Wind Tunnel Investigation of Pedestrian-Level Wind Conditions:

Fast-track Application for 188 Beaumont St, Auckland

Westhaven Residential Limited Partnership
February 2026

Prepared by:

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Qualifications and Experience

My name is Amir Pirooz. I am a Wind Engineer and the Managing Director of FidelicFlow Ltd. I am also a Numerical Weather Prediction (NWP) and Computational Fluid Dynamics (CFD) Modeller and Analyst at Earth Sciences New Zealand (formerly NIWA). My professional work focuses on the simulation of airflow over urban environments and complex terrain, the conduct of wind tunnel tests for environmental wind assessments, and the evaluation of wind loads on structures. I specialise in the analysis of historical meteorological records, particularly wind speed, for applications such as estimating regional design wind speeds for the revised AS/NZS 1170.2:2021 standard, assessing long-term trends in extreme winds, and understanding wind and gust climatology.

I hold a PhD in Mechanical Engineering, specialising in Wind Engineering, from the University of Auckland.

A selection of recent work relevant to the present study includes:

Consulting and Research Work Through FidelicFlow Ltd:

- Wind tunnel assessment of cladding pressures on a ~400 m tower in the Middle East (client: FD Global, UK);
- Pedestrian-level wind speed assessments for multiple developments in Auckland (clients: Marutūāhu Ockham Group; Conrad Properties Group Ltd);
- Wind engineering expert advice for a High Court case;
- Wind tunnel and numerical simulation of airflow in urban areas [1,2], around important infrastructures [3], and complex terrain [4].

Relevant Experience Undertaken in Previous and Other Professional Roles

(included here to demonstrate my personal technical capability; not delivered through FidelicFlow Ltd)

- Numerical simulation of airflow to assess wind shear at an overseas airport;
- Design wind speed assessment for Luganville, Vanuatu [5];
- Detailed analysis of the wind condition in the Weka Pass region that damaged one of Transpower's pylons [6];
- Assessment of wind effects and container wind loads across Ports of Auckland sites [7-9];
- Design wind load assessment for a cableway over the Manganui Gorge, Mount Taranaki [10];
- Investigated the impact of aircraft wake turbulence on near-ground wind conditions at the Queenstown airport [11];
- Development of New Zealand ReAnalysis (NZRA) [12], which is the first convective-permitting reanalysis model over New Zealand model;
- Sub-km NWP simulation to generate gridded bias correction factors to improve wind speed forecasts [13].

Relevance to the Present Assessment

The present assessment draws on:

- Established research on Auckland and New Zealand wind climatology [14-20];
- My contribution [21] to the most recent revision of AS/NZS 1170.2 Wind Loading Standard;

- Previous research and consulting work on airflow in urban environments and complex terrain using wind tunnel testing and numerical simulations [1-4,22-25], as well as numerous wind assessments for both high- and low-rise developments.

Executive Summary

FidelicFlow Ltd. was commissioned by Westhaven Residential Limited Partnership to undertake a **wind tunnel study** assessing the likely impact of a **proposed development at 188 Beaumont St, Wynyard Quarter, Auckland**, on the local pedestrian-level wind environment. This report has been prepared for the purpose of a substantive application submitted by Westhaven Residential Limited Partnership for a referred project under the Fast-track Approvals Act 2024 (FTAA) in respect of the 188 Beaumont Street project (the "Project"). The Project is an urban development project in Auckland's city centre involving a residential-led mixed use building comprising of residential apartments, ground floor retail and ancillary car parking.

The assessment draws on the long-term wind climatology of Auckland and incorporates wind tunnel testing of both the existing site configuration and the Project to evaluate the aerodynamic effects of the new buildings on surrounding wind conditions. This assessment has been undertaken in accordance with the requirements of the **Auckland Unitary Plan (Operative in Part),** specifically **Standard H8.6.28 Wind in the City Centre zone**. The objectives and policies of the AUP seek to require development to avoid, remedy or mitigate adverse wind effects on public open spaces, including streets.

The **wind tunnel testing** was performed at a **1:300 scale** for three configurations: **existing, existing with under-construction buildings on Orams Site**, and **proposed development** – covering **16 wind directions.** The surrounding model extended to a **radius of 500 m** around the Project to ensure accurate representation of neighbouring structures. In addition, a study was undertaken to evaluate potential improvements in pedestrian comfort and safety through the introduction of **a comprehensive mitigation package**.

Supplementary **computational fluid dynamics (CFD)** simulations were also carried out to provide further insight into the airflow behaviour at the site. The CFD analysis focused on the south-westerly (SW) and north-easterly (NE) wind directions, identified as the most critical directions, and was used to illustrate complex flow phenomena such as separation, reattachment, and local acceleration around the proposed building.

The main conclusions of the analysis are as follows (*Location numbers refer to probe testing locations shown in **Figure 16***):

1. Pedestrian Comfort (without mitigation measures)

Existing configuration:

- The site is naturally exposed to winds from the west through northeast, leading to generally elevated background wind conditions.
- Several probe testing locations (**Figure 18**) along Jellicoe Street (13, 29–37) exceeded the desired comfort level (Category D instead of C).
- The remaining areas, along Jellicoe and Beaumont Streets, were rated Category B or C and are acceptable for their intended pedestrian use.

Proposed configuration – ground level:

- The proposed building significantly modifies the local wind environment (**Figure 19**), providing shelter in some areas and increasing wind exposure in others.
- Many previously exposed probe testing locations across the Silo park, and Jellicoe Street (1, 3, 25–37) experience improved conditions (Categories B–C).

- However, wind acceleration near building corners and along Beaumont Street results in some Category E probe testing locations (13, 17, 23) and category D (very windy) probe testing locations (11, 31, 49 and 51) due to flow separation.
- All other locations remain acceptable for their intended use.

2. Pedestrian Safety (without mitigation measures)

Existing configuration:

- Wind conditions around the existing site (**Figure 20**) are within the pedestrian safety threshold of 25 m/s.
- Probe testing location 85 becomes unsafe after the inclusion of the under-construction building on Orams site, **Figure 21**, (not 188 Beaumont development).

Proposed configuration – ground level:

The Project increases gust wind speeds across the site (**Figure 22**), creating several *unsafe* locations, primarily under south-westerly to westerly winds:

- Flow separation from the western corners of the building elevates gusts at probe testing location 49, rendering it unsafe. Secondary separation and undercroft effects extend these impacts to Jellicoe Street (probe testing locations 13, 23, and 31), which are also classified as unsafe.
- Additional *unsafe* probe testing locations (7, 45, 47, 51) occur along Beaumont Street and at its intersection with Jellicoe Street, where combined flow separation and wind shear generate local acceleration zones.

3. Proposed Configuration with Mitigation

Given the adverse wind effects introduced by the Project, a mitigation study was undertaken to address wind comfort and safety issues, particularly those associated with corner acceleration and dominant south-westerly to north-easterly winds. Several mitigation configurations were tested through wind tunnel experiments and supported by CFD simulations. **The final recommended mitigation package**, developed in alignment with the Boffa Miskell landscape plan (dated 9 December 2025), comprises:

- A continuous 1.2 m high glass balustrade (RL 4.6) along the western deck edge of the proposed building;
- An approximately 3 m high solid wall at the western corner of the building;
- A 2.6 m wide awning;
- New trees on the western side of the building;
- Additional landscaping, including trees, potted plants, and concrete edge wall along the ramp on Jellicoe St.

Wind tunnel tests, together with numerical simulations, demonstrate that the incorporation of these mitigation measures improves pedestrian wind comfort to **Category C or better** at all publicly accessible locations. Pedestrian wind safety across the site is rated as **safe** at all assessed locations, with the exception of Location 85 on Beaumont Street (a vehicular route), which remains classified as unsafe in both the existing (**Figure 21**) and proposed configurations (**Figure 31**).

Accordingly, with the inclusion of the recommended mitigation measures, the proposed development is expected **to comply with the pedestrian wind comfort and safety requirements of the Auckland Unitary Plan.**

1. Introduction

On 3 September 2025, Westhaven Residential Limited Partnership ("**Client**"), commissioned FidelicFlow Ltd ("**Consultant**") to undertake a wind tunnel study to assess the likely pedestrian-level wind (PLW) conditions around a proposed development at 188 Beaumont Street, Wynyard Quarter in Auckland ("**Project**"). The Project involves a new building in the City Centre zone and therefore requires a wind condition assessment in accordance with Standard **H8.6.28** Wind of the Auckland Unitary Plan – Operative in Part (AUP). The assessment considers the long-term wind climatology of Auckland, as well as the form of the Project and the surrounding built environment, to evaluate the potential effects of the project on pedestrian-level airflow with particular reference to the wind standards in the AUP.

This report and assessment are based on:

- Site visit: the writer visited the site on 5 September 2025.
- Wind tunnel tests on a 1:300 scale of the Project to analyse the wind speed conditions at the site with the existing and proposed conditions.
- Established research and published knowledge on Auckland and New Zealand wind climatology [14,15,17-20].
- A supplementary computational fluid dynamic (CFD) simulation (Section 7).
- Reviewing drawings of the proposed development, dated 4 September 2025, 12 November 2025 and 19 December 2025.
- Relevant experience and contributions to the recent version of the AS/NZS 1170.2 Wind Loading Standard [21].
- Previous research and consulting experience on wind flow in urban areas and complex terrain using wind tunnel and numerical simulations [1-4,22-25].
- The AUP wind standard (**H8.6.28** – Business: City Centre Zone [26]).
- Literature on the topic of wind flow around buildings and wind comfort/safety criteria.

2. Site Location and Proposed Development

The proposed building (**Figure 1**), hereafter referred to as the "proposed building", is located at 188 Beaumont Street, Auckland Central. The Project is an urban development project in Auckland's city centre involving a residential-led mixed use building comprising residential apartments, ground floor retail and ancillary car parking. The development comprises three buildings, with the tallest reaching approximately 81.05 m above site level, and the other two rising to about 37.97 m and 31.56 m, respectively, measured to the top of the rooftop plant structures (refer to architectural drawings received from Warren and Mahoney, dated 19 December 2025). Detailed elevations, including RL values, are provided in Appendix C, **Figure A-12**.

The main entrances are situated along Beaumont and Jellicoe Streets. As shown in **Figure 1** the proposed building occupies a site on the northern side of Wynyard Quarter, surrounded by medium- to high-rise developments extending from the eastern to the southern sides. To the west and north, the site is more exposed to open sea, transitioning into suburban areas further afield – North Shore to the north and West Harbour to the west.

Figure 1. Google Earth image of the development site at 188 Beaumont Street, Auckland CBD. The inset shows the boundaries of the proposed building.

An architect's view of the buildings is shown in Figure 2. Public can access the building through the footpaths on Beaumont and Jellicoe Streets. The entrance to the building is internalised and is covered by building overhangs. The proposed development is approximately 50 m wide along Beaumont Street and 110 m along the Jellicoe Street. The proposed building is 81.05 m (RL84.05 m) tall at its highest level.

A survey of the site shows there are no significant topographic features that have the potential to influence the wind flow.

The critical outdoor areas associated with the proposed building that are accessible to the public include the main entrances, footpaths along Beaumont and Jellicoe Streets, the café and restaurant area on the west side, and the carpark on the east side of the development.

(a)

(b)

Figure 2. Architect's view of the proposed buildings, viewed from (a) the northeast, and (b) west (source: Warren and Mahoney, dated 19 December 2025).

3. Auckland Wind Climatology

Figure 3 depicts the directional frequency of hourly mean and maximum daily gust wind speeds per 22.5° interval at the Auckland International Airport ("Auckland Aero") for the period 1995 to 2024. It is evident that the prevailing wind directions for Auckland are the NE and SW directions, and to lesser extend W. The windrose plot of the daily maximum gust wind speed also demonstrates that the strongest wind speeds are from these directions. For the south-westerly sector, the majority of wind speeds are greater than 5 m/s. Similar trend can be seen for gust wind speeds, however, gust wind speeds exceeding 25 m/s are not common from any wind directions. The directional frequency of wind speeds at Whenuapai and MOTAT meteorological stations are presented in **Appendix A**. The wind distribution at Whenuapai is similar to that at Auckland Aero, with a directional shift. In contrast, MOTAT experiences lower wind speeds due to the rougher surrounding terrain compared to Auckland Aero.

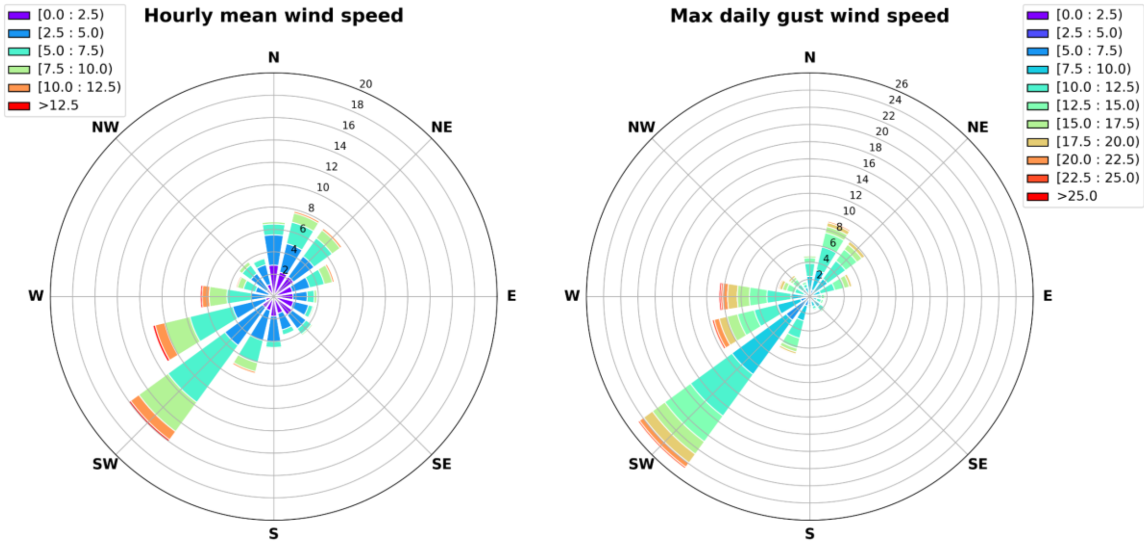


Figure 3. Directional wind frequency (in percentage) of hourly mean wind speed (left) and maximum daily gust wind speed (right) at Auckland Aero station.

4. Wind Effect and Acceptability Criteria

The acceptable criteria for wind effects generated by buildings depend on the intended use of the surrounding areas (**Figure 4a**). These criteria are typically defined in terms of the probability of exceedance of specified wind speed thresholds at given statistical levels.

The present assessment has been undertaken with reference to the categories and criteria specified in the AUP [27] (specifically **H8.6.28** – Business: City Centre Zone [26]), which, at the 5% exceedance probability level, are closely aligned with Lawson's comfort criteria [28].

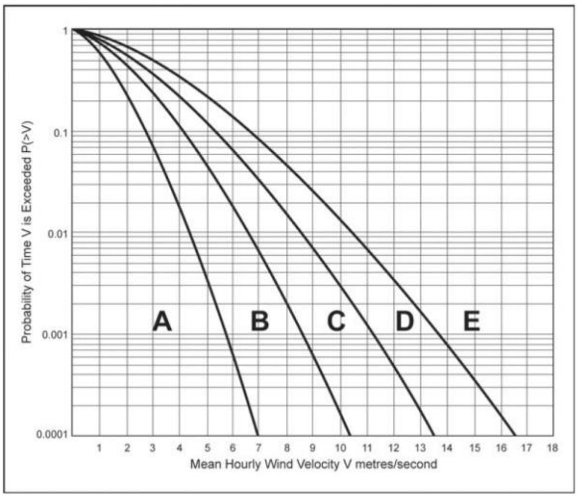
The AUP (H8.6.28) requires that any new building must not cause the probability of occurrence of hourly mean wind speed to exceed the category for the intended use of the area as shown in **Figure 4a**. The curves on the **Figure 4b** graph show the boundaries between the **acceptable** categories (A-D) and **unacceptable** category (E).

The corresponding wind speed thresholds are presented in **Figure 4b** and are summarised below for a **5% exceedance probability**.

- Category A: 0 – 3.22 m/s
- Category B: 3.22 – 4.83 m/s
- Category C: 4.83 – 6.27 m/s
- Category D: 6.27 – 7.72 m/s
- Category E: > 7.72- m/s

Table H8.6.28.1 Performance categories

Cateory	Description
Category A	Areas of pedestrian use containing significant formal elements and features intended to encourage longer term recreational or relaxation use, such as. major and minor public squares, parks and other open spaces, including. Aotea Square, Queen Elizabeth Square, Albert Park, Myers Park, St Patrick's Square, and Freyberg Place
Category B	Areas of pedestrian use containing minor elements and features intended to encourage short-term recreation or relaxation, such as minor pedestrian open spaces, pleasance areas in road reserves, streets with significant groupings of landscaped seating features, including Khartoum Place, Mayoral Drive pleasance areas, and Queen Street
Category C	Areas of formed footpath or open space pedestrian linkages, used primarily for pedestrian transit and devoid of significant or repeated recreational or relaxational features, such as footpaths where not covered in categories A or B above
Category D	Areas of road, carriage way, or vehicular routes, used primarily for vehicular transit and open storage, such as roads generally where devoid of any features or form which would include the spaces in categories A - C above
Category E	Represents conditions which are dangerous to the elderly and infants and of considerable cumulative discomfort to others. Category E conditions are unacceptable and are not allocated to any physically defined areas of the city
Note: All through-site links and other private land given over to public use as bonus features, or subject to public access easements, must be subject to the wind environmental categories.	



(a) (b)

Figure 4. AUP's requirement for wind control: (a) wind categories and intended activities and locations; (b) Mean speed probabilities corresponding to wind categories.

While comfort categories have been assigned based on the 5 % exceedance probability, wind speeds corresponding to 50 hours per year exceedance (0.57 %) were also examined to confirm the consistency of categorisation across statistical levels. This approach provides a complementary measure of windiness frequency and aligns with common practice in pedestrian-level wind environment assessments.

