ENVIRONMENTAL WIND SPEED MEASUREMENTS ON A WIND TUNNEL MODEL OF THE O'CONNELL PRECINCT DEVELOPMENT, SYDNEY

By

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&

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SUMMARY

A wind tunnel study has been conducted on a 1/400 scale model of the proposed O'Connell Precinct Development to determine likely environmental wind impacts of the development. The wind conditions have been assessed with respect to the Safety standard as well as the Walking, Standing and Sitting comfort standards.

The wind tunnel testing quantified the wind conditions for the Proposed Envelope Configuration of February 2024 and compared the results against the DCP Base Case Envelope. The Proposed Envelope Configuration was shown to achieve equivalency or better average GEM wind speed for all the Test Locations tested than the DCP Base Case Envelope Configuration.

The average 5% exceedance gust equivalent mean (GEM) wind speed over all the Test Locations for the cases tested is summarised in the table below:

Test Case	Average 5% exceedance GEM wind speed (m/s) across all Test Locations
Proposed Envelope	3.58
DCP Base Case	3.62

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Report 202-20-WT-ENV-03

O'CONNELL PRECINCT DEVELOPMENT, SYDNEY
ENVIRONMENTAL WIND TUNNEL MODELLING

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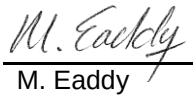

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1. INTRODUCTION

This environmental wind study report has been prepared by MEL Consultants and supports a Request for a Planning Proposal to amend the Sydney Local Environmental Plan 2012 (Sydney LEP) and amendments proposed to the Sydney Development Control Plan 2012 (Sydney DCP 2012) in relation to the O'Connell Precinct. This report is submitted to the City of Sydney Council (Council) on behalf of the proponent.

The O'Connell Precinct represents a significant opportunity in Central Sydney to renew a number of aging assets and deliver a highly engaging and multi-dimensional destination. The holistic reimaging of the Precinct will unlock a key site in the commercial heart of Sydney's Central Business District (CBD), bringing a sense of activity, wonder and respite to an established, but evolving locality.

This report should be read in conjunction with all supporting material associated with the Request for a Planning Proposal and DCP amendment, including the Planning Justification Report prepared by Ethos Urban.

1.1 Background

The Central Sydney Planning Strategy (CSPS) was first released in 2016 and sets out a 20-year land use vision, planning priorities and actions to achieve a place-led and people-led vision for growth in Central Sydney. The CSPS were endorsed by Council on 14 December 2020 and amendments to the Sydney LEP 2012 were gazetted in December 2021, supported by amendments to the Sydney DCP 2012.

The central aim of the CSPS is to support good growth while balancing the need to protect and enhance the public places that make the city unique. It provides the strategic direction to continue to position and strengthen Central Sydney as Australia's most productive and strategically important employment centre. Through 10 key moves, the CSPS balances opportunities for development to meet demands and achieve Council's job targets through to 2036, being 100,000 jobs unlocked through an additional 2.9 million square metres of employment generating floor space.

Importantly, the CSPS includes opportunities for increased height and density in key locations, balanced with environmental sustainability initiatives and sets criteria for excellence in urban design.

In this context, and over a number of years, the proponent has brought together the individual sites within the O'Connell Precinct to amalgamate a collective Precinct with the intention to deliver a world class mixed-use commercial redevelopment.

The amendments sought to the Sydney LEP 2012 and Sydney DCP 2012 have been discussed with Council staff over a number of years, including presentations of the proposal to Council's Design Advisory Panel. These pre-lodgement discussions have informed the proposed amendments and scope of the assessment provided within this Report.

1.2 Site Location and Context

The O'Connell Precinct is located within the City of Sydney Local Government Area (LGA). The precinct is within the north-eastern portion of the Sydney CBD and is in immediate proximity to existing public transport infrastructure and a diverse mix of business, retail, cultural and entertainment destinations. The Precinct is also strategically located adjacent to the future Hunter Street metro station.

Specifically, the O'Connell Precinct has a total area of approximately 6,737m^2. It is irregular in shape and is bounded by Spring Street and Bent Street to the north, O'Connell Street to the south and south-east. The Precinct formally contains the following lots and street addresses:

- Lot 1 DP814858 or 1 O'Connell Street, Sydney
- Lot 2 DP172068, 8 Spring Street, Sydney
- Lot 1 DP74923 and Lot 1 DP176768 or 10-14 Spring Street, Sydney
- Lot 1 DP724946, 16 Spring Street, Sydney
- Lot 2 DP 74923, 17 O'Connell Street, Sydney
- Lot 1 DP131917 or 19 O'Connell Street, Sydney
- Strata DP63932 23 O'Connell Street, Sydney

Collectively, these lots and addresses are referred to as the ‘Precinct’ or ‘Site’ throughout this Report.

The Precinct includes a number of existing buildings, the majority of which are anticipated to be demolished to facilitate the renewal for the new commercial redevelopment. Of note, the heritage listed at 19 O’Connell Street building will be retained, as well as the existing 1 O’Connell Street commercial building, including the heritage listed facades of 1 O’Connell Street.

The boundaries of the O’Connell Precinct are illustrated in Figure 1.

