable for activities such as window-shopping

C1 is suitable for footpaths used for purposeful pedestrian traffic only (eg not where shops might induce slower activities like window-shopping)

CX suggest winds whose force can be felt by the body (branches on trees would be visibly swaying) and where walking will start to become inconvenient or challenging for certain classes of pedestrians, eg the frail, pedestrians holding parcels, parents holding children, etc.

"SAFETY" Criteria

The safety acceptability criteria used in this report, currently referenced by many Australian Local Government Development Control Plans, are the so-called **Melbourne (1978) criteria**, summarised in **Table 3**.

Table 3 Melbourne (1978) Wind Acceptability Criteria – SAFETY

Type of Criteria	Gust Wind Speed Occurring Once Per Year	Activity Concerned
Safety	24 m/s	Knockdown in Isolated Areas
	23 m/s	Knockdown in Public Access Areas

4.2 Significance Criteria – Comfort

The significance criteria used by SLR in the assessment of "Comfort-related" wind effects at measurement locations surrounding the site are based on comparing the **wind-tunnel predicted** conditions at any particular location with the target usage at the same location (eg sitting, strolling, leisure walking, etc) as defined by the Lawson (2001) Comfort Criteria.

- The proposed development is deemed to have a **"Beneficial"** impact at any particular location if wind conditions are calmer than the levels associated with the target usage at that location.
- When wind conditions at any particular location, with the addition of the proposed development, are close to the levels associated with the target usage at that location, the impact is termed **"Negligible".**
- The proposed development is deemed to have an **"Unfavourable"** impact at any particular location if wind conditions are higher (windier) than the levels associated with the target usage at that location.

The chosen significance criteria are shown **Table 4**.

- All "Unfavourable" impacts (whether minor, moderate or major) are considered to be "significant", requiring consideration of mitigation for local conditions to become suitable for the intended use of the area.
- In considering mitigation under these such circumstances, "Baseline" wind conditions should also be considered if pre-existing conditions are already exceeding the target wind levels at the project site.

Table 4 Significance Criteria Related to Lawson Acceptability Criteria

Impact	Predicted Wind Microclimate
Beneficial – Major	Wind Conditions are 3-levels calmer than desired
Beneficial – Moderate	Wind Conditions are 2-levels calmer than desired
Beneficial – Minor	Wind Conditions are 1-level calmer than desired
Negligible	Wind Conditions are at the same level as desired
Unfavourable – Minor	Wind Conditions are 1-level windier than desired

Impact	Predicted Wind Microclimate
Unfavourable – Moderate	Wind Conditions are 2-levels windier than desired
Unfavourable – Major	Wind Conditions are 3-levels windier than desired OR Wind Conditions are in the Lawson “CX” or “SX” category

4.3 Comments on the Application of the Acceptability Criteria

Approach for Areas Where Existing Wind Conditions Already Exceed Criteria

In many urban locations, either because of exposure to open upstream conditions or because of street “canyon” effects, etc, the relevant Comfort and Safety criteria may already be currently exceeded.

In such instances, a new development should:

- ideally not exacerbate existing adverse wind conditions; and
- wherever feasible and reasonable, ameliorate such conditions.

For this reason, in the assessment of wind tunnel predictions of wind conditions associated with a newly proposed development, it can be useful to compare the wind microclimate in the “Proposed” condition (ie with the proposed development) with the wind microclimate of the pre-existing “Baseline” condition – as has been done in the present study.

The probabilistic way in which the Comfort Criteria are defined indicates that the relevant activity may be unsuitable at a particular location for about 5% of the time (say around 18 days per year). For the rest of the time, the relevant activity may be suitable (given that winds will be lower than the prescribed acceptability level). Moreover, it is noted that the recommended limiting values for comfort-related wind conditions were generally derived from subjective assessments of wind acceptability. These have been found to vary considerably with the height, strength, age, etc, of the pedestrian concerned.

Accordingly, some latitude can be applied to the Comfort Criteria in particular taking into account the extent of windy conditions, eg some relaxation of the criteria may be acceptable for small areas under investigation which are used infrequently.

The safety criteria shown in **Table 3** reflect the potential for stronger winds to cause a loss of balance and even possible wind knock-down, especially for frail pedestrians. The criteria are accordingly significantly more stringent.

Mitigation Using Landscaping

The Australasian Wind Engineering Society (AWES) Guidelines for Pedestrian Wind Effects Criteria includes advice related to the use of landscaping (trees, shrubs, etc) for mitigation of adverse wind conditions.

In particular, the AWES Guideline notes the following:

- Trees planted in locations where the 23 m/s safety criterion is exceeded are likely to experience wind speeds every 5 years or so which will be sufficient to destroy or severely damage many trees.

- Trees placed in high wind areas therefore have the potential to shed limbs during windstorms, thereby causing a public danger and a public nuisance.
- Moreover, landscaping planted in high wind locations rarely matures to its normal full height necessary for the assumed wind mitigation it will provide.
- Finally, trees located on public footpaths become the responsibility of the local municipality. Their maintenance, replacement following damage, loss of limbs, etc, can become burdensome financially (assuming the Municipality is even aware of such damage) and cannot be guaranteed.

Accordingly, the AWES Guideline does not recommend the use of landscaping when seeking to mitigate wind conditions that equal or exceed the public safety 23 m/s criterion.

5.0 WIND TUNNEL TEST METHODOLOGY

5.1 Simulation of Natural Wind

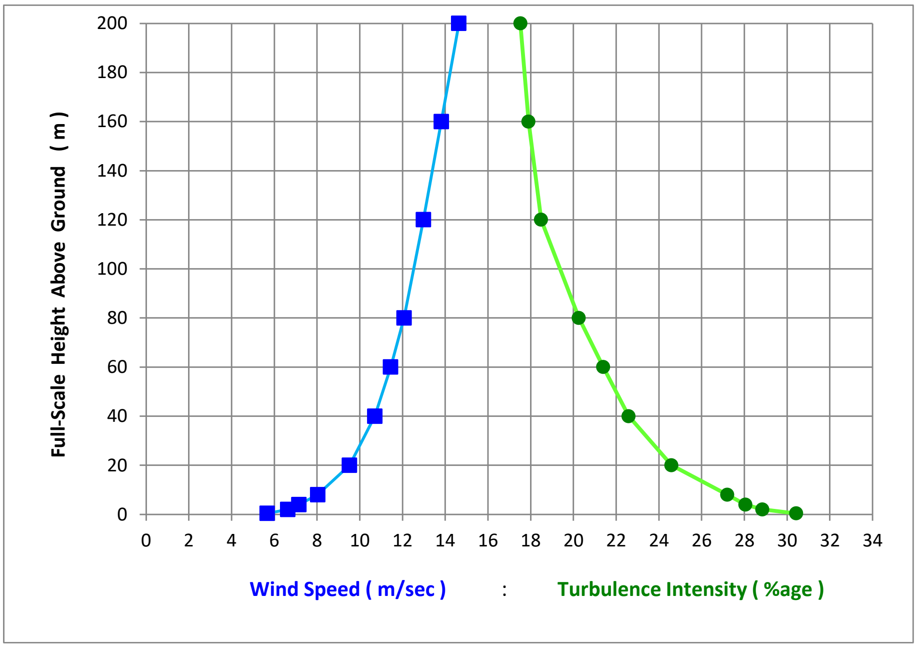
Similarity requirements between the wind tunnel model and prototype (ie full-scale) need to be fulfilled so that similitude in the flow conditions is satisfied. Usually all requirements cannot be satisfied, and compromises need to be made. In this type of wind tunnel test, it is possible to waive strict adherence to the full range of similarity parameters, eg the need to take into account buoyancy effects which are not relevant under strong wind conditions.

The wind tunnel test has been carried out using a geometric length scale of 1:300 for all dimensions (standard wind tunnel test scaling) and by scaling the boundary layer approach wind in the wind tunnel to the same scale as in the atmosphere.

The approach wind was modelled by matching terrain category conditions for all wind directions. In the wind tunnel, this is achieved by an almost 20-metre fetch of appropriate roughness elements.

The upstream profile conditions simulated in the present study is slightly more “urban” than a Suburban Terrain Category 3, associated with the presence of medium density, medium height surroundings. The variation of mean wind speed (blue curve) and turbulence intensity (green curve) is shown in **Figure 6**.

Figure 6 Wind Tunnel Test Profiles of Mean Wind and Turbulence Intensity



5.2 Proposed Development Models and Proximity Model

Development Models

A 1:400 scale model of the proposed development was built based on based on the drawings received in January 2026, using 3D printing for testing purposes – refer **Figure 7.**

To take into account the influence of the immediate surrounding physical environment, all neighbouring buildings and local topography within a diameter of almost 900 m around the site were included in the purpose-built 1:400 scale "proximity model" used for the test as shown in **Figure 7.**

The study has involved the testing of the following built environment "scenarios":

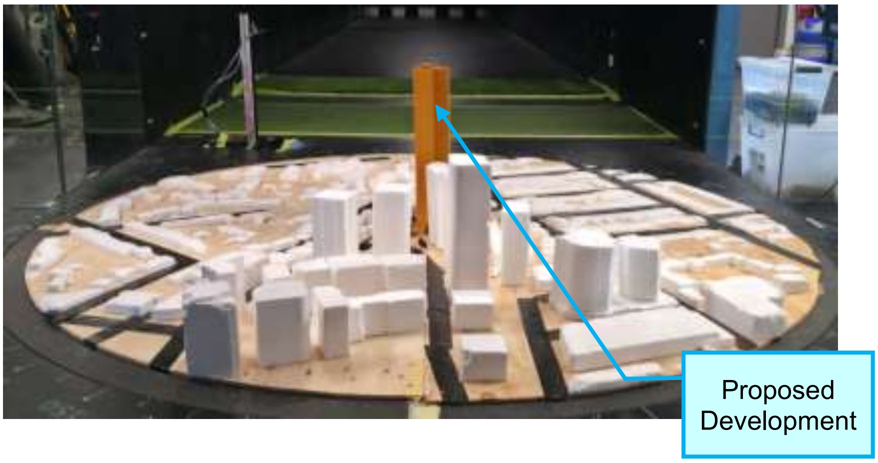
- Scenario 1 – **"Baseline"** The existing built environment,
- Scenario 2 – **"Proposed"** "Baseline" + Proposed Development

Figure 7 1:400 Scale Model of the Proposed Development (View from Southwest)

Scenario 2 – "Proposed" Scenario – View from South

**"Baseline"
(existing) Model
View from North**

**"Proposed"
(existing) Model
View from South**



5.3 Data Processing

Wind speed measurements were taken at 10° intervals:
the 0° wind direction is from the north, with east at 90°, south at 180°, etc.

The wind speeds at the locations of interest are measured
in the wind tunnel using Irwin sensors.

Wind speeds in the wind tunnel were measured at a height
corresponding to approximately chest height (1.5 m) in full scale.

The sampling time for each measurement is 60 seconds.

Wind speed measurements are recorded as dimensionless ratios
of the mean and gust ground level velocity to a mean reference wind speed
at a (full-scale) height of 200 m above ground level.

The reader is referred to the publication referenced below for a full description of this technique and validation of Irwin sensor data using hot-wire anemometry.

LTR-LA-242 "A Simple Omni-Directional Sensor for Wind Tunnel Studies of Pedestrian Level Winds" (Irwin, National Aeronautical Establishment, Ottawa, Canada, May 1980)

The measured wind speeds are transformed using the directional wind speed information derived from the local wind climate to yield ground level wind speeds as a function of annual return period and directional mean reference wind speed – refer **Figure 8**. The measured ground level wind speeds thus incorporate both the building and terrain/topographical aspects of the location as well as the directional probability of wind speed for the Project Site. The results are computed on a probabilistic basis, enabling calculation of wind events which will occur at the probability levels relevant to the Lawson Comfort Criteria, ie 5% exceedance level on an annual basis, and the peak annual wind speed relevant to the Melbourne 23 m/s Safety Criterion, using the local Project Site statistical wind distribution.