Regarding safety, the AUP [27] specifies that the average annual maximum 3-second gust must not exceed 25 m/s.

5. Effect of Terrain (roughness)

Due to the logarithmic profile of the atmospheric boundary layer winds, the velocity gradient is high close to the ground and wind speed increases rapidly with height. This results from terrain roughness close to the ground which reduces the wind speed. As elaborated in standard wind-engineering references, e.g. [29,30], when strong winds within a fully developed atmospheric boundary layer encounter a change in surface roughness, such as flow transitioning from open country to suburban or urban terrain, the flow undergoes an adjustment process, characterised by the development of an internal boundary layer and associated changes in turbulent structure. The adjustment starts at ground level and gradually moves upwards. The effects of this process are evident when comparing the wind distributions measured at the MOTAT station, which is influenced by rougher terrain (Figure A-2), with those from the Auckland Aero station, representing smoother upstream exposure (Figure 3).

The directional terrain roughness at the 188 Beaumont St site was calculated for each of the sections shown in **Figure 5** employing methodologies outlined in AS/NZS1170.2:2021 [31] and ESDU [32], for a radius much larger than the minimum requirement specified in [31]. Comparing the 188 Beaumont St site terrain roughness against open-terrain roughness, a set of multipliers was derived (**Figure 6**) to convert wind speed at 10 m height over open-terrain to equivalent wind speeds at **81 m** height at the 188 Beaumont St site.

The multipliers (**Figure 6**) are applied to Auckland Aero data – previously homogenised and corrected to open-terrain wind speeds [15,21] – to obtain the corresponding mean and gust wind speed distributions at 81 m height at the 188 Beaumont St site (**Figure 7**). In comparison with 10 m open-terrain wind speeds, the resulting wind speed multipliers (**Figure 6**) at the proposed development site on Beaumont Street at 81 m height are generally greater than 1.0, reflecting the local exposure and roughness characteristics.

Figure 7 shows that for all directions, the likely directional mean and 3-s gust wind speeds at the 188 Beaumont St site at the reference height of 81 m are higher than wind speeds at Auckland Aero (**Figure 3**). Additionally, **Figure 8** compares the maximum 5% probability of exceedance mean wind speeds, maximum annual mean, and average annual maximum gust wind speeds at the 188 Beaumont St and Auckland Aero. It is evident that from WSW to E wind directions, the smoother terrain and increased reference height results in increased wind speeds at 188 Beaumont St. While the wind speeds for the other directions (ESE to SSW) at the 188 Beaumont St site at 81 m are comparable with Auckland Aero; meaning that the rougher terrain at 188 Beaumont St offsets the increased wind speeds due to an increase in height to 81 m (i.e. the proposed building height).

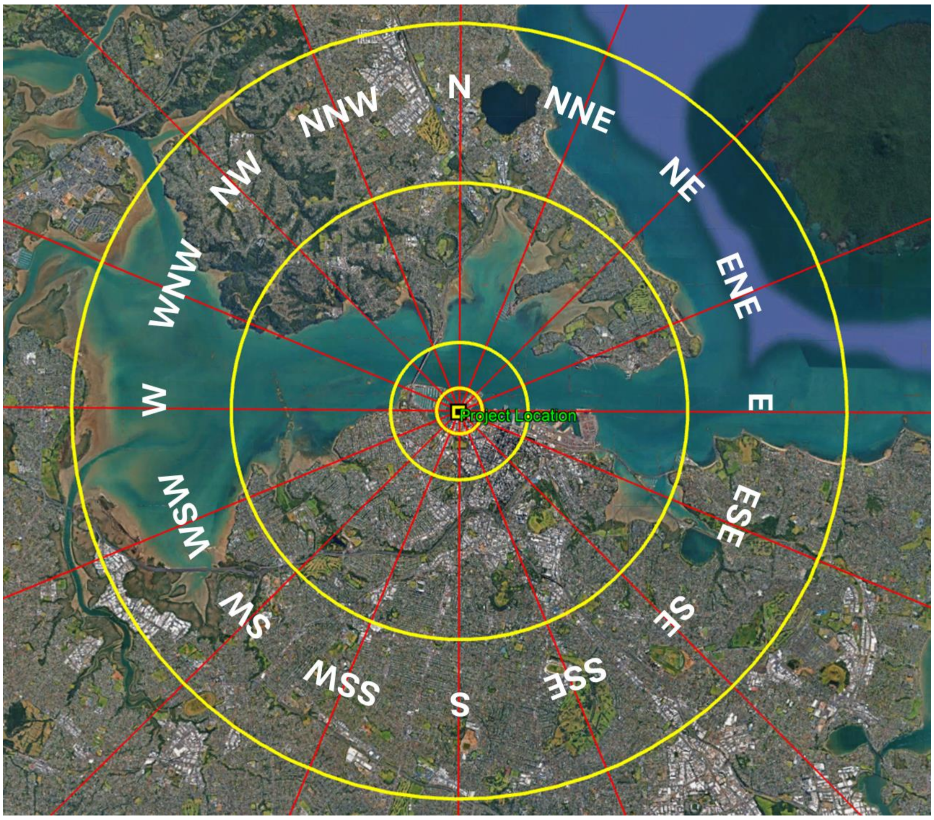


Figure 5. Visual variation of terrain around the proposed development site for each of 16 wind directions.

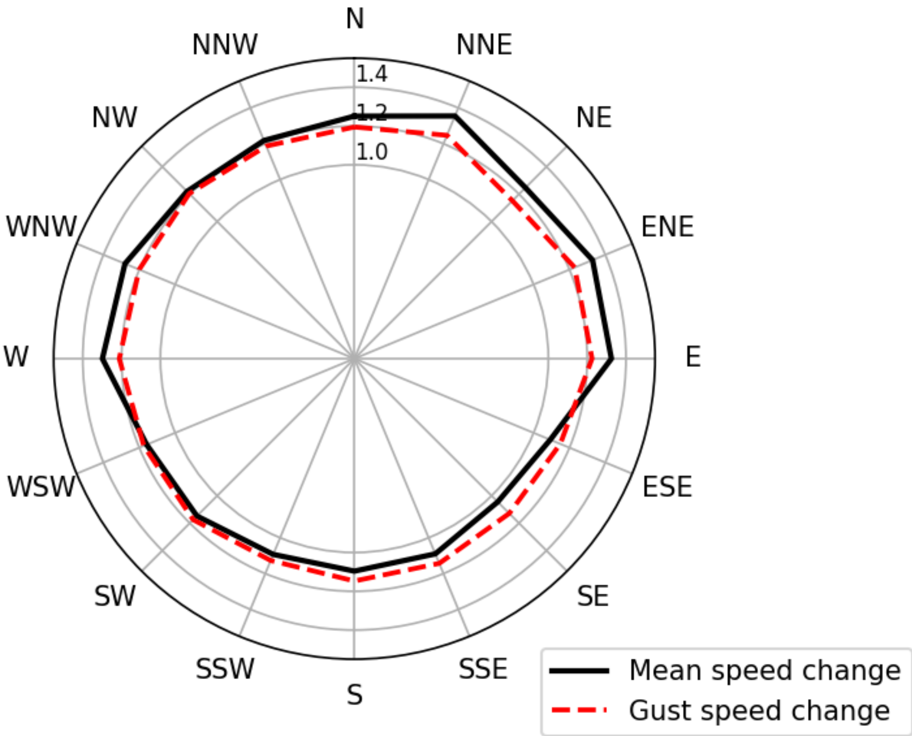


Figure 6. Conversion factors for mean and gust wind speeds to convert wind speed at 10 m over open-terrain to equivalent wind speed at the 188 Beaumont St site at 81 m height.

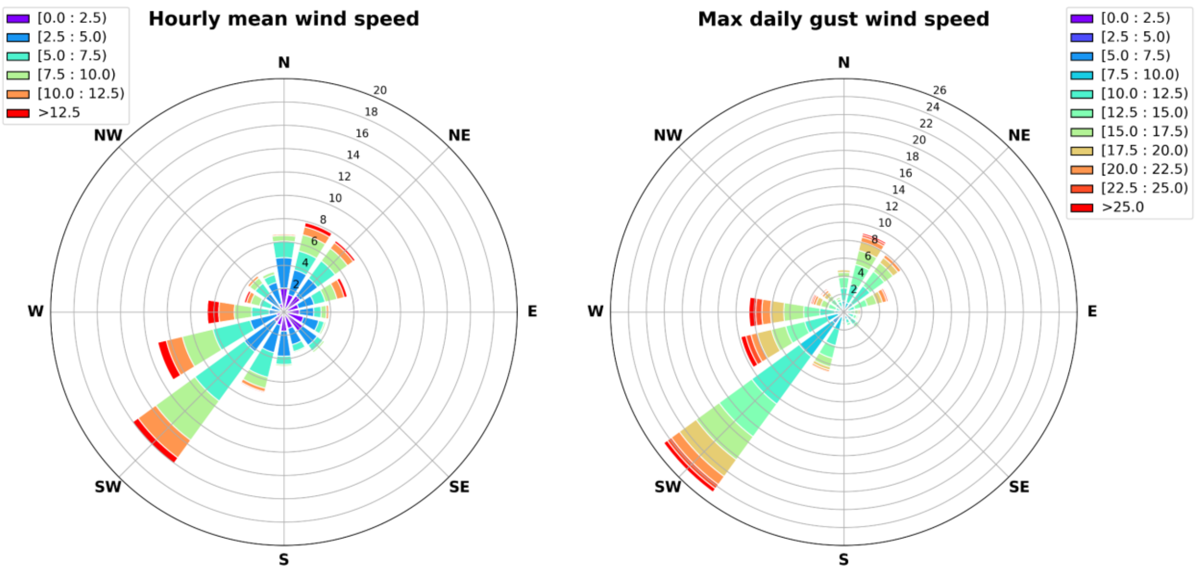


Figure 7. Potential wind distribution at the development site at 81 m height obtained by applying conversion factors in Figure 6 to wind speeds at Auckland Aero.

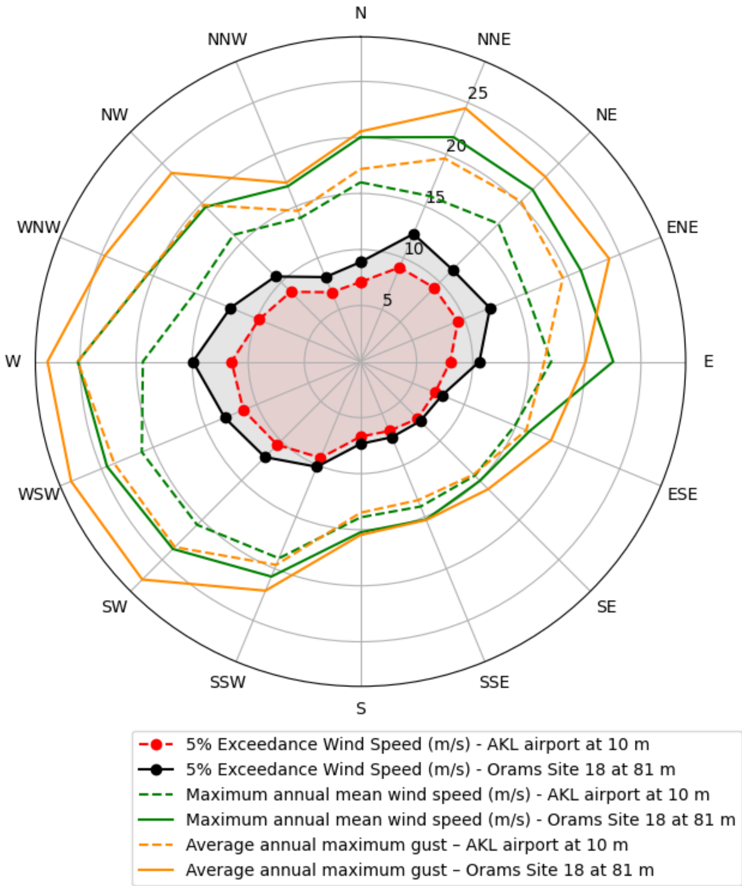


Figure 8. Directional maximum annual mean wind speed, average annual maximum gust, and 5% probability of exceedance mean winds at the Auckland Aero and the Project location.

6. Wind Tunnel Tests

6.1. Wind tunnel setup

Following the guidelines outlined in the *Australasian Wind Engineering Society (AWES) Quality Assurance Manual* [33], industry-standard Atmospheric Boundary Layer (ABL) wind tunnel testing was conducted using a purpose-built, 3D-printed model of the proposed development at a scale of 1:300. The surrounding model extended to a radius of 500 m around the development to ensure accurate representation of neighbouring structures.

The wind tunnel test for this study was conducted in the closed-circuit wind tunnel (**Figure 9**) at the Mechanical Engineering Department, University of Auckland. The test section measures 3.6 m wide by 2.5 m high and 20 m long, with a maximum wind speed exceeding 20 m/s. The specifications of the wind tunnel make it ideal for the replication of the atmospheric boundary layer, e.g. [4], and testing tall buildings, e.g. [1,2], with minimal blockage effect.

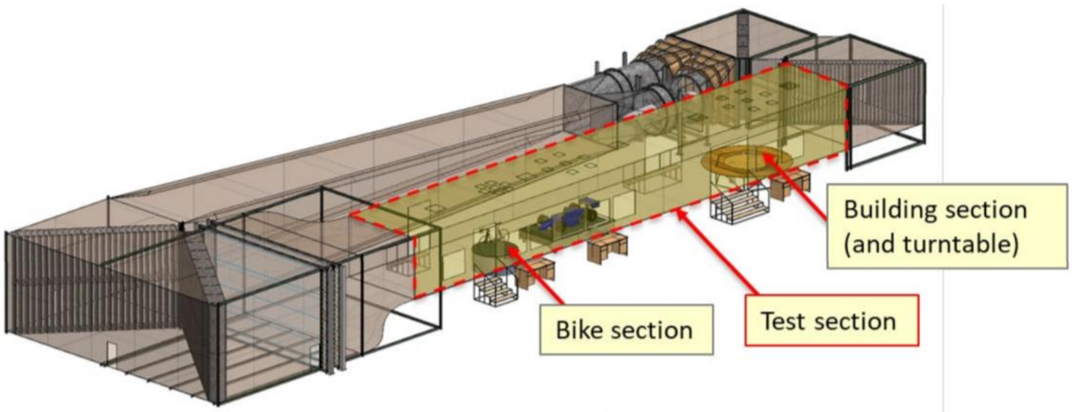


Figure 9. Schematic of the wind tunnel test at the University of Auckland.

The target model was produced using high-resolution SLA 3D printing according to the drawings supplied to FidelicFlow by Warren and Mahoney for the wind tunnel tests:

File name	Date received
20250904_188 Beaumont_Wind Model.3dm	4 September 2025

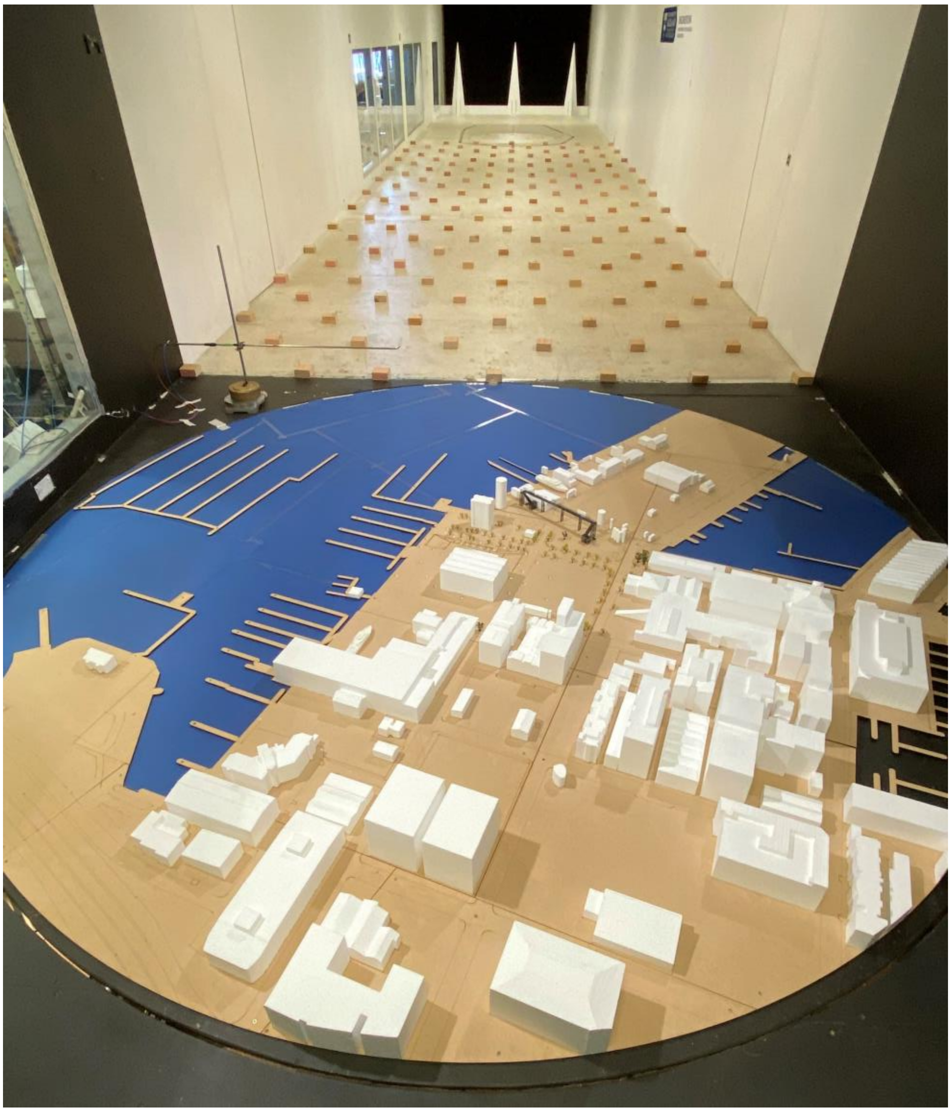
The wind-tunnel model of the proposed building was developed based on the drawings supplied to the consultant on 4 September 2025 (**Figure 2**). Subsequent drawings provided by Warren and Mahoney, dated 12 November 2025, include minor plan-form setbacks at Levels 9 and 16, of approximately 300 mm, 900 mm, and 600 mm on the north, east/west, and south façades, respectively. (**Figure A-12** and **Figure A-14**).

