15780

APPENDIX D

Wind Impact Assessment Report

RWDI

REPORT

48 BEECROFT ROAD

EPPING, NSW

PEDESTRIAN WIND STUDY

RWDI #1804388 REV D

May 16, 2019

SUBMITTED TO

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1 INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by PDS Australia to consult on the pedestrian wind conditions for the proposed 48-54 Beecroft Road located in Epping, Sydney, NSW. The proposed building is approximately 72 m tall from Beecroft Road and 76 m from Rawson Street due to the elevation change around the building footprint. The building consists of a 19-storey tower with a mechanical penthouse on the roof. The purpose of the study was to assess the wind environment around the development in terms of pedestrian wind comfort and safety. The achievement of this objective included wind tunnel testing of a 1:300 scale model of the proposed development for the following configurations:

Configuration A - Existing: existing site with existing and under-construction surroundings;

Configuration B - Proposed: proposed development with existing and under-construction surroundings; and

Configuration C - Proposed: revised proposed development with landscaping features and existing and under-construction surroundings.

Configuration D - Mitigation: revised proposed development with existing surrounding buildings and wind mitigation measures.

The photographs in Figures 1a, 1b, 1c and 1d show the test model in RWDI's boundary-layer wind tunnel. The test model was constructed using the design information and drawings listed in Appendix A. This report summarizes the methodology of wind tunnel studies for pedestrian wind conditions, describes the Parramatta pedestrian wind comfort and safety criteria, presents the local wind conditions and their effects on pedestrians and provides conceptual wind control measures, where necessary.

2 SUMMARY OF WIND CONDITIONS

The wind conditions around the proposed 48 Beecroft Road are discussed in detail in Section 5 of this report and may be summarized as follows:

- Around the existing site (Configuration A) conditions are largely suitable for a mix of sitting through walking activities, with the exception of parts of Rawson Street which are uncomfortably windy.
- Conditions would become windier as a result of the proposed development (Configuration B) without the consideration of landscaping features. Larger parts of Rawson Street and Beecroft Road would become uncomfortably windy in this scenario compared to the existing site.
- The revisions to the building massing and addition of landscaping in Configuration C do not significantly improve the wind microclimate results compared to Configuration B. Some locations become calmer, while others are made windier in this scenario.
- With the introduction of the wind mitigation measures (Configuration D), wind conditions in and around the proposed development are generally improved such that they become largely suitable for their intended use by the general public. However, there are some locations where uncomfortable conditions persist. These conditions may be tolerable by considering the usage of the area and given the wind speed only marginally exceeds the threshold value (16m/s) for comfortable walking. In RWDI's opinion, the gust-based comfort criteria are overly conservative in this case, and an assessment by more widely accepted "GEM" (gust-equivalent mean) criteria would demonstrate that the mitigated development would have wind conditions that are suitable for the intended pedestrian use.
- It is noted that the location of the site in Epping being inland is less exposed to prevailing coastal sea breezes compared to similar sites closer to the coast. As such, meteorological data from Bankstown Airport has been used in the assessment rather than data from Sydney International Airport.

3 METHODOLOGY

As shown in Figures 1a to 1d, the wind tunnel model included the proposed development and all relevant surrounding buildings and topography within a 340-m radius of the study site. The boundary-layer wind conditions beyond the modelled area were also simulated in RWDI's wind tunnels based on approach profiles and terrain roughness detailed in Appendix B. As shown in the profiles for mean wind speed and turbulence for each sector of terrain roughness, the calculated profiles by using the ESDU method were found to closely follow the standard suburban profile. Therefore, the wind tunnel tests were conducted using the suburban profile for all wind directions, and any difference between the calculated and tunnel profiles was corrected numerically after testing.

Configurations A and B were tested in RWDI's boundary layer wind tunnel facility in Guelph, Ontario, Canada. Configuration C, which incorporated updates to the design of the proposed development, and additional landscaping elements, was tested in RWDI's facility in Trivandrum, Kerala, India. Additional mitigation workshops were conducted in order to alleviate the undesired wind conditions predicted in previous Configuration C.

The model was instrumented with 60 (Irwin) wind speed sensors to measure the mean and gust wind speeds at a full-scale height of approximately 1.5 m (Appendix C). The measured wind speed ratios in Appendix C were referenced to the mean wind speed at a reference height close to the top of the boundary-layer profile, from which the site wind speed was then referenced to the 10 m height wind records at a local airport through detailed ESDU wind profile calculations.

The long-term weather data recorded at the Bankstown Airport (for the period from 1989 to 2014) were analyzed for the Summer (November through April) and Winter (May through October) seasons. Figure 2 graphically depicts the directional distributions of wind frequencies and speeds for the two seasons. Winds from the south-east and north-east are predominant during the summer, while winds in the winter originate predominantly from the north-west, west and south-west, as indicated by the wind roses in Figure 2. Annually, the stronger wind events tend to occur more often during the summer than the winter, with the northeast and south-easterly winds generating the majority of "windy" local microclimate conditions.

Wind statistics from Bankstown Airport were combined with the wind tunnel data in order to predict the frequency of occurrence of full-scale wind speeds. The full-scale wind predictions were then compared with the City of Parramatta criteria for pedestrian comfort and safety. Appendix D presents directional weightings for each sensor location to illustrate the statistical combination of wind speeds and directional frequency to determine an overall categorization of the wind conditions.

It is noted that the location of the site in Epping being inland is less exposed to prevailing coastal sea breezes compared to sites closer to the coast. Meteorological data from Bankstown Airport has therefore been used (rather than data from Sydney International Airport), since it is likely to be more representative of an inland location.

4 EXPLANATION OF CRITERIA

The City of Parramatta DCP wind criteria are described in the table below, using gust wind speeds occurring 0.1% of the time annually.

Gust Speed (m/s)	Pedestrian Area	Rating
Comfort		
≤10	Retail streets	Sitting
11-13	Major pedestrian streets, parks and public places	Standing
14-16	All other streets	Walking
17-23	All Pedestrian areas	Windy/Uncomfortable
Safety		
>23	All Pedestrian areas	Unacceptable/Unsafe

The rating at the last column is added for presentation purposes (and is used in the presentation of results later in this report). A wind speed greater than the 16 m/s criterion for all other streets is rated as Windy or Uncomfortable, and a wind speed greater than 23 m/s is rated as unacceptable or unsafe.

Gust wind speeds at a 0.1% occurrence represent a relatively infrequent wind event, and are not representative of the more commonly occurring wind conditions. We would argue that mean or gust equivalent mean (GEM) wind speeds at an occurrence of 20% are more representative for commonly occurring wind conditions affecting wind comfort. Municipalities around the world and in Australia including Sydney and Melbourne are moving away from using outdated gust-based criteria due to the inherent flaws with this approach, and notably windy precincts developed based on this approach. The GEM wind comfort criteria has also been applied for the majority of recent developments located within the Parramatta CBD precinct due to the greater accuracy to full-scale measurements. However, for the purpose of this assessment, results are presented as per the current requirements of the wind comfort criteria outlined in the Parramatta City Council DCP.

5 PREDICTED WIND CONDITIONS

Figures 3 to 6 graphically depict the predicted wind comfort conditions pertaining to the three tested configurations. The numerical information related to these results are presented in Table 1, located in the Tables section of this report.

Taller buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level (see Image 1). Such a Downwashing Flow is often the main cause for wind accelerations around large buildings at the pedestrian level. These flows subsequently accelerate around windward facing building corners and could result in severe wind activity near the corner (see Image 2). If these building/wind combinations occur for prevailing winds, there is a greater potential for increased wind activity.

Image 1 – Downwashing Flow

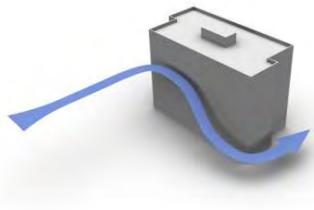

Image 2 – Corner Acceleration

The following is a detailed discussion of the suitability of the predicted wind comfort conditions for the anticipated pedestrian use of each area.

Wind conditions comfortable for walking are appropriate for footpaths and other areas where pedestrians are likely to be active. Lower wind speeds conducive to sitting are recommended for outdoor seating areas and terraces intended for relaxed passive activities, while winds suitable for standing are preferred at main entrances where pedestrians are apt to linger.

5.1 Configuration A – Existing (Figure 3)

For the existing configuration, wind conditions on and around the site are mostly expected to be in the range suitable for sitting use to walking use throughout the year (Figure 3). There is one location that has uncomfortable wind conditions, namely along Rawson Street represented by measurement location 22.

There were no occurrences of strong winds exceeding the safety threshold.

5.2 Configuration B – Proposed (Figure 4)

On-site Areas – Ground Level (Locations 1 to 10 and 47 to 60)

Wind speeds on the footpaths on-site to the north and on Beecroft Road are predicted to have walking wind conditions or better in the area around locations 31 and 47 with one uncomfortable condition at location 48.

Conditions comfortable for standing and sitting are expected throughout the year at the residential lobby entrance fronting on Hunts Lane (Location 10) and the entrance on Level 1 (Location 57) respectively. These conditions are appropriate for the intended use of these areas.

Wind speeds on the on-site footpath on Rawson Street are expected to be higher due to the downwashing and subsequent acceleration of winds from the north-west, west and south-west (Images 1 and 2). The resulting wind speeds are rated uncomfortable for any activities on the west and south sides of the proposed development, along Rawson street and Hunts Lane represented by locations 1 to 7. However, one location (Location 9) on the south side of the development (Hunts Lane) had walking wind conditions which are appropriate. The upper ground floor represented by the locations 51 to 60 is predicted to have a range of wind conditions suitable for standing use to walking use with one uncomfortable wind condition at location 60. These conditions are likely to be too windy for amenity activities.

Off-site Areas (Locations 11 to 46)

Wind conditions at surrounding areas and footpaths have a range of wind conditions suitable for sitting use through uncomfortable conditions as shown in figure 4. Locations where uncomfortable wind conditions are expected to occur are represented by locations 18, 20, 21, 22, 41, 43 and 44.

5.3 Configuration C – Proposed Development with Landscaping Features (Figure 5)

Configuration C incorporated modifications to the building massing and the addition of soft landscaping elements, which are visible in the photographs in Figure 1c. We would note that the station building and footbridge were updated in this configuration to include additional detail, to more accurately capture the wind behavior in this area.

On and Off-Site Areas

The wind conditions are largely consistent with Configuration B at many locations. There are fewer areas on Rawson Street and Beecroft Road that are classified as uncomfortable becoming suitable for walking at locations 1, 2, 20, 43, 48 and suitable for standing at locations 4, 11, 41, 44. However, several uncomfortable locations remain as per the previous configurations (locations 3, 5, 6, 7 and 18). There are two locations 35 and 47 where walking conditions were expected in previous configuration, which became uncomfortable in configuration C (not suitable for the intended pedestrian use, and therefore requiring mitigation measures).

Upper Ground Floor (Amenity Spaces)

Uncomfortable wind condition at location 60 in Configuration B became suitable for standing in Configuration C. However, location 53 became windier, expected to have uncomfortable wind conditions. All other locations have mix of standing and walking wind conditions which are likely to be too windy for the intended amenity use.