5.4 Test Method – Sensor Locations

In the wind tunnel testing, Irwin wind sensors were positioned at the locations shown in **Figure 9**.

These locations were chosen as potentially susceptible to adverse wind conditions, eg near building corners, or represent locations of interest throughout the development, eg near primary building entrances and along footpaths.

- Locations 1-34 were positioned at ground level locations surrounding the site and were measured for all two scenarios; "Baseline" and "Proposed" test scenarios.
- Locations 35-47 were positioned within the elevated communal open spaces.

Figure 8 Sensor Locations on ground level - Baseline Scenario

Figure 9 Sensor Locations on ground level - Proposed Scenario

Figure 10 Sensor Locations on level 1- Proposed Scenario

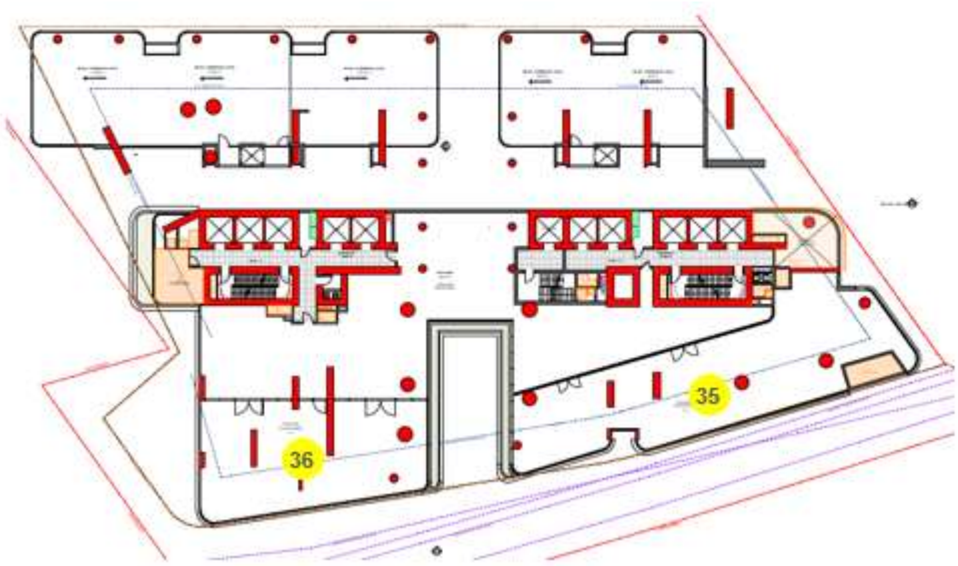


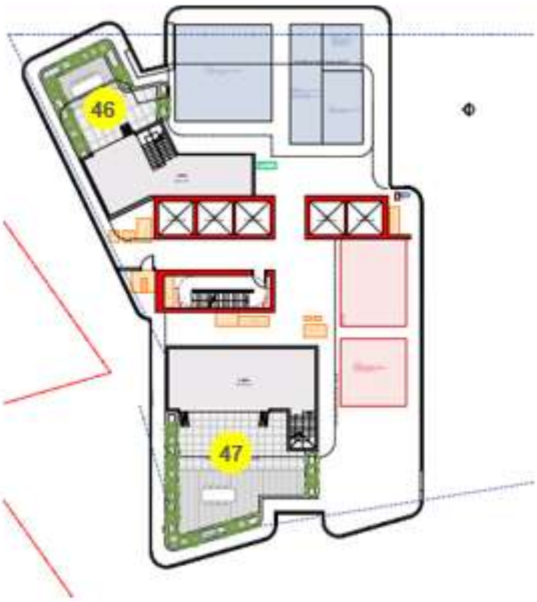
Figure 11 Sensor Locations on level 2- Proposed Scenario

Figure 12 Sensor Locations on level 34 - Proposed Scenario

Figure 13 Sensor Locations on level 38 - Proposed Scenario

Figure 14 Sensor Locations on level 57 - Proposed Scenario

Figure 15 Sensor Locations on level 61- Proposed Scenario



5.5 Sample Test Result

An example of the test results and interpretation of these results is shown in **Figure 16** illustrating the peak annual mean and representative gust wind speeds at:

Sensor: **Location 7**
Location: At the ground level, situated on the north side of the development, in close proximity to the entrance of the arcade.

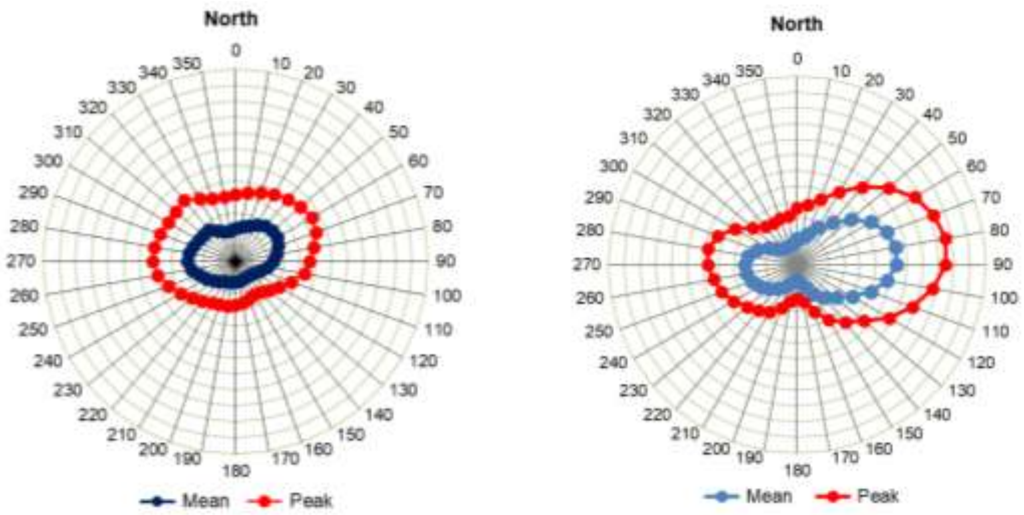
The polar diagram shows the output of the wind tunnel test results in terms of the ratio of local ground level wind speeds to the 200 m height reference mean wind speed:

Mean wind speed ratio: "navy blue" data points.
Gust wind speed ratio: "red" data points.

The polar diagram circumferential markings show the above ratios in "0.1" intervals.

Figure 16 Sample Polar Plot Test Result – Location 7

Scenario 1 – "Baseline" **Scenario 2- "Proposed"**



Scenario 1 - "Baseline" Scenario

- Location 7 receives minimal shielding from the west and east due to the relatively open nature of the surroundings with low rise residential development and railway. As a result, existing winds at this location are higher from the east and west.
-

Scenario 2 - "Proposed" Scenario

- The introduction of the proposed development leads to an elevation in wind speed at location 7, attributed to corner acceleration, the downwash effect, and the channelling of wind along the north facade of the tower. Nevertheless, a significant decrease in southward winds is measured at this location due to the shielding effect generated by the proposed development. Consequently, the prevailing winds at Location 7 are expected to stem from the east and west.

5.6 Lawson (2001) and Melbourne (1978) Calculation Methodology

As described in previous sections, the wind tunnel results are processed as follows:

- The wind tunnel test data yield ratios of the local ground level wind speed (mean and peak gust) to the reference height (200 m full-scale) mean wind speed (refer **Figure 6**) in the wind tunnel.
- The local Project Site wind speed and wind direction probability distribution is then used to calculate the probability of occurrence of the "GEM" wind speeds at an annual exceedance level of 5% to compare to the Lawson (2001) Comfort Criteria and the peak annual gust to compare to the Melbourne (1978) 23 m/s Safety Criterion.

5.7 Wind Tunnel Test Data - All Scenarios

Appendices B, C and **D** present the relevant wind tunnel test result polar plots for all locations across all scenario test runs.

Note that the polar plots are the ratios of the local ground level wind speed (mean and peak gust) to the reference height (200 m full-scale) mean wind speed (refer **Figure 6**) in the wind tunnel, and do not take into account the directional "strength" characteristics of the Project site wind rose.

6.0 TEST RESULTS

6.1 Predicted Melbourne (1978) Safety Criteria Levels

The results of the combination of wind tunnel test results (local ground level wind speed ratios) with the wind speed and wind direction probability distribution (peak annual gust) relevant to safety yielded the following results:

- In the "Baseline" scenario, the **peak annual gust at ALL locations** around the site are below the 23 m/s safety criterion level,
- In the "Proposed" scenario, **peak annual gusts at ALL locations** around the site continue to remain below the 23 m/s safety criterion level.

6.2 Predicted Lawson Comfort Criteria Levels

The results of the combination of wind tunnel test results (local ground level wind speed ratios) with the wind speed and wind direction probability distribution (5% annual exceedance level) derived for the site compared to the Lawson Comfort criteria are shown in **Figure 17.**