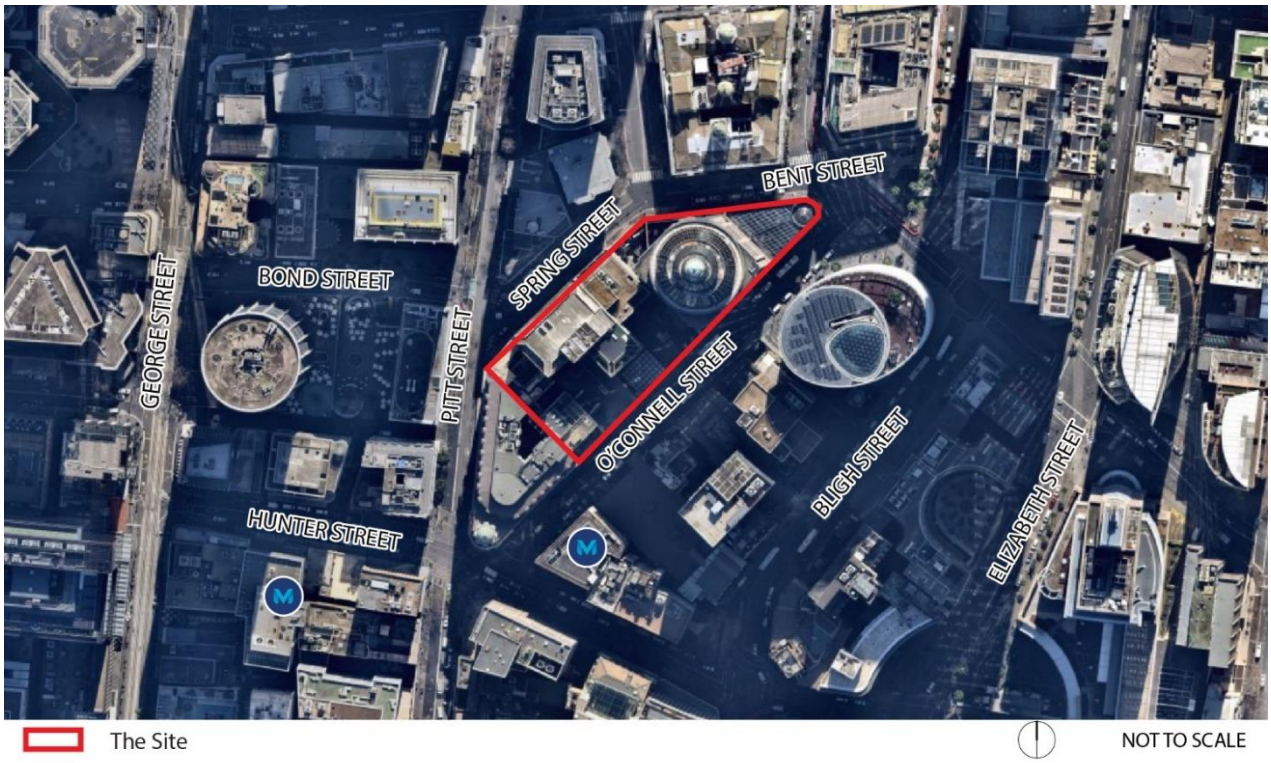

Figure 1. Location of the development site within the context of the Sydney CBD.

1.3 Overview of the Proposal

The reimaging of the O'Connell Precinct will comprise an integrated mixed-use commercial development that retains the existing 1 O'Connell Street commercial building, protects existing heritage, introduces a highly permeable and activated ground plane with enhanced public realm edges, provides opportunities for diverse cultural uses, and delivers premium grade commercial floor space in a new office tower.

The realisation of the O'Connell Precinct will be achieved through amendments to the Sydney LEP 2012 and Sydney DCP 2012.

The amendments sought to the Sydney LEP 2012 will encourage and facilitate the reimagining of the Precinct for a non-residential development by allowing for:

- an increased maximum Floor Space Ratio (FSR); and
- an increased maximum Building Height.

Supporting the amendments to the Sydney LEP 2012 is an amendment to the Sydney DCP 2012 which includes site-specific controls that address matters such as building envelope; pedestrian connections; parking; vehicular access and loading; design excellence; heritage; sustainability; and public art.

The proposed amendments will directly support Council's endorsed CSPS by unlocking additional employment generating floor space. They will also facilitate significant public benefits to be delivered on site, through new cultural and community uses, east-west through site link, enhanced activation and embellishment of the public domain.

For assessment purposes, the vision for the O'Connell Precinct has been articulated in a reference design prepared by Matt Pullinger Architect and Stewart Architecture (provided under separate cover). This reference design is provided as a supporting document with the Request for a Planning Proposal and DCP amendment, and serves as a baseline proof of concept.

1.4 Environmental Wind Conditions Study

A wind tunnel model study was commissioned by Lend Lease to undertake a comparative massing study of environmental wind conditions around the proposed development between the DCP Base Case Envelope and the proposed massing envelope based on digital information provided by Stewart Architecture and Matthew Pullinger Architects received February, 2024. These tests were carried out in the MEL Consultants 400kW Boundary Layer Wind Tunnel during February 2024.

The configurations tested are summarised below:

- DCP Base Case Envelope
- Proposed Envelope February 2024 scheme

and these configurations are shown in Figures 6 and 7.

The immediate surrounding terrain is dominated by high-rise commercial buildings of the Sydney CBD and in the far field the surrounding terrain includes suburban housing and the open waters of Circular Quay and Sydney Harbour.