5.4 Configuration D – Proposed Development with Mitigation Measures (Figure 6 and Appendix F)

As part of the Client's commitment to ensure the suitable wind microclimate is achieved with the completed proposed development in situ, a number of mitigation measures have been explored to ensure the desired wind conditions for the intended pedestrians use. The following mitigation measures were developed through a series of wind mitigation workshops: -

- In addition to the trees at west side of the proposed development at ground level, shrubs of 1.8m high added between the trees;
- A series of porous screens of 2m wide and 2m high at 2m interval to the south-west corner of the proposed development;
- Shrubs of 1.8m high around Location 53, at south-east corner of the proposed development;
- A canopy of 1m deep at southwest corner of the proposed development;
- Three porous screens of 2m wide and 2m high at both sides of the retail in west side of the upper ground level; and
- Shrubs of 1.8m high at south side of the upper ground level around Location 56.

These wind mitigation measures are shown in Appendix F.

On and Off-Site Areas

The addition of mitigation measures helps to reduce the wind speed (refer table 1_Mitigation) at several key areas around the proposed development. The conditions along Rawson Street that were uncomfortable in Configuration C (Locations 3, 5, 6, 7 and 18) become suitable for walking in Configuration D. However, uncomfortable conditions (Locations 21, 22, 35) at north-west of the proposed development, along Rawson Street remain consistent with the configuration C and Location 22 is pre-existing in the baseline scenario (Existing – Configuration A). These conditions might be tolerable by considering the wind speed (only marginally exceeding the threshold value of walking criteria) and usage of the area where pedestrians would move intentionally (i.e. would have no reason to linger in these locations). Similarly, other such borderline cases where wind speed slightly increased when compared to configuration C (Locations 30 and 9) are likely acceptable for the intended pedestrian use.

The rest of the locations in and around the proposed development remain consistent with Configuration C, having a range of wind conditions suitable for sitting use to walking use.

Upper Ground Floor (Amenity Spaces)

The wind speed at southeast corner of the proposed development (Location 53) is reduced when compared with configuration C, and only marginally exceeds the threshold value of walking. Provided that there is no reason for pedestrians to linger in this specific location, the conditions are likely to be tolerable for the intended pedestrian use, especially given that the gust-based comfort criteria are overly conservative in this instance (a "GEM" or gust-equivalent-mean assessment would indicate that this area is suitable for its intended pedestrian use).

The rest of the area is predicted to have wind conditions suitable for standing use with exception of walking wind conditions at south side (Locations 56 and 60). Additional localised shelter (such as porous screen covering the southwest corner at Location 60) could be applied post-build for specific seating areas if required.

5.5 Safety Exceedance

There were no occurrences of strong winds exceeding the safety threshold in Configurations A, B, C and D.

5.6 Updated Landscape Design

After completion of the wind tunnel testing, the landscape design has been updated to consider the abovementioned treatment mitigation measures. The following are nopted to have been incorporated into the current design scheme:

- Urbis Landscape Design dated May 2, 2019. The landscape design has incorporated the noted tree and shrub planting along Hunts Lane as well as Rawson Street. The recommended shrub planting as also be incorporated on Ground Level to provide the required wind comfort criteria.
- The updated Architectural Model from Woods Bagot, dated May 10, 2019, has incorporated the recommended awning along Hunts Lane. It is noted that deeper awning options were modelled, however no benefit was noted from a wind mitigation perspective.
- It is recommended that the additional screening elements be incorporated in the landscape areas on Hunts Lane, as noted in the model tested for Configuration D, but included in the final Landscape Design, which is noted to be finalized during the detailed design phase.

6 CONCLUSIONS

The inclusion of purposely designed wind mitigation measures provides a substantial benefit to pedestrian wind comfort, Wind conditions in and around the proposed development are improved when compared against the unmitigated scenarios, and are predominantly suitable for walking use or calmer. Furthermore, there would be no exceedances of the safety criterion.

The few "uncomfortable" conditions that persist only marginally exceed the threshold for comfortable walking. Given that these occur in areas where pedestrians are not expected to linger, and also given that the gust-based criteria for comfort are likely to be overly conservative in this scenario (see note below), we would conclude that the conditions are suitable for the intended pedestrian use.

Note regarding gust-based criteria:

We would note that wind speed thresholds defined in the Parramatta wind comfort criteria (gust wind speeds at a 0.1% annual occurrence) represent relatively infrequent wind events, and are not representative of more commonly occurring wind conditions. We would argue that mean or gust equivalent mean wind speeds at an occurrence of 20% are more representative for commonly occurring wind conditions affecting wind comfort. The GEM wind comfort criteria has also been applied for the majority of recent developments located within the Parramatta CBD precinct due to the greater accuracy to full-scale measurements. However, for the purpose of this assessment, results are presented as per the current requirements of the wind comfort criteria outlined in the Parramatta City Council DCP.

7 APPLICABILITY

The wind conditions presented in this report pertain to the proposed 48 Beecroft Road development as detailed in the architectural design drawings listed in Appendix A. Should there be any design changes that deviate from this list of drawings, the wind condition predictions presented may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

8 REFERENCES

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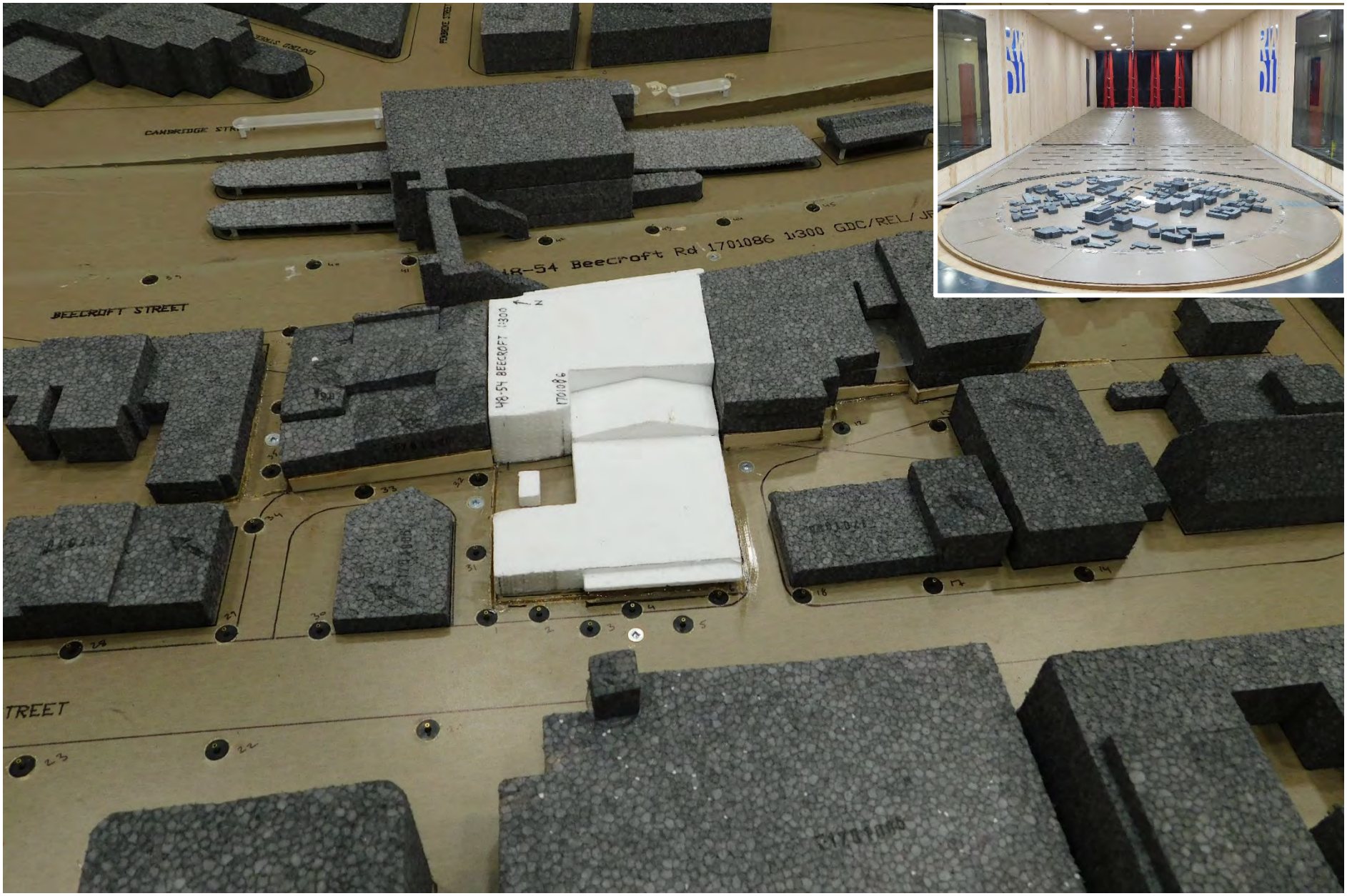
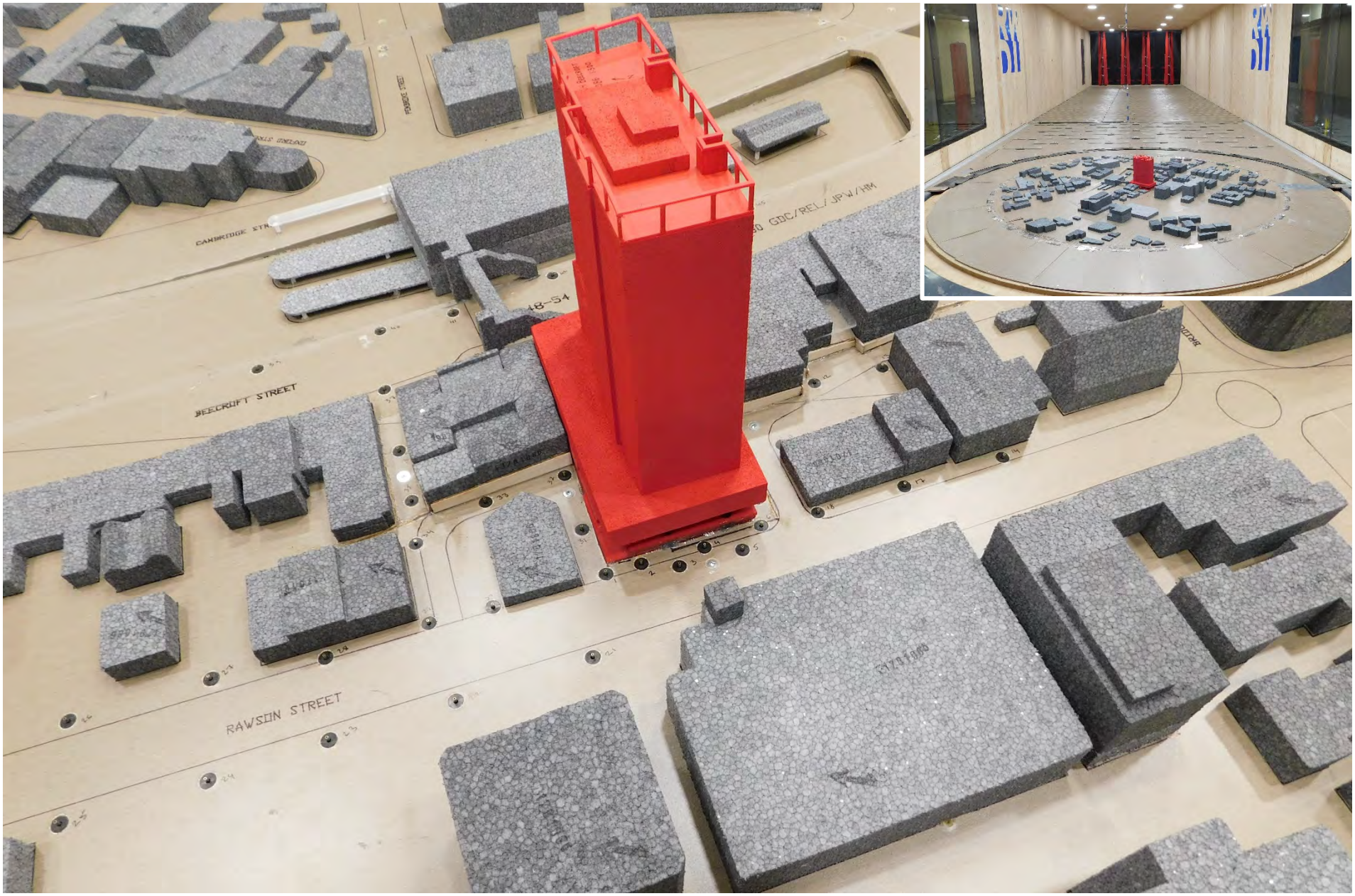
8) Durgin, F.H. (1997). "Pedestrian Level Wind Criteria Using the Equivalent average", Journal of Wind Engineering and Industrial Aerodynamics, Vol. 66, pp. 215-226.