To assess the potential influence of these refinements, a set of computational fluid dynamics (CFD) simulations was undertaken using the 12 November 2025 drawings (Appendix B.1). The results indicate that the minor upper-level setbacks at Levels 9 and 16 do not result in any measurable or material change to pedestrian-level wind speeds.

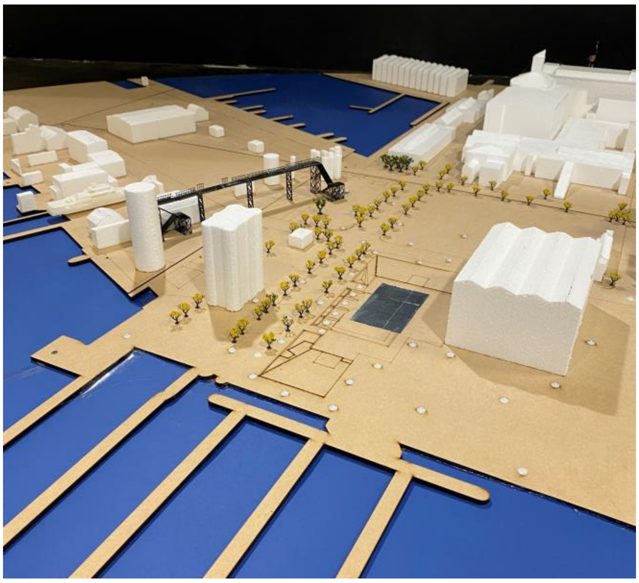
Photographs of the target and surround models were sent to the client for review at various stages prior to the wind tunnel test.

Tests were conducted for the following configurations of the development site:

1. **Existing configuration**: using the existing surrounding buildings and structures (**Figure 10**);
2. **Existing configuration with approved developments under construction**: incorporating the existing surrounding buildings with the two buildings currently under construction and the two marine tanks on the Orams site (blue buildings in **Figure 11**).
3. **Proposed configuration**: using the proposed development with the existing surrounds (**Figure 12**).
4. **Proposed development with approved developments under construction and mitigation measures:** See Section 9.



(a)



(b)

(c)

Figure 10. (a) Wind tunnel model of the existing site viewed from South. Close up of the development site with the existing condition viewed from west (b) and east (c).

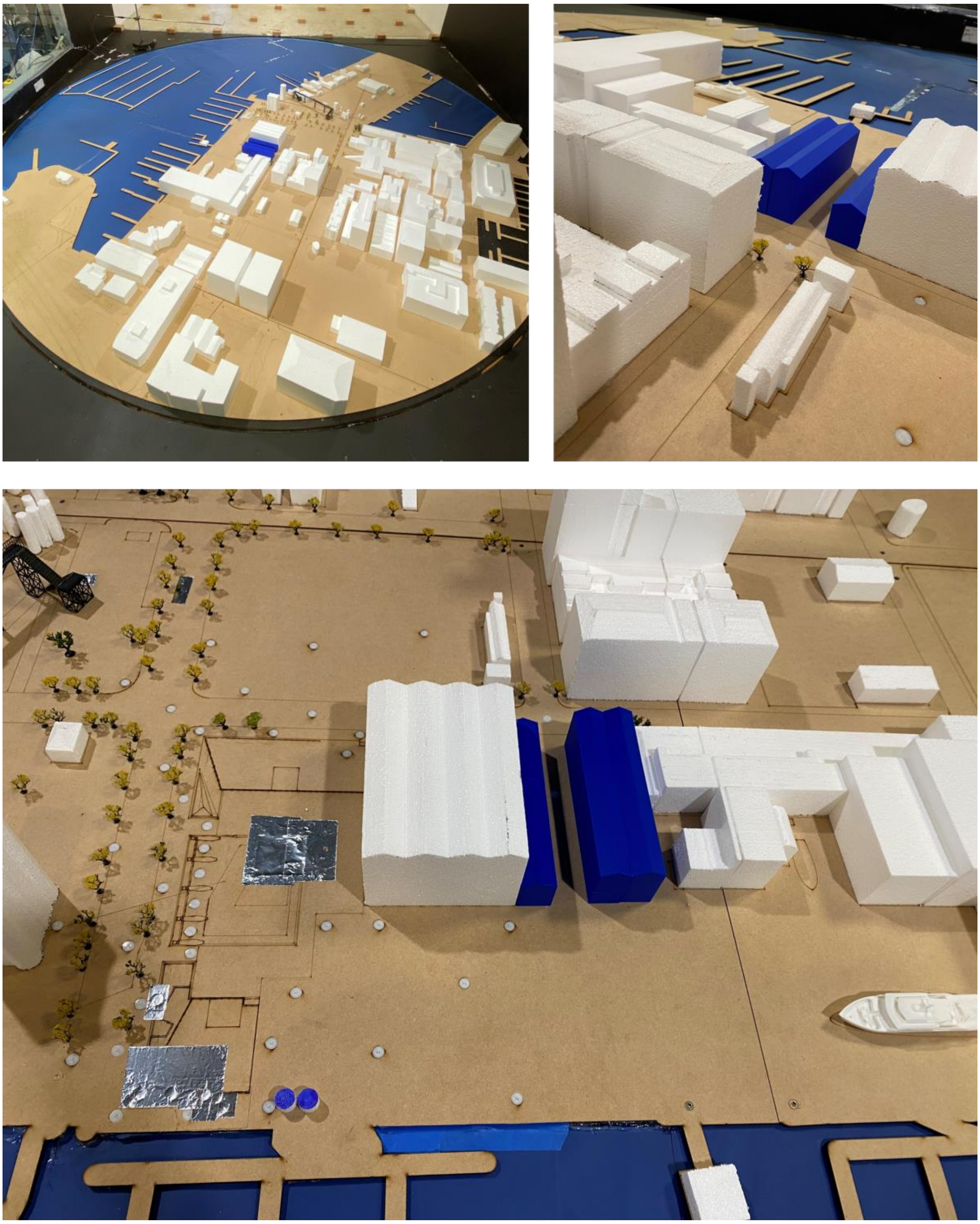


Figure 11. Existing configuration with approved developments under construction on the Orams site (shown in blue). The two marine tanks located near the western boundary of the Project will remain in place following construction of the proposed development.

Figure 12. Close-up photographs of the proposed development. Irwin probes are visible around the site at ground level, on the podium, and on several balconies of the proposed building.

To accurately model the characteristics of the approaching winds, such as turbulence intensity and velocity profiles, in the wind tunnel, a combination of roughness blocks, square posts, stripping fences, and spires was installed in the upwind section (Figure 10a).

The analyses of terrain conditions (Section 5) determined the turbulence characteristics and wind speed profile for the 16 wind sectors (Figure 13). Based on the similarity of turbulence intensity values at the 81 m reference height, the wind directions were grouped into three representative profiles to adequately characterise the flow conditions at the development site.

The aerodynamic roughness, inlet velocity profile and turbulence intensity profile were replicated according to ESDU [32] and AS/NZS1170.2 [31] within a ±10% variation in accordance with the AWES Quality Assurance Manual (QAM) [33]. The target and measured profiles of mean and gust wind speeds, as well as turbulence intensity, for each of the three directional groups are presented in Figure 14.

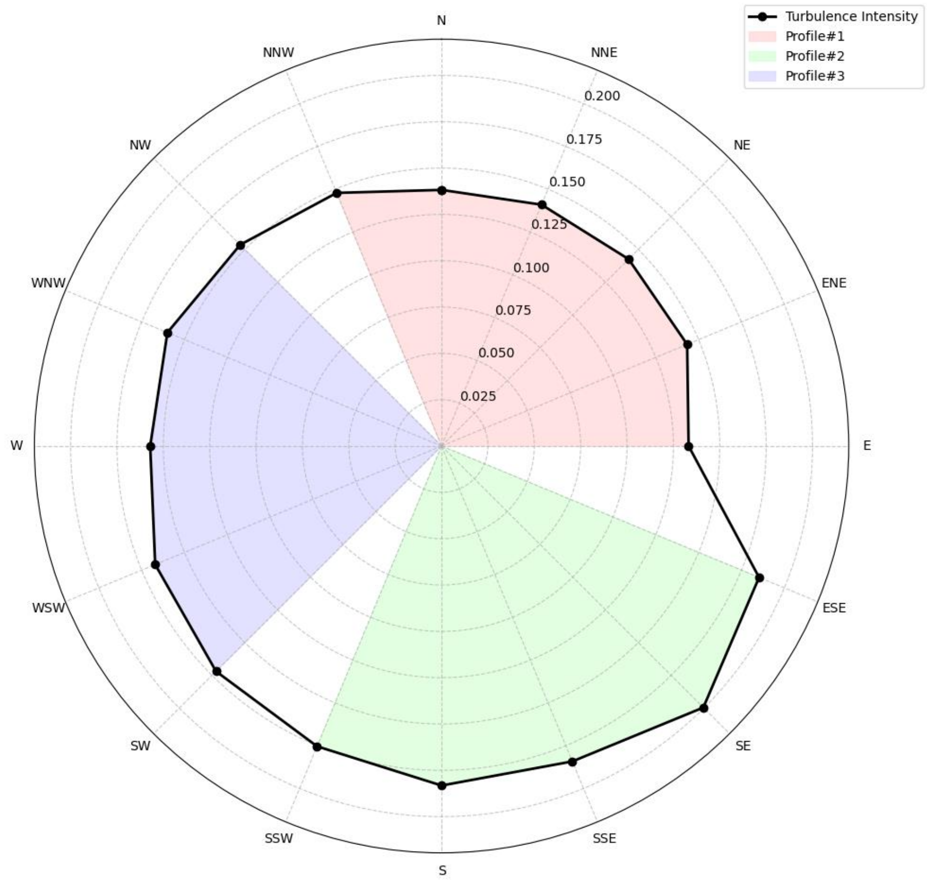


Figure 13. Directional turbulence intensity at the development site at the 81 m reference height.

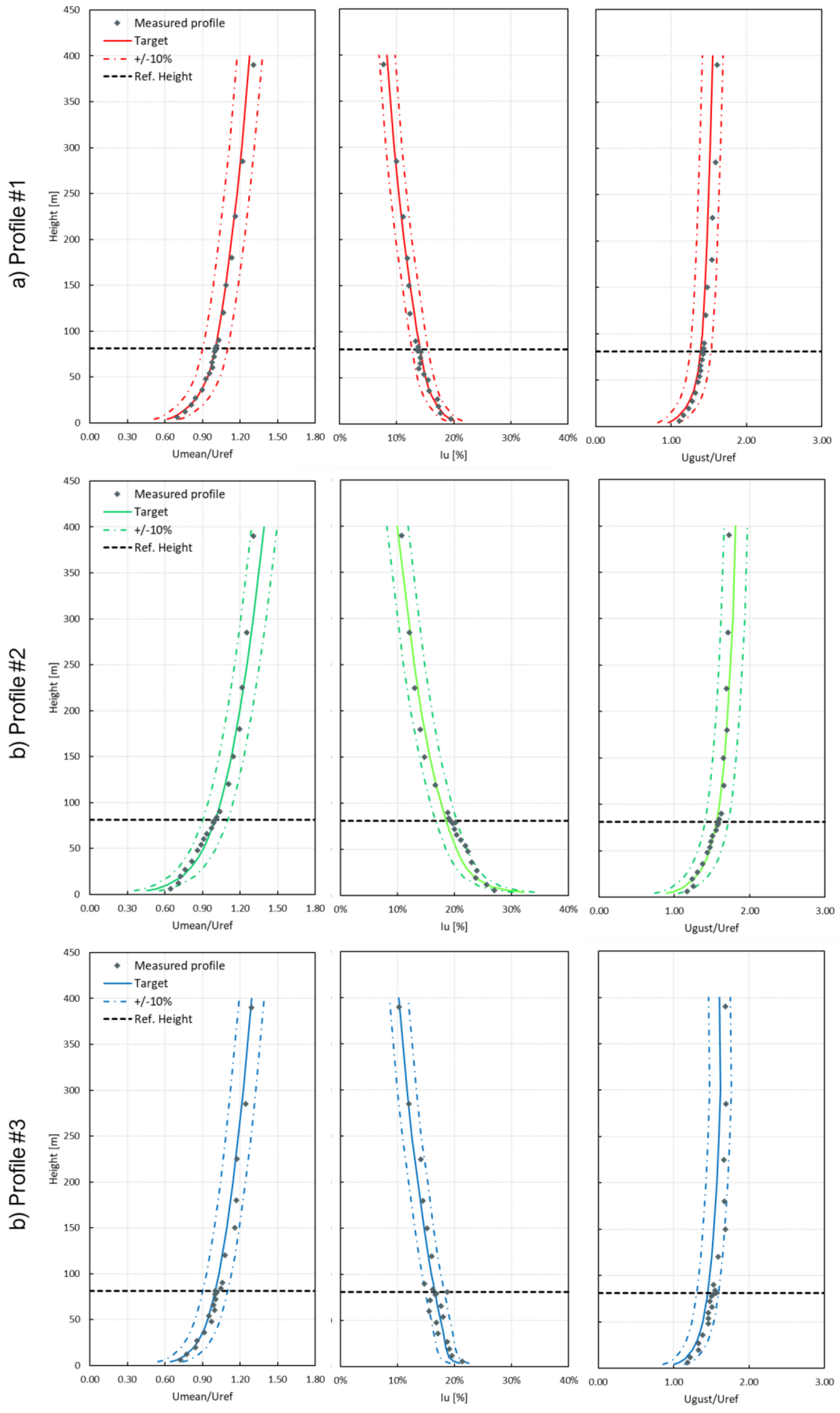


Figure 14. Comparison between target and wind tunnel–measured mean wind velocity (left), turbulence intensity (middle), and gust wind speed (right) for: a) profile#1 – NNW to E; b) profile#2 – ESE to SSW; and c) profile#3 – SW to NW.

6.2. Instrumentation and Measurements

A total of 50 (35 on the ground and 15 on the target building) omnidirectional, pressure-based wind speed sensors, commonly referred to as Irwin probes and similar to those described in [34] and shown in Figure 15, were employed to measure local wind velocities simultaneously at multiple points on the model. These probes capture both mean and fluctuating components of the flow, providing high-resolution temporal and spatial data. These sensor are widely used for the assessment of pedestrian level wind speed [35], airflow on the roof of buildings [36], and environmental flows [4].

Calibration of the probes was conducted in June 2025 using a Cobra sensor[1] as a reference. The calibration relationship is expressed as:

$$U = \alpha + \beta\sqrt{\Delta P} \qquad \text{Eq. 1}$$

Figure 15. Close up photo of the surface level wind speed sensor (i.e. Irwin probe).

The Irwin probes were positioned to avoid mutual interference, with spacing between probes greater than 10 d (where d is the probe tip diameter), in accordance with guidance on wake effects [37].

Pressure measurements were performed using an electronically scanned pressure system, allowing high-frequency sampling to capture rapid signal fluctuations. The system employed Honeywell differential pressure transducers (XSCL04DC) with a time response of 1 ms. Measurements were recorded at a sampling frequency of 400 Hz over a 60-second duration in the wind tunnel, corresponding to approximately 150 minutes in full scale. A velocity ratio of $U_{WT}/U_{fs} = 0.5$ was used in the tunnel, where U_{fs} represents the wind speed with a 1-year return period.

Fluctuating pressure measurements obtained via long tubes are prone to distortion due to the 'organ pipe' effect, where specific frequencies are amplified or attenuated depending on the tube's geometric properties, such as length and diameter. To address this distortion, the measured data in this study were digitally corrected using a recursive filter, as detailed in [38,39]. The filter's parameters were specifically calibrated to compensate for the frequency response characteristics associated with the tube length employed.

The gust wind speed at each location was calculated using,

[1] https://www.turbulentflow.com.au/Products/CobraProbe/CobraProbe.php

$$\hat{U} = \overline{U} + g\sigma \quad \text{Eq. 2}$$

where $\hat{U}$ is the 3-second gust velocity, $\overline{U}$ is the mean velocity, g is the peak factor, which is taken to be 3.4 [40], and σ is the standard deviation of the velocity measurement.

The 3-second gusts calculated using Eq. 2 were cross-checked against gusts derived from the wind tunnel time series, using the appropriate model-to-prototype scaling [23] (e.g., 3-second equivalent moving average). The results were found to be comparable, confirming the validity of the peak factor approach.

The speed-up ratios based on the wind tunnel results are calculated by dividing wind speeds at the Irwin probe locations by the reference wind speed at 81 m (i.e. top of the proposed building). These ratios were then correlated with the full-scale mean and average annual maximum gust wind speeds (Figure 7 and Figure 8). The results were subsequently evaluated against the Auckland Unitary Plan comfort and safety criteria.

Figure 16 shows the Irwin probe locations at ground level around the site.