2. ENVIRONMENTAL WIND CRITERIA

The advancement of wind tunnel testing techniques, using large boundary layer flows to simulate the natural wind, has facilitated the prediction of wind speeds likely to be induced around a development. To assess whether the predicted wind conditions are likely to be acceptable or not, some form of criteria are required. The Sydney Design Control Plan 2012 (Sydney DCP), including Sydney DCP Amendment 2020, has defined wind comfort standards for the assessment of the wind conditions in Sydney City. The definition of the standards is as follows:

Wind Safety Standard is an annual hourly maximum peak 0.5 second gust wind speed measured between 6am and 10pm Eastern Standard Time of 24 meters per second.

Wind Comfort Standard is an hourly mean wind speed for each wind direction, with probability of exceedance less than 5% per annum (averaged over all wind directions) measured between 6am and 10pm Eastern Standard Time (equivalent to 292 hours per annum), of equal to or less than:

- 4 metres/second for sitting areas
- 6 metres/second for standing areas
- 8 metres/second for walking areas

Mean wind speed means the maximum of:

- Hourly mean wind speed, or
- Gust equivalent mean wind speed (gust wind speed divided by 1.85)

It is noted that the above Safety standard is assessed for each wind direction while the above Comfort standards are pass/fail criteria as they only assess the summation of probabilities of exceedance across all wind directions to determine whether a location passes or fails the threshold criterion. There may be cases that the Test Locations pass the ‘all directions combined’ criterion but still fail the same criterion when applied correctly for a particular wind direction.

The Sydney DCP uses the definition of mean wind speed as based on the hourly wind speed so the probabilities will be determined from the hourly wind data for an applicable automatic weather station for the City of Sydney. The probability data used have been corrected for the approach terrain at the location of the automatic weather station (in this case Sydney Airport) and referenced to 10m in Terrain Category 2. This is the standard reference height of AS/NZS1270.2:2011.

3. MODEL AND EXPERIMENTAL TECHNIQUES

A 1/400 scale model of the built form of the DCP Base Case and O'Connell Precinct Development was constructed from digital information provided by Stewart Architecture and Matthew Pullinger Architects received February 2024.

The scale model of the development and surrounding buildings was tested in a model of the natural wind generated by flow over roughness elements augmented by vorticity generators at the beginning of the wind tunnel working section. The surrounding buildings include all built and under construction buildings in the immediate vicinity. The basic natural wind model was for flow over suburban terrain, the characteristics of which are given in Figure 2. The surrounding wind tunnel model of all significant buildings, out to a minimum radius of 300m, modified the approach wind model for the presence of the surrounding buildings. The wind tunnel study did not include any existing or proposed street trees in the public realm

The techniques used to investigate the environmental wind conditions and the method of determining the local criteria are given in detail in Reference 2. Hot-wire anemometry was used to measure the local wind speeds at various locations around the proposed building. The signals from the hot-wire anemometers were recorded by a data acquisition system for 30 seconds for each wind direction studied. Previous investigations by MEL Consultants have found this time period to be sufficient to achieve piecewise stationarity, i.e. the signal statistics become independent of the sample period. The data acquisition system uses a high accuracy digital low pass filter to filter the recorded data to give an effective full scale 3 second peak gust wind speed. MEL Consultants acknowledge that hot-wire anemometers would measure erroneous mean values in high turbulence wind environments such as the urban setting of the Sydney CBD. Therefore, MEL Consultants will only use the gust wind speed measured by the hot-wire anemometer for the analysis of the environmental wind conditions. To obtain the GEM (hourly mean) for the assessment against the wind criteria the gust wind speed will be divided by 1.85. Wind tunnel velocity measurements were made for an equivalent 1 hour period in full scale and filtered to provide an equivalent full scale 3 second gust wind speed. Photographs of the models as tested in the wind tunnel are shown in Figures 3 and 4.

4. DISCUSSION

Velocity measurements were made at various locations around the O'Connell Precinct Development for different wind directions at 22.5° intervals for a DCP Base Case Envelope and the Proposed Envelope Configuration.

The following details present all configurations tested during the wind tunnel study:

- DCP Base Case (Figure 6)
- Proposed Development Envelope (Figure 7)

The DCP Base Case Envelope and all the Proposed Configuration was constructed from digital information provided by Stewart Architecture and Matthew Pullinger Architects received February 2024.

4.1 Equivalence Study and Discussion of Results

As discussed in Section 2, the Sydney DCP 2012, including the proposed amendments to the methodology of assessment for wind conditions proposed by Council in the Sydney DCP Amendment 2020, the wind comfort criteria are pass/fail criteria based on an assessment of the summation of probabilities for all wind directions combined. Therefore, to assess the wind conditions at each Test Location, the calculated 5% exceedance GEM wind speeds from the measurements and the exceedances associated with each comfort criterion will be presented in tabular form in Tables 1 – 9. It is noted that at each Test Location the directional specific wind conditions may be higher than those of the tabulated results, which integrate the results over all wind directions.

To help with the assessment, the criterion satisfied at each Test Location have been colour coded as shown below. The average 5% exceedance gust equivalent mean (GEM) wind speed of all Test Locations has also been provided for each of the configurations tested in Table 10.