BEECROFT STREET
48-54 Beecroft Rd 1701086 1:300 GDC/REL/
48-54 BEECROFT 1:300
1701086



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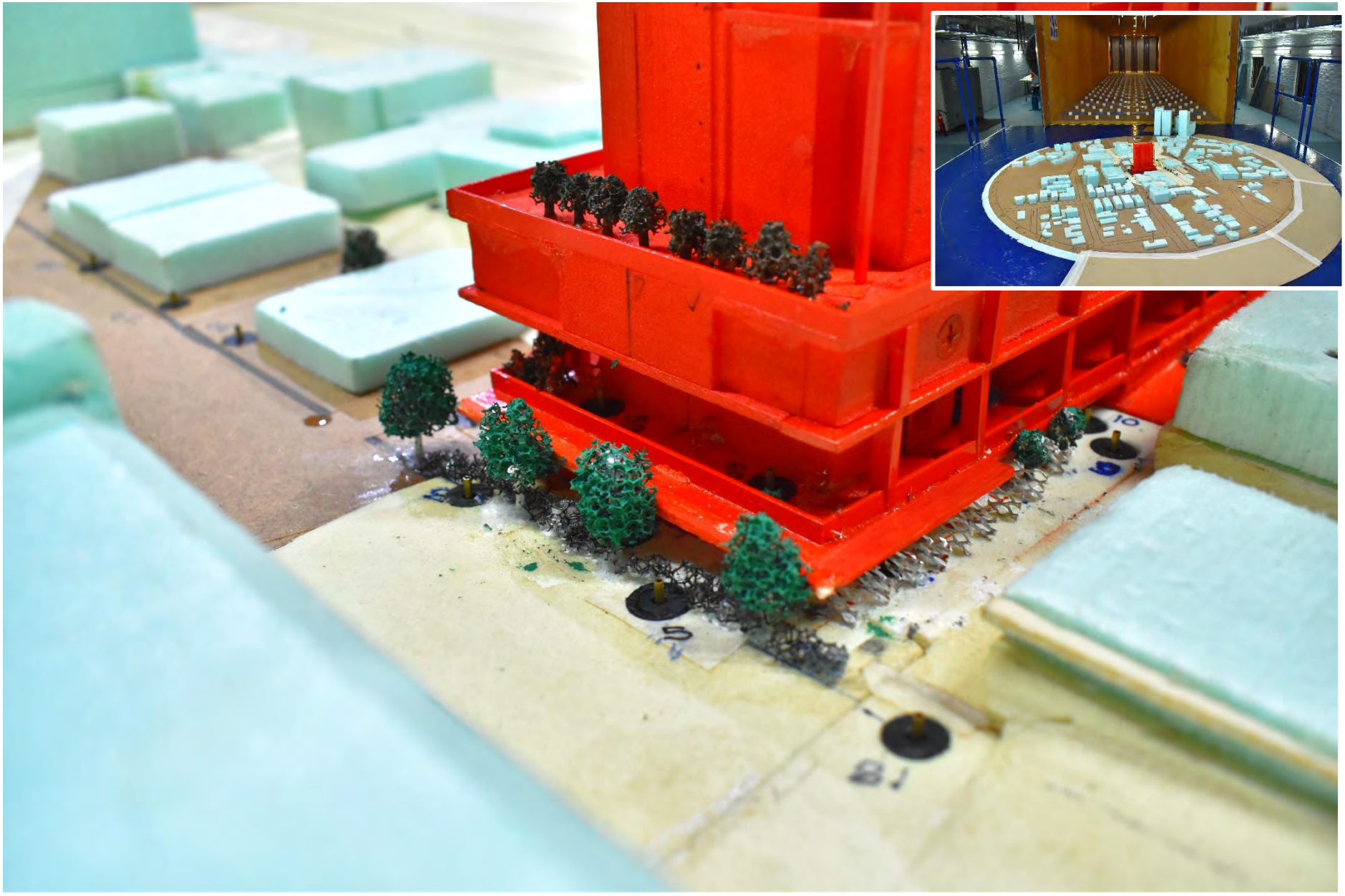


Wind Tunnel Study Model
Mitigation

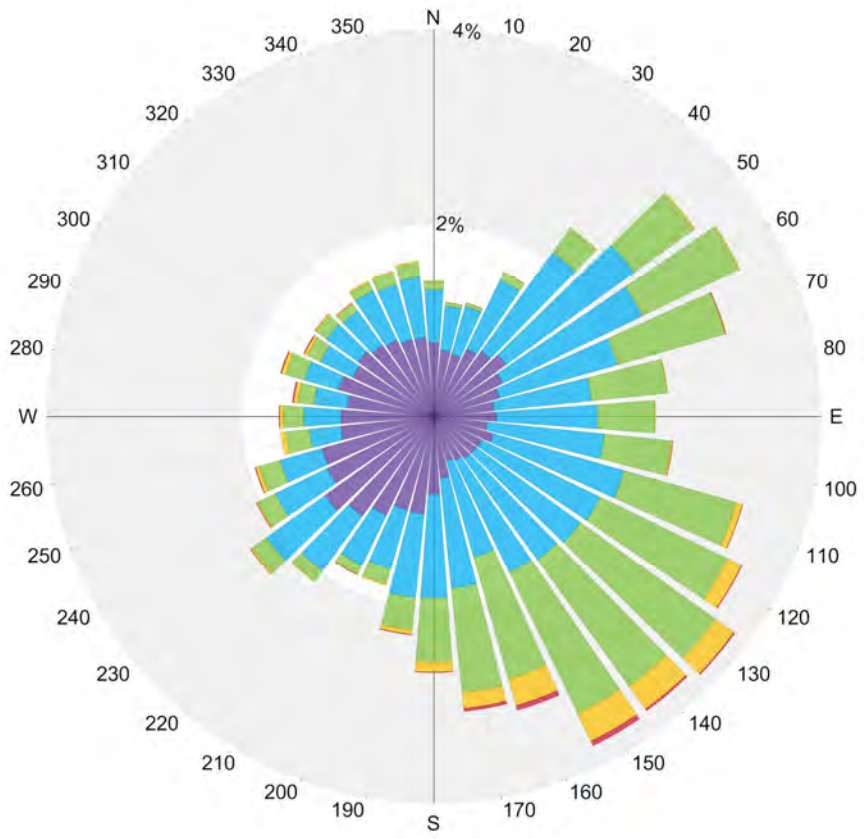
48 Beecroft Road – Sydney, Australia

Project #1804388

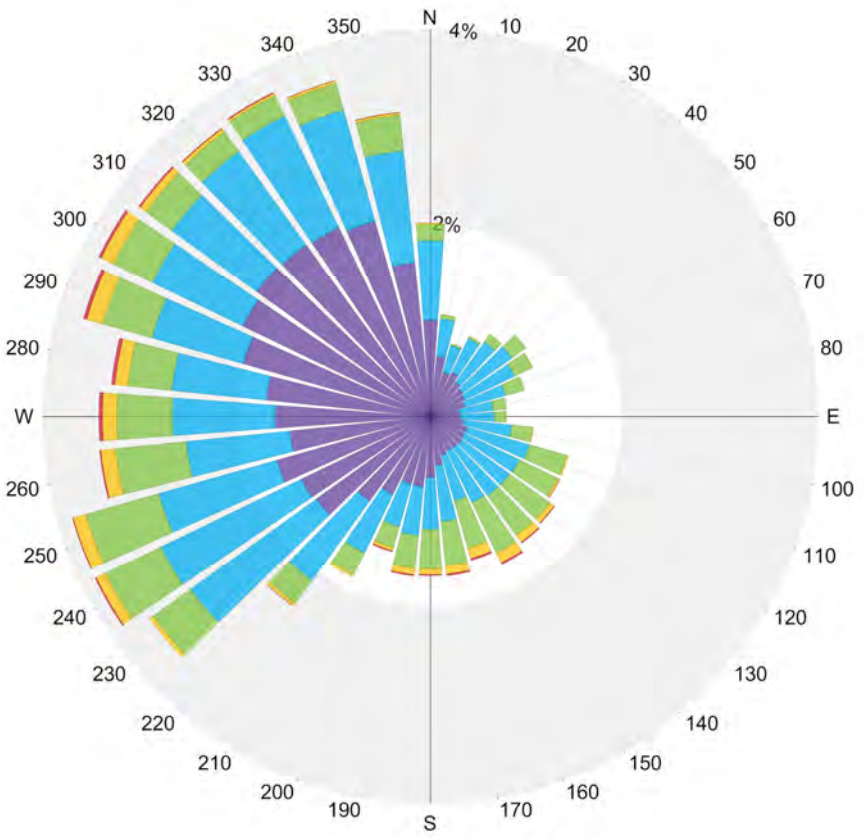
Figure No. 1d

Date: April 22, 2019

RWDI



Summer
(November - April)



Winter
(May - October)

Wind Speed (km/h)	Probability (%) Summer	Winter
Calm	17.8	21.1
1-10	30.2	36.0
11-20	30.3	28.2
21-30	19.3	12.5
31-40	2.1	1.9
>40	0.2	0.3