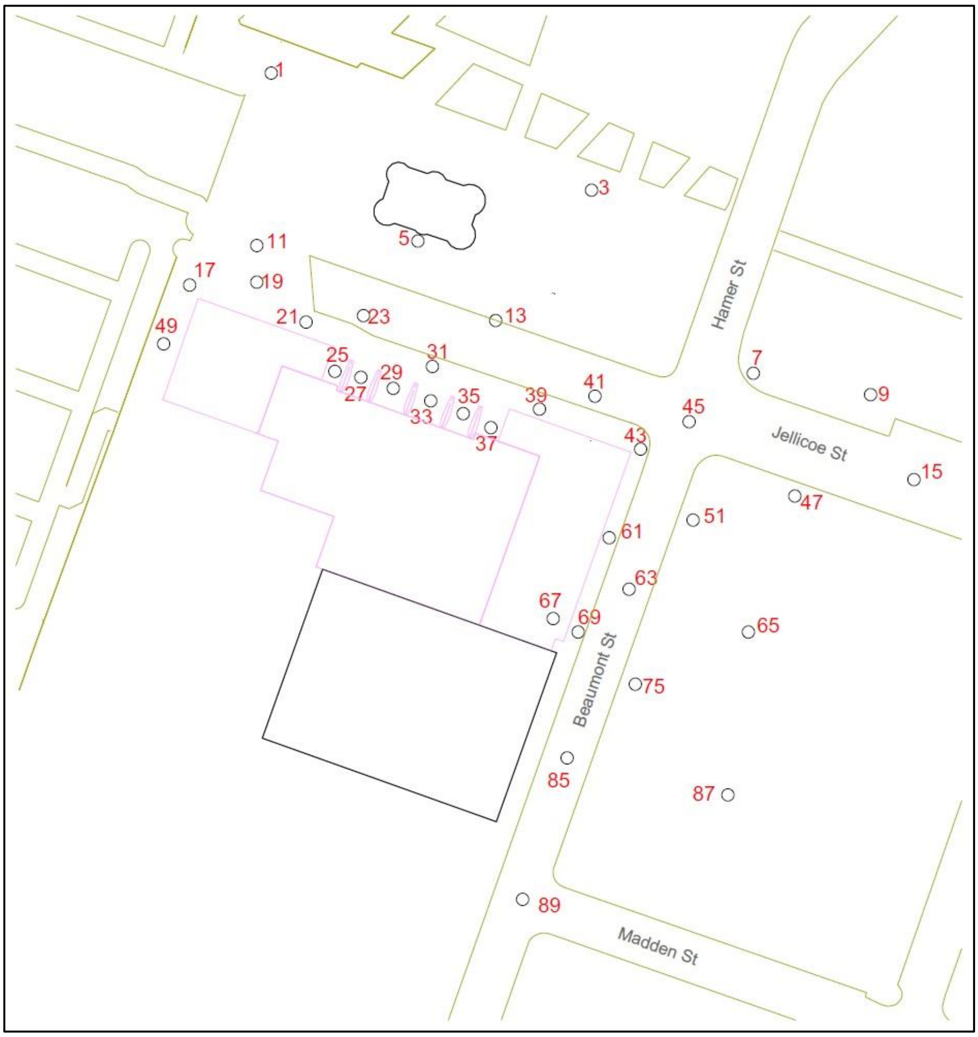


Figure 16. Study point locations on the ground level around the development site.

7. Supplementary CFD Simulations

CFD simulations are allowed by wind loading standard and AWES Quality Assurance Manual [33,41] for environmental wind speed assessment. Here in this study, CFD simulations are conducted to assist in interpreting the results and to provide more detailed insight to the airflow behaviour at the proposed development site.

While due care was taken in conducting these CFD simulations, it is important to note that they were not intended to provide high-fidelity predictions or to replace wind-tunnel experiments. Rather, the CFD modelling was undertaken to provide a three-dimensional representation of the wind field, assist in identifying the flow mechanisms responsible for elevated wind speeds, and support the development and assessment of appropriate mitigation measures (See Section 8.3 and Appendix B).

The main limitations of the current simulations include:

- Simulations were only carried out for the dominant wind directions in Auckland, i.e. SW and NE.
- Only the proposed buildings and main structures upstream of the proposed development were included in the simulation domain (Figure 23 and Figure A-5).
- Only the primary features of the new buildings, specifically the overall building massing and aerodynamic form, were modelled. Detailed architectural features (e.g. balconies) were not included, which is expected to result in conservative wind conditions.
- Although a high-resolution mesh was utilised to ensure the capture of key flow features, a formal mesh-independency analysis was not conducted, as the CFD results are presented as a supplementary tool to aid interpretation of the wind tunnel data, which forms the basis of the final recommendations.

A three-dimensional steady-state Reynolds-averaged Navier–Stokes (RANS) approach was used. For modelling turbulence, the shear-stress transport (SST) model [42] was employed. For both the advection and turbulence terms of the governing equations a second order discretisation scheme was used. A pressure-driven method [43] was used to generate horizontally homogeneous atmospheric boundary layer. More detail can be found in [4].

The boundaries of the CFD domain are located more than 2 km away from the target building to ensure that there is no blockage effect. A fine mesh with a minimum cell size of 0.1 m around the target building was generated. The cell size gradually increases with distance from the proposed building to optimise computational efficiency. Additionally, inflation layers with a first layer thickness of 0.1 m were created around the target and surrounding buildings to more accurately capture the flow gradients near solid boundaries.

The first set of simulations (Section 8.3) was based on the drawings of the proposed building dated 4 September 2025. As explained in Section 2, subsequent simulations (Appendix B.1) were conducted incorporating the minor setbacks at Levels 9 and 16 based on the drawings dated 12 November 2025.

8. Results and Discussion

8.1. Pedestrian Comfort

8.1.1. Existing Configuration

The site is located in an exposed area, with open sea adjacent to the development from the west to northeast, and low- to medium-rise buildings in the immediate vicinity from the east to south. Consequently, relatively high wind speeds occur at the site under existing conditions, as shown in the wind speed distributions in **Figure 7** and **Figure 8**. **Figure 17** presents the pedestrian wind comfort conditions for the existing configuration. Locations 13 and 29–37 along Jellicoe Street are Category D, exceeding the desired Category C. Locations 1, 3, and 89 (at the intersection of Beaumont and Madden Streets) are also Category D. Category D is considered acceptable for Location 89, as it is situated on a vehicular route. All other locations are rated Category B or C and are considered acceptable for their intended use.

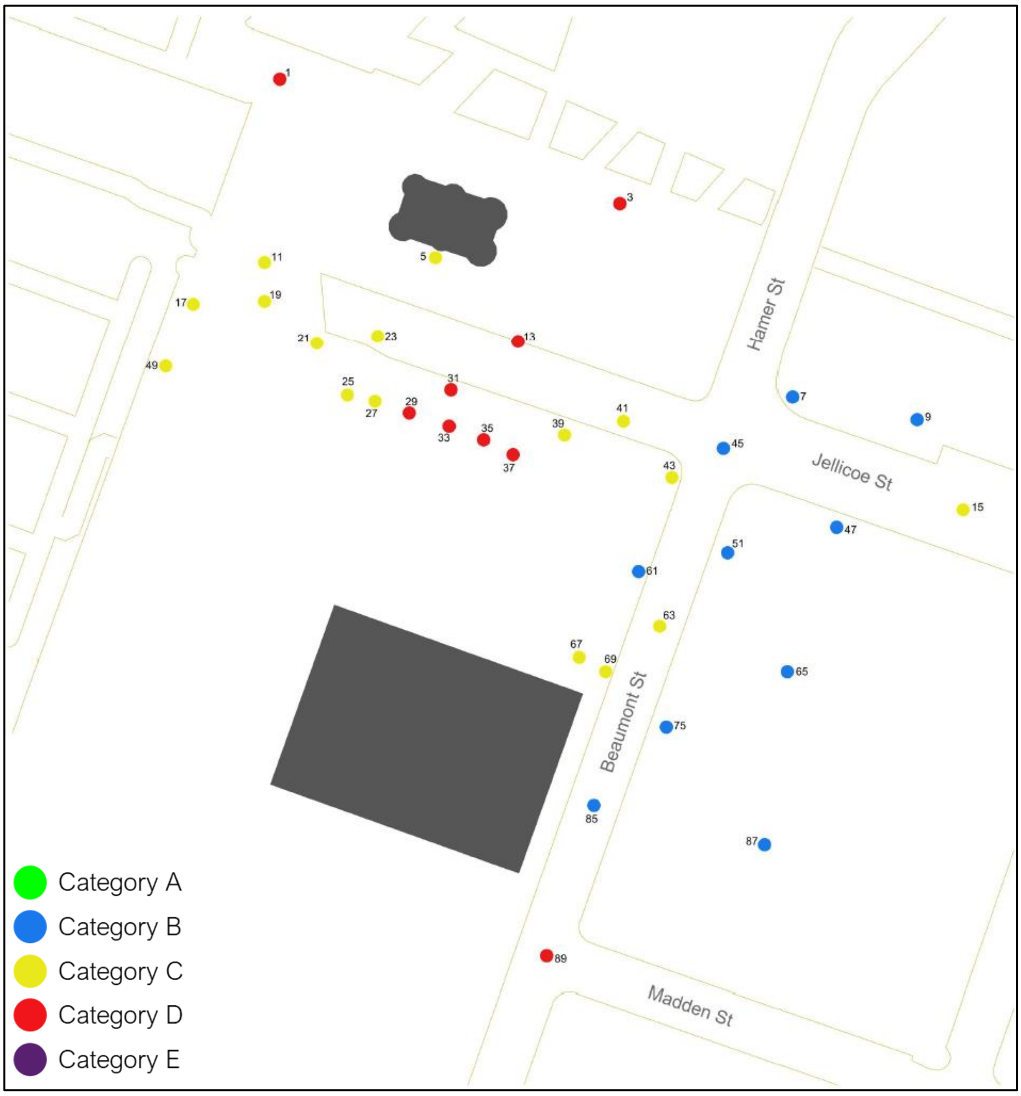


Figure 17. Pedestrian wind **comfort** conditions of the **existing configuration,** assessed against criteria in the AUP OIP.

8.1.2. Existing Configuration with Buildings Under Construction (Orams Site)

This tested configuration includes the existing buildings together with the two buildings under construction and the two marine tanks on the Orams site (shown in light grey in Figure 18). The inclusion of these structures does not affect the comfort categories at most investigated locations. The main changes are as follows:

- Location 63 on Beaumont St, and Locations 41 and 43 (at Jellicoe and Beaumont intersection) improved from Category C to Category B;
- Location 85 on Beaumont St changed from Category B to Category D; Category D is still considered acceptable, as the location is on a vehicular route;
- Location 87 improves from Category B to Category A.

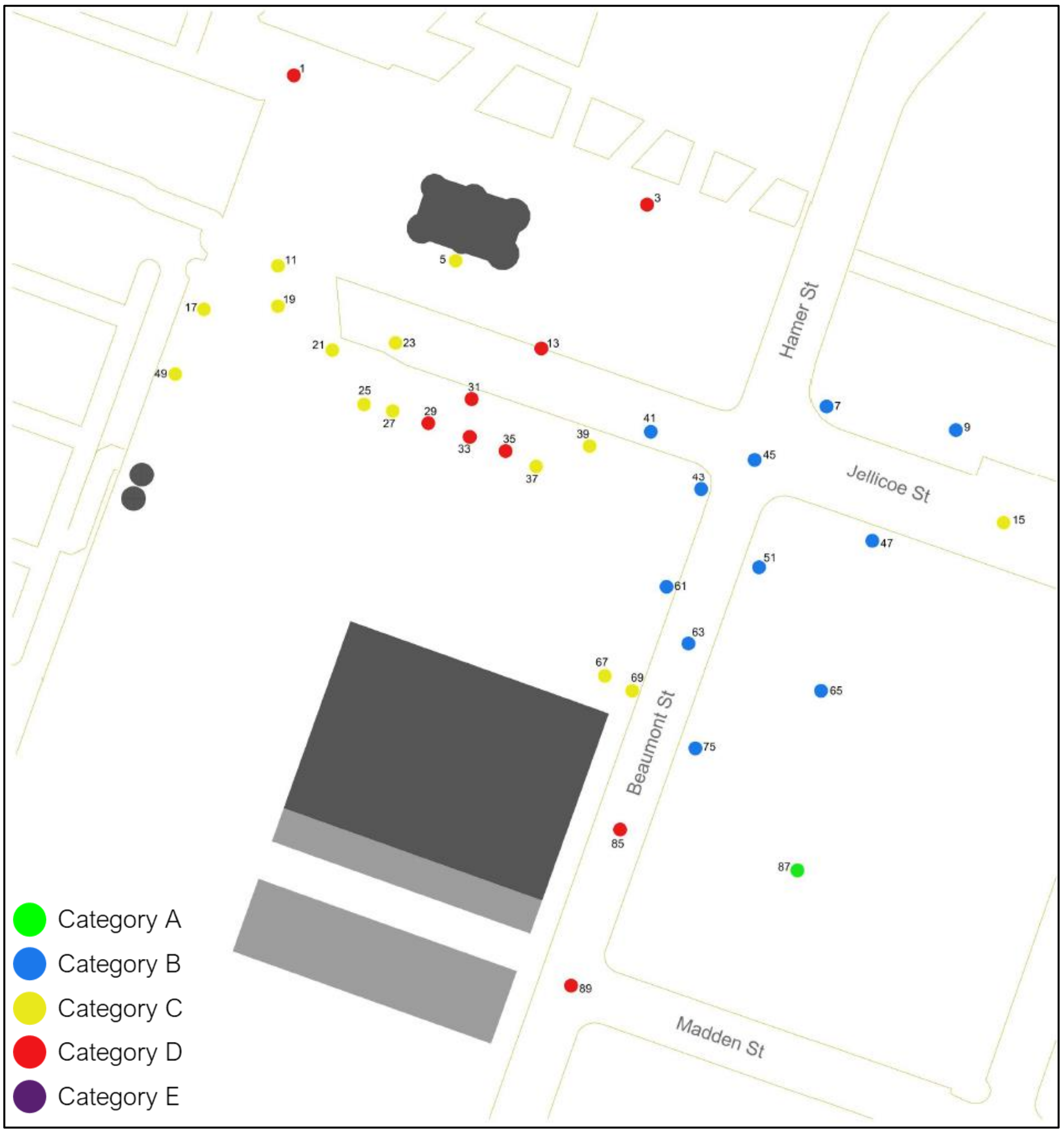


Figure 18. Pedestrian wind comfort conditions for the existing configuration with buildings under construction on the Orams site, assessed against the AUP OIP criteria.

8.1.3. Proposed Configuration (ground level) without mitigation

Due to the size and height of the proposed building, wind conditions around it vary widely, ranging from Category B to Category E (dangerous – very windy). **Figure 19** demonstrates that the proposed building considerably changes the wind flow distribution in the site compared to the existing configuration. The building provides sheltering for some locations (1, 3, 25 – 37), reducing their category from C, D and E to B and C. This represents a beneficial outcome, with improved pedestrian wind comfort across several key locations. In contrast, the building increases the wind flow at other locations changing the comfort category by one category or making them uncomfortable/dangerous. Locations 13, 17, and 23 are rated category E – this is due to the flow separation from the corner of the building for SW-W wind directions (see Section 8.3 for CFD results and visualisation). This flow separation also affects Location 11 changing its category from C to D. Location 17 is also affected by NE winds. Additionally, flow acceleration along Beaumont St changes most locations from category B to C – which is still acceptable for their intended use, except for Location 51 which is now category D.

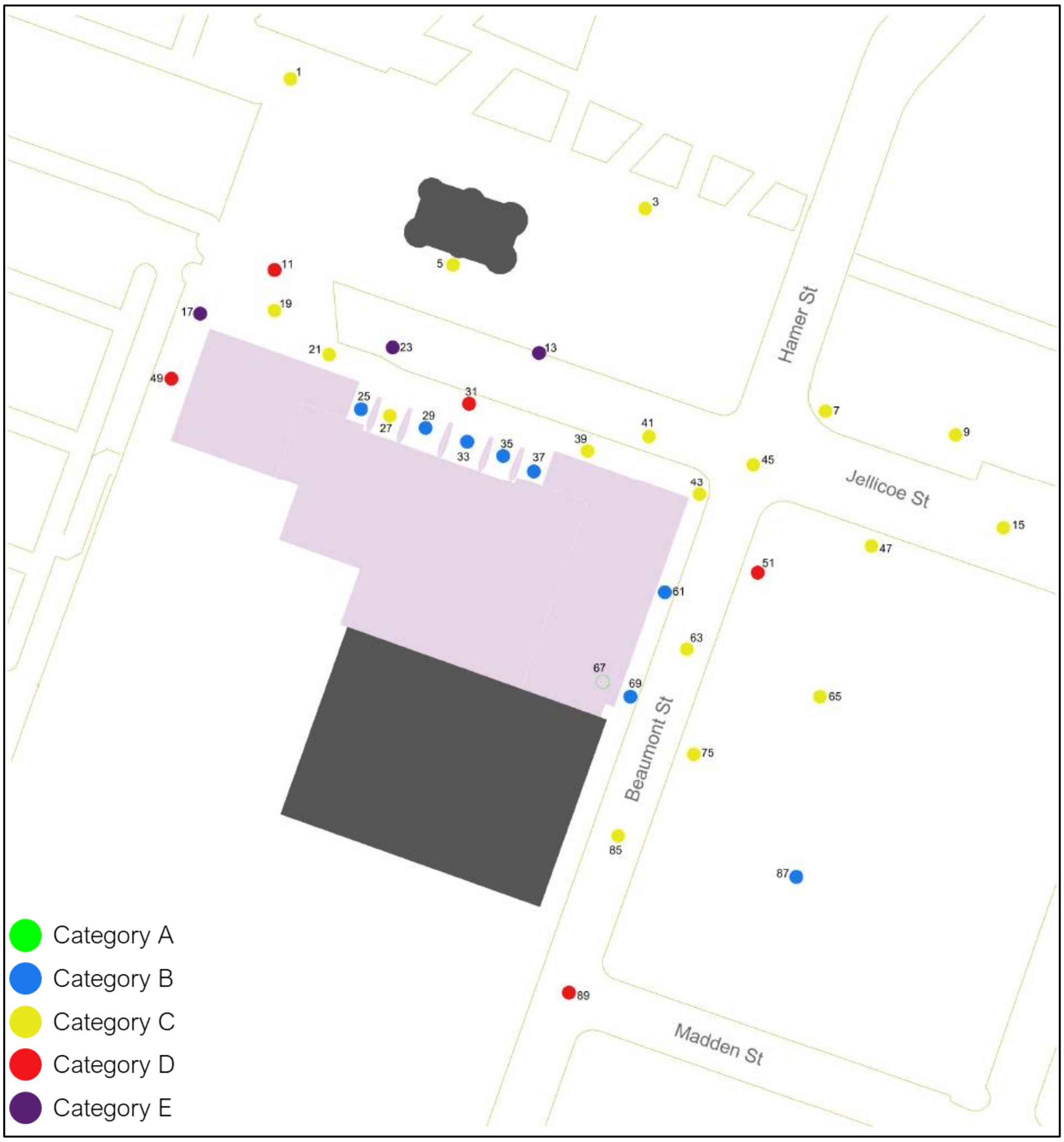


Figure 19. Pedestrian wind **comfort** conditions of the **proposed configuration,** assessed against criteria in the AUP OIP.