Comfort Criteria	GEM Wind Speed Range (m/s)
Pedestrian Sitting	0 – 4.0
Pedestrian Standing	4.1 – 6.0
Pedestrian Walking	6.1 – 8.0
Uncomfortable	> 8.1

Table 1: Pedestrian Wind Comfort and Safety – Pitt Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
1	Proposed 2024	5.03%	0.84%	0.08%	Pass	4.01
	Base 2024	5.20%	0.99%	0.12%	Pass	4.05
2	Proposed 2024	3.30%	0.27%	0.01%	Pass	3.65
	Base 2024	3.23%	0.43%	0.05%	Pass	3.57
3	Proposed 2024	5.25%	1.39%	0.22%	Pass	4.08
	Base 2024	4.45%	0.93%	0.11%	Pass	3.83
4	Proposed 2024	3.27%	0.32%	0.01%	Pass	3.58
	Base 2024	4.54%	0.60%	0.04%	Pass	3.89
5	Proposed 2024	0.53%	0.01%	0.00%	Pass	2.50
	Base 2024	0.64%	0.01%	0.00%	Pass	2.58
6	Proposed 2024	2.96%	0.29%	0.01%	Pass	3.58
	Base 2024	3.00%	0.34%	0.01%	Pass	3.49
7	Proposed 2024	2.27%	0.13%	0.01%	Pass	3.42
	Base 2024	1.93%	0.08%	0.00%	Pass	3.28
8	Proposed 2024	3.83%	0.49%	0.03%	Pass	3.73
	Base 2024	3.36%	0.36%	0.01%	Pass	3.60
9	Proposed 2024	7.04%	2.32%	0.61%	Pass	4.67
	Base 2024	5.99%	1.65%	0.26%	Pass	4.30
10	Proposed 2024	5.27%	1.23%	0.16%	Pass	4.08
	Base 2024	4.73%	0.96%	0.09%	Pass	3.92
11	Proposed 2024	0.21%	0.00%	0.00%	Pass	2.35
	Base 2024	0.17%	0.00%	0.00%	Pass	2.24
12	Proposed 2024	0.42%	0.01%	0.00%	Pass	2.60
	Base 2024	0.72%	0.02%	0.00%	Pass	2.74

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 2: Pedestrian Wind Comfort and Safety – O'Connell Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
13	Proposed 2024	2.53%	0.25%	0.03%	Pass	3.36
	Base 2024	0.92%	0.04%	0.00%	Pass	2.83
14	Proposed 2024	3.21%	0.37%	0.03%	Pass	3.55
	Base 2024	7.36%	1.42%	0.19%	Pass	4.56
15	Proposed 2024	2.89%	0.30%	0.02%	Pass	3.39
	Base 2024	6.84%	1.16%	0.15%	Pass	4.42
16	Proposed 2024	4.15%	0.40%	0.03%	Pass	3.81
	Base 2024	8.23%	1.59%	0.23%	Pass	4.69
17	Proposed 2024	4.11%	0.39%	0.04%	Pass	3.80
	Base 2024	4.60%	0.56%	0.04%	Pass	3.92
18	Proposed 2024	5.91%	0.81%	0.08%	Pass	4.17
	Base 2024	4.64%	0.48%	0.03%	Pass	3.94
19	Proposed 2024	0.87%	0.07%	0.01%	Pass	2.73
	Base 2024	0.96%	0.05%	0.00%	Pass	2.89
20	Proposed 2024	2.50%	0.22%	0.03%	Pass	3.35
	Base 2024	6.39%	1.01%	0.11%	Pass	4.32
21	Proposed 2024	2.98%	0.26%	0.02%	Pass	3.45
	Base 2024	3.86%	0.38%	0.02%	Pass	3.75
22	Proposed 2024	0.63%	0.02%	0.00%	Pass	2.70
	Base 2024	1.02%	0.04%	0.00%	Pass	2.92
23	Proposed 2024	2.31%	0.16%	0.01%	Pass	3.40
	Base 2024	6.29%	0.94%	0.10%	Pass	4.30
24	Proposed 2024	4.50%	0.38%	0.03%	Pass	3.90
	Base 2024	6.20%	0.75%	0.05%	Pass	4.25
25	Proposed 2024	2.47%	0.26%	0.01%	Pass	3.33
	Base 2024	2.82%	0.28%	0.01%	Pass	3.52

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 3: Pedestrian Wind Comfort and Safety – Spring Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
26	Proposed 2024	2.52%	0.14%	0.01%	Pass	3.38
	Base 2024	1.53%	0.04%	0.00%	Pass	3.04
27	Proposed 2024	4.34%	0.76%	0.08%	Pass	3.84
	Base 2024	4.18%	0.78%	0.08%	Pass	3.77
28	Proposed 2024	5.52%	0.91%	0.12%	Pass	4.11
	Base 2024	5.68%	1.22%	0.19%	Pass	4.16