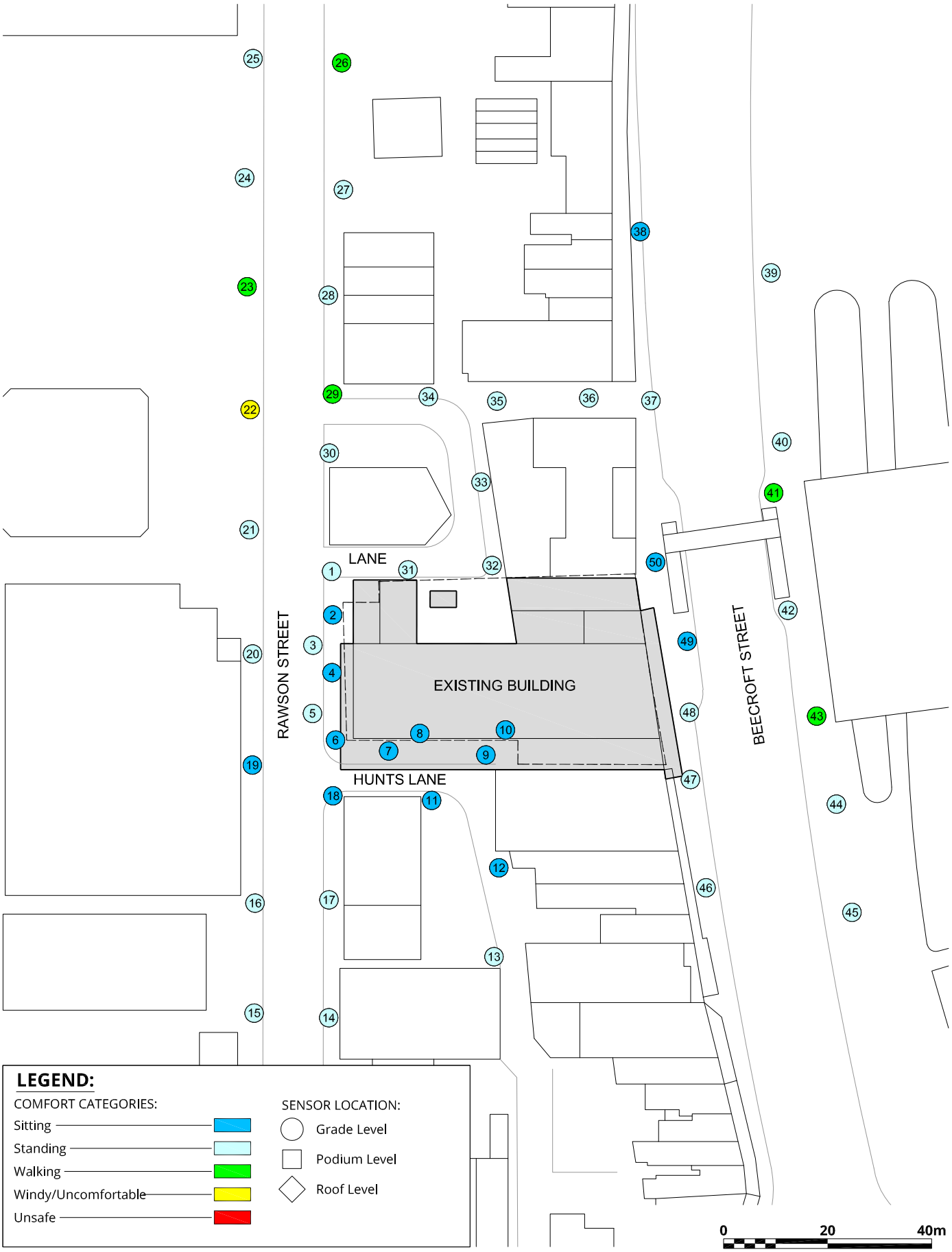
Directional Distribution (%) of Winds (Blowing From)
Bankstown Airport (BOM) (1989 - 2014)

Figure No. 2

48 Beecroft Road – Epping (Sydney), NSW

Project #1804388

Date: April 29, 2019



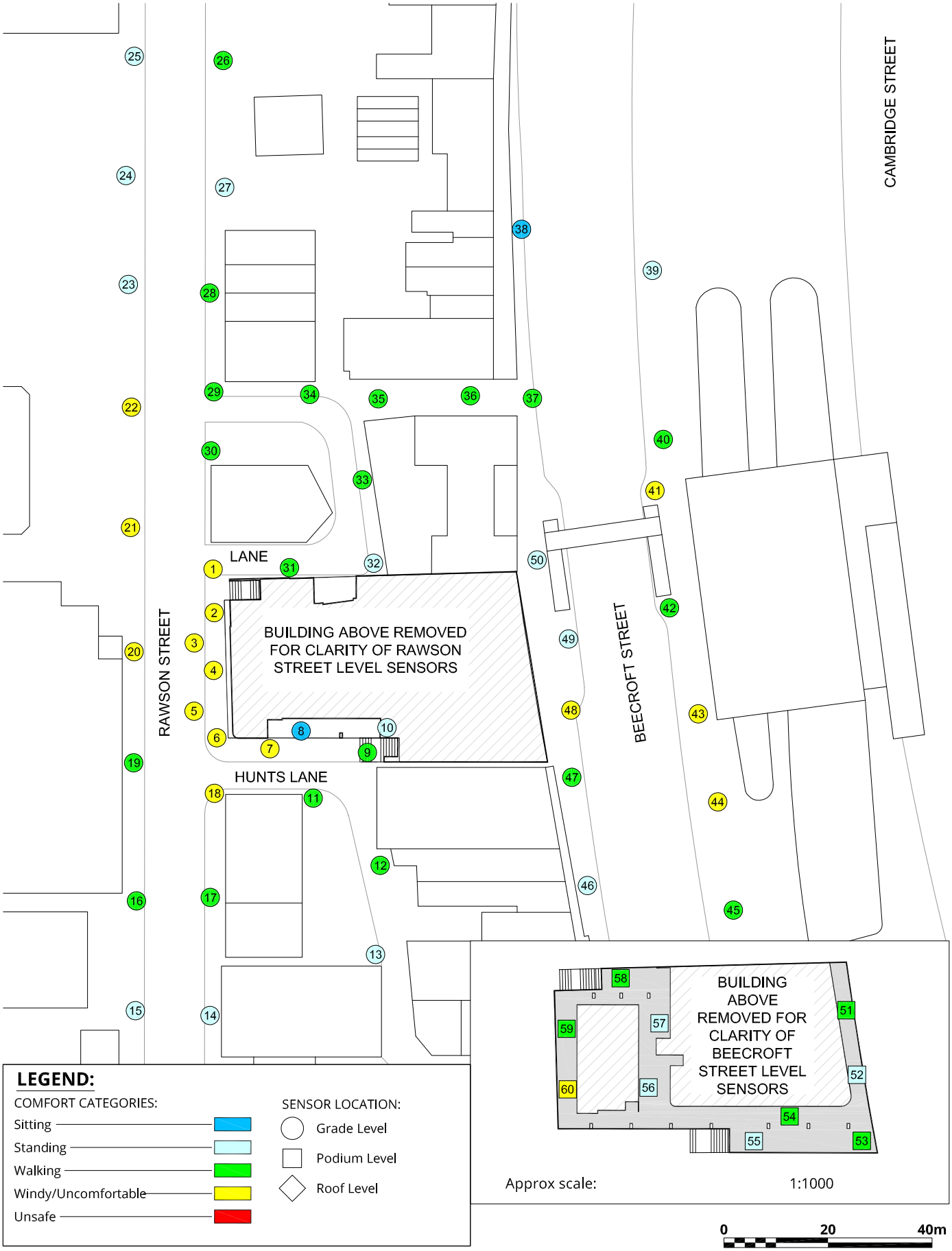
Pedestrian Wind Safety Conditions
Existing Development
Configuration - A
Annual

48 Beecroft Road - Sydney, NSW

Project #1804388

True North

Drawn by: MBR	Figure: 3
Approx. Scale:	1:1000
Date Revised:	Jan. 24, 2019



Pedestrian Wind Safety Conditions

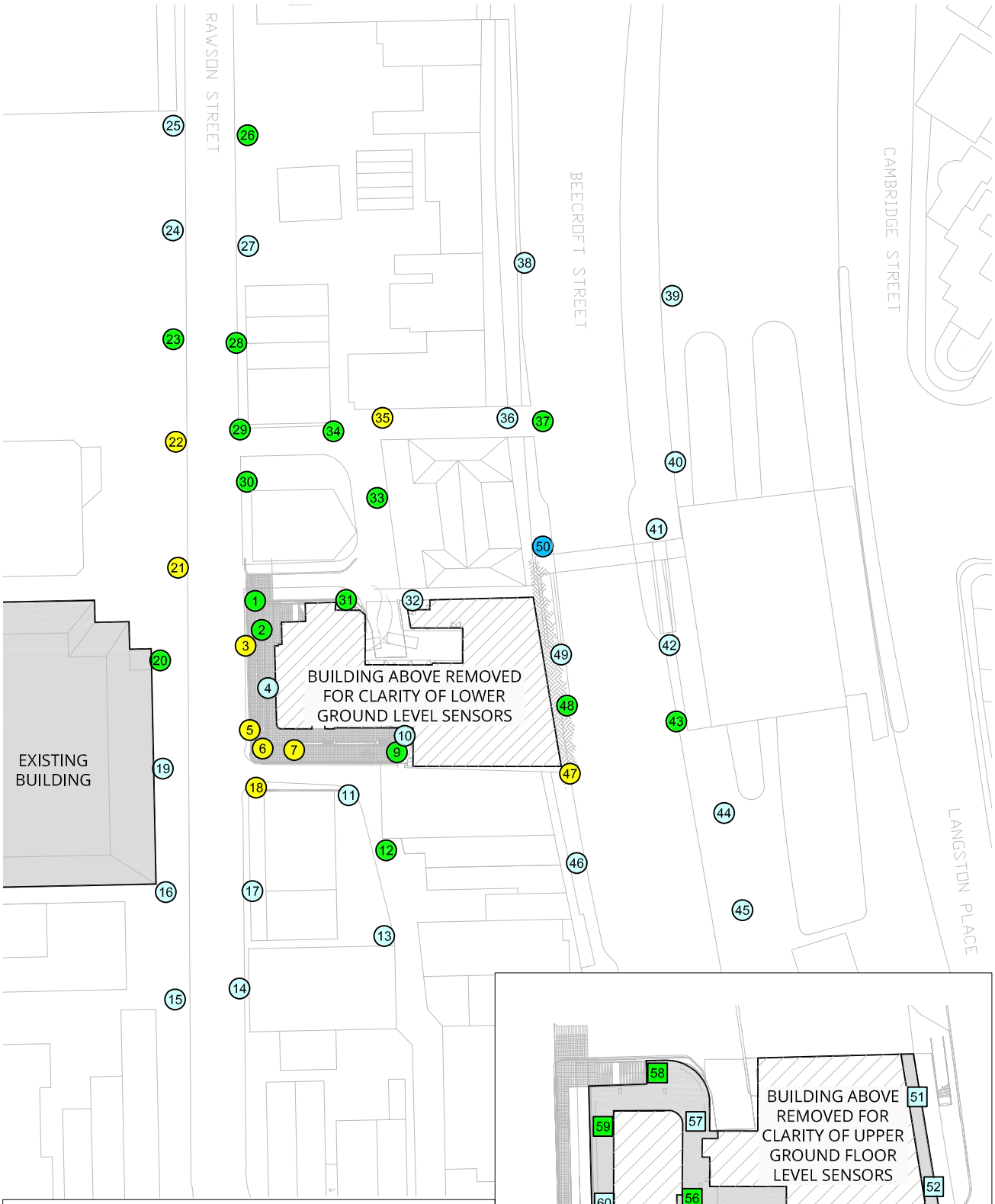
Proposed Development
Configuration - B
Annual

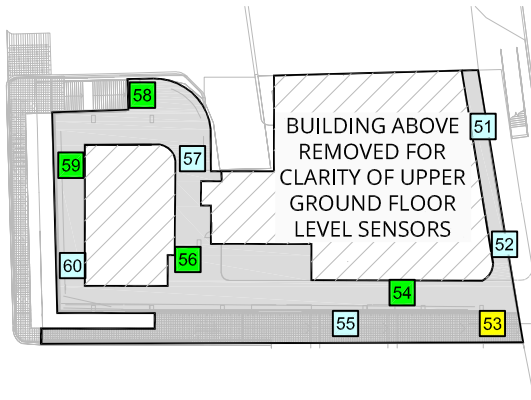
48 Beecroft Road - Sydney, NSW

Project #1804388

True North

Drawn by: MBR	Figure: 4
Approx. Scale:	1:1000
Date Revised:	Jan. 24, 2019





UPPER GROUND FLOOR PLAN
Scale: 1:1000

LEGEND:

COMFORT CATEGORIES:
- Sitting
- Standing
- Walking
- Windy/Uncomfortable
- Unsafe