8.2. Pedestrian Safety

For the safety assessment, a threshold of 25 m/s for the annual maximum 3-second gust wind speed was adopted (see Section 4).

8.2.1. Existing Configuration

The existing wind conditions around the development site were found to be safe and within the pedestrian safety threshold at all locations (**Figure 20**).

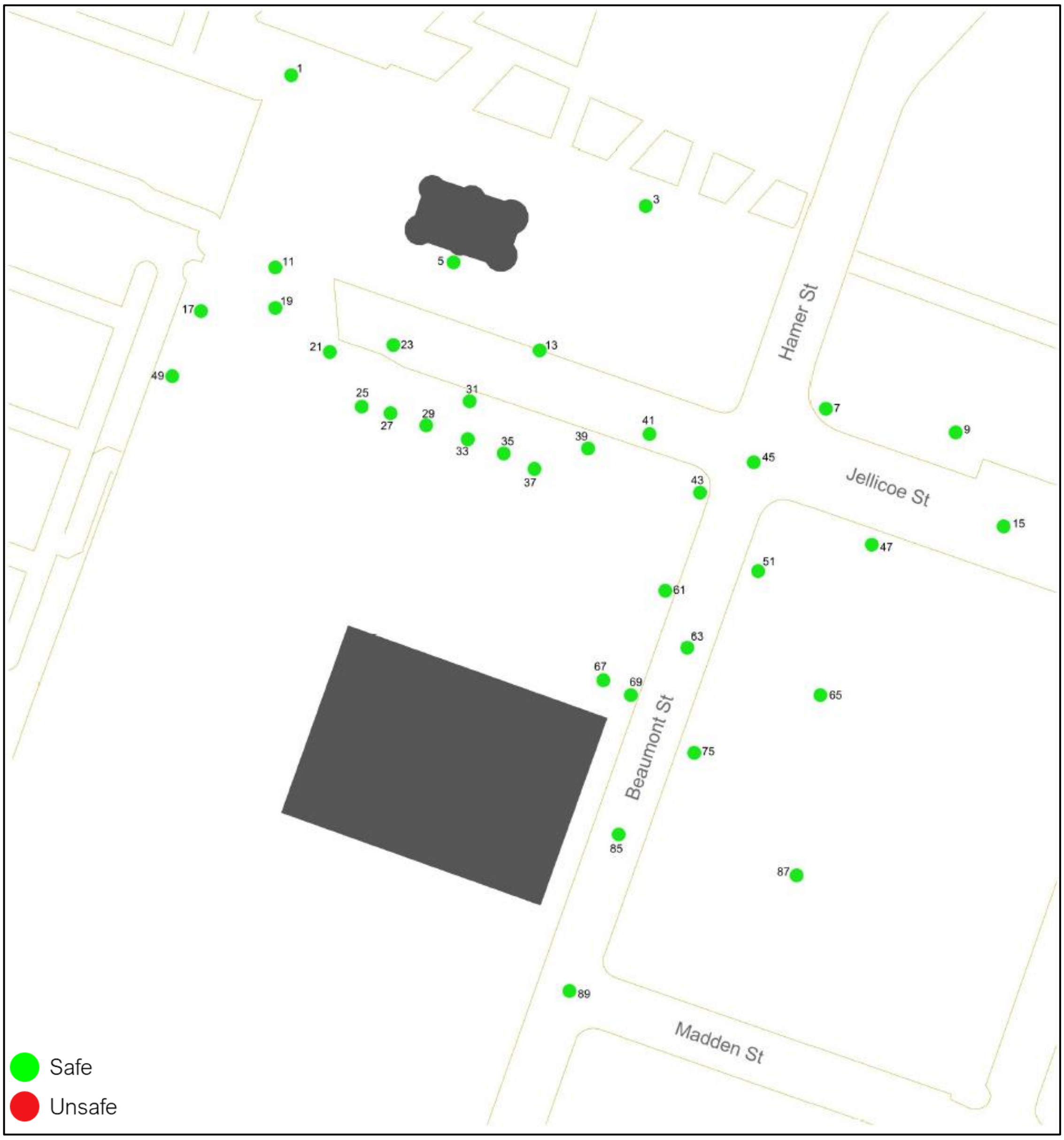


Figure 20. Pedestrian wind **safety** conditions of the **existing configuration,** assessed against criteria in the AUP OIP.

8.2.2. Existing Configuration with Buildings Under Construction (Orams Site)

The inclusion of the buildings under construction on the Orams site results in an increase in gust wind speeds exceeding the safety threshold at Location 85. In addition, Location 43 (at the Jellicoe Street–Beaumont Street intersection) experience a slight increase in gust wind speeds (less than 25 m/s), which is still considered safe. All other locations remain within the same safety category as the existing configuration.

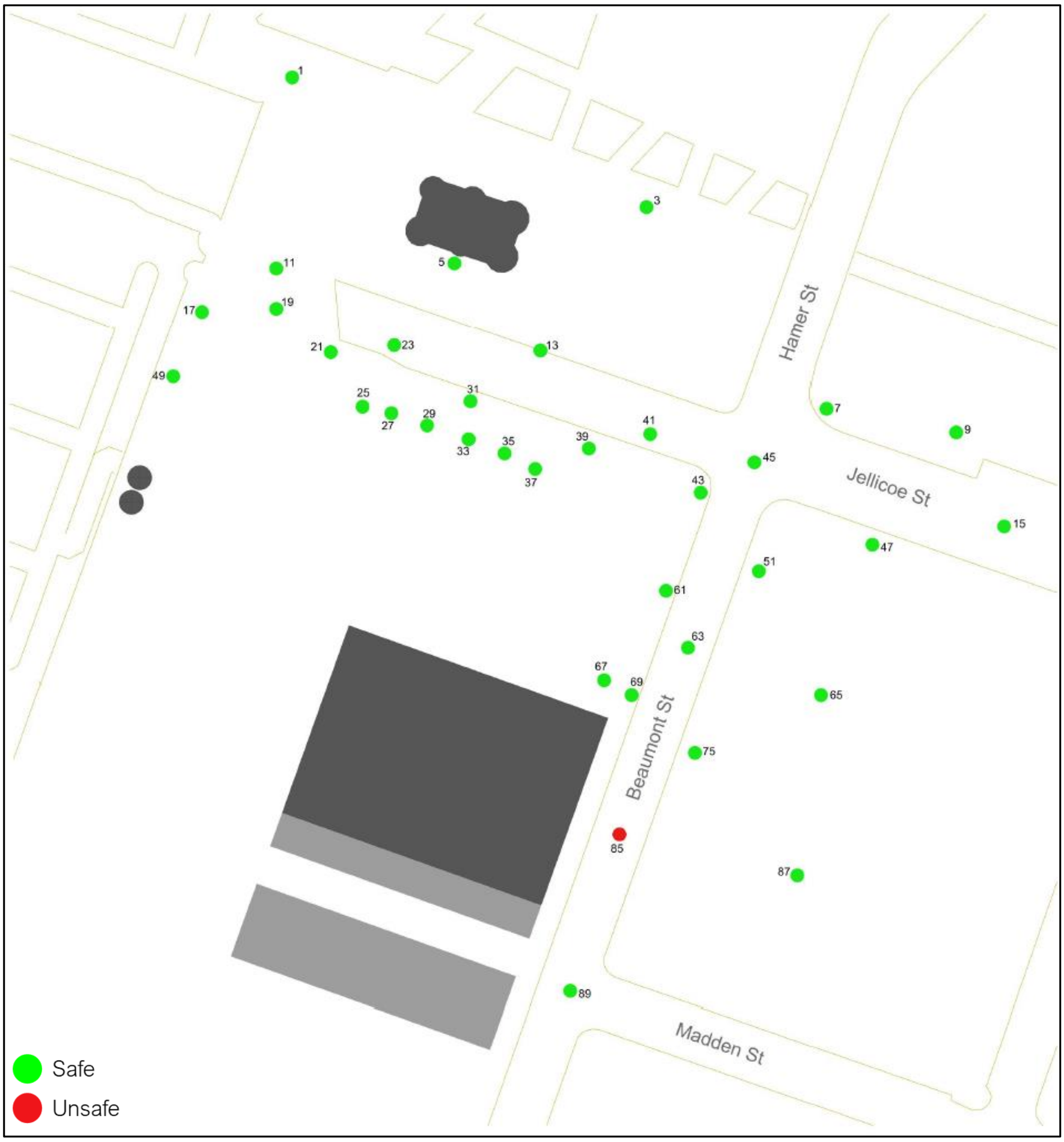


Figure 21. Pedestrian wind **safety** conditions for the **existing configuration with buildings under construction on the Orams site**, assessed against the AUP OIP criteria.

8.2.3. Proposed Configuration (ground level) without mitigation

The proposed development increases the gust wind speed around the building compared with the existing configuration, resulting in eight unsafe locations (**Figure 22**) along Jellicoe and Beaumont Streets as well as on the western side of the proposed building. All the unsafe locations experience gusts of greater than 25 m/s for SW to W wind directions. The flow separation from the corners on the west side of the building increases the gust wind speed at Location 49. The flow separation/corner-effect also extends into Jellicoe St and impacts Locations 13, 23 and 31. This flow separation combined with slight downwash effect from the Silo 6 structure as well as the slight "*undercroft*"[2] effect (see **Figure 25**) under the building overhang generates a complex flow regime and turbulence that increase gust wind speeds at the mentioned locations.

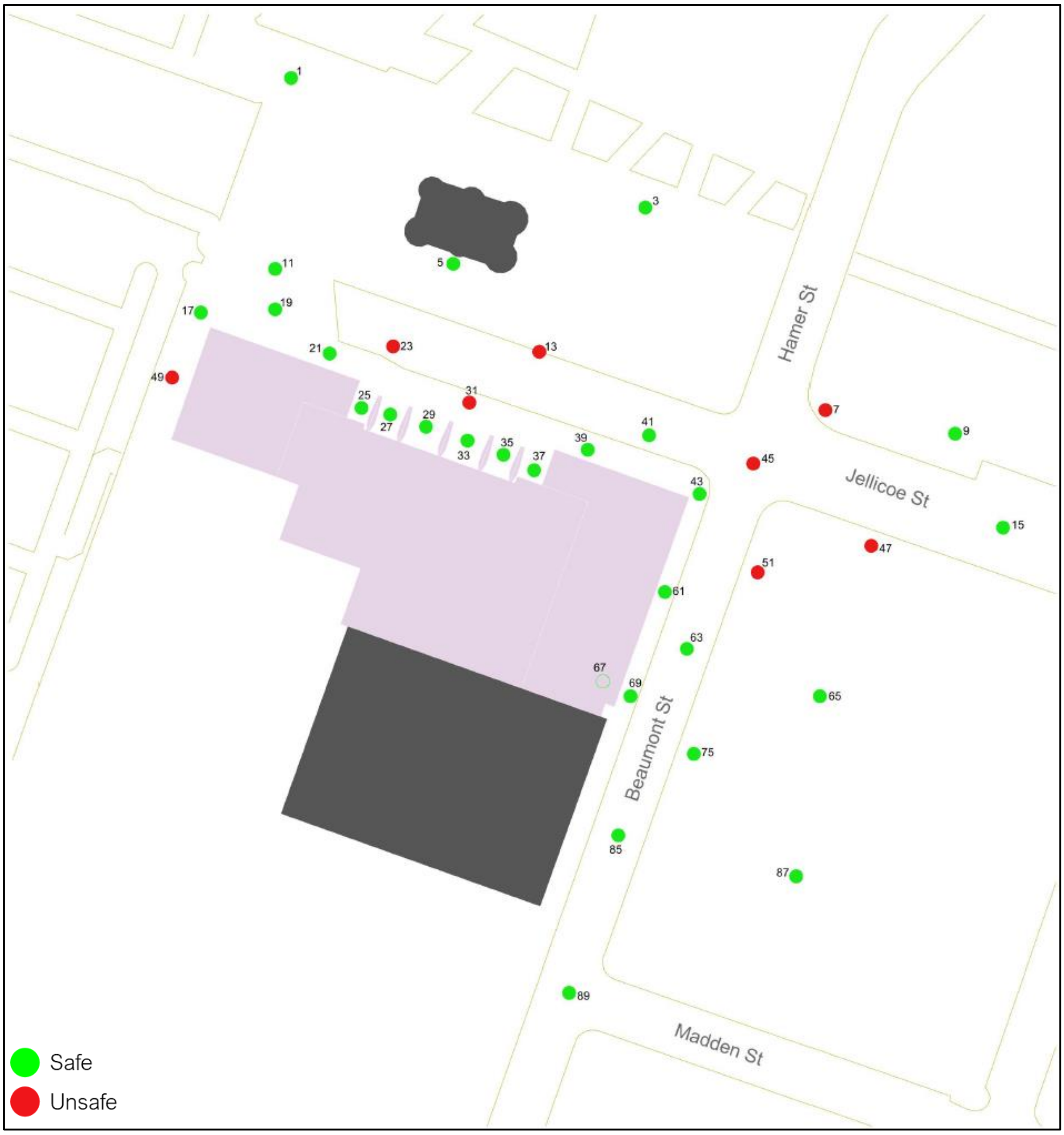


Figure 22. Pedestrian wind **safety** conditions of the **proposed configuration,** assessed against criteria in the AUP OIP.

[2] The "undercroft" effect is a well-known adverse building-wind characteristic in which winds are drawn toward the negative pressure region within the undercroft, resulting in concentrated, adverse airflow through the undercroft.

Locations 7, 45, 47 and 51, at the intersection of Beaumont, Jellicoe and Hamer streets, are also rated unsafe. As visualised in **Figure 25**, the flow separation from the corner of the existing building, exacerbated by flow acceleration due to wind shear along the existing and proposed buildings, results in a large area of accelerated flow on Beaumont Street and its intersection with Jellicoe Street.

8.3. CFD results for SW and NE winds (proposed development without mitigation measures)

Computational fluid dynamics (CFD) simulations were conducted for a simplified model of the proposed development and its surroundings for southwesterly (SW) and northeasterly (NE) wind directions, Auckland's dominant wind directions, to aid in interpreting the complex flow behaviours and better explaining the comfort and safety conditions discussed in the previous sections.

Figure 23 and **Figure 26** illustrate the wind speed for SW and NE wind directions at 1.5 m above the ground, respectively. For SW winds, the areas of increased wind speed (red regions in the figures) demonstrate the flow separation from the corners of the buildings. These regions were evaluated as categories E (Locations 13, 17, 23) and D (11, 31, 49, 51 and 89). On the north side of the proposed building, on Jellicoe St, a region of increased wind speed and turbulence (shown in dashed box in **Figure 23**) led to increased gust wind speed and creating a unsafe wind condition (Locations 13, 23 and 31). Similarly, the corner effect extends downstream on Beaumont St and Jellicoe St influencing the safety condition at Locations 89, 5 1, 47, 45 and 7.

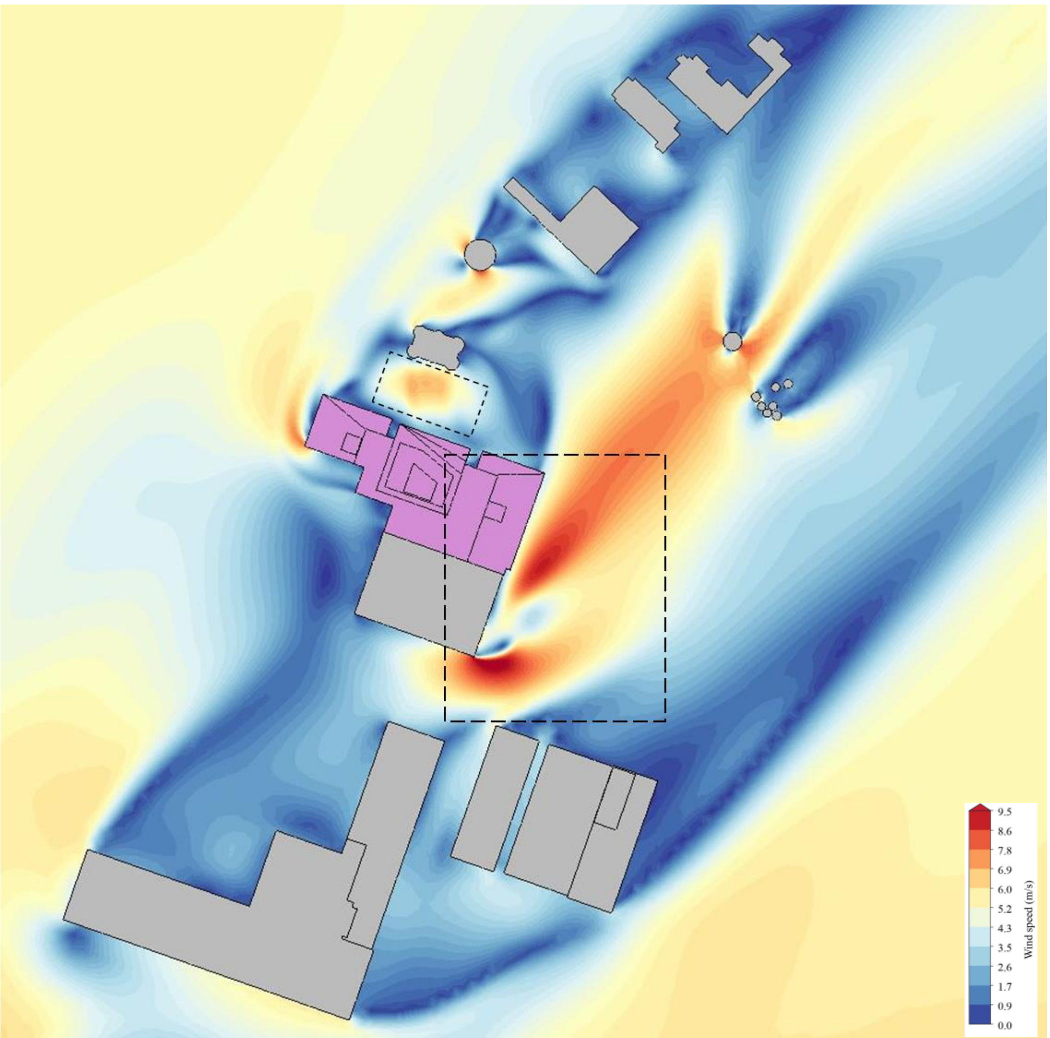


Figure 23. Spatial distribution of wind speeds for SW winds around the proposed configuration at 1.5 m above ground level, obtained from CFD simulations. Red regions indicate areas of high wind speeds (in these simulations, the maximum wind speed at 1.5 m above ground is approximately 10 m/s).