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 4: Pedestrian Wind Comfort and Safety – Bent Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
29	Proposed 2024	3.77%	0.25%	0.02%	Pass	3.76
	Base 2024	3.84%	0.25%	0.01%	Pass	3.76
30	Proposed 2024	2.45%	0.26%	0.01%	Pass	3.30
	Base 2024	2.52%	0.26%	0.01%	Pass	3.34
31	Proposed 2024	3.44%	0.29%	0.01%	Pass	3.67
	Base 2024	3.03%	0.27%	0.01%	Pass	3.56
32	Proposed 2024	6.04%	1.39%	0.28%	Pass	4.23
	Base 2024	5.15%	1.38%	0.33%	Pass	4.04
33	Proposed 2024	10.58%	2.06%	0.28%	Pass	5.02
	Base 2024	9.02%	1.72%	0.22%	Pass	4.79
34	Proposed 2024	7.07%	1.39%	0.21%	Pass	4.44
	Base 2024	8.29%	2.50%	0.78%	Pass	4.86
35	Proposed 2024	6.30%	0.58%	0.04%	Pass	4.21
	Base 2024	6.60%	0.79%	0.09%	Pass	4.28
36	Proposed 2024	1.97%	0.12%	0.00%	Pass	3.22
	Base 2024	1.90%	0.10%	0.00%	Pass	3.19
37	Proposed 2024	1.46%	0.06%	0.00%	Pass	3.04
	Base 2024	0.58%	0.02%	0.00%	Pass	2.57
38	Proposed 2024	5.16%	0.79%	0.07%	Pass	4.04
	Base 2024	3.29%	0.52%	0.04%	Pass	3.54
39	Proposed 2024	7.15%	1.83%	0.30%	Pass	4.56
	Base 2024	6.38%	1.28%	0.16%	Pass	4.31

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 5: Pedestrian Wind Comfort and Safety – Loftus Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
40	Proposed 2024	5.94%	0.63%	0.04%	Pass	4.19
	Base 2024	4.48%	0.44%	0.03%	Pass	3.89

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 6: Pedestrian Wind Comfort and Safety – Gresham Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
41	Proposed 2024	3.55%	0.43%	0.06%	Pass	3.66
	Base 2024	3.10%	0.35%	0.04%	Pass	3.56

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 7: Pedestrian Wind Comfort and Safety – Bond Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
42	Proposed 2024	3.42%	0.54%	0.04%	Pass	3.55
	Base 2024	2.44%	0.29%	0.01%	Pass	3.15

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 8: Pedestrian Wind Comfort and Safety – Curtin Place

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
43	Proposed 2024	0.63%	0.02%	0.00%	Pass	2.61
	Base 2024	0.37%	0.01%	0.00%	Pass	2.49

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

Table 9: Pedestrian Wind Comfort and Safety – Hunter Street

Test Location	Configuration	Wind Comfort Standard				GEM wind speed (m/s)
		Sitting	Standing	Walking	Safety	
44	Proposed 2024	0.09%	0.00%	0.00%	Pass	2.26
	Base 2024	0.09%	0.00%	0.00%	Pass	2.23
45	Proposed 2024	0.61%	0.01%	0.00%	Pass	2.65
	Base 2024	0.38%	0.01%	0.00%	Pass	2.47

Note: Orange – Fail Criterion (≥5%)

Green – Pass Criterion (<5%)

The average 5% exceedance GEM pedestrian wind speeds across all test locations for each of the configurations tested are presented in Table 10 below.

Table 10: Average 5% exceedance GEM wind speed of all Test Locations

Average GEM wind speed for all Test Locations	Proposed	average	3.58
	Base		3.62

The Proposed Envelope was shown to achieve equivalency or better than the DCP Base Case.

5. CONCLUSIONS

A wind tunnel study has been conducted on a 1/400 scale model of the proposed O'Connell Precinct Development to determine likely environmental wind impacts of the development. The wind conditions have been assessed with respect to the Safety standard as well as the Walking, Standing and Sitting comfort standards.

The wind tunnel testing quantified the wind conditions for the Proposed Envelope Configuration of February 2024 and compared the results against the DCP Base Case Envelope. The Proposed Envelope Configuration was shown to achieve equivalency or better average GEM wind speed for all the Test Locations tested than the DCP Base Case Envelope Configuration.

The average 5% exceedance gust equivalent mean (GEM) wind speed over all the Test Locations for the cases tested is summarised in the table below:

Test Case	Average GEM wind speed (m/s) across all Test Locations
Proposed Envelope	3.58
DCP Base Case	3.62

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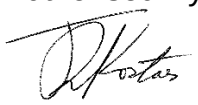

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REFERENCES

1. W. H. Melbourne, Criteria for environmental wind conditions, Journal of Industrial Aerodynamics, Volume 3, 1978, pp. 241-249
2. W. H. Melbourne, Wind environment studies in Australia, Journal of Industrial Aerodynamics, Volume 3, 1978, pp. 201-214