SENSOR LOCATION:
- Grade Level
- Podium Level

0 25 50m

Pedestrian Wind Safety Conditions

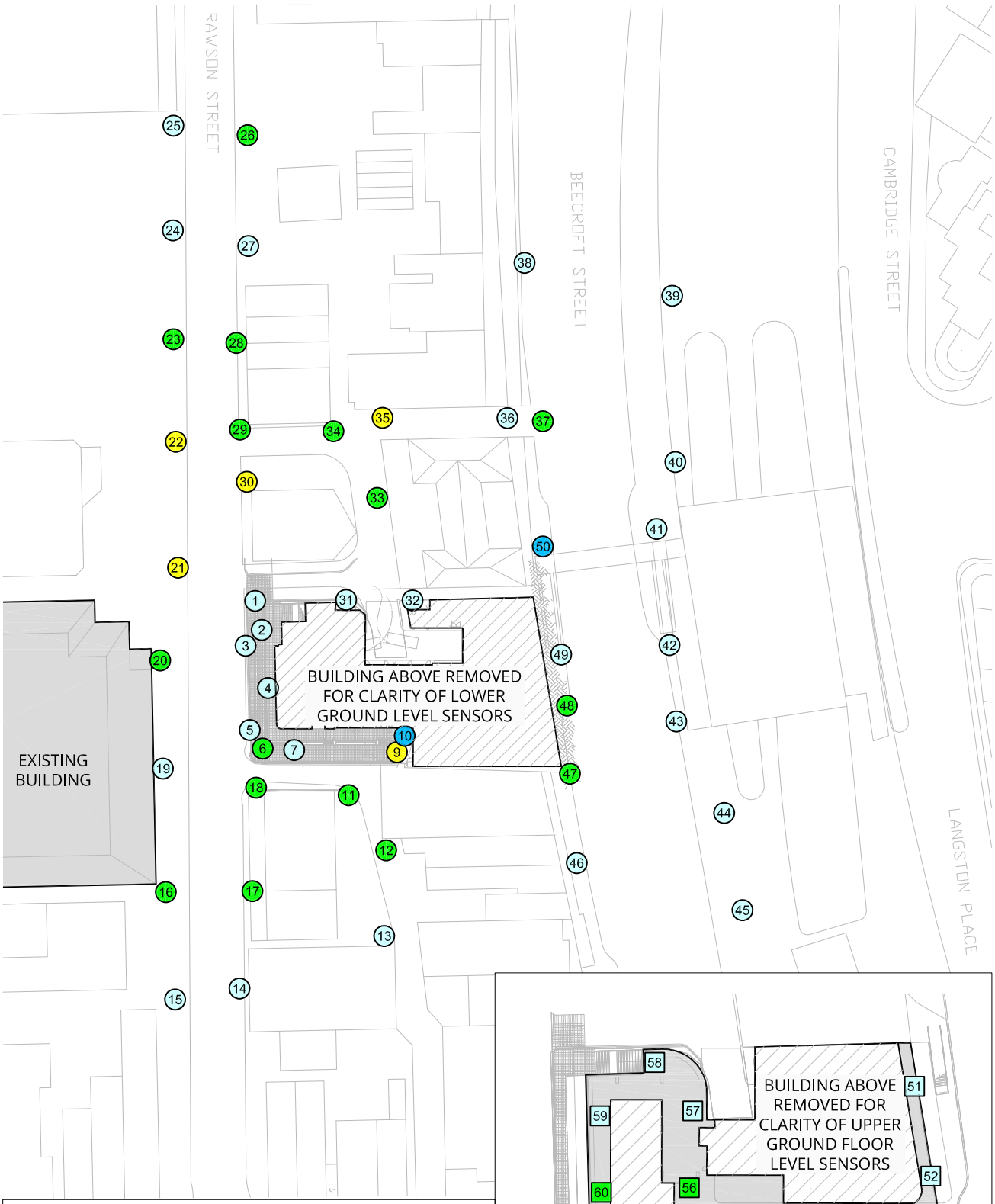
Proposed Development with Landscaping features
Configuration - C
Annual

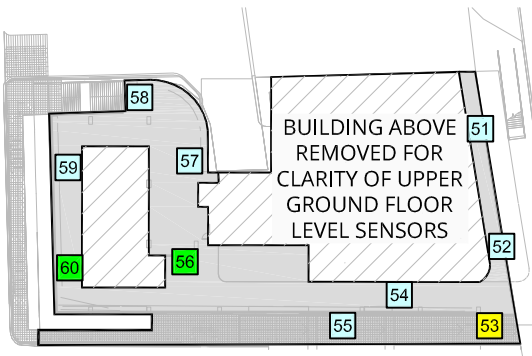
48 Beecroft Road - Sydney, NSW

Project #1804388

True North

Drawn by: ABN	Figure: 5	
Approx. Scale:	1:1250	
Date Revised:	Apr. 29, 2019	





UPPER GROUND FLOOR PLAN
Scale: 1:1000

LEGEND:

COMFORT CATEGORIES:
- Sitting
- Standing
- Walking
- Windy/Uncomfortable
- Unsafe

SENSOR LOCATION:
- Grade Level
- Podium Level

0 25 50m

Pedestrian Wind Comfort Conditions

Mitigation
Configuration - D
Annual

48 Beecroft Road - Sydney, NSW

Project #1804388

True North

Drawn by:	ABN	Figure:	6
Approx. Scale:	1:1250		
Date Revised:	Apr. 29, 2019		

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
1	Configuration A	11	Standing
	Configuration B	17	Uncomfortable
	Configuration C	14	Walking
	Configuration D	11	Standing
2	Configuration A	9	Sitting
	Configuration B	17	Uncomfortable
	Configuration C	14	Walking
	Configuration D	12	Standing
3	Configuration A	11	Standing
	Configuration B	19	Uncomfortable
	Configuration C	17	Uncomfortable
	Configuration D	13	Standing
4	Configuration A	10	Sitting
	Configuration B	18	Uncomfortable
	Configuration C	11	Standing
	Configuration D	11	Standing
5	Configuration A	11	Standing
	Configuration B	19	Uncomfortable
	Configuration C	17	Uncomfortable
	Configuration D	11	Standing

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
6	Configuration A	9	Sitting
	Configuration B	20	Uncomfortable
	Configuration C	21	Uncomfortable
	Configuration D	15	Walking
7	Configuration A	3	Sitting
	Configuration B	18	Uncomfortable
	Configuration C	17	Uncomfortable
	Configuration D	13	Standing
8	Configuration A	3	Sitting
	Configuration B	8	Sitting
	Configuration C	-	-
	Configuration D	-	-
9	Configuration A	5	Sitting
	Configuration B	15	Walking
	Configuration C	15	Walking
	Configuration D	17	Uncomfortable
10	Configuration A	7	Sitting
	Configuration B	11	Standing
	Configuration C	11	Standing
	Configuration D	10	Sitting

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
11	Configuration A	9	Sitting
	Configuration B	14	Walking
	Configuration C	13	Standing
	Configuration D	14	Walking
12	Configuration A	9	Sitting
	Configuration B	14	Walking
	Configuration C	14	Walking
	Configuration D	14	Walking
13	Configuration A	11	Standing
	Configuration B	12	Standing
	Configuration C	11	Standing
	Configuration D	11	Standing
14	Configuration A	12	Standing
	Configuration B	13	Standing
	Configuration C	11	Standing
	Configuration D	11	Standing
15	Configuration A	13	Standing
	Configuration B	12	Standing
	Configuration C	11	Standing
	Configuration D	11	Standing

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
16	Configuration A	12	Standing
	Configuration B	14	Walking
	Configuration C	12	Standing
	Configuration D	14	Walking
17	Configuration A	12	Standing
	Configuration B	14	Walking
	Configuration C	12	Standing
	Configuration D	14	Walking
18	Configuration A	9	Sitting
	Configuration B	17	Uncomfortable
	Configuration C	17	Uncomfortable
	Configuration D	15	Walking
19	Configuration A	9	Sitting
	Configuration B	14	Walking
	Configuration C	12	Standing
	Configuration D	12	Standing
20	Configuration A	11	Standing
	Configuration B	18	Uncomfortable
	Configuration C	16	Walking
	Configuration D	15	Walking

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
21	Configuration A	12	Standing
	Configuration B	18	Uncomfortable
	Configuration C	18	Uncomfortable
	Configuration D	17	Uncomfortable
22	Configuration A	17	Uncomfortable
	Configuration B	17	Uncomfortable
	Configuration C	17	Uncomfortable
	Configuration D	17	Uncomfortable
23	Configuration A	14	Walking
	Configuration B	13	Standing
	Configuration C	14	Walking
	Configuration D	14	Walking
24	Configuration A	13	Standing
	Configuration B	13	Standing
	Configuration C	13	Standing
	Configuration D	13	Standing
25	Configuration A	12	Standing
	Configuration B	12	Standing
	Configuration C	11	Standing
	Configuration D	11	Standing

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
26	Configuration A	15	Walking
	Configuration B	14	Walking
	Configuration C	14	Walking
	Configuration D	14	Walking
27	Configuration A	12	Standing
	Configuration B	13	Standing
	Configuration C	12	Standing
	Configuration D	12	Standing
28	Configuration A	12	Standing
	Configuration B	14	Walking
	Configuration C	14	Walking
	Configuration D	14	Walking
29	Configuration A	15	Walking
	Configuration B	15	Walking
	Configuration C	14	Walking
	Configuration D	14	Walking
30	Configuration A	12	Standing
	Configuration B	16	Walking
	Configuration C	16	Walking
	Configuration D	17	Uncomfortable

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
31	Configuration A	11	Standing
	Configuration B	14	Walking
	Configuration C	14	Walking
	Configuration D	13	Standing
32	Configuration A	11	Standing
	Configuration B	12	Standing
	Configuration C	13	Standing
	Configuration D	13	Standing
33	Configuration A	11	Standing
	Configuration B	14	Walking
	Configuration C	15	Walking
	Configuration D	14	Walking
34	Configuration A	11	Standing
	Configuration B	15	Walking
	Configuration C	14	Walking
	Configuration D	15	Walking
35	Configuration A	11	Standing
	Configuration B	14	Walking
	Configuration C	17	Uncomfortable
	Configuration D	17	Uncomfortable

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
36	Configuration A	11	Standing
	Configuration B	14	Walking
	Configuration C	13	Standing
	Configuration D	12	Standing
37	Configuration A	11	Standing
	Configuration B	14	Walking
	Configuration C	14	Walking
	Configuration D	14	Walking
38	Configuration A	9	Sitting
	Configuration B	10	Sitting
	Configuration C	11	Standing
	Configuration D	11	Standing
39	Configuration A	12	Standing
	Configuration B	12	Standing
	Configuration C	13	Standing
	Configuration D	12	Standing
40	Configuration A	12	Standing
	Configuration B	15	Walking
	Configuration C	13	Standing
	Configuration D	13	Standing

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
41	Configuration A	14	Walking
	Configuration B	20	Uncomfortable
	Configuration C	12	Standing
	Configuration D	11	Standing
42	Configuration A	11	Standing
	Configuration B	14	Walking
	Configuration C	11	Standing
	Configuration D	11	Standing
43	Configuration A	14	Walking
	Configuration B	17	Uncomfortable
	Configuration C	14	Walking
	Configuration D	13	Standing
44	Configuration A	12	Standing
	Configuration B	17	Uncomfortable
	Configuration C	12	Standing
	Configuration D	13	Standing
45	Configuration A	13	Standing
	Configuration B	14	Walking
	Configuration C	13	Standing
	Configuration D	13	Standing