Figure 17 Predicted Lawson Comfort Levels - "Baseline" Scenario – Ground Level

Figure 18 Predicted Lawson Comfort Levels - "Proposed" Scenario – Ground Level

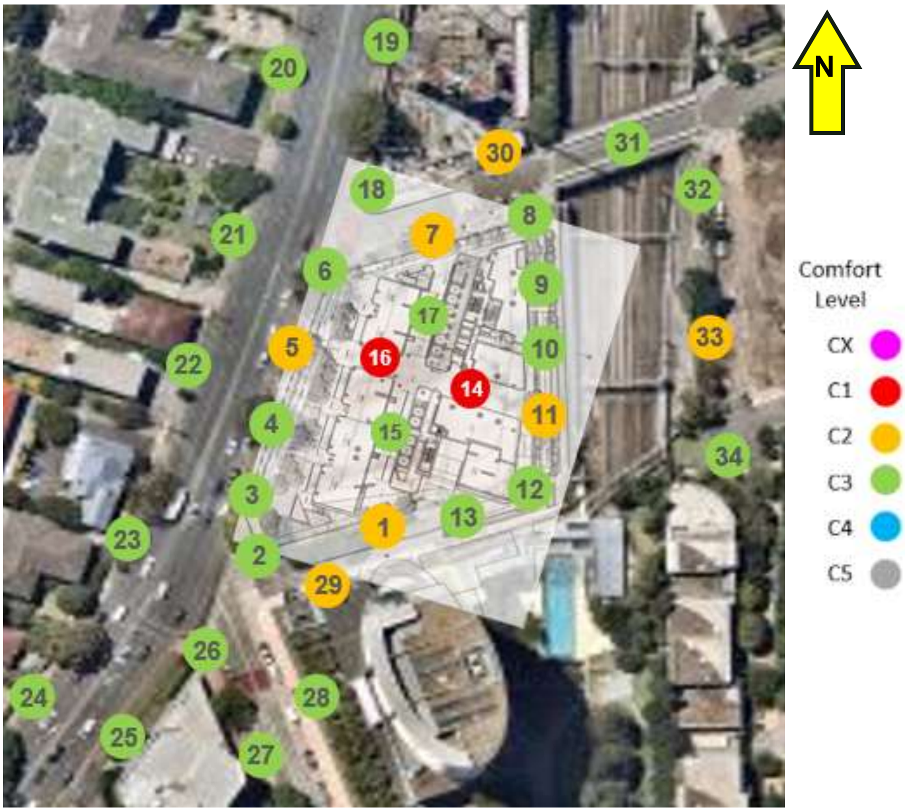


Figure 19 Predicted Lawson Comfort Levels - "Proposed" Scenario – Level 1

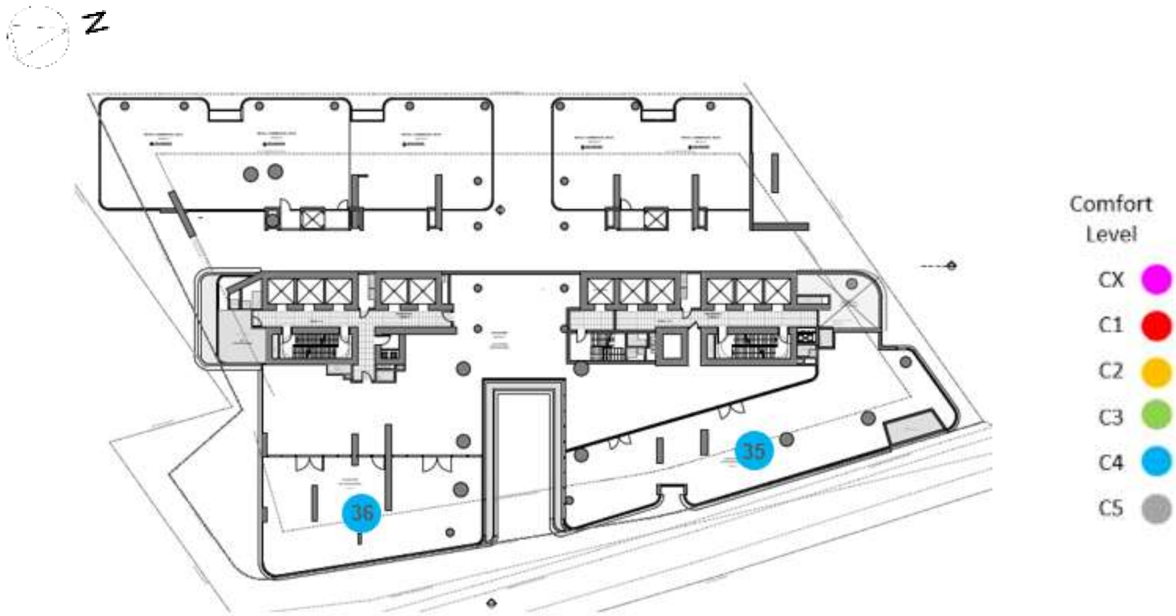


Figure 20 Predicted Lawson Comfort Levels - "Proposed" Scenario – Level 2

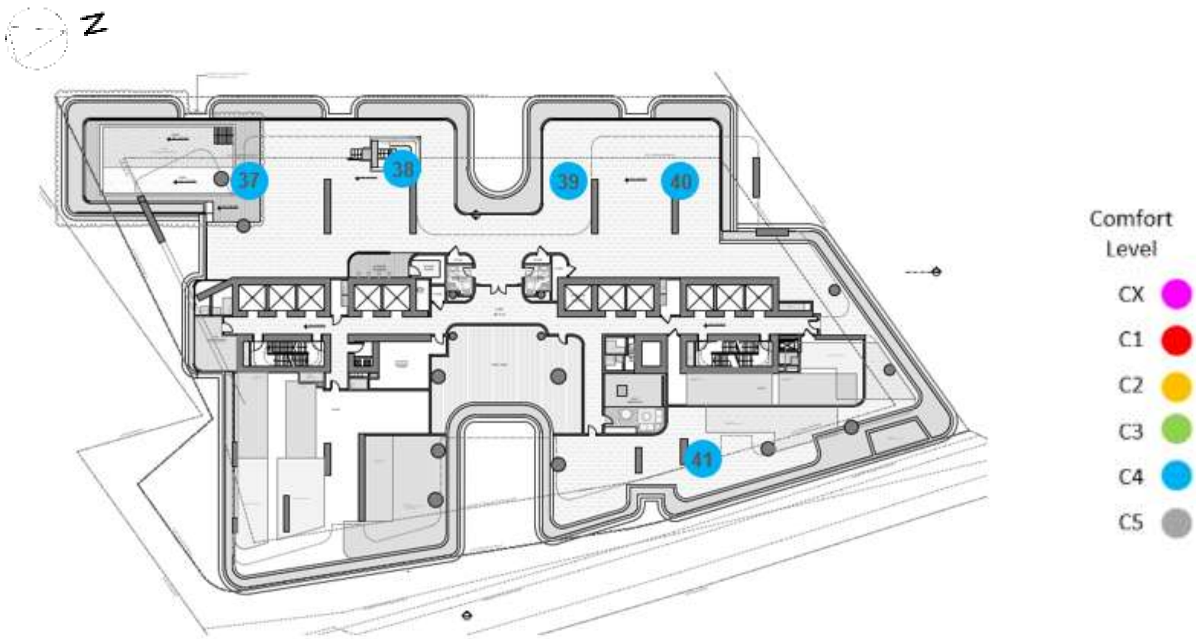


Figure 21 Predicted Lawson Comfort Levels - "Proposed" Scenario – Level 34

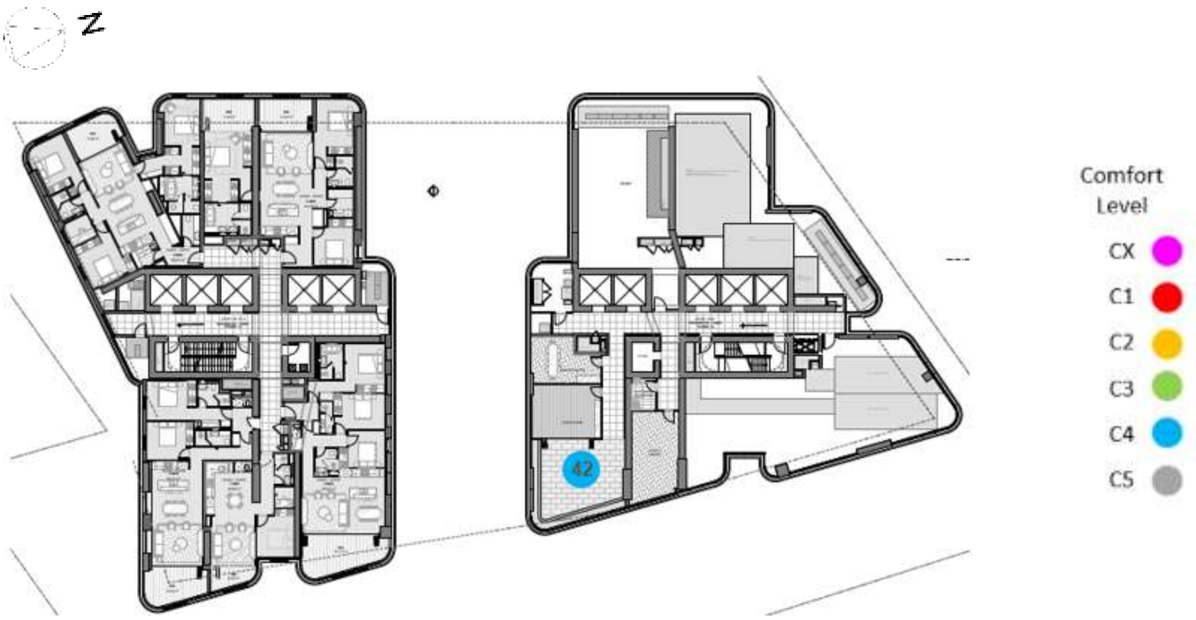


Figure 22 Predicted Lawson Comfort Levels - "Proposed" Scenario – Level 38

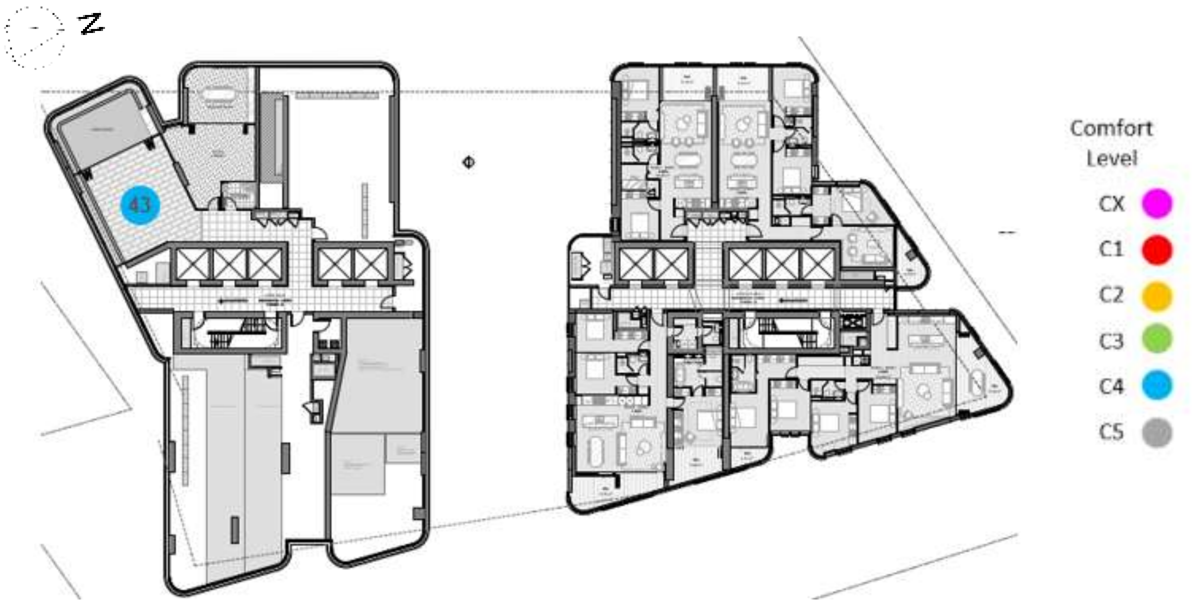


Figure 23 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 57

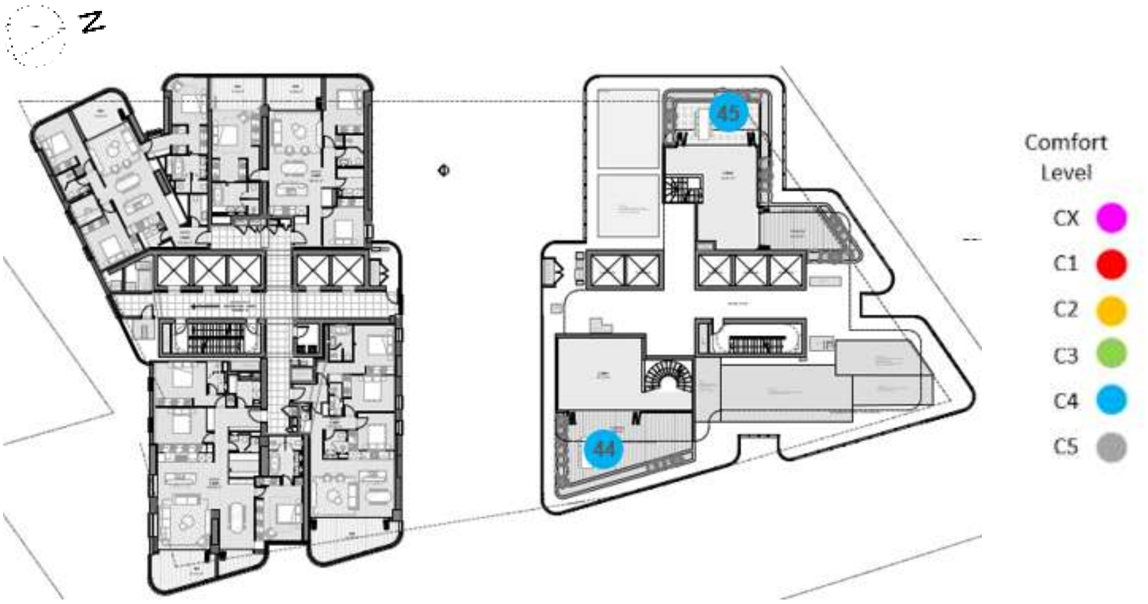
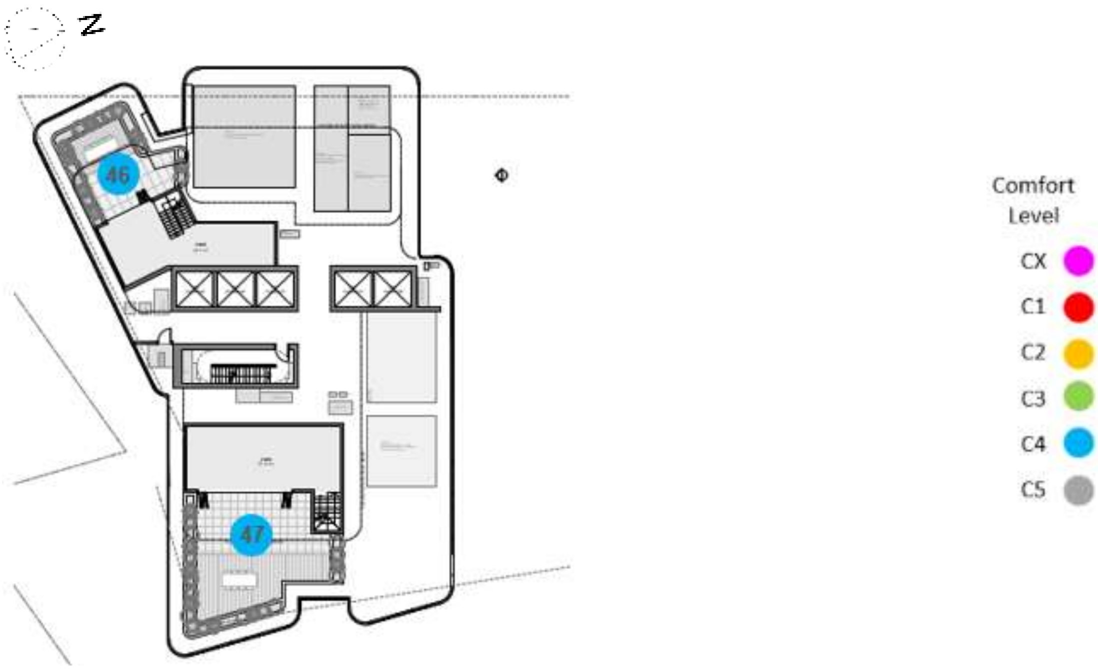