FIGURES

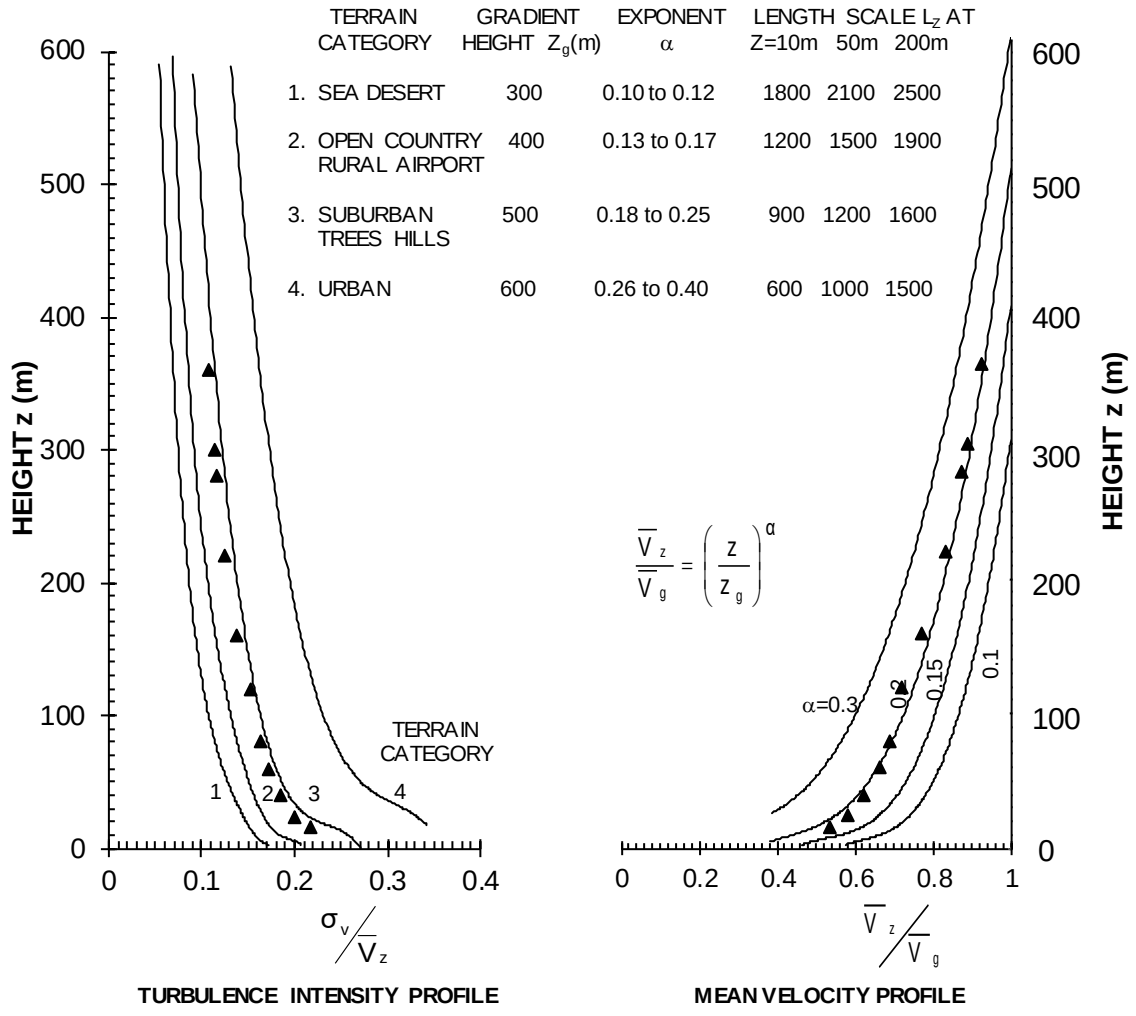


Figure 2 - 1/400 scale TC3 boundary layer turbulence intensity and mean velocity profiles in the MEL Consultants Boundary Layer Wind Tunnel 4.8m x 2.2m working section, scaled to full scale dimensions.

Figure 3 – View of the 1/400 scale for the DCP Base Case model of The O'Connell Precinct Development in the wind tunnel.

Figure 4 – View of the 1/400 scale model of the Proposed Envelope in the wind tunnel.