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
46	Configuration A	12	Standing
	Configuration B	12	Standing
	Configuration C	12	Standing
	Configuration D	12	Standing
47	Configuration A	11	Standing
	Configuration B	14	Walking
	Configuration C	17	Uncomfortable
	Configuration D	14	Walking
48	Configuration A	11	Standing
	Configuration B	19	Uncomfortable
	Configuration C	14	Walking
	Configuration D	14	Walking
49	Configuration A	8	Sitting
	Configuration B	13	Standing
	Configuration C	13	Standing
	Configuration D	12	Standing
50	Configuration A	9	Sitting
	Configuration B	11	Standing
	Configuration C	9	Sitting
	Configuration D	9	Sitting

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
51	Configuration A	-	-
	Configuration B	15	Walking
	Configuration C	13	Standing
	Configuration D	12	Standing
52	Configuration A	-	-
	Configuration B	13	Standing
	Configuration C	12	Standing
	Configuration D	12	Standing
53	Configuration A	-	-
	Configuration B	15	Walking
	Configuration C	19	Uncomfortable
	Configuration D	17	Uncomfortable
54	Configuration A	-	-
	Configuration B	14	Walking
	Configuration C	14	Walking
	Configuration D	11	Standing
55	Configuration A	-	-
	Configuration B	11	Standing
	Configuration C	12	Standing
	Configuration D	12	Standing

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

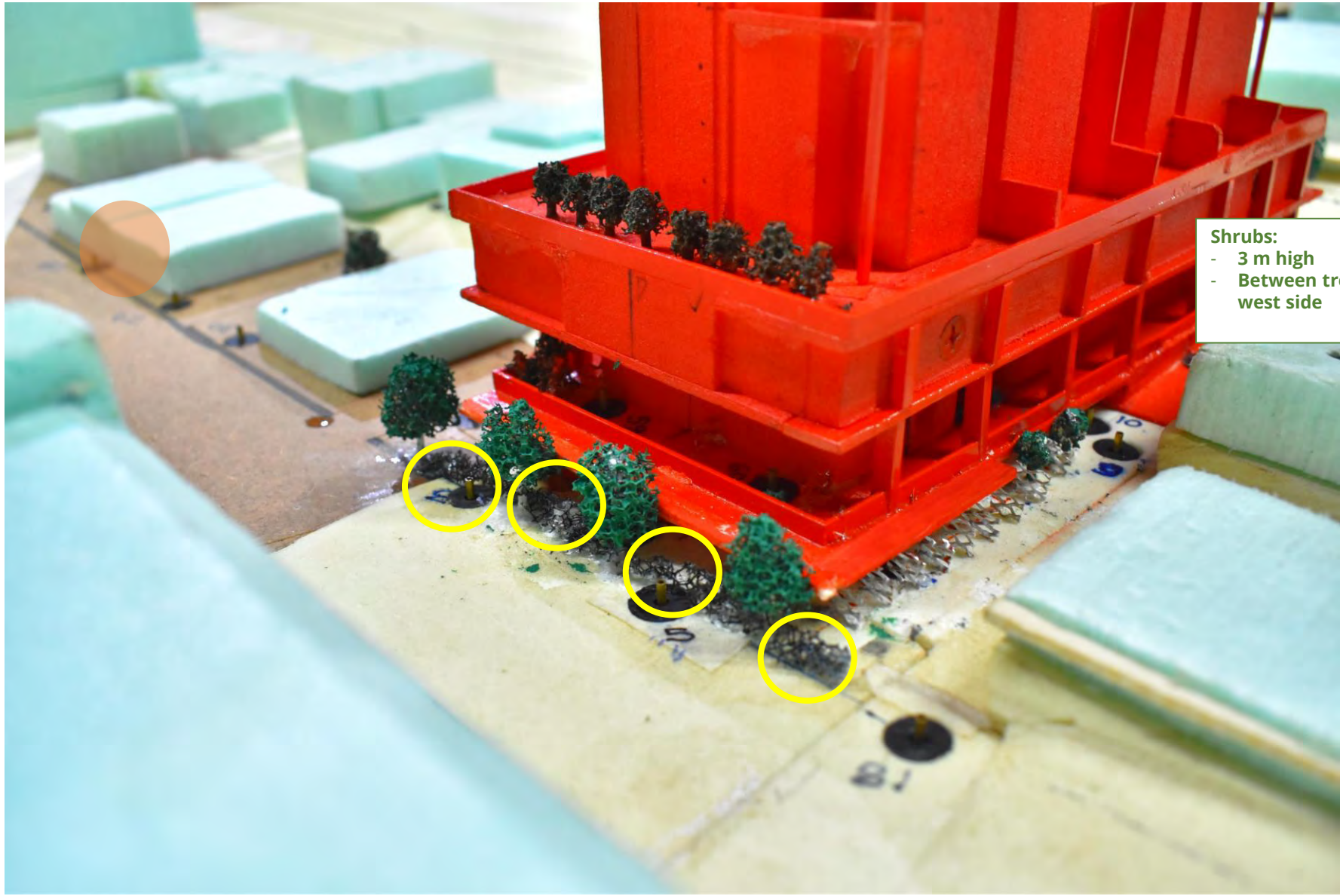
≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

Location	Configuration	Comfort and Safety	
		Annual	
		Speed (m/s)	Rating
56	Configuration A	-	-
	Configuration B	12	Standing
	Configuration C	16	Walking
	Configuration D	14	Walking
57	Configuration A	-	-
	Configuration B	11	Standing
	Configuration C	12	Standing
	Configuration D	12	Standing
58	Configuration A	-	-
	Configuration B	14	Walking
	Configuration C	14	Walking
	Configuration D	11	Standing
59	Configuration A	-	-
	Configuration B	15	Walking
	Configuration C	14	Walking
	Configuration D	12	Standing
60	Configuration A	-	-
	Configuration B	18	Uncomfortable
	Configuration C	13	Standing
	Configuration D	14	Walking

Configurations
Configuration A = Existing site with existing approved surroundings
Configuration B = Proposed development with existing approved surroundings
Configuration C = Proposed development with landscaping features and existing approved surroundings
Configuration D = Proposed development with existing approved surroundings and wind mitigation measures

≤ 10 m/s	Sitting
11 to 13	Standing
14 to 16	Walking
17 to 23	Uncomfortable
>23 m/s	Unsafe

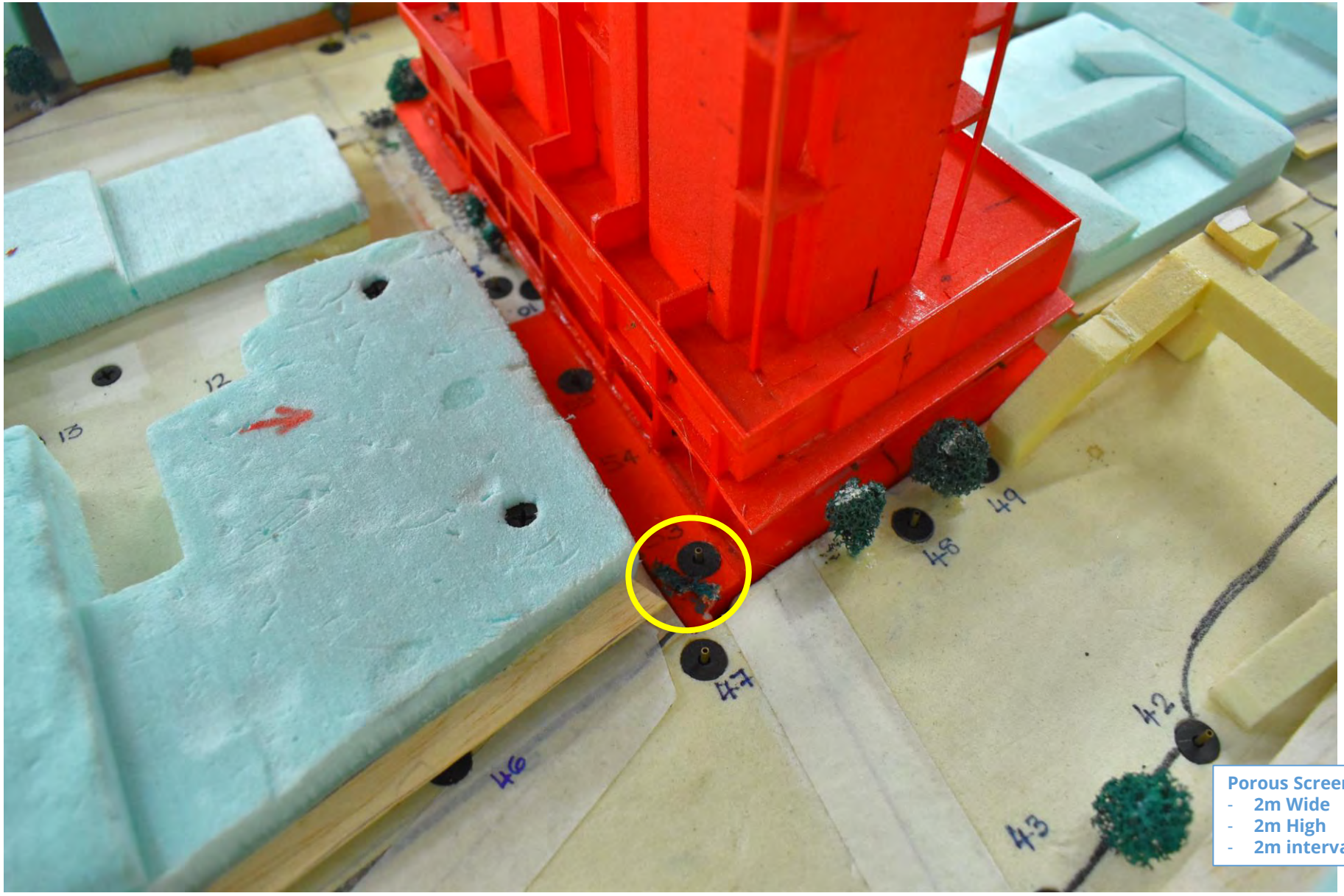
Lower Ground – Shrubs of 1.8m high between trees at west side