Figure 24 Predicted Lawson Comfort Levels - “Proposed” Scenario – Level 61



6.2.1 Impact of the Proposed Development on Existing Wind Conditions

Table 5 presents a comparison between the wind-tunnel predicted Lawson (2001) Comfort levels for the "Baseline", "Proposed" and "Proposed + Mitigation" scenarios and the Target Comfort levels for the surrounding areas, as well as the locations within the proposed development and the elevated communal terrace areas.

"Baseline" Scenario

- As noted above, NO locations are predicted to experience winds which exceed the Safety Criterion,
- There are NO areas with the potential to experience winds which exceed the "CX" Comfort Criterion,
- Most locations surrounding the site fall "C2" (Walking) category, and some locations move to the "C3" (Standing) category due to limited shielding from the surrounding buildings itself.

"Proposed" Scenario

- As noted above, NO locations are predicted to experience winds which exceed the Safety Criterion,
- There are NO areas with the potential to experience winds which exceed the "CX" Comfort Criterion,
- All locations surrounding the site generally remain at the Lawson "C2" (Strolling) or "C3" (Standing) category; most locations undergo a moderate alteration in local wind speed by one Lawson Comfort Criteria level.

6.2.2 Impact of the Proposed Development Relative to Target Comfort Levels

It is noted that none of the landscaping proposed for the development was included in the "Proposed" built environment scenarios. Testing in their absence assists in confirming areas where wind mitigation may be needed and more importantly, using the polar plot information shown in **Appendices B** and **C**, revealing the wind directions of most concern, further assisting the decision making in relation to placement of specific landscaping elements.

"Proposed" Built Environment Scenario

- Lawson Comfort levels at most measurement locations comply with their "Target" Comfort level,
- Lawson Comfort Levels range from "C2" (suitable for leisure walking/strolling) to "C3" (suitable for sitting),
- There are NO areas with the potential to experience winds which exceed the 23 m/s Safety Criterion.

It will be recalled (refer **Section 3.2**) that all locations where the significance impact is "Unfavourable" leads to consideration of mitigation treatments (also taking into account the existing "Baseline" conditions).

Table 5 Assessment of Impacts – Wind Tunnel Predicted Comfort Level of “Baseline” and “Proposed” Scenarios Relative to Target Comfort Level

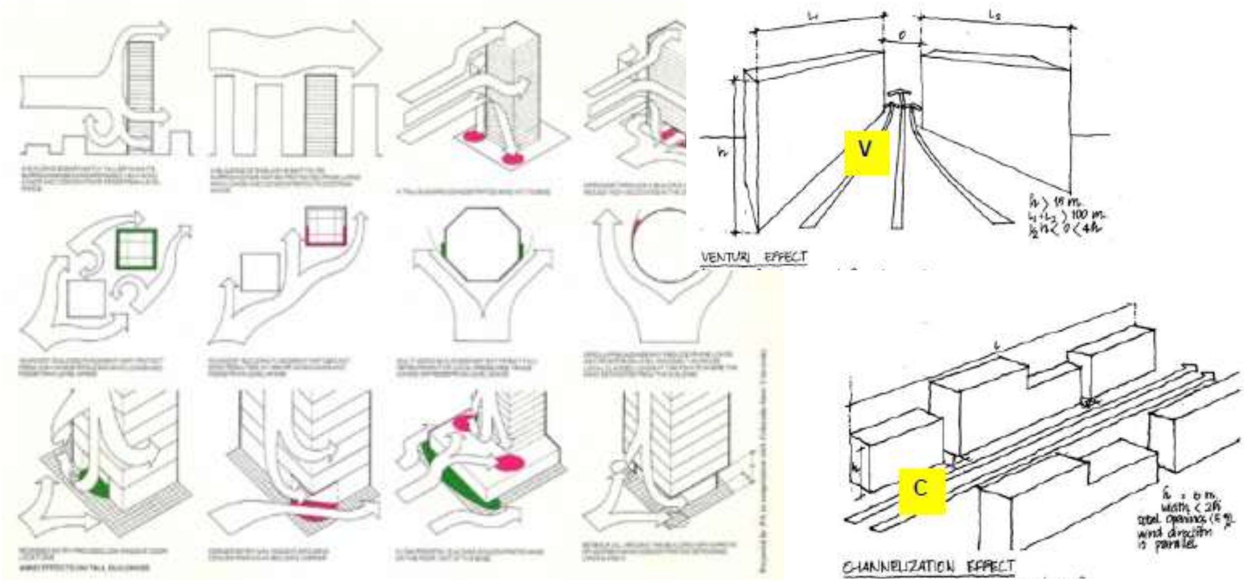
Location	Target	“Baseline”	“Proposed”	“Proposed” Impact (refer Table 4) Relative to Target Comfort Level
1	C2	C3	C2	Negligible
2	C2	C3	C3	Favourable Minor
3	C3	C2	C3	Negligible
4	C3	C2	C3	Negligible
5	C2	C3	C2	Negligible
6	C2	C3	C3	Favourable Minor
7	C2	C3	C2	Negligible
8	C2	C3	C3	Favourable Minor
9	C2		C3	Favourable Minor
10	C2		C3	Favourable Minor
11	C2		C2	Negligible
12	C2		C3	Favourable Minor
13	C2	Note 1	C3	Favourable Minor
14	C3		C1	Unfavourable Moderate
15	C3		C3	Negligible
16	C3		C1	Unfavourable Moderate
17	C3		C3	Negligible
18	C2	C2	C3	Favourable Minor
19	C2	C3	C3	Favourable Minor
20	C2	C3	C3	Favourable Minor
21	C2	C3	C3	Favourable Minor
22	C2	C3	C3	Favourable Minor
23	C2	C3	C3	Favourable Minor
24	C2	C3	C3	Favourable Minor
25	C2	C3	C3	Favourable Minor
26	C2	C3	C3	Favourable Minor
27	C2	C4	C3	Favourable Minor
28	C2	C3	C3	Favourable Minor
29	C2	C3	C2	Negligible
30	C2	C3	C2	Negligible
31	C2	C3	C3	Favourable Minor
32	C2	C3	C3	Favourable Minor
33	C2	C3	C2	Negligible
34	C2	C3	C3	Favourable Minor
35	C3		C4	Favourable Minor
36	C3		C4	Favourable Minor
37	C4		C4	Negligible
38	C4		C4	Negligible
39	C4		C4	Negligible
40	C4		C4	Negligible
41	C3	Note 1	C4	Favourable Minor
42	C3		C4	Favourable Minor
43	C3		C4	Favourable Minor
44	C4		C4	Negligible
45	C4		C4	Negligible
46	C4		C4	Negligible
47	C4		C4	Negligible

Note All Unfavourable impacts are deemed “significant” and require consideration of wind mitigation.

7.0 WIND MITIGATION OPTIONS

Figure 25 shows some common wind impact flow patterns surrounding a new building development.

Figure 25 Common Built Environment Windflow Patterns



On the basis of the above, wind mitigation options generally fall into two categories:

- Windbreaks designed to mitigate **vertical or oblique** winds (eg downwash winds); and
- Windbreaks designed to mitigate **horizontal** winds (eg channelling/funnelling winds).

7.1 Windbreaks Suited to Mitigating Vertical/Oblique Winds

Wind mitigation options suited to ameliorating vertical/oblique wind conditions include:

- Horizontal (or near horizontal) Canopies, Awnings and Pergolas (solid or of moderate porosity) which are able to deflect winds approaching from above and redirect the wind away from ground level areas below.

7.2 Windbreaks Suited to Mitigating Horizontal Winds

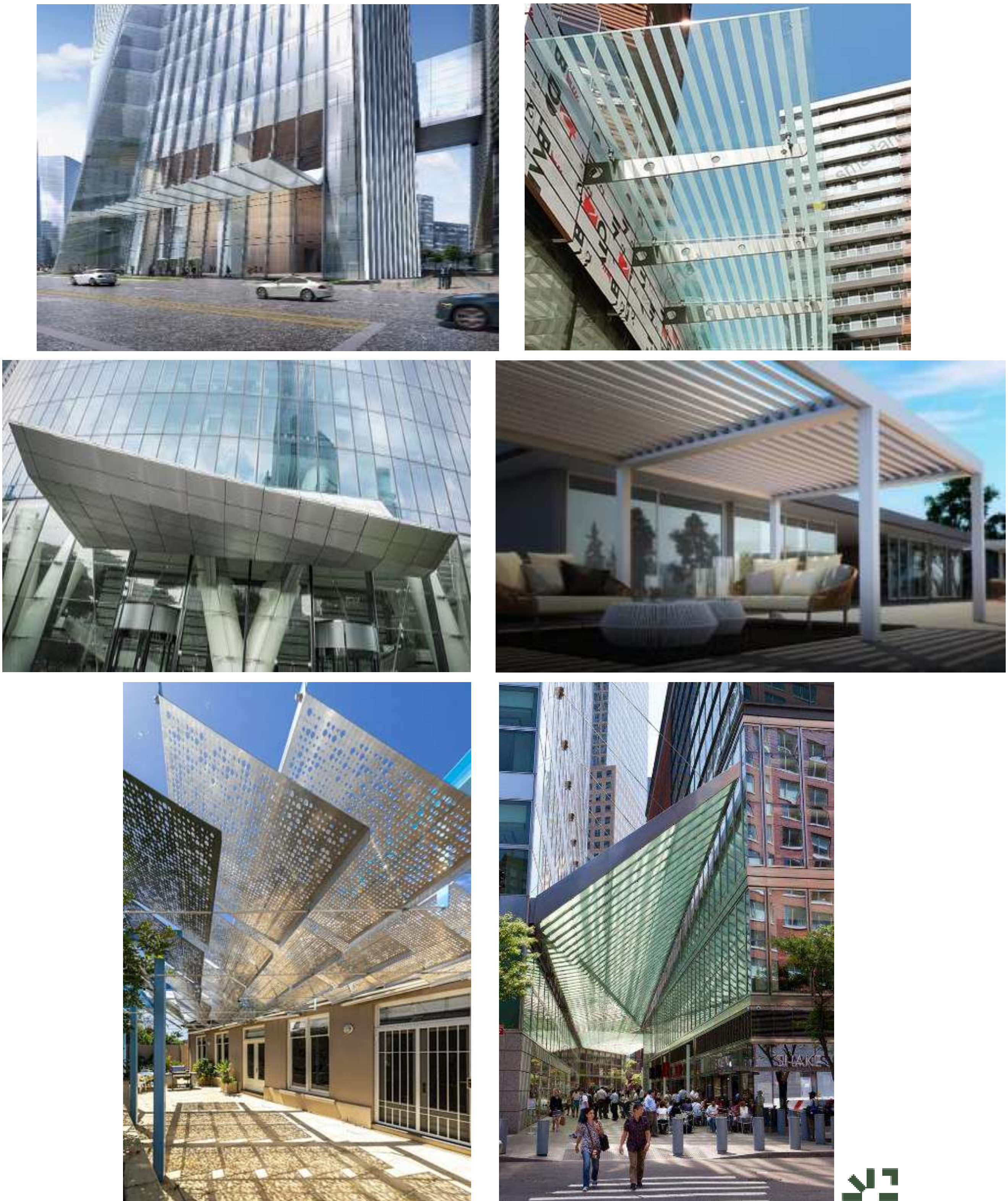
Wind mitigation options suited to ameliorating horizontal wind conditions include:

- Landscaping: trees, shrubs, vegetation, etc; and
- Sculptural screening (solid or of moderate porosity) – which can also be combined with landscaping.