For NE winds (**Figure 26**), flow separation from the northwest-facing corner of the proposed building generates a high wind speed region affecting Locations 11, 17, and 23. Additionally, a corner effect from the adjacent existing building influences the comfort conditions at Location 89 at the intersection of Beaumont and Madden streets.

A closer look at the SW wind effects around the proposed building, under its overhangs and internalised entrances, is shown in **Figure 24**, demonstrating calmer conditions, particularly at the entrance on Jellicoe Street, which aligns with the B-rated comfort criteria for these locations (**Figure 19**). These calmer conditions are attributable to the shielding provided by the building overhangs (already incorporated in the design of the Project – **Figure 2**), which effectively dampen downwash and shear-induced gusts.

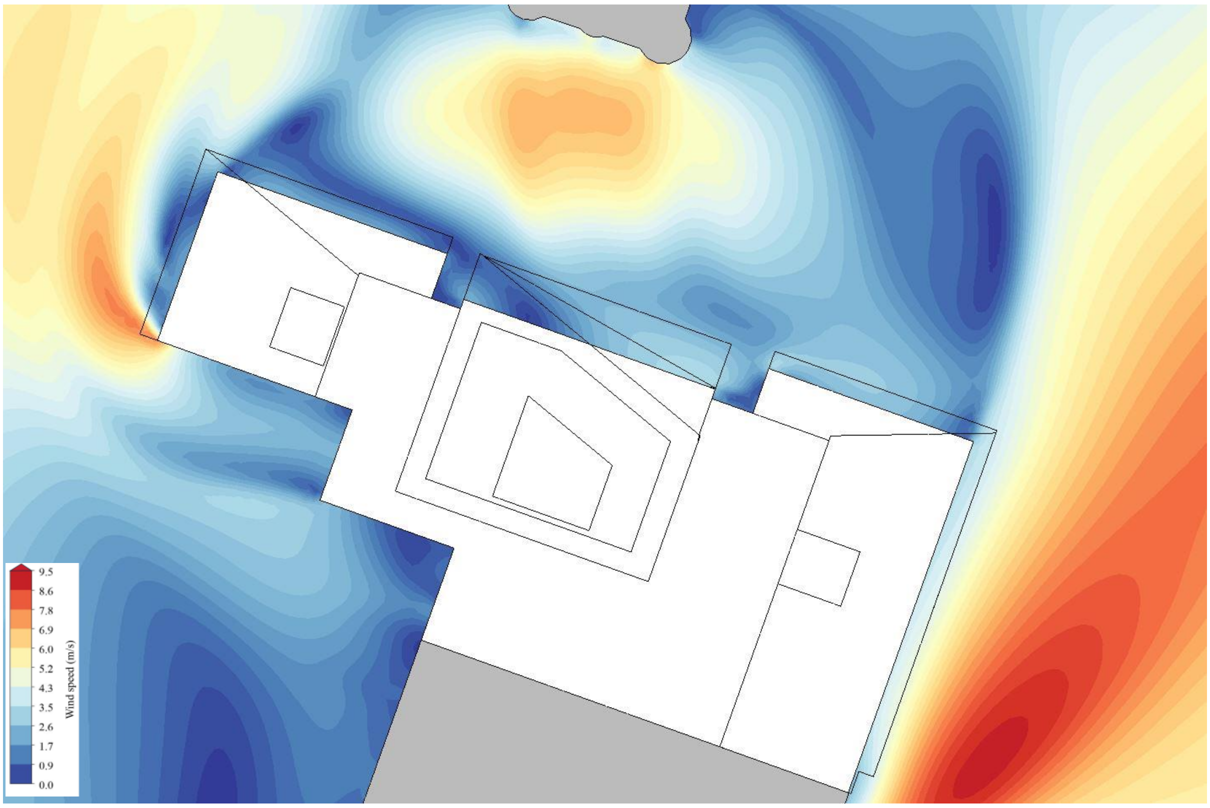


Figure 24. Zoomed-in spatial distribution for SW wind speeds around the proposed building at 1.5 m above ground, obtained from CFD simulations. Red shading indicates higher wind speeds (with a maximum of approximately 10 m/s in these simulations), while dark blue indicates near-zero wind speeds.

As briefly mentioned earlier, the presence of corners and building overhang or undercrofts can further accelerate the flow. **Figure 25** illustrates that, at the west-side corner of the proposed building, winds are drawn toward the negative pressure area within the undercroft, creating concentrated adverse airflow through the undercroft and resulting in increased wind speeds.

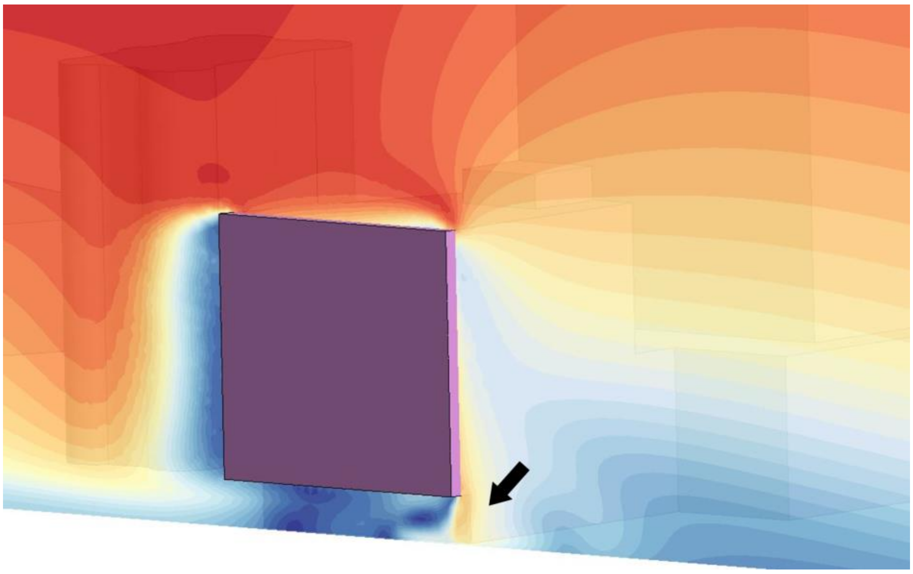


Figure 25. Zoomed-in spatial distribution of wind speeds around the proposed building at 1.5 m above ground, obtained from CFD simulations. Red shading indicates higher wind speeds (with a maximum of approximately 10 m/s in these simulations), while dark blue indicates near-zero wind speeds.

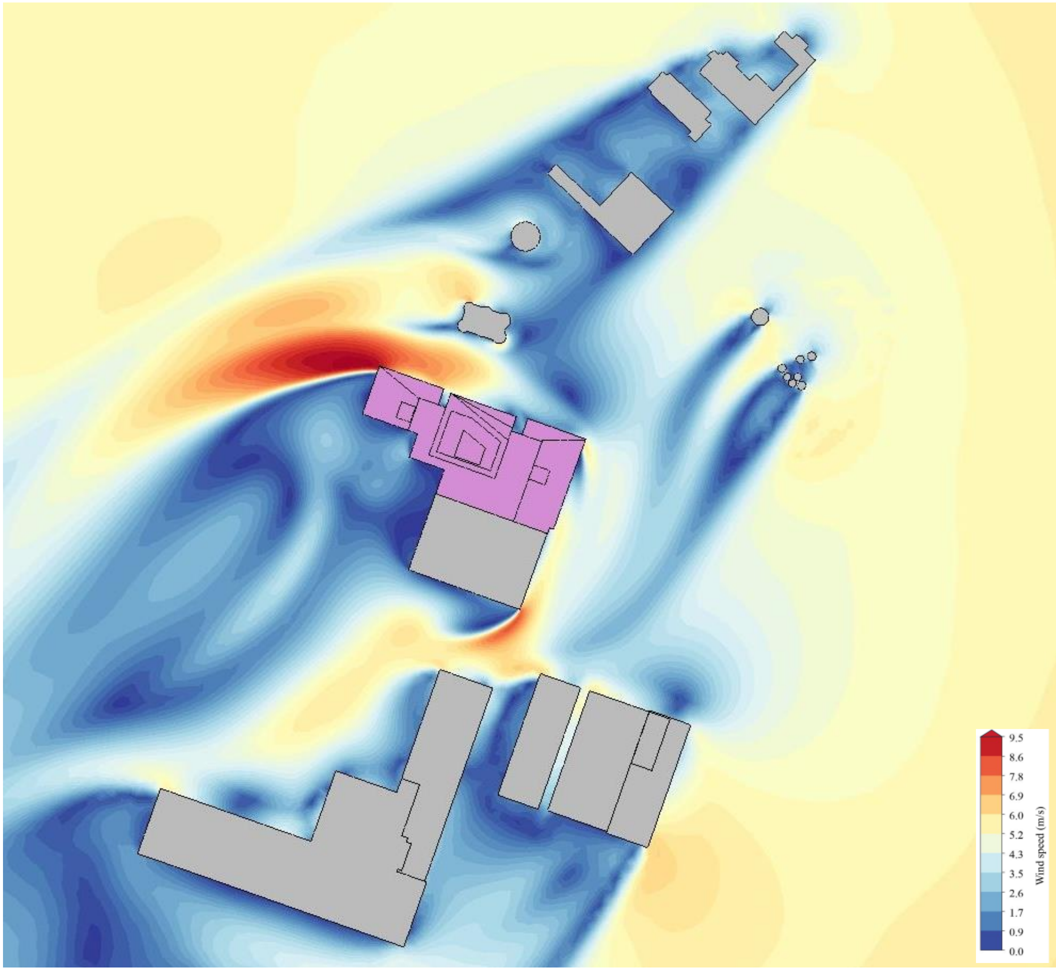


Figure 26. Spatial distribution of wind speeds for NE winds around the proposed configuration at 1.5 m above ground level, obtained from CFD simulations. Red shading indicates higher wind speeds (with a maximum of approximately 10 m/s in these simulations), while dark blue indicates near-zero wind speeds.

9. Mitigation

To mitigate the adverse effects of corner acceleration and dominant wind directions, and to improve pedestrian comfort and safety at the development site, several mitigation measures were investigated (see Appendix B). The recommended mitigation measures, developed in alignment with the landscape plan prepared by Boffa Miskell (dated 9 December 2025), include:

- A continuous glass balustrade with a height of 1.2 m (RL 4.6) along the deck edge on the western side of the proposed building (item 12 in Figure 27).
- An approximately 3 m high solid wall between the western corner of the building and the waterfront (item 16 in Figure 27).
- A 2.6 m wide awning (shown by the black dashed line in Figure 27).
- New trees on the western side of the building (items 11 and 15 in Figure 27).
- Additional landscaping elements, such as potted plants near the access ramp and on the western deck, a concrete edge wall (item 3) along the ramp on Jellicoe St, and a garden edge (item 10).

In addition, while wind conditions on the podium are not a matter for assessment under the AUP wind standards, mitigation measures on the Level 4 podium of the proposed building were also included in the mitigation testing, in accordance with the design prepared by Warren and Mahoney (dated 1 December 2025). This is because these measures were not required to achieve compliance with pedestrian-level wind comfort and safety criteria but may further enhance wind conditions on the podium and in adjacent areas.

Figure 29 shows the final mitigation measures modelled at a 1:300 scale for wind tunnel testing.

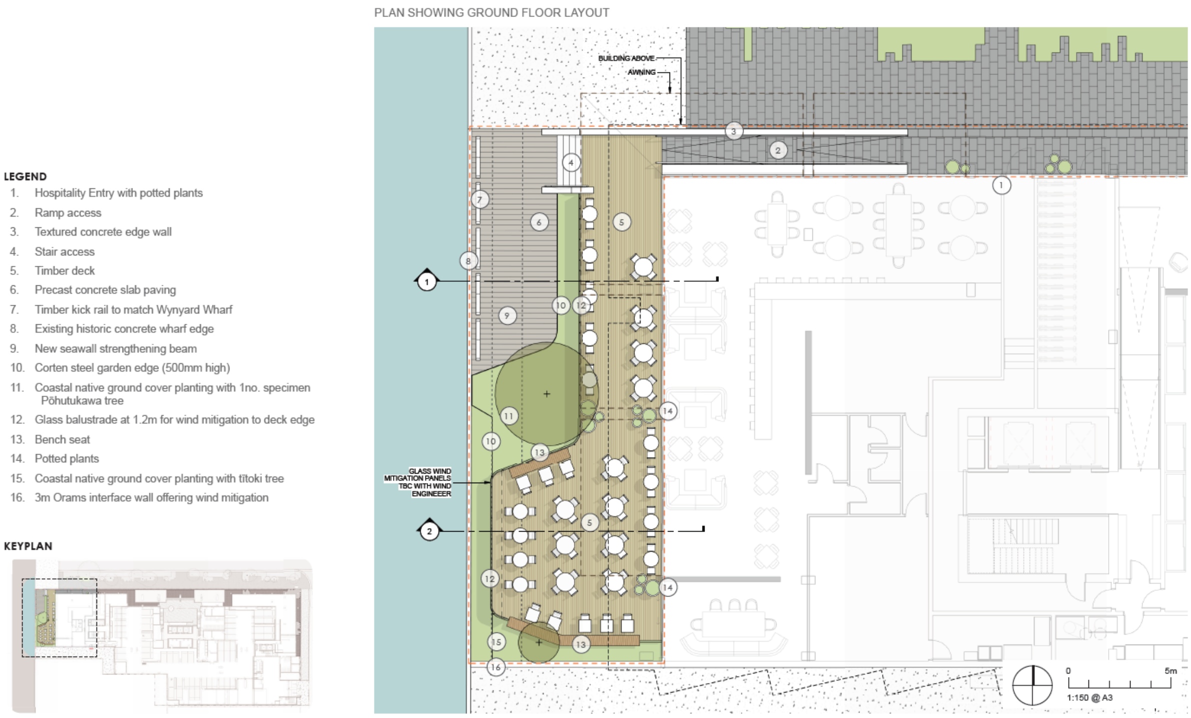


Figure 27. Landscape plan (Boffa Miskell, 9 Dec 2025) and wind mitigations.

Figure 28. Architect's view of the landscape on the west side of the proposed development (Boffa Miskell, 9 Dec 2025).

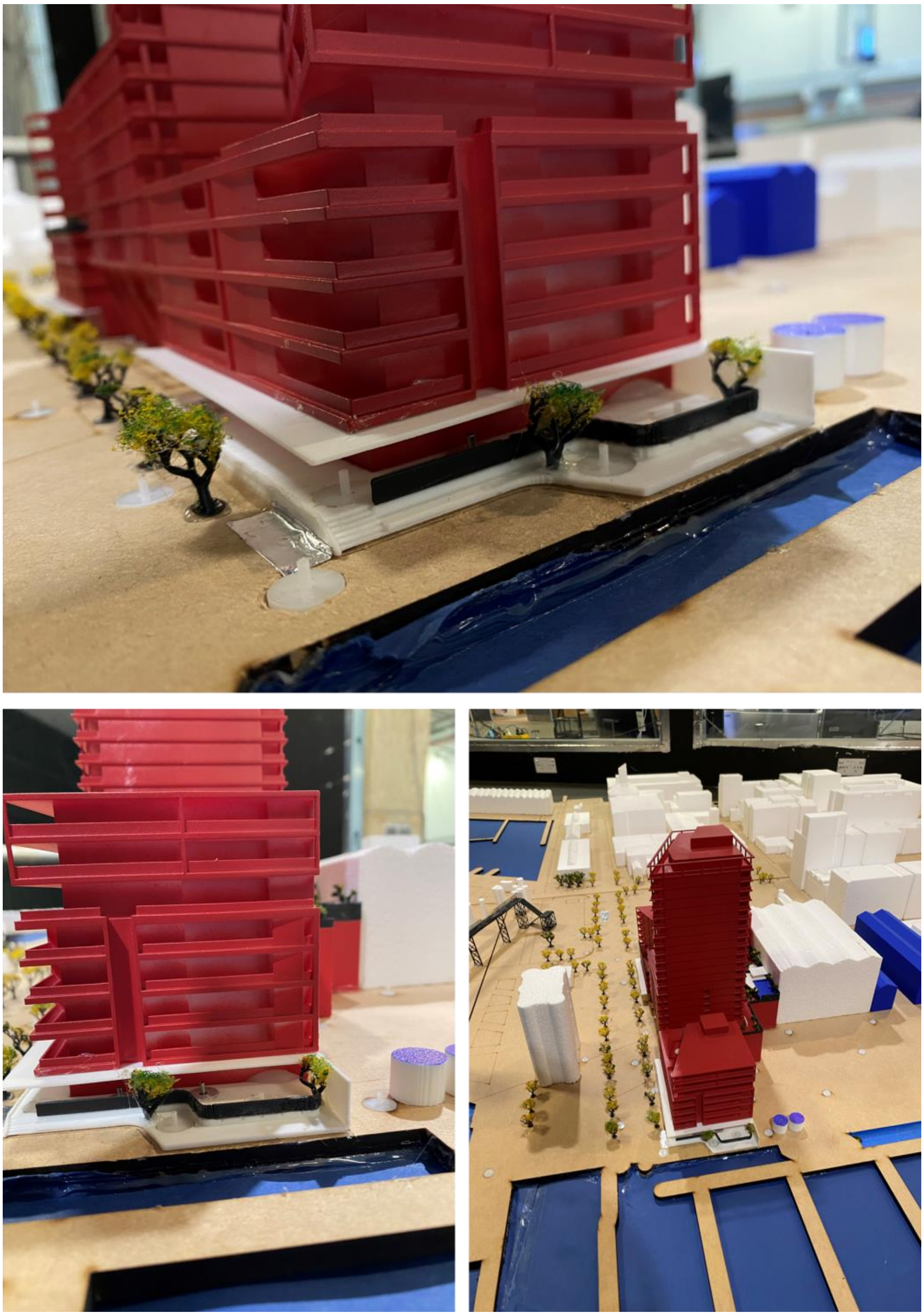


Figure 29. Modelled landscape and mitigation measures at a 1:300 scale for wind tunnel testing.