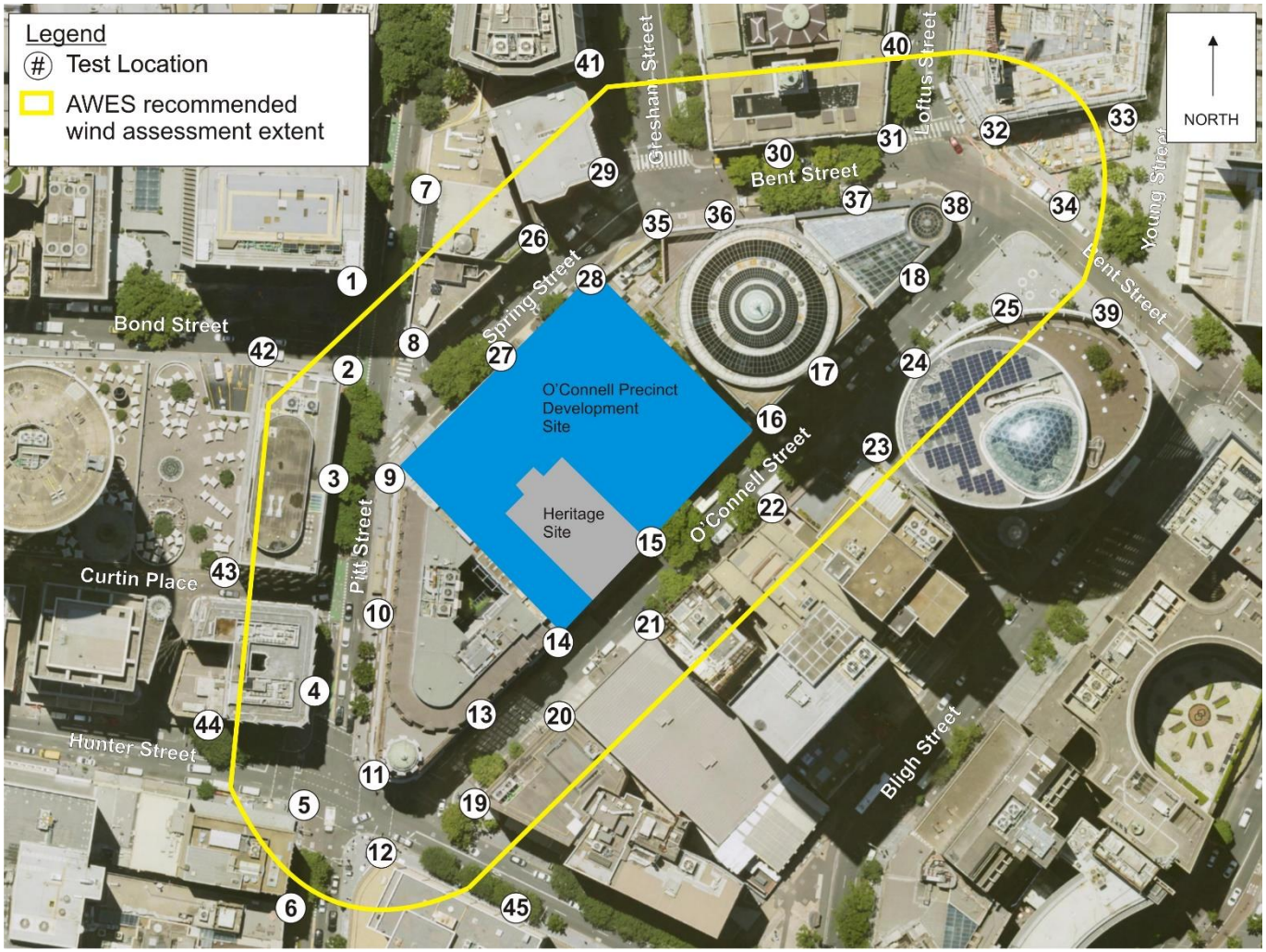
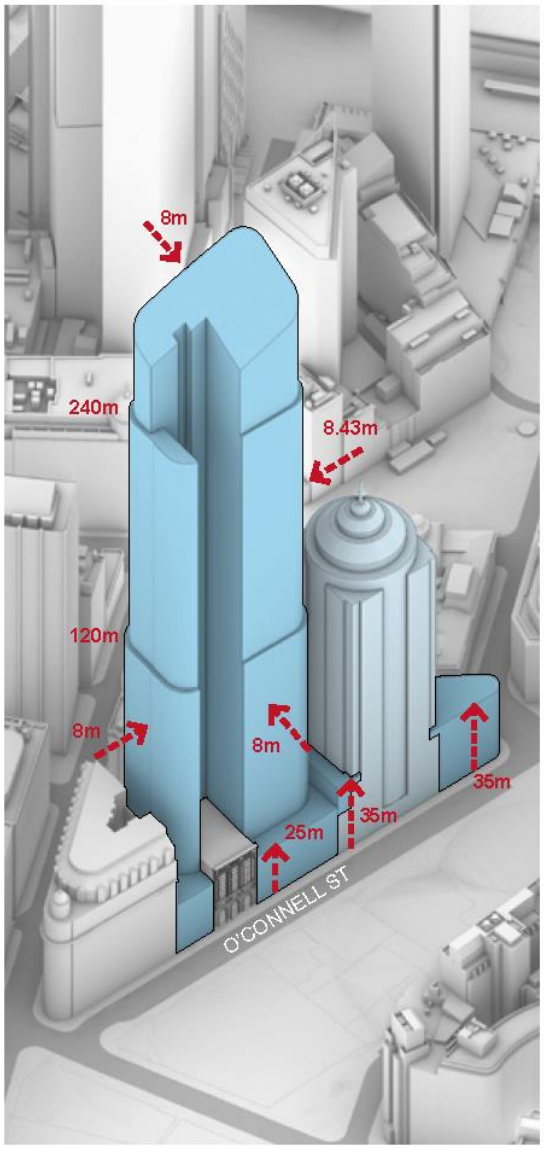


Figure 5 - Ground Level Test Locations for The O'Connell Precinct Development, Sydney with extent of radius from site based on the Australasian Wind Engineering Society (AWES) guidelines (yellow line).