7.3 Horizontal Windbreak Examples

Figure 26 shows typical examples of horizontal windbreak options typically found in urban built environments – they can be solid or porous, purely horizontal or with a slope aimed at deflecting oblique windflow.

Figure 26 Horizontal Windbreak Options



7.4 Vertical Windbreak Examples

Figure 27 shows examples of vertical windbreak options found in urban built environments – they can be solid or porous, involve landscaping (full or partial), timber, glazing, etc, and can provide a wide range of utilitarian functions beyond their wind mitigation capability (eg seating, advertising, etc).

Figure 27 Vertical Windbreak Options

Landscaping

Solid

Multi-Function

Combination

8.0 MITIGATION AND TREATMENT RECOMMENDATIONS

Sections 4 and **5** provided guidance as to the areas where the adopted wind acceptability criteria had the potential to be exceeded and an indication as to the likely local optimum wind treatment strategy, eg whether the wind condition of interest is likely to arise from accelerating winds which require vertical windbreaks (such as landscaping) or downwash winds which require horizontal windbreaks (such as awnings, canopies). Based on the Lawson Comfort and Safety Levels identified through the wind tunnel testing for the "Proposed", scenario, wind mitigations are recommended for the following locations:

8.1 Wind Mitigation Recommendations

The following features, already planned for the development, will significantly ameliorate local wind conditions.

- Maintain the proposed/existing trees/landscaping on the sides of the development to mitigate the impact of local wind speeds. It is recommended that all trees/landscaping to be evergreen and densely foliating to maintain its effectiveness throughout the year – refer **Figure 28**.
- Uphold the proposed setbacks, colonnades, and awnings at ground-level building entrances to reduce wind speeds from downwash and to redirect airflow along pedestrian pathways – refer **Figure 28**.
- Keep the proposed planter boxes within the ground-level space to mitigate wind channelling effects in this area. Landscaping should be evergreen and densely foliated for continuous effectiveness throughout the year – refer **Figure 28**.
- Locations 14 and 16 currently satisfy the business walking comfort criterion but exceed the recommended standing comfort criterion. Therefore, additional wind mitigation measures are recommended within the through-site link to reduce potential wind channelling (refer **Figure 28**):
    - Full-height vertical windbreak elements (porous screens or glazed panels) at the corner of the through-site link intersection to reduce wind channelling.
    - Solid wind screen (approximately 3 m high) near the western entrance of the through-site link to limit penetration of high-speed winds.
    - Retention of the proposed art sculpture at the link intersection to help disrupt and redirect wind flows.
    - Planter boxes along the eastern side of the link, with vegetation reaching a minimum height of approximately 1.5 m, to increase local surface roughness and assist in reducing wind speeds within the corridor.
    - It should be noted that the above recommended architectural and landscape elements were not included in the wind tunnel model due to scale limitations; however, they are expected to assist in disrupting and redirecting wind flows, particularly from westerly and easterly directions. At the Detailed Design stage, 3D CFD simulations may be undertaken to further assess wind conditions and identify areas where additional mitigation measures may be required.
- For the communal open spaces, maintain the proposed solid vertical windbreak around the perimeter, along with the planned trees and landscaping. It is recommended that all trees and landscaping be evergreen and densely foliated to

ensure effectiveness year-round – refer **Figure 29**, **Figure 30**, **Figure 31**, **Figure 32**, **Figure 33** and **Figure 34**.