9.1. Mitigation Results

The incorporation of the mitigation measures at the proposed building, together with the two buildings under construction on the Orams site, results in a significant improvement in both pedestrian wind comfort (**Figure 30**) and safety (**Figure 31**) around the Project site.

All the tested locations now meet the AUP wind comfort criteria for their intended use, including all the public footpath locations around 188 Beaumont St are assessed as Category B or C (**Figure 30**). Overall, the introduction of the mitigation measures improves wind comfort conditions at most locations (3, 11, 13, 17, 19, 23, 31, 49, 51) when compared with the proposed site configuration without mitigation (Sections 8.1.3 and **Figure 19**). The remaining locations exhibit no material change, and all locations achieve wind conditions that are acceptable for their intended use.

Five additional probe locations were introduced on the western side of the proposed building (Locations 201, 203, 205, 207, and 209). These locations are generally assessed as Category A or B, with Location 207 rated Category C due to localised flow acceleration along the ramp (see **Figure A-8**).

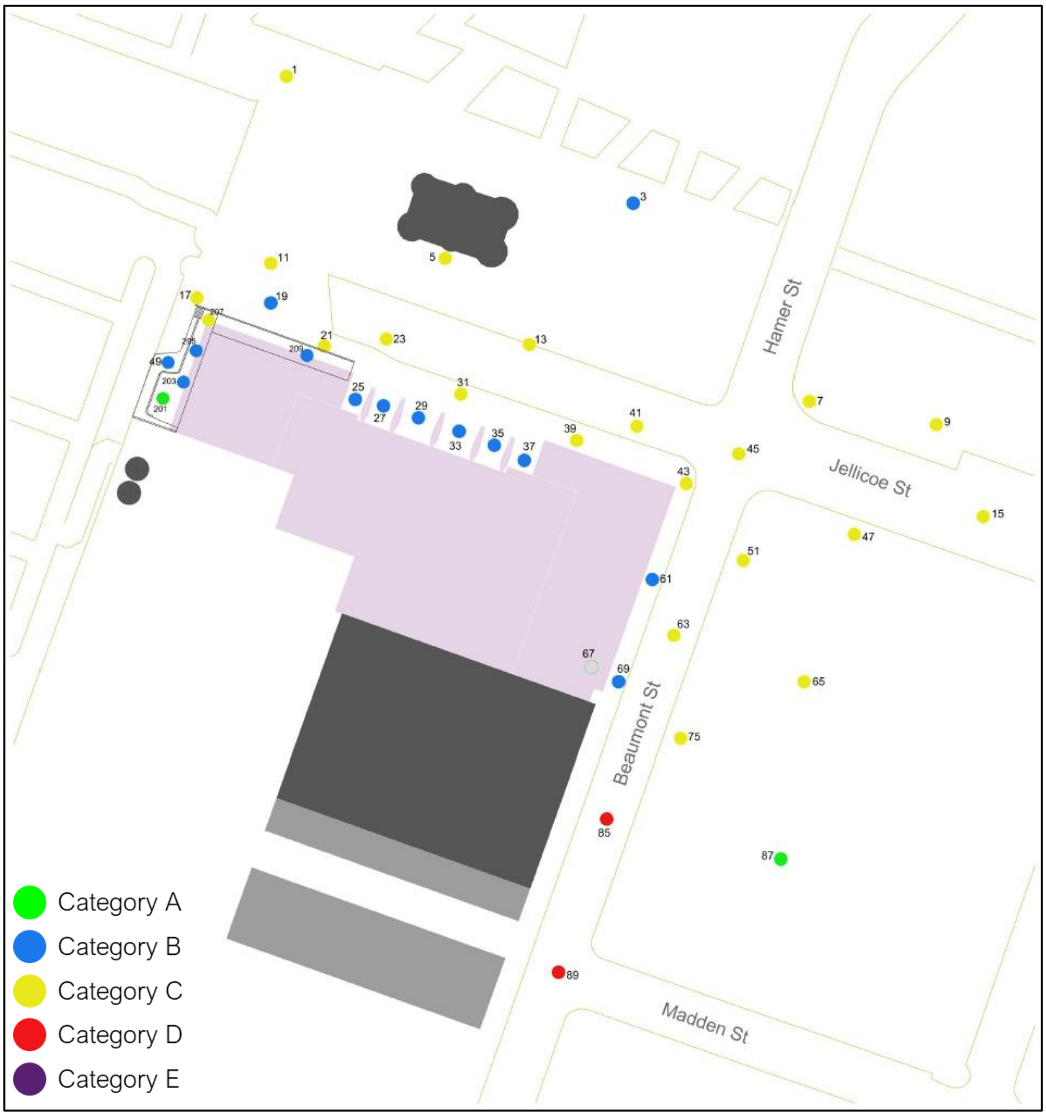


Figure 30. Pedestrian wind **comfort** conditions of the **proposed configuration with mitigations (see Figure 29),** assessed against criteria in the AUP OIP.

Locations 85 and 89 remain classified as Category D, consistent with the existing condition (Figure 18). Accordingly, the proposed development does not worsen wind conditions at these locations. Locations 85 and 89 are vehicular routes, for which Category D is appropriate for their intended use.

The wind safety condition has also improved around the 188 Beaumont St site with the incorporation of the mitigation measures. The only location remaining classified as unsafe is Location 85, which was also rated unsafe under the existing configuration (Figure 21). As the proposed development does not increase wind speeds at this location, it does not exacerbate the pre-existing unsafe condition and is therefore considered compliant with the wind safety provisions of H8.6.28.

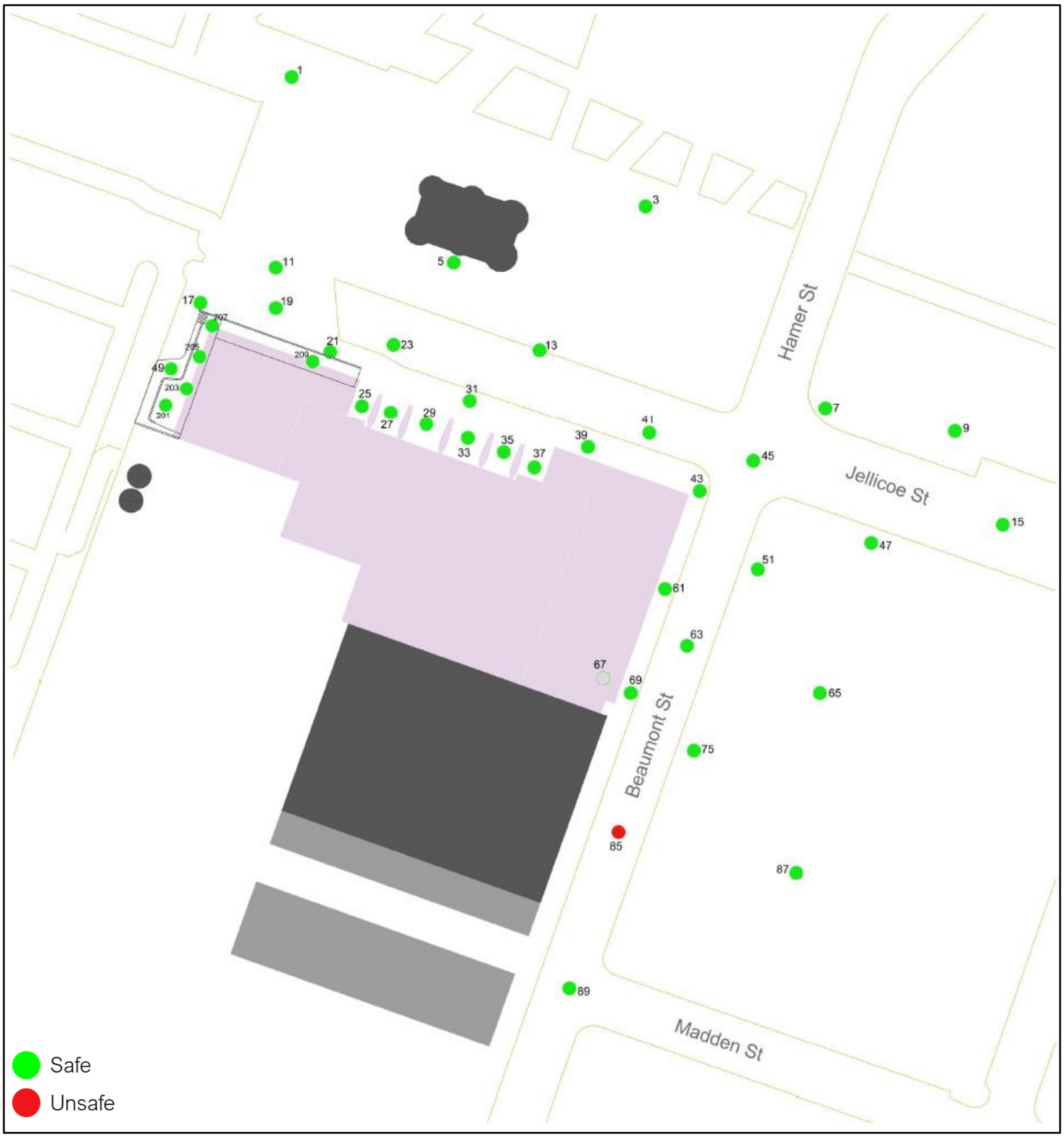


Figure 31. Pedestrian wind **safety** conditions of the **proposed configuration with mitigations (see Figure 29)**, assessed against criteria in the AUP OIP.

10. Conclusions

Wind tunnel testing and complementary computational fluid dynamics (CFD) modelling have been undertaken to assess the pedestrian-level wind environment associated with the proposed residential-led mixed used development at 188 Beaumont Street, Auckland. The assessment provides a comprehensive evaluation of existing and post-development wind conditions and has been carried out in accordance with the requirements of the Auckland Unitary Plan (AUP) wind standards (H8.6.28).

The results indicate that the existing site is naturally exposed to elevated wind conditions, particularly under south-westerly to north-easterly wind directions, reflecting its waterfront location and surrounding urban geometry. The introduction of the proposed building significantly modifies the local wind field, producing beneficial sheltering in several previously exposed areas, while also generating localised regions of increased wind speeds near building corners and along Beaumont Street due to flow separation and channelling effects.

To address these effects and achieve compliance with the AUP pedestrian wind comfort and safety criteria, a series of mitigation measures was tested through wind tunnel experiments and supported by CFD analyses. **The recommended mitigation package**, developed in alignment with the Boffa Miskell landscape design (dated 9 December 2025), comprises a continuous 1.2 m high glass balustrade along the western deck edge, an approximately 3 m high solid wall between the western corner of the building and the waterfront, a 2.6 m wide awning, and new trees along the western side of the building. Additional landscape elements, including potted plants, are expected to provide further localised improvement and mitigation.

The combined mitigation scheme is shown to substantially reduce regions of accelerated flow, particularly along the western frontage and adjacent public spaces. With the incorporation of these measures, **all publicly accessible locations meet the AUP wind comfort criteria for their intended use** and **rated safe**. Locations that remain subject to higher wind exposure are either consistent with the existing condition, suitable for their intended (non-pedestrian) use, or not publicly accessible.

Overall, the assessment demonstrates that the proposed development, when implemented with the recommended mitigation measures, can achieve acceptable pedestrian wind comfort and safety outcomes in accordance with the Auckland Unitary Plan.

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Appendix A: Whenuapai and MOTAT wind climatology

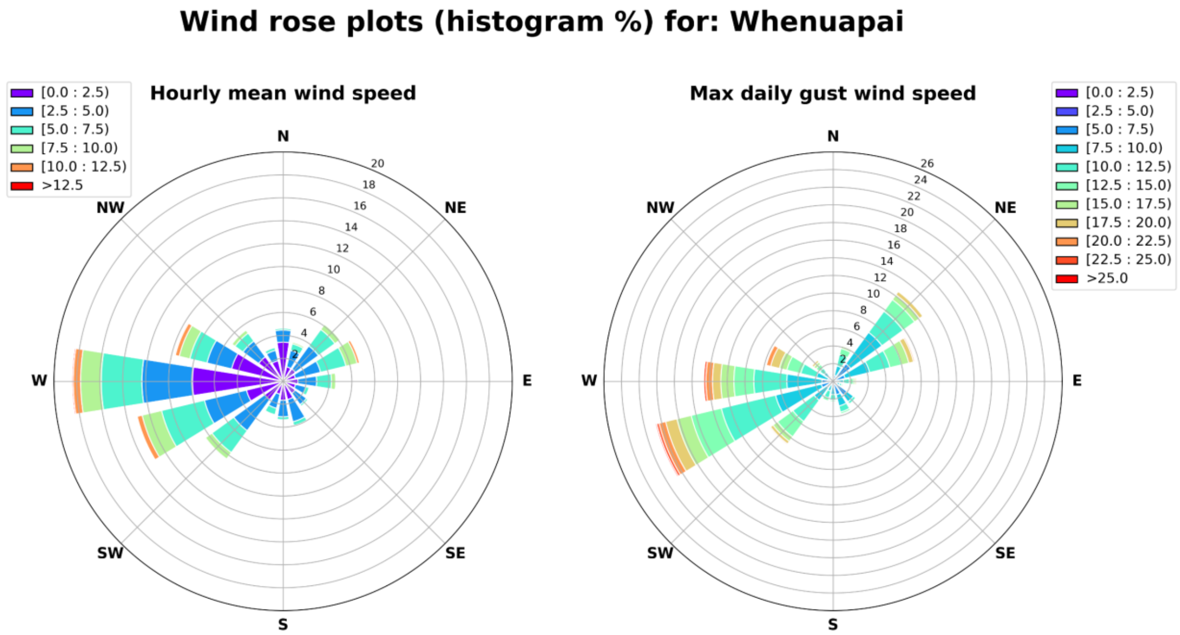

Figure A-1. Directional wind frequency (in percentage) of hourly mean wind speed (left) and maximum daily gust wind speed (right) at Whenuapai.

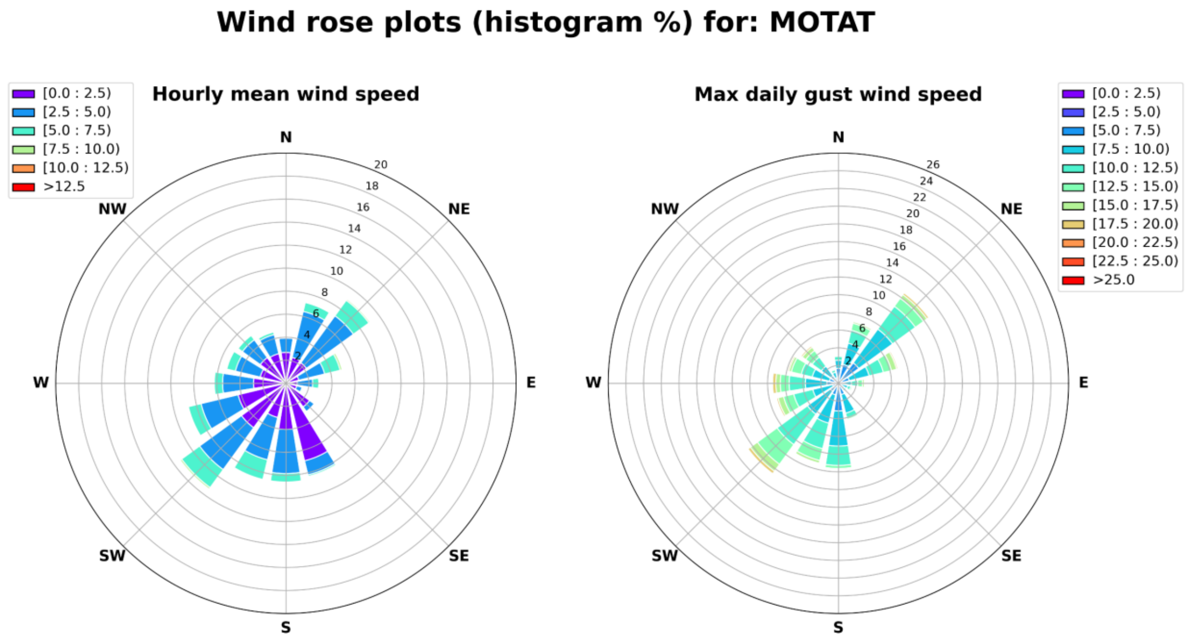

Figure A-2. Directional wind frequency (in percentage) of hourly mean wind speed (left) and maximum daily gust wind speed (right) at MOTAT

Appendix B: Other Investigated Mitigations

To improve pedestrian wind comfort and safety around the proposed development at 188 Beaumont Street, a range of mitigation options was investigated. Three representative options are presented in this Appendix. In summary:

1. Option 1 demonstrated that:
    - Solid balustrades along the western side of the proposed building are required to mitigate accelerated wind conditions along the western frontage and Jellicoe St;
    - The awning is effective in reducing downwash effects and mitigating undercroft-related flows.
2. Options 2 and 3 demonstrated that the inclusion of additional mitigation measures, such as further solid screening on the western side of the building and a balustrade along the top of the seawall, does not result in a material improvement to pedestrian-level wind conditions beyond that achieved with Option 1 and in Section 9.

The outcomes of these numerical simulations and wind tunnel tests informed the final recommended mitigation strategy presented in Section 9.

B.1. Option #1

As discussed in Section 6.1, the two buildings on the Orams Site currently under construction and shown in gold colour in Figure A-3, where included in Option #1 investigation. These under-construction buildings provide some sheltering from south-westerly winds along Beaumont Street.