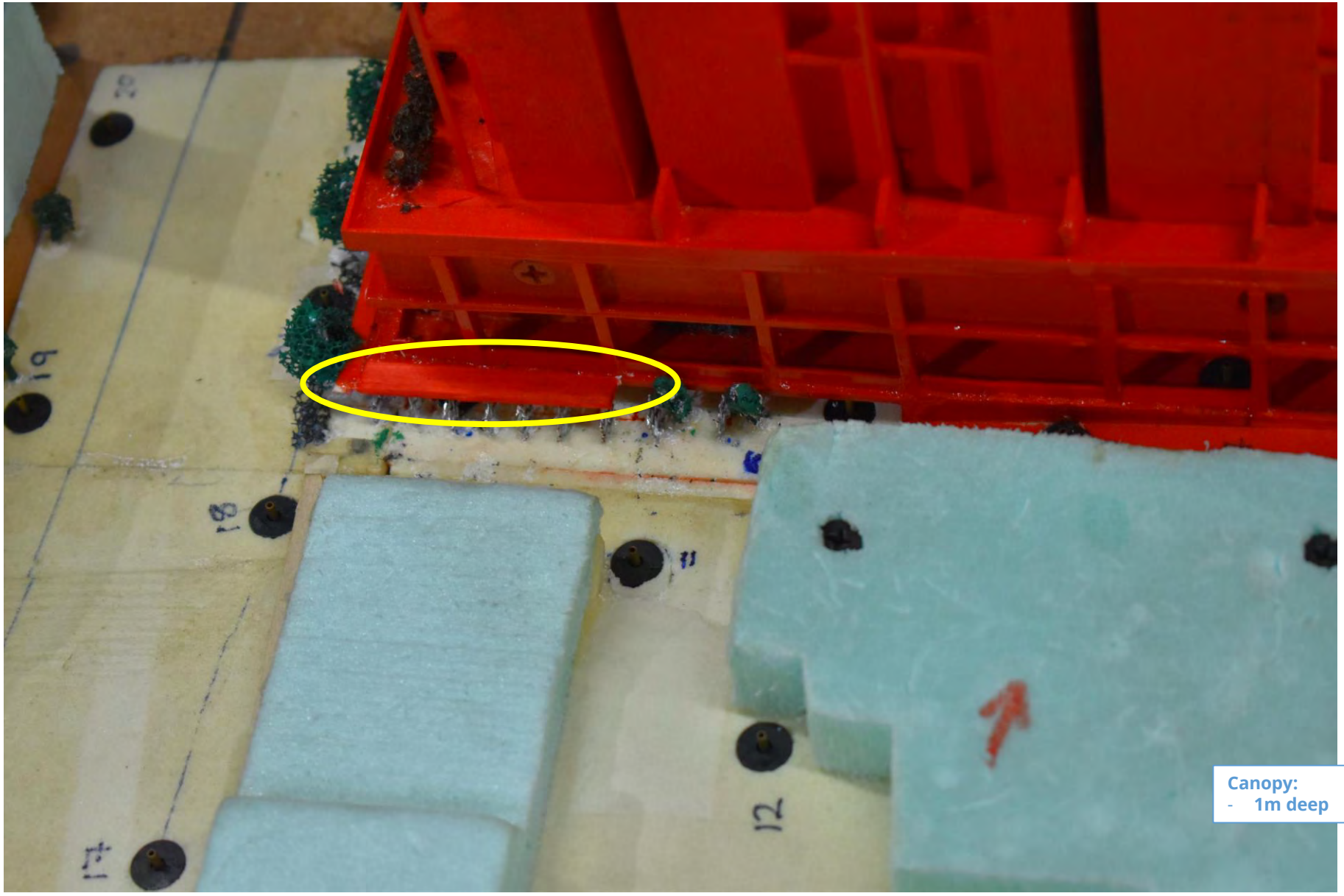
Lower Ground – Porous screens of 2m wide and 2m high at 2m interval

Porous Screens:
- 2m Wide
- 2m High
- 2m interval

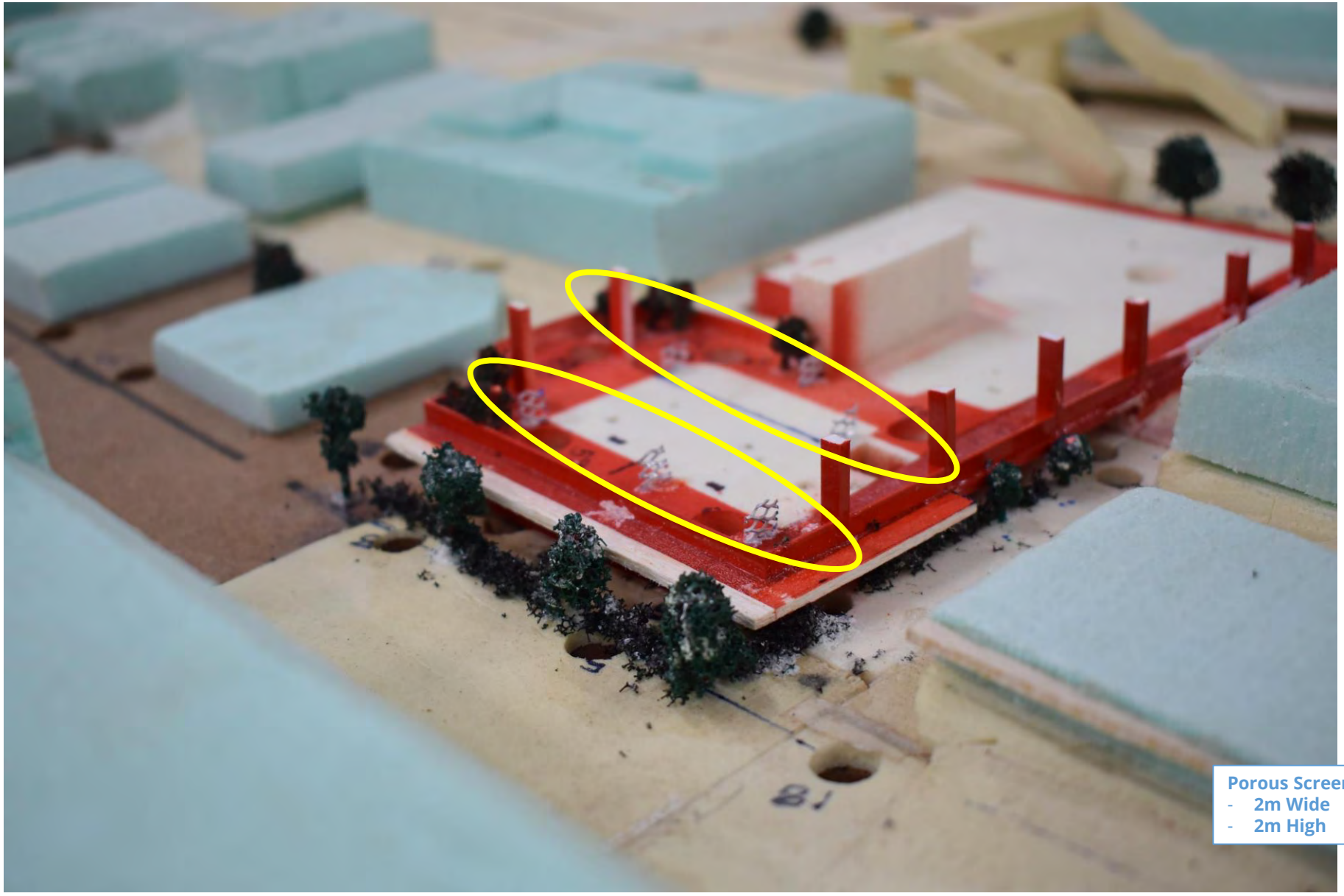
Lower Ground – Shrubs of 1.8m high at south-east corner (Location 53)



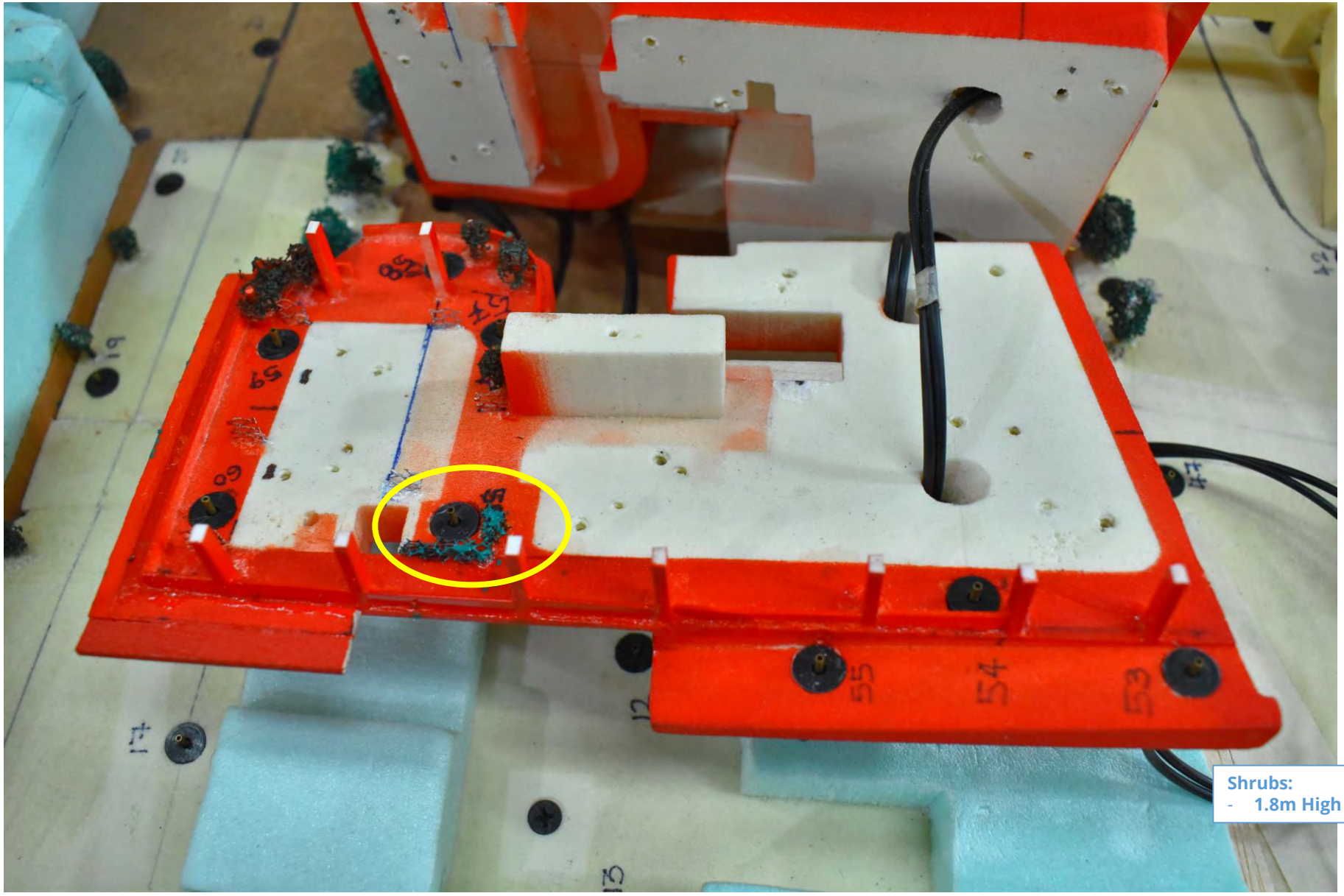
Upper Ground – Canopy of 1m deep at south-west corner



Upper Ground – Porous screens of 2m wide and 2m high



Upper Ground – Shrubs of 1.8m high



Shrubs:
- 1.8m High

Unit 1 Tilers Road
Milton Keynes
Buckinghamshire
United Kingdom MK11 3LH

MEMORANDUM

DATE:	August 21, 2019	**RWDI REFERENCE #:** 1804388
TO:	Sameh Ibrahim	**EMAIL:** sameh@pdsaust.com.au
FROM:	Kevin Peddie	**Email:** kevin.peddie@rwdi.com
	Michael Pieterse	michael.pieterse@rwdi.com
RE:	**Wind Comfort Conditions – Parramatta City Council Draft Wind Criteria** **48-54 Beecroft Road, Epping** **Sydney, NSW**	

Dear Sameh,

During the briefing meeting with the Planning Panel and City of Parramatta Council on July 31, 2019, it was raised by the City of Parramatta that they have become aware of the inconsistencies and accuracy of the Annual Gust Criteria (noted in the Parramatta DCP) for the prediction of wind comfort for people in outdoor environments. As such they are currently in the process of developing a revised planning scheme which will be based on the Gust Equivalent Mean (GEM) comfort criteria, in line with the direction of other major councils around Australia, including the City of Sydney and City of Melbourne. It was requested that RWDI present the wind comfort results based on the GEM criteria used globally, leveraging our international experience. The results of this analysis was presented in the Gust Equivalent Mean (GEM) Criteria document dated August 1, 2019.