Figure 28 Wind Mitigation for the Development – Ground level

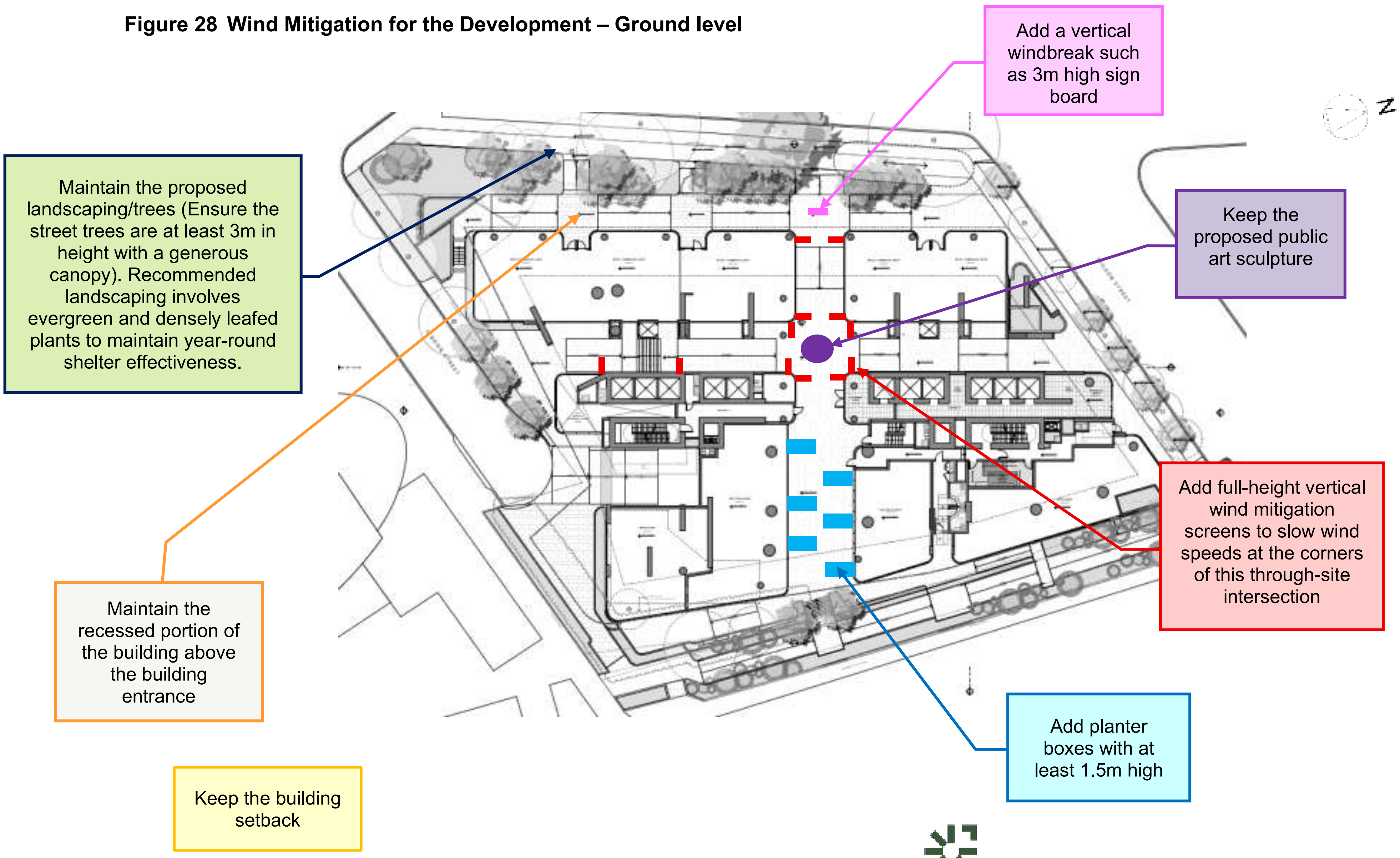


Figure 29 Wind Mitigation for the Development – Level 1

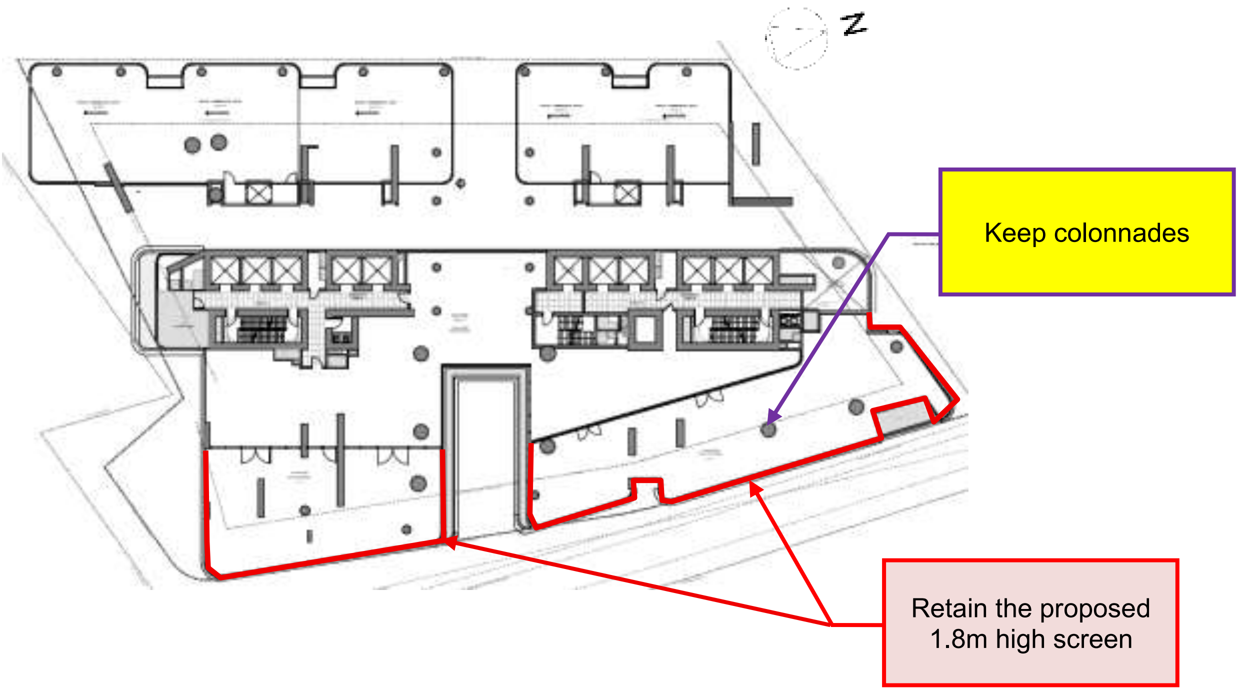


Figure 30 Wind Mitigation for the Development – Level 2

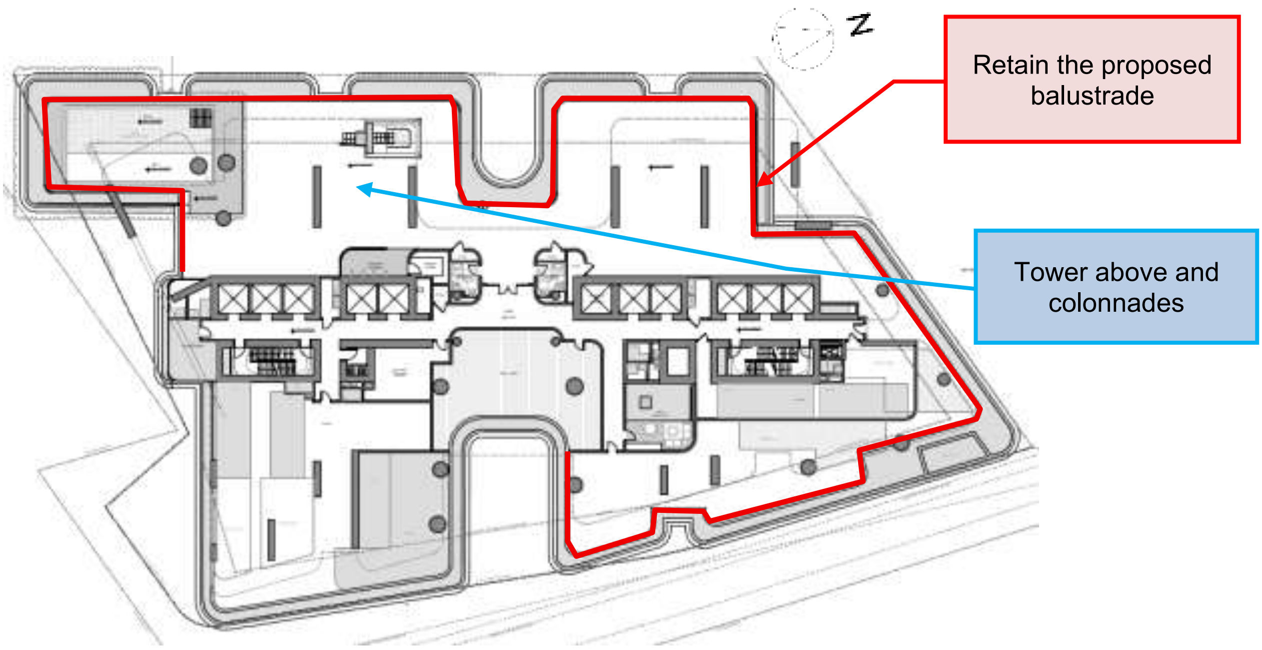


Figure 31 Wind Mitigation for the Development – Level 34

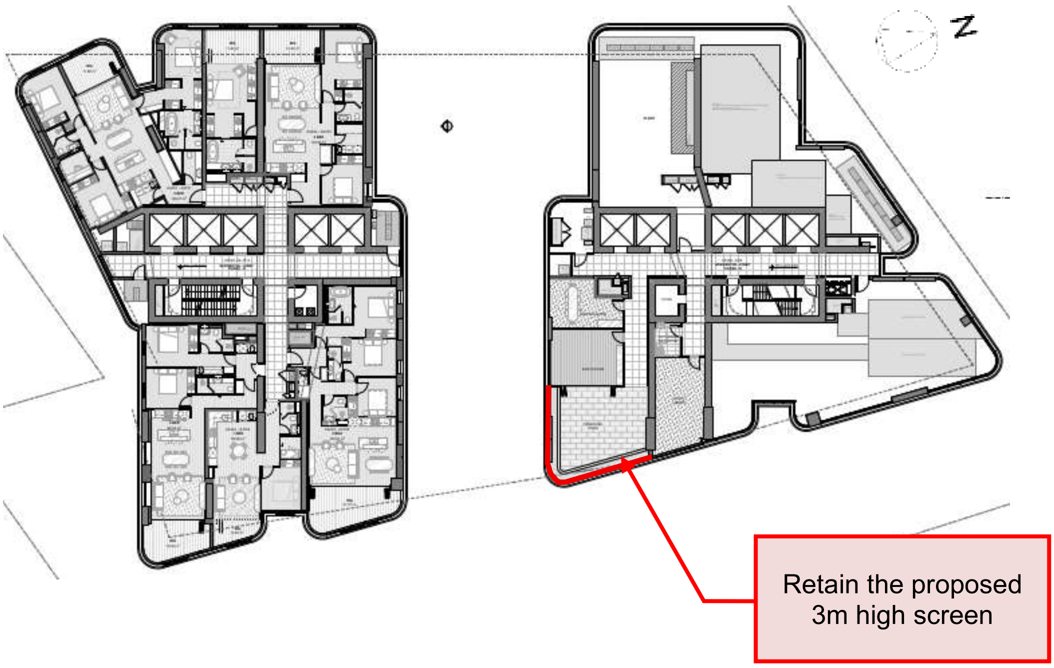


Figure 32 Wind Mitigation for the Development – Level 38

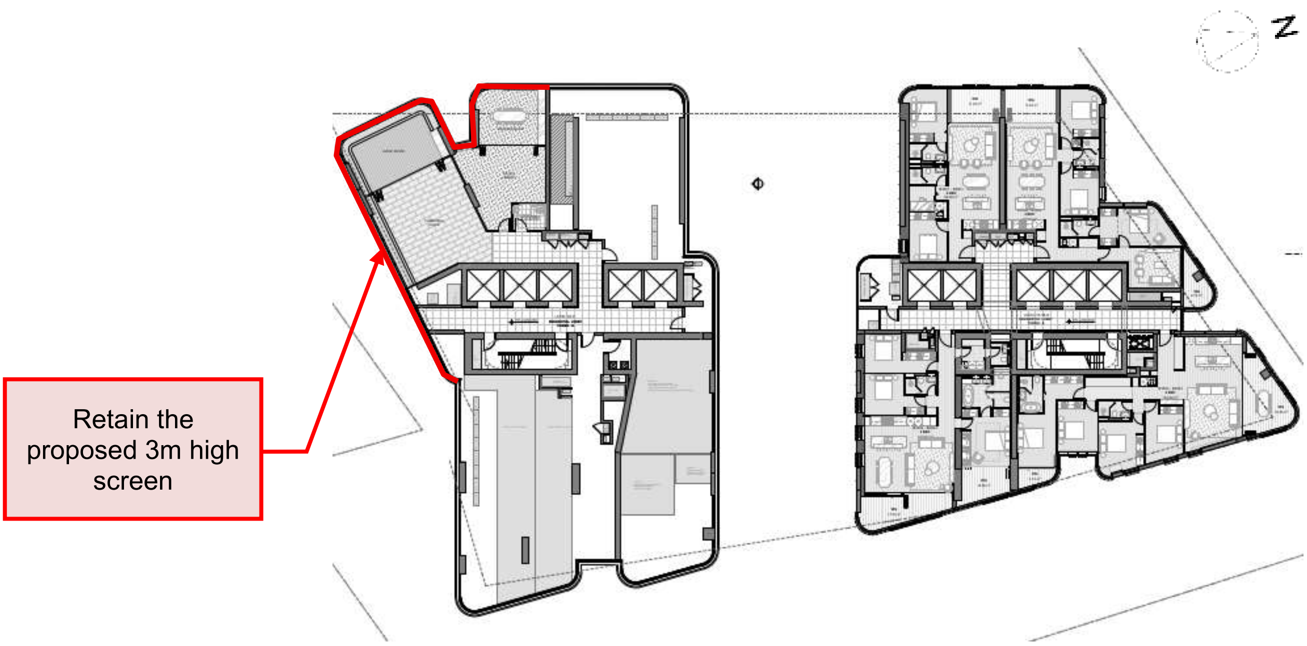


Figure 33 Wind Mitigation for the Development – Level 57

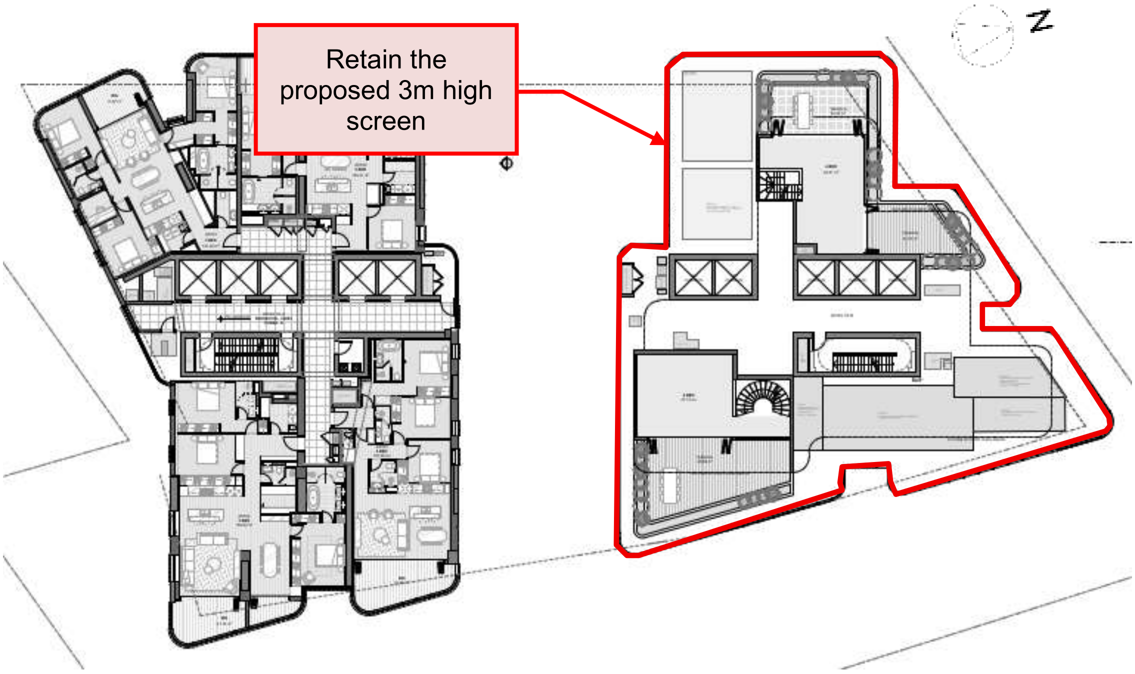
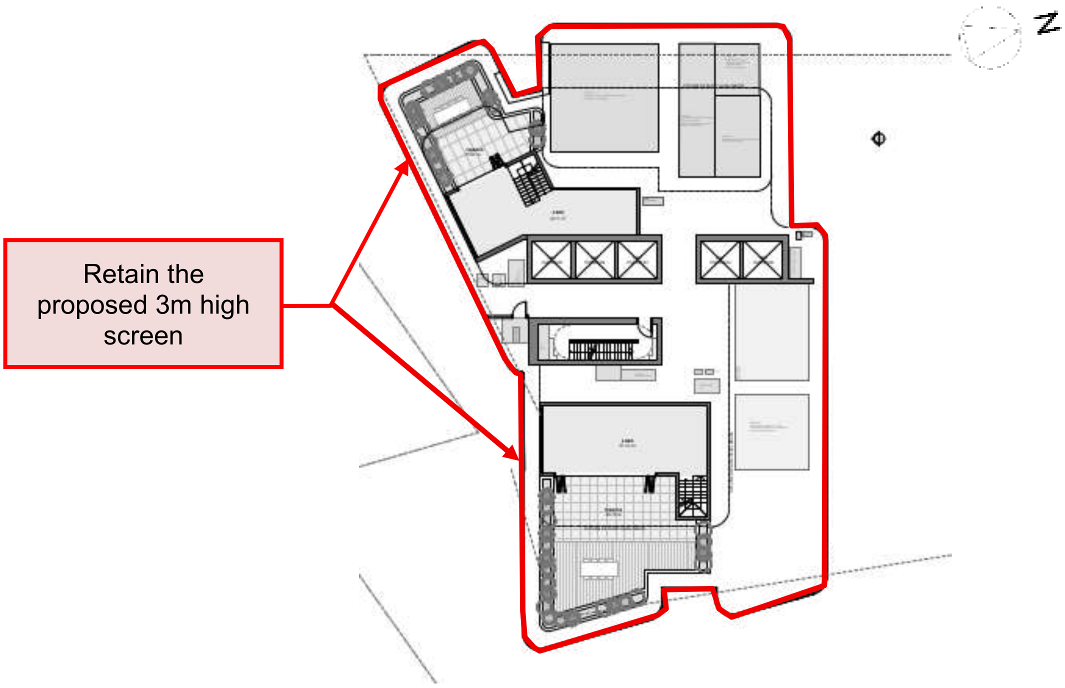


Figure 34 Wind Mitigation for the Development – Level 61



9.0 Conclusion

SLR Consulting Australia Pty Ltd (SLR) has been engaged by BB Wilson Property Pty Ltd to perform a quantitative wind assessment of the proposed development at 849, 853, and 859 Pacific Highway and 2 and 8 Wilson Street, Chatswood, via an Environmental Wind Tunnel Study. Following an initial wind tunnel tests conducted in December 2023 and November 2024, the design has now been revised to increase the height. Consequently, an additional wind tunnel test has been conducted to evaluate the impact of these changes.