O'CONNELL STREET 3D



SPRING STREET 3D

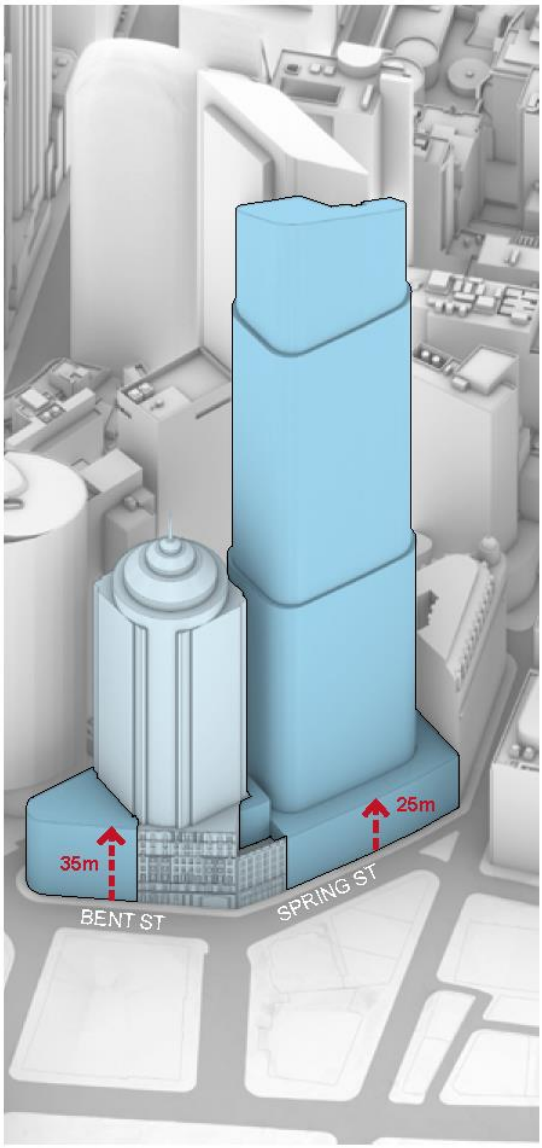


Figure 6 – 3D Drawing of the DCP Base Case Envelope.

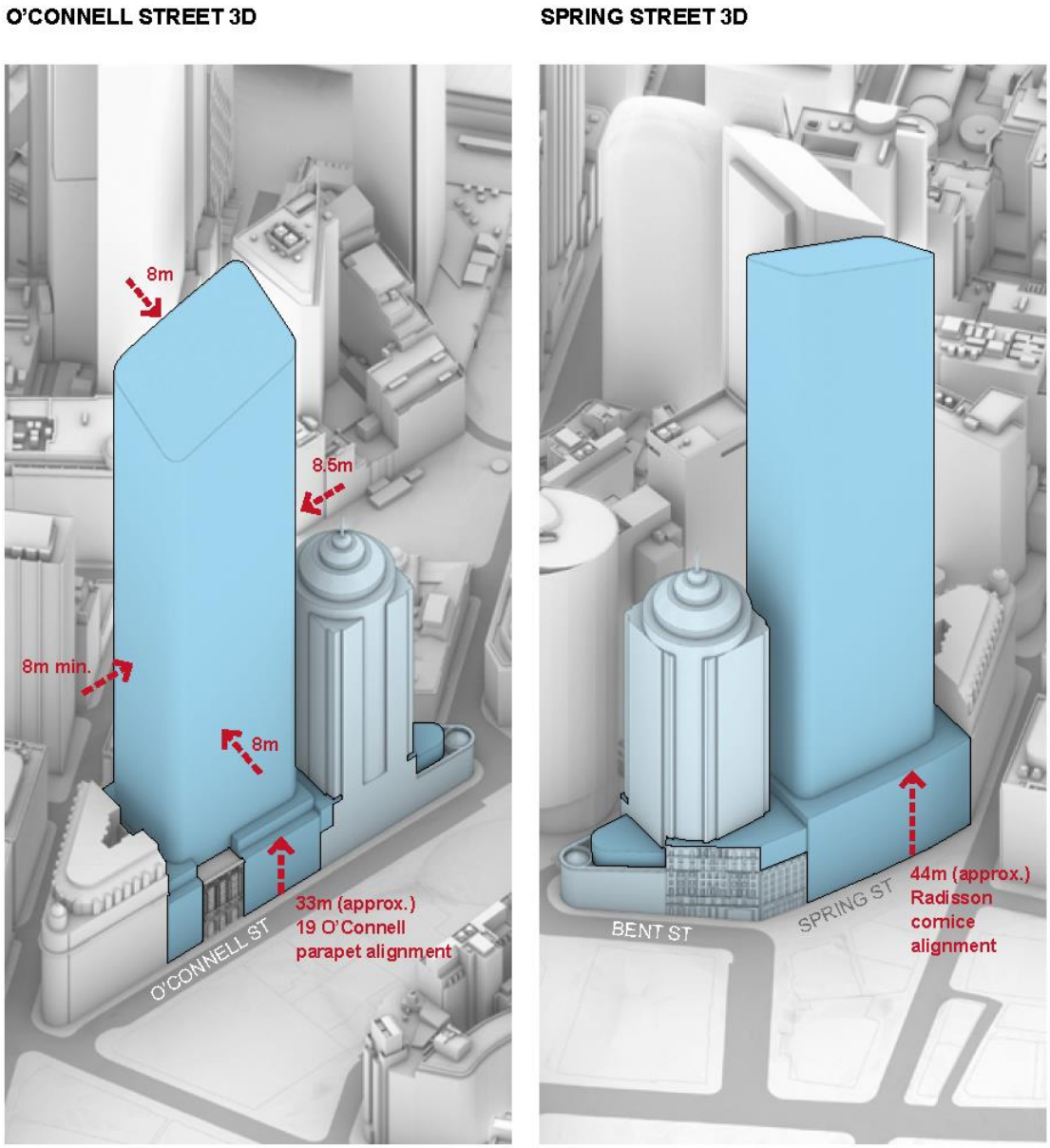


Figure 7 – 3D Drawing of the Proposed Development (Feb 2024) Envelope.