On review of the abovementioned report, council have subsequently provided advice on an alternative GEM Comfort criteria on August 14, 2019, and is expected to form part of the upcoming draft Wind Comfort Criteria for council. This is noted to have been developed by an alternative wind consultant.

Draft Parramatta City Council Wind Comfort Criteria

The draft Wind Comfort Criteria being developed by Parramatta City Council, is based on the criteria developed by Lawson and combines the effect of mean and gust speeds on pedestrian comfort which can be quantified by a Gust Equivalent Mean (GEM). A summary of the criteria based against the intended use is noted in the following table.

Comfort Category	GEM Speed (m/s)	Description
Fine Dining	≤ 2	Outdoor fine dining
Sitting	≤ 4	Pedestrian Sitting (such as café style dining), or scheduled outdoor events
Standing	≤ 6	Pedestrian Standing, generally suitable for outdoor planting
Pedestrian Walking	≤ 8	Pedestrian Walking, seating in stadia should be <7m/s
Business Walking	≤ 10	Business Walking (objective walking from A to B or for cycling)
Uncomfortable	> 10	Uncomfortable conditions

Notes:

(1) GEM speed = max (mean speed, gust speed/1.85);
(2) GEM speeds listed above are based on a seasonal exceedance of 5% of the time between 6:00 and 23:00. Nightly hours between 0:00 and 5:00 are excluded from the wind analysis for comfort since limited usage of outdoor spaces is anticipated.

Safety Criterion	Gust Speed (m/s)	Description
General Access Areas	< 15	Areas that are used as general access areas should not be exceeded ore than 2 times per year.
Able Bodied Areas	< 20	Areas where only able bodied people are expected to access , with limited or not access to frail people of cyclists.

Notes:

(1) Based on an annual exceedance of 0.022% of the time; and,
(2) Maximum of the mean or GEM wind speed. These are usually rare events, but deserve special attention in city planning and building design due to their potential safety impact on pedestrians.

Results and Discussion

The wind conditions for the outdoor areas associated with the development have been re-analysed and compared against the proposed draft Parramatta City Council Gust Equivalent Mean (GEM) comfort criteria as noted in the above outlined table. The same wind tunnel test data (previously analysed using the annual gust criteria and presented in the Pedestrian Wind Study report prepared by RWDI dated May 16, 2019, RWDI #1804388 REV D) and the memorandum dated August 1, 2019.

The predicted wind conditions for the existing conditions are noted in Table 1, while the wind conditions with the inclusion of the subject proposed development are noted in Table 2.

With the inclusion of the proposed development (without any landscaping), the wind conditions generally satisfy either the sitting or standing criteria for the majority of the locations. A number of locations along Rawson Street and Hunts Lane are noted to satisfy the walking criteria. Point 6 is noted to have a marginal exceedance of the walking criteria during the summer months, however with the inclusion of the street trees along Rawson Street noted in the landscape drawings, this location is noted to satisfy the walking criteria (as noted in Table 3). Wind conditions at all locations for all configurations assessed are predicted to meet the safety criterion.

Therefore, with the inclusion of the subject development, wind conditions for all outdoor areas will satisfy the walking criterion based on the GEM criteria indicated by the City of Parramatta, without the need for any wind amelioration treatment.

Yours truly,

Kevin Peddie, B.E.(Aero), MsEM, CPEng
Regional Manager / Associate

Michael Pieterse, M.A.Sc., CPEng, P.Eng.
Project Manager / Associate

TABLES

Table 1: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort			
		Summer		Winter	
		Speed (m/s)	Rating	Speed (m/s)	Rating
1	Existing	3.06	Sitting	3.33	Sitting
2	Existing	3.33	Sitting	3.06	Sitting
3	Existing	3.89	Sitting	3.61	Sitting
4	Existing	3.33	Sitting	3.33	Sitting
5	Existing	3.89	Sitting	3.61	Sitting
6	Existing	2.78	Sitting	2.78	Sitting
7	Existing	1.11	Outdoor fine dining	1.39	Outdoor fine dining
8	Existing	1.11	Outdoor fine dining	1.11	Outdoor fine dining
9	Existing	1.67	Outdoor fine dining	1.67	Outdoor fine dining
10	Existing	1.94	Outdoor fine dining	2.22	Sitting
11	Existing	3.06	Sitting	3.06	Sitting
12	Existing	2.78	Sitting	3.06	Sitting
13	Existing	2.78	Sitting	3.33	Sitting
14	Existing	3.89	Sitting	3.89	Sitting
15	Existing	4.72	Standing	4.17	Standing
16	Existing	4.44	Standing	4.17	Standing
17	Existing	3.89	Sitting	3.89	Sitting
18	Existing	3.33	Sitting	3.06	Sitting
19	Existing	3.61	Sitting	3.06	Sitting
20	Existing	4.44	Standing	3.61	Sitting
21	Existing	4.44	Standing	4.17	Standing
22	Existing	4.72	Standing	5.28	Standing
23	Existing	4.44	Standing	4.44	Standing
24	Existing	4.44	Standing	4.44	Standing
25	Existing	4.44	Standing	4.17	Standing
26	Existing	4.72	Standing	4.72	Standing

Table 1: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort			
		Summer		Winter	
		Speed (m/s)	Rating	Speed (m/s)	Rating
27	Existing	4.17	Standing	4.17	Standing
28	Existing	3.89	Sitting	3.89	Sitting
29	Existing	4.44	Standing	5.00	Standing
30	Existing	3.06	Sitting	3.61	Sitting
31	Existing	3.33	Sitting	3.33	Sitting
32	Existing	2.50	Sitting	3.33	Sitting
33	Existing	2.78	Sitting	3.61	Sitting
34	Existing	3.89	Sitting	3.61	Sitting
35	Existing	3.33	Sitting	3.61	Sitting
36	Existing	3.33	Sitting	3.61	Sitting
37	Existing	3.89	Sitting	3.61	Sitting
38	Existing	3.61	Sitting	2.78	Sitting
39	Existing	4.17	Standing	4.17	Standing
40	Existing	4.17	Standing	4.17	Standing
41	Existing	5.00	Standing	4.72	Standing
42	Existing	3.61	Sitting	3.61	Sitting
43	Existing	5.00	Standing	4.17	Standing
44	Existing	4.17	Standing	3.89	Sitting
45	Existing	4.44	Standing	4.17	Standing
46	Existing	4.72	Standing	3.61	Sitting
47	Existing	4.17	Standing	3.61	Sitting
48	Existing	4.17	Standing	3.61	Sitting
49	Existing	3.06	Sitting	2.78	Sitting
50	Existing	3.06	Sitting	3.06	Sitting

Table 1: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort			
		Summer		Winter	
		Speed (m/s)	Rating	Speed (m/s)	Rating
Seasons		**Hours**		**Comfort Speed (km/h)**	
Summer	November - April	6:00 - 23:00 for comfort		(5% Seasonal Exceedance)	
Winter	May - October			< 2	Outdoor fine dining
Configurations				2 - 4	Sitting
Existing	Without the proposed development			4 - 6	Standing
				6 - 8	Walking
				8 - 10	Business Walking
				> 10	Uncomfortable

Table 2: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort			
		Summer		Winter	
		Speed (m/s)	Rating	Speed (m/s)	Rating
1	Proposed	6.11	Walking	5.28	Standing
2	Proposed	6.11	Walking	5.56	Standing
3	Proposed	6.94	Walking	6.11	Walking
4	Proposed	6.11	Walking	5.56	Standing
5	Proposed	7.78	Walking	6.67	Walking
6	Proposed	8.33	Business Walking	6.94	Walking
7	Proposed	6.39	Walking	5.83	Standing
8	Proposed	3.06	Sitting	2.78	Sitting
9	Proposed	4.17	Standing	4.44	Standing
10	Proposed	3.33	Sitting	3.33	Sitting
11	Proposed	4.72	Standing	4.17	Standing
12	Proposed	3.61	Sitting	4.17	Standing
13	Proposed	3.89	Sitting	3.89	Sitting
14	Proposed	3.61	Sitting	3.89	Sitting
15	Proposed	4.72	Standing	4.17	Standing
16	Proposed	5.00	Standing	4.44	Standing
17	Proposed	3.89	Sitting	4.17	Standing
18	Proposed	4.44	Standing	5.28	Standing
19	Proposed	4.72	Standing	4.72	Standing
20	Proposed	7.50	Walking	6.11	Walking
21	Proposed	6.67	Walking	5.56	Standing
22	Proposed	5.56	Standing	5.28	Standing
23	Proposed	4.44	Standing	4.44	Standing
24	Proposed	4.44	Standing	4.44	Standing
25	Proposed	4.72	Standing	4.17	Standing
26	Proposed	5.00	Standing	4.72	Standing

Table 2: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort			
		Summer		Winter	
		Speed (m/s)	Rating	Speed (m/s)	Rating
27	Proposed	4.44	Standing	4.44	Standing
28	Proposed	5.00	Standing	4.72	Standing
29	Proposed	5.00	Standing	5.00	Standing
30	Proposed	5.28	Standing	4.72	Standing
31	Proposed	4.44	Standing	4.72	Standing
32	Proposed	3.89	Sitting	3.89	Sitting
33	Proposed	4.17	Standing	4.17	Standing
34	Proposed	5.28	Standing	4.72	Standing
35	Proposed	4.44	Standing	4.72	Standing
36	Proposed	3.89	Sitting	4.44	Standing
37	Proposed	5.00	Standing	4.44	Standing
38	Proposed	3.61	Sitting	3.06	Sitting
39	Proposed	4.17	Standing	4.17	Standing
40	Proposed	4.72	Standing	4.44	Standing
41	Proposed	7.50	Walking	6.11	Walking
42	Proposed	5.00	Standing	5.00	Standing
43	Proposed	5.28	Standing	5.28	Standing
44	Proposed	4.44	Standing	4.72	Standing
45	Proposed	4.44	Standing	4.44	Standing
46	Proposed	4.17	Standing	3.89	Sitting
47	Proposed	4.44	Standing	4.17	Standing
48	Proposed	6.67	Walking	6.39	Walking
49	Proposed	4.17	Standing	3.89	Sitting
50	Proposed	3.61	Sitting	3.61	Sitting
51	Proposed	4.44	Standing	4.72	Standing

Table 2: Pedestrian Wind Comfort and Safety Conditions

Location	Configuration	Wind Comfort			
		Summer		Winter	
		Speed (m/s)	Rating	Speed (m/s)	Rating
52	Proposed	4.44	Standing	4.17	Standing
53	Proposed	5.56	Standing	5.00	Standing
54	Proposed	5.28	Standing	4.72	Standing
55	Proposed	3.61	Sitting	3.61	Sitting
56	Proposed	3.89	Sitting	3.89	Sitting
57	Proposed	2.22	Sitting	3.06	Sitting
58	Proposed	3.61	Sitting	4.17	Standing
59	Proposed	4.72	Standing	5.00	Standing
60	Proposed	3.89	Sitting	5.28	Standing

Seasons		Hours
Summer	November - April	6:00 - 23:00 for comfort
Winter	May - October	

Configurations	
Proposed	With the proposed development

Comfort Speed (m/s)	
(5% Seasonal Exceedance)	
< 2	Outdoor fine dining
2 - 4	Sitting
4 - 6	Standing
6 - 8	Walking
8 - 10	Business Walking
> 10	Uncomfortable