The assessment has been carried out via a Discrete Sensor Environmental Wind Tunnel Study whereby wind tunnel measurements were made to investigate wind conditions throughout and around the proposed development (simulated via a 1:400 scale model) at areas to be used by visitors and occupants of the development itself.

The proposed mixed-use development, which comprises of two towers, is positioned amidst Pacific Hwy to the west, Wilson Street to the north/northeast, Railway to the east, and O'Brien Street to the south. in High-rise towers can be found to the south of the site, and in the more distant northwestern direction from this development lies Blue Gum Creek.

Built Environment Scenarios Assessed

The study has involved the testing of three built environment "scenarios":

- Scenario 1 – **"Baseline"** The existing built environment
- Scenario 2 – **"Proposed"** "Baseline" + Proposed Development

Wind Acceptability Criteria

The criteria adopted for the present study are:

- "Comfort" Lawson (2001) Comfort Criteria; and
- "Safety" Melbourne (1978) 23 m/s Safety Criterion.

Project Site Wind Climate

Using long-term wind records obtained from nearby Bureau of Meteorology stations at Bankstown Airport and Sydney Kingsford Smith Airport, SLR has determined that determined that Chatswood has local winds characteristics somewhat closer to Sydney (KS) Airport than Bankstown Airport, given the project site's distance inland from the coast. Accordingly, key prevailing wind directions of interest are the northeast, southeast and south for summer and mainly west quadrant winds for winter.

"Baseline" (Existing) Wind Environment

Close to the ground, the "regional" wind patterns described above are affected by the local terrain, topography and built environment, all of which influence the "local" wind environment.

- As noted in **Section 1.3**, the site is partially shielded from the north, east, and west, as it is presently bordered by a combination of low to mid-rise residential structures on the west and north aspects of the proposed development. Conversely, the site experiences moderate shielding from the south, attributed to the presence of some high-rise buildings on the southern side of the development.

- The terrain on the western side of the site undergoes significant elevation changes, impacting the nearby westerly wind patterns and speeds.

“Proposed” Wind Environment

Testing of the “Proposed” scenario (which incorporates a number of already planned windbreak treatments) yielded the follows areas of potential concern in relation to future wind impact:

- Entrance locations;
- Surrounding pedestrian walkways;
- Ground-level public domain areas; and
- Elevated communal open spaces.

Already Planned Wind Amelioration Treatments

The following treatments relevant to wind mitigation have already been incorporated in the current design scheme:

- Preserve the proposed or existing trees and landscaping along the sides of the development to help reduce local wind speeds. It is recommended that all trees and landscaping be evergreen with dense foliage to ensure year-round effectiveness – refer **Figure 28.**
- Maintain the proposed setbacks, colonnades, and awnings at ground-level entrances to minimize wind speeds from downwash and to guide airflow along pedestrian pathways – refer **Figure 28.**
- Retain the proposed planter boxes at ground level to counteract wind channelling effects in this area. Evergreen, densely foliated landscaping is recommended for continuous effectiveness throughout the year –refer **Figure 28**.
- Locations 14 and 16 currently satisfy the business walking comfort criterion but exceed the recommended standing comfort criterion. Therefore, additional wind mitigation measures are recommended within the through-site link to reduce potential wind channelling (refer **Figure 28**). These measures include the introduction of full-height vertical windbreak elements, such as porous screens or glazed panels, at the corner of the through-site link intersection, as well as a solid wind screen approximately 3 m high near the western entrance to limit the penetration of high-speed winds. In addition, retention of the proposed art sculpture at the link intersection is recommended, as it may help disrupt and redirect wind flows. Planter boxes along the eastern side of the link, with vegetation reaching a minimum height of approximately 1.5 m, are also recommended to increase local surface roughness and assist in reducing wind speeds within the corridor. It should be noted that these architectural and landscape elements were not included in the wind tunnel model due to scale limitations; however, they are expected to contribute to disrupting and redirecting wind flows, particularly from westerly and easterly directions. At the Detailed Design stage, once the design is finalised, 3D CFD simulations may be undertaken to further assess wind conditions and identify areas where additional mitigation measures may be required.
- For the communal open spaces, keep the proposed solid vertical windbreak around the perimeter, along with the planned trees and landscaping. Evergreen, densely foliated trees and landscaping are recommended to ensure year-round effectiveness - refer **Figure 29, Figure 31, Figure 32, Figure 33, and Figure 34.**

Summary

On the basis of the above, the overall effect of the proposed development on the local wind microclimate is predicted to be “not significant” (refer Section 3.2) and the proposed development should satisfy the nominated Wind Acceptability criteria for the project.

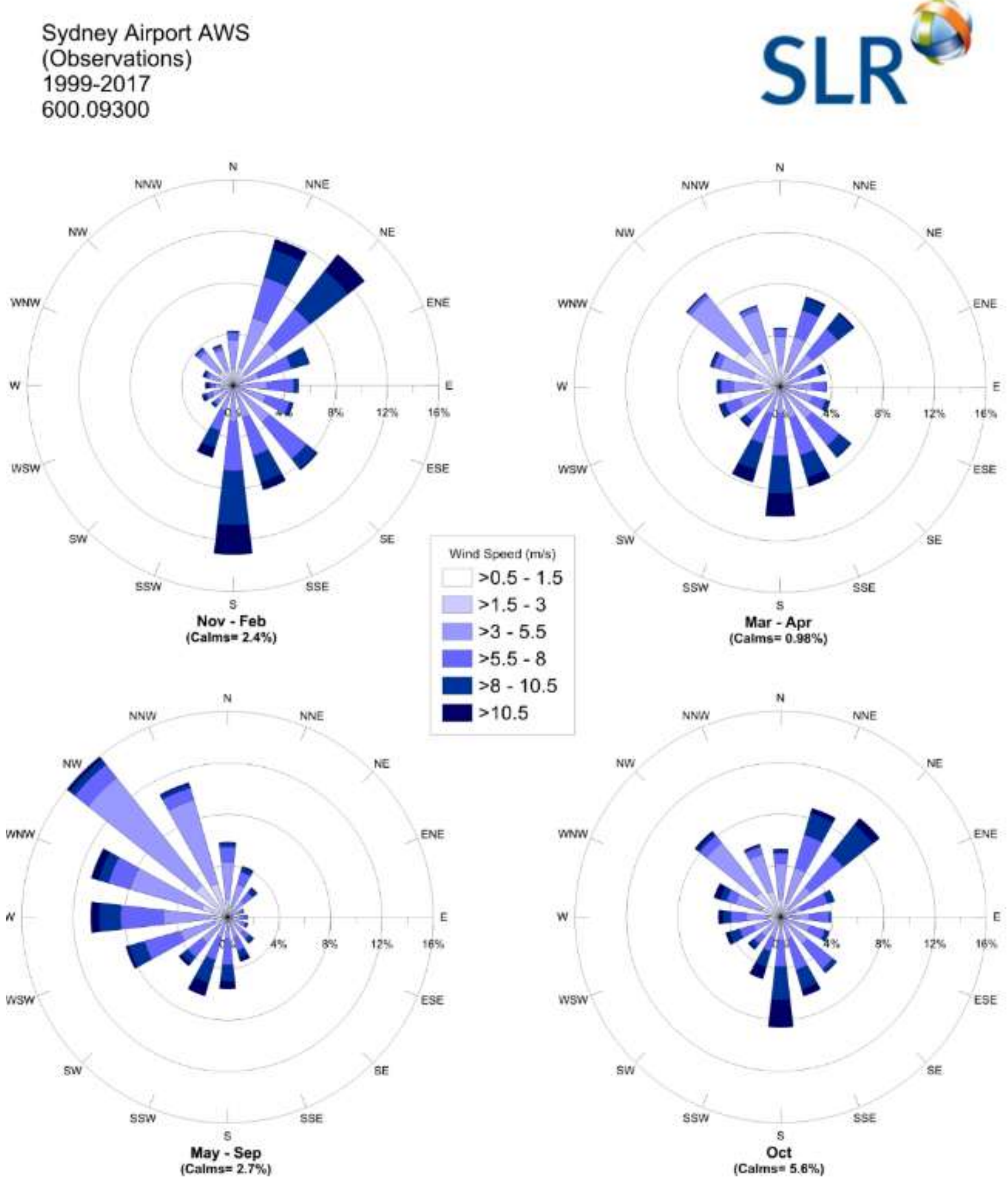
10.0 Feedback

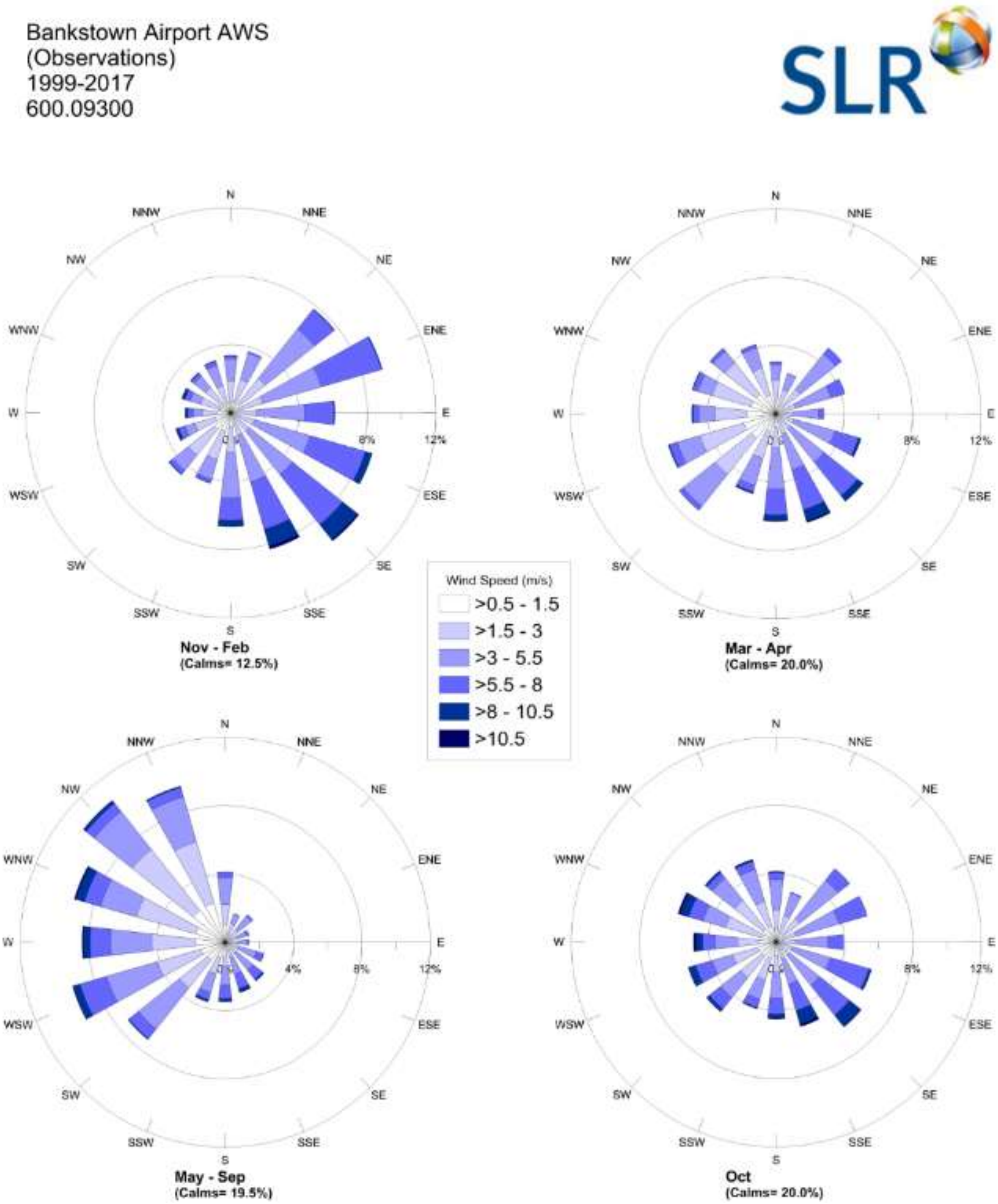
At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via https://www.slrconsulting.com/en/feedback.

We recognise the value of your time and we will make a $10 donation to our Charity Partner - Lifeline, for every completed form.

Appendix A Seasonal Wind Roses for Bureau of Meteorology Met Stations at Sydney (Kingsford Smith) Airport and Bankstown Airport

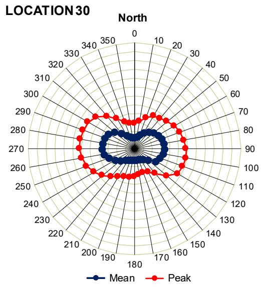

Sydney Airport AWS
(Observations)
1999-2017
600.09300
Wind Speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5
Nov - Feb
(Calms= 2.4%)
Mar - Apr
(Calms= 0.98%)
May - Sep
(Calms= 2.7%)
Oct
(Calms= 5.6%)

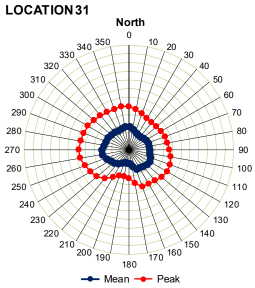

Bankstown Airport AWS
(Observations)
1999-2017
600.09300
SLR
Nov - Feb
(Calms= 12.5%)
Mar - Apr
(Calms= 20.0%)
May - Sep
(Calms= 19.5%)
Oct
(Calms= 20.0%)
Wind Speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
4%
8%
12%

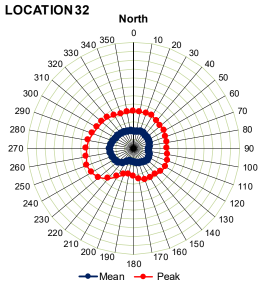
Appendix B Wind Tunnel Test Data (Polar Plots) – BASELINE Scenario

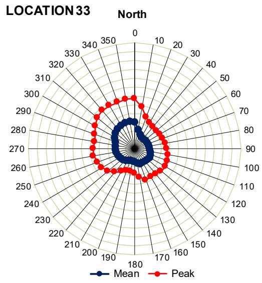
The polar diagram plots show the local (ground level) mean and peak gust wind speed as a ratio of the mean reference wind speed (at a full-scale height of 200 m).The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.

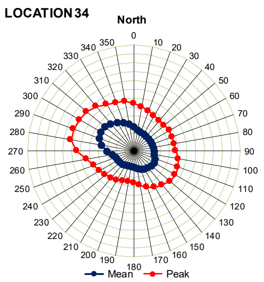

LOCATION 1
LOCATION 2
LOCATION 3
LOCATION 4
LOCATION 5
LOCATION 6
LOCATION 7
LOCATION 8
LOCATION 18
LOCATION 19
LOCATION 20
LOCATION 21
LOCATION 22
LOCATION 23
LOCATION 24
LOCATION 25
LOCATION 26
LOCATION 27
LOCATION 28
LOCATION 29
North
Mean
Peak


LOCATION 30
North
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350
Mean
Peak


LOCATION 31
North
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350
Mean
Peak

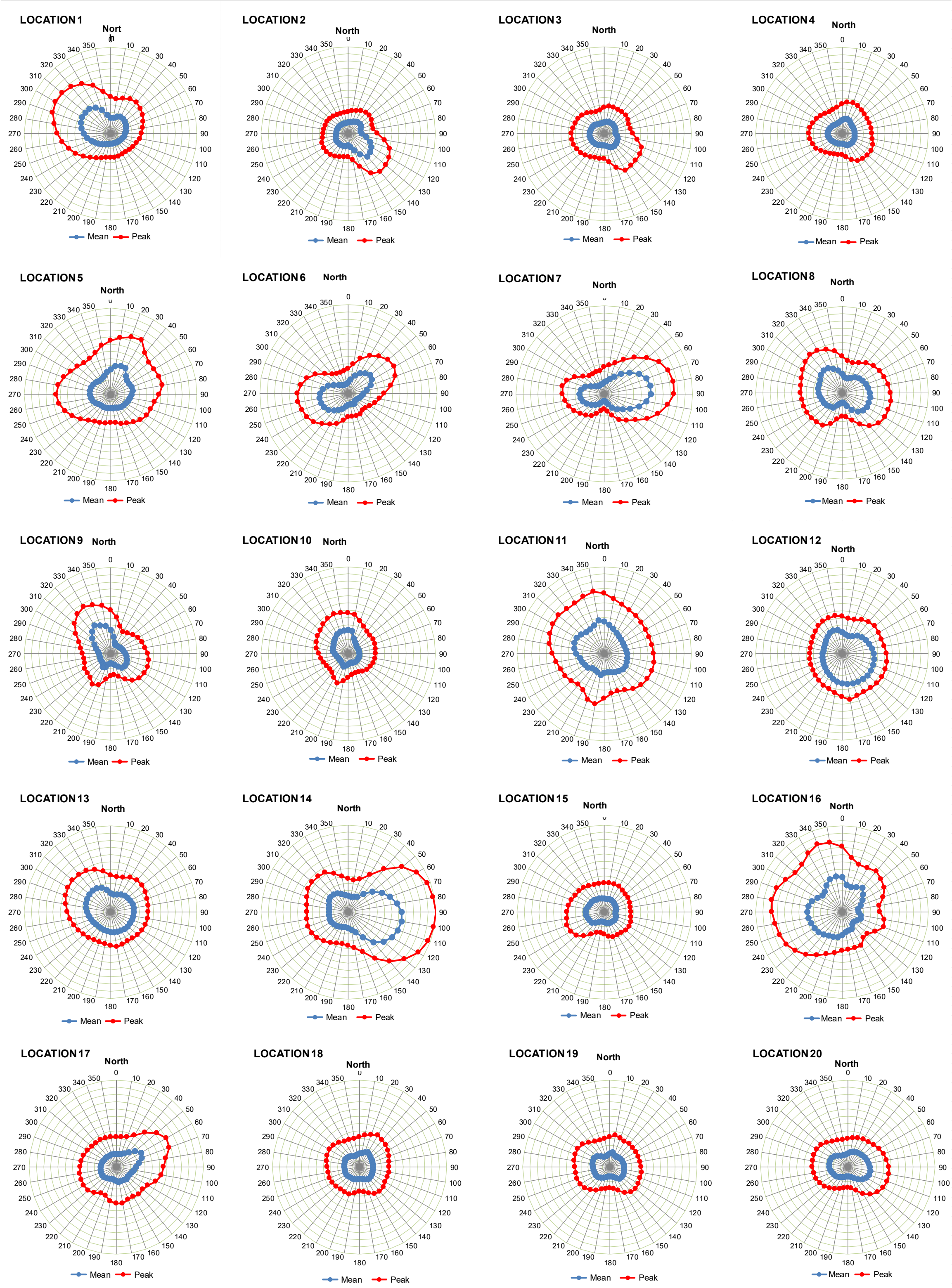

LOCATION 32
North
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350
Mean
Peak


LOCATION 33
North
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350
Mean
Peak

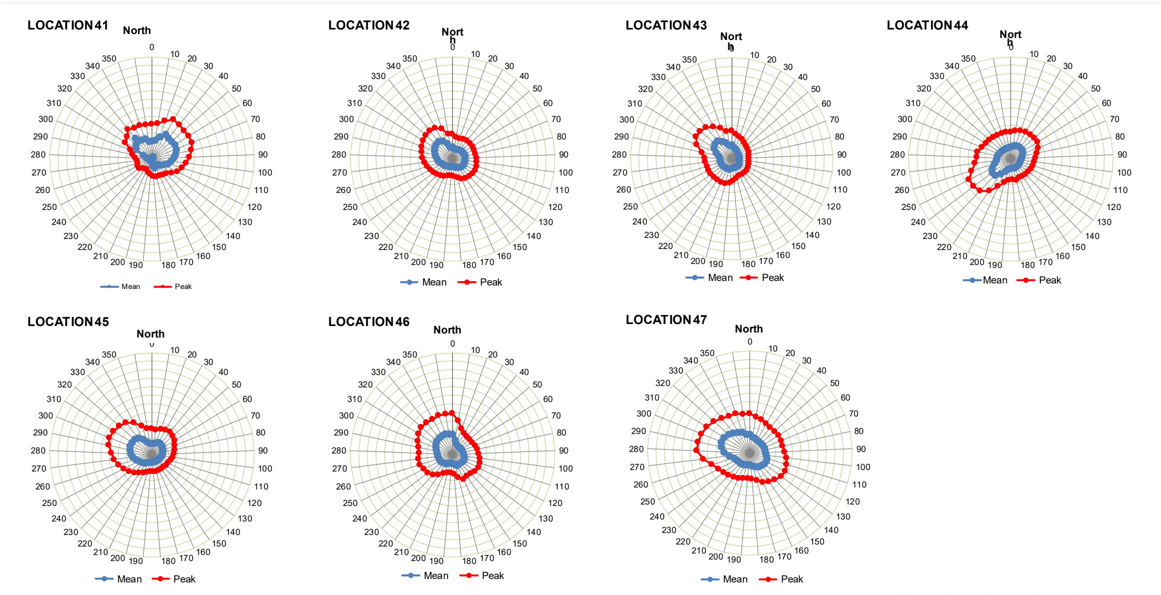

LOCATION 34
North
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350
Mean
Peak

Appendix C Wind Tunnel Test Data (Polar Plots) – PROPOSED Scenario

The polar diagram plots show the local (ground level) mean and peak gust wind speedas a ratio of the mean reference wind speed (at a full-scale height of 200 m).The polar diagram circumferential lines representing gradations in 0.1 intervals, ie 10% ratios.


LOCATION 1
North
Mean Peak
LOCATION 2
North
Mean Peak
LOCATION 3
North
Mean Peak
LOCATION 4
North
Mean Peak
LOCATION 5
North
Mean Peak
LOCATION 6
North
Mean Peak
LOCATION 7
North
Mean Peak
LOCATION 8
North
Mean Peak
LOCATION 9
North
Mean Peak
LOCATION 10
North
Mean Peak
LOCATION 11
North
Mean Peak
LOCATION 12
North
Mean Peak
LOCATION 13
North
Mean Peak
LOCATION 14
North
Mean Peak
LOCATION 15
North
Mean Peak
LOCATION 16
North
Mean Peak
LOCATION 17
North
Mean Peak
LOCATION 18
North
Mean Peak
LOCATION 19
North
Mean Peak
LOCATION 20
North
Mean Peak


LOCATION 21
LOCATION 22
LOCATION 23
LOCATION 24
LOCATION 25
LOCATION 26
LOCATION 27
LOCATION 28
LOCATION 29
LOCATION 30
LOCATION 31
LOCATION 32
LOCATION 33
LOCATION 34
LOCATION 35
LOCATION 36
LOCATION 37
LOCATION 38
LOCATION 39
LOCATION 40
North
Mean
Peak


LOCATION 41
North
Mean
Peak
LOCATION 42
Mean
Peak
LOCATION 43
Mean
Peak
LOCATION 44
Mean
Peak
LOCATION 45
North
Mean
Peak
LOCATION 46
North
Mean
Peak
LOCATION 47
North
Mean
Peak

Making Sustainability Happen