To improve wind conditions on the west side of the building (café and restaurant area) and to reduce accelerated wind speeds along Jellicoe Street, several mitigation measures were considered, as shown in Figure A-3 and Figure A-4, including:

- Five 2 m (RL 5.4) pivotable panels, which can be rotated to face the incoming wind and, if required, form a solid barrier.
- Approximately 3 m solid wall between the western corner of the building and the waterfront – blue wall in Figure A-3;
- 1.5 m high feature screen;
- 1.2 m glass balustrade along deck edge;
- 2.6 m wide awning.

To evaluate the effectiveness of these mitigation measures, CFD simulations were conducted for south-westerly (SW) and north-easterly (NE) wind directions.

It should be noted that pivotable panels were investigated as a potential mitigation option; however, their operation based on real-time wind direction would be challenging. Accordingly, the final mitigation package replaces these panels with a continuous solid balustrade (see Section 9 and Figure 27).

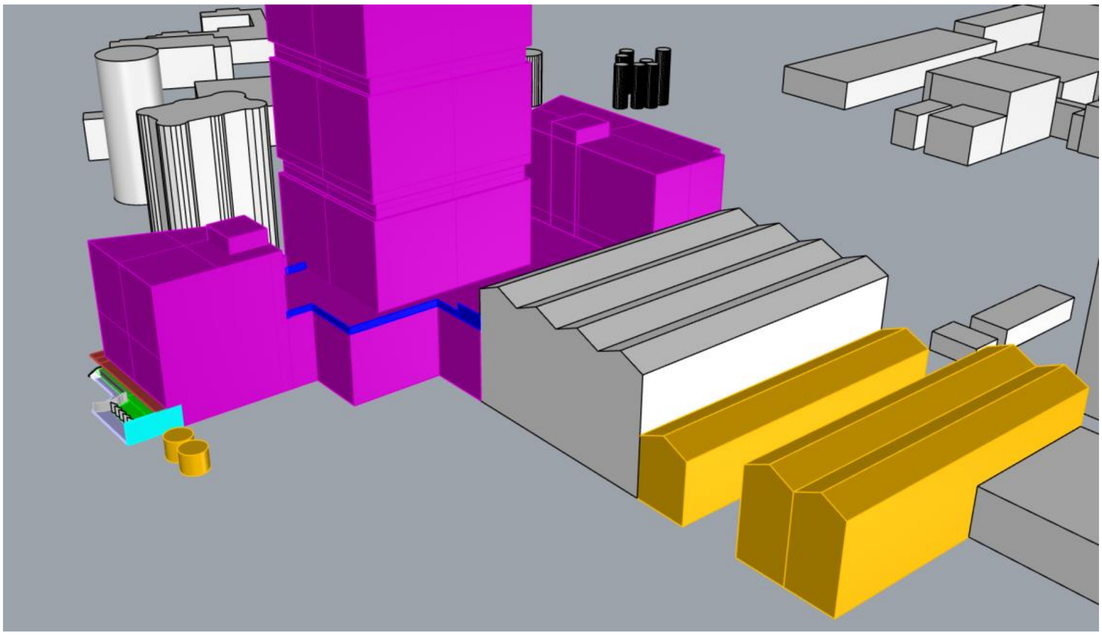

Figure A-3. Option #1 mitigation and under-construction buildings on the Orams Site. Solid balustrades on the west side of the proposed building, as well as at the northeast-facing corner.

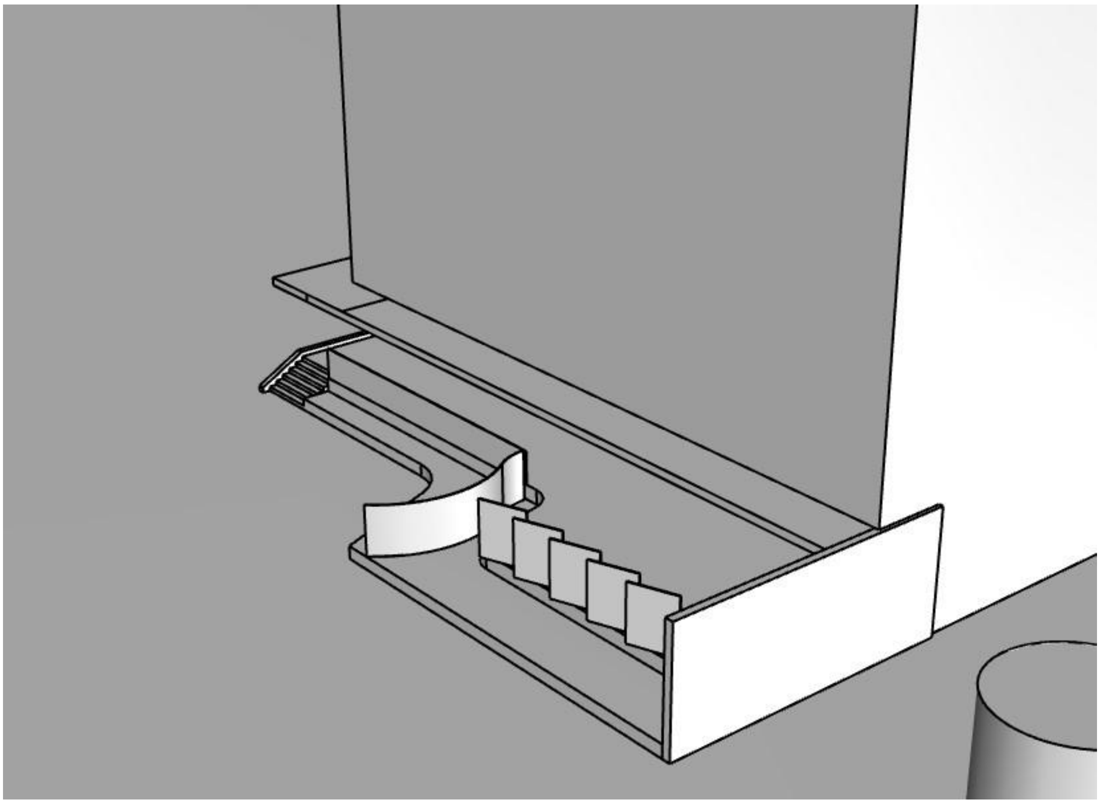

Figure A-4. Modelled landscape and mitigation features for the CFD simulations.

It should be noted that the CFD results are **conservative**, as details such as trees and small architectural features, which can influence wind flow and provide additional sheltering, are not included in the simulations.

Comparing Figure 23 and Figure A-5 demonstrates that the mitigations in Option #1, together with the under-construction buildings (green buildings in Figure A-5) have improved wind conditions across the publicly accessible areas. The pivotable fins, solid wall, and balustrades on the western side of the building provide sheltering and redirect the airflow towards the sea, resulting in improved conditions on the western side of the building (i.e. the café and restaurant area) as well as along Jellicoe Street. A zoomed-in view of the velocity contours in Figure A-6 highlights the areas of reduced wind speeds for SW winds.

The wind velocity contours for NE winds in Figure A-7 show an area of increased wind speeds along Jellicoe Street and at the north-west-facing corner of the building. This local acceleration results in Category C comfort conditions. The planned trees and pots are expected to further improve wind conditions in this area.

Figure A-8 illustrates that, under NE winds, the airflow passes through the ramp and accelerates along the glass balustrade along the deck edge. Installing plant pots at the entrance to the ramp, similar to the proposed item 14 in Figure 27, could slow the airflow before it reaches the ramp and provide additional mitigation.

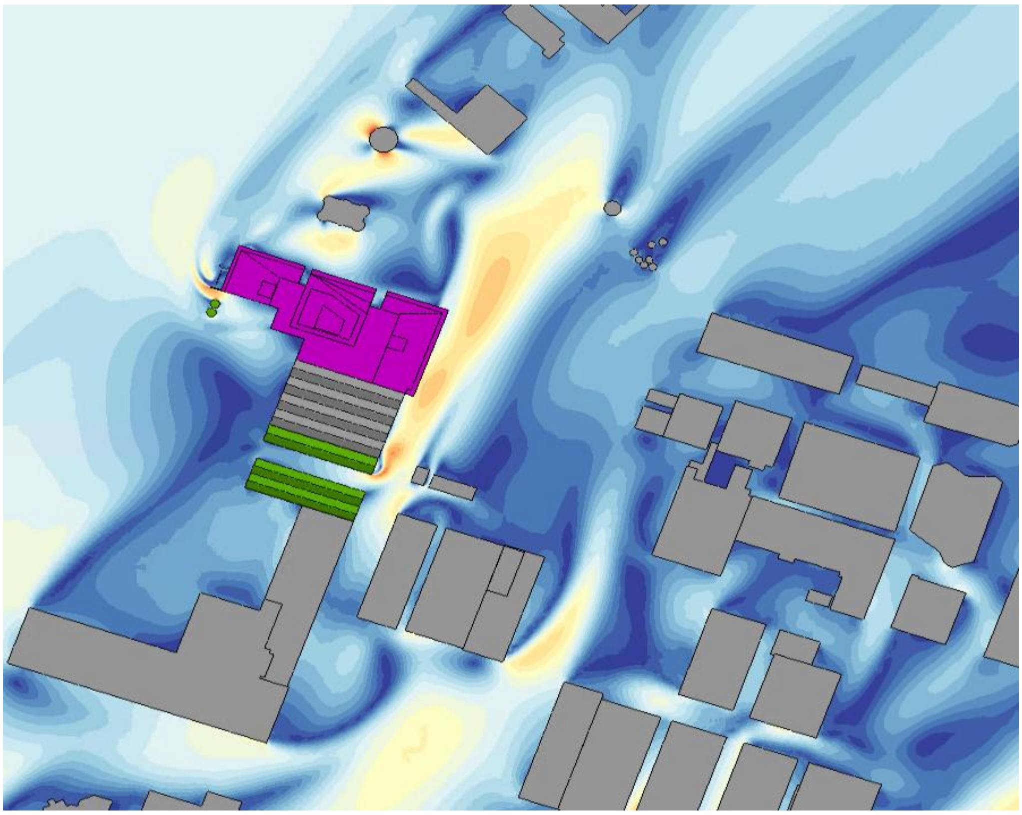

Figure A-5. Option #1: spatial distribution of wind speeds for SW winds around the proposed configuration at 1.5 m above ground level, obtained from CFD simulations. Red shading indicates higher wind speeds (with a maximum of approximately 10 m/s in these simulations), while dark blue indicates near-zero wind speeds.

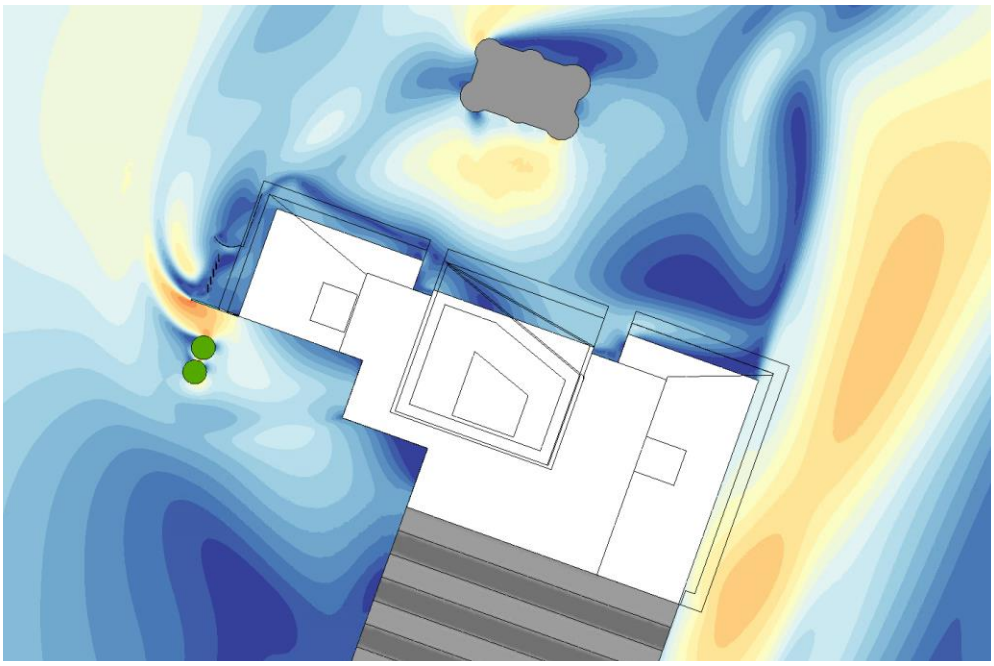

Figure A-6. Zoomed-in spatial distribution for SW wind speeds around the proposed building with Option #1 considerations at 1.5 m above ground, obtained from CFD simulations. Red shading indicates higher wind speeds (with a maximum of approximately 10 m/s in these simulations), while dark blue indicates near-zero wind speeds.

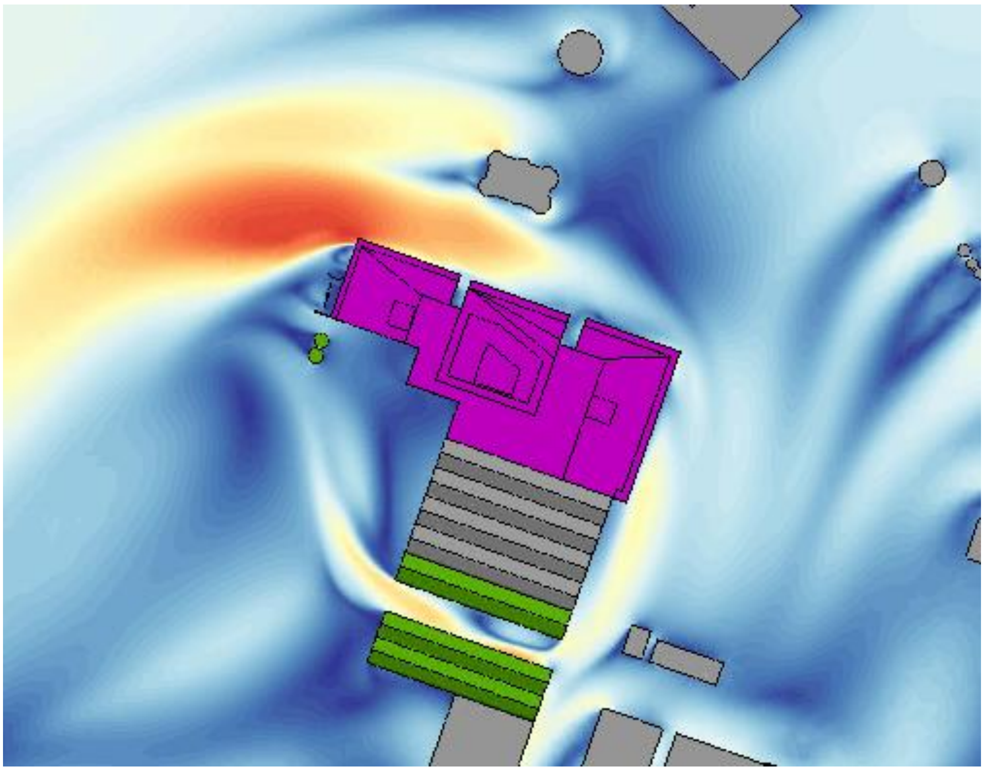

Figure A-7. Option #1: spatial distribution of wind speeds for NE winds around the proposed configuration at 1.5 m above ground level, obtained from CFD simulations. Red shading indicates higher wind speeds (with a maximum of approximately 10 m/s in these simulations), while dark blue indicates near-zero wind speeds.

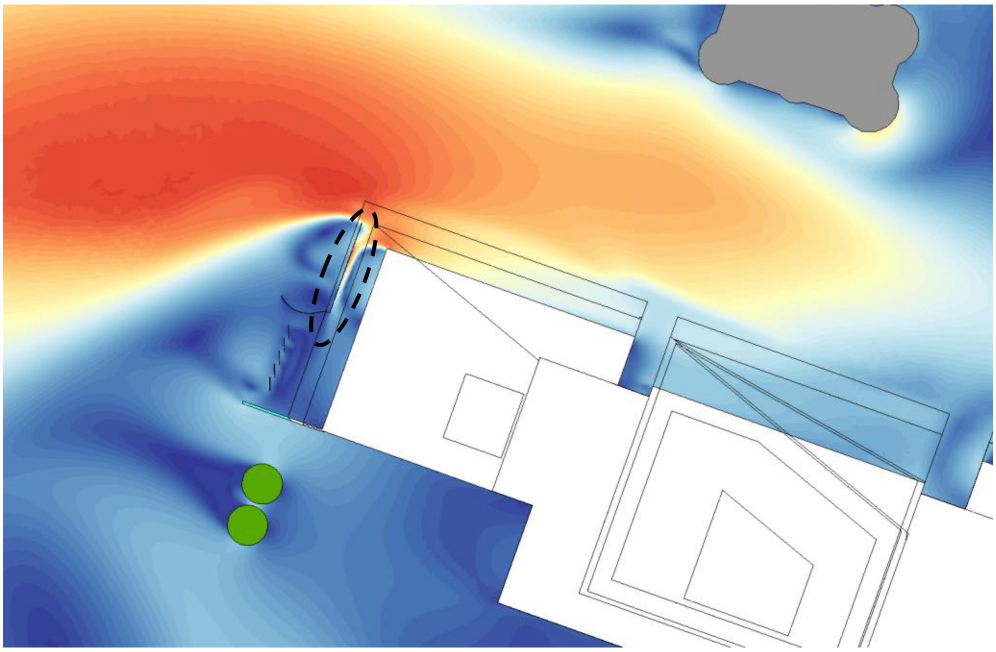

Figure A-8. Zoomed-in spatial distribution for NE wind speeds around the proposed building with Option #1 considerations at 1.5 m above ground, obtained from CFD simulations. The dashed circle shows the area of increased wind speed in the restaurant area along the solid glass balustrade. Red shading indicates higher wind speeds (with a maximum of approximately 10 m/s in these simulations), while dark blue indicates near-zero wind speeds.

The 2.6 m-wide awning (building canopy) also provides effective mitigation against downwash, reducing vertical wind deflection from the upper storeys and improving wind conditions within the publicly accessible pedestrian areas, particularly along Jellicoe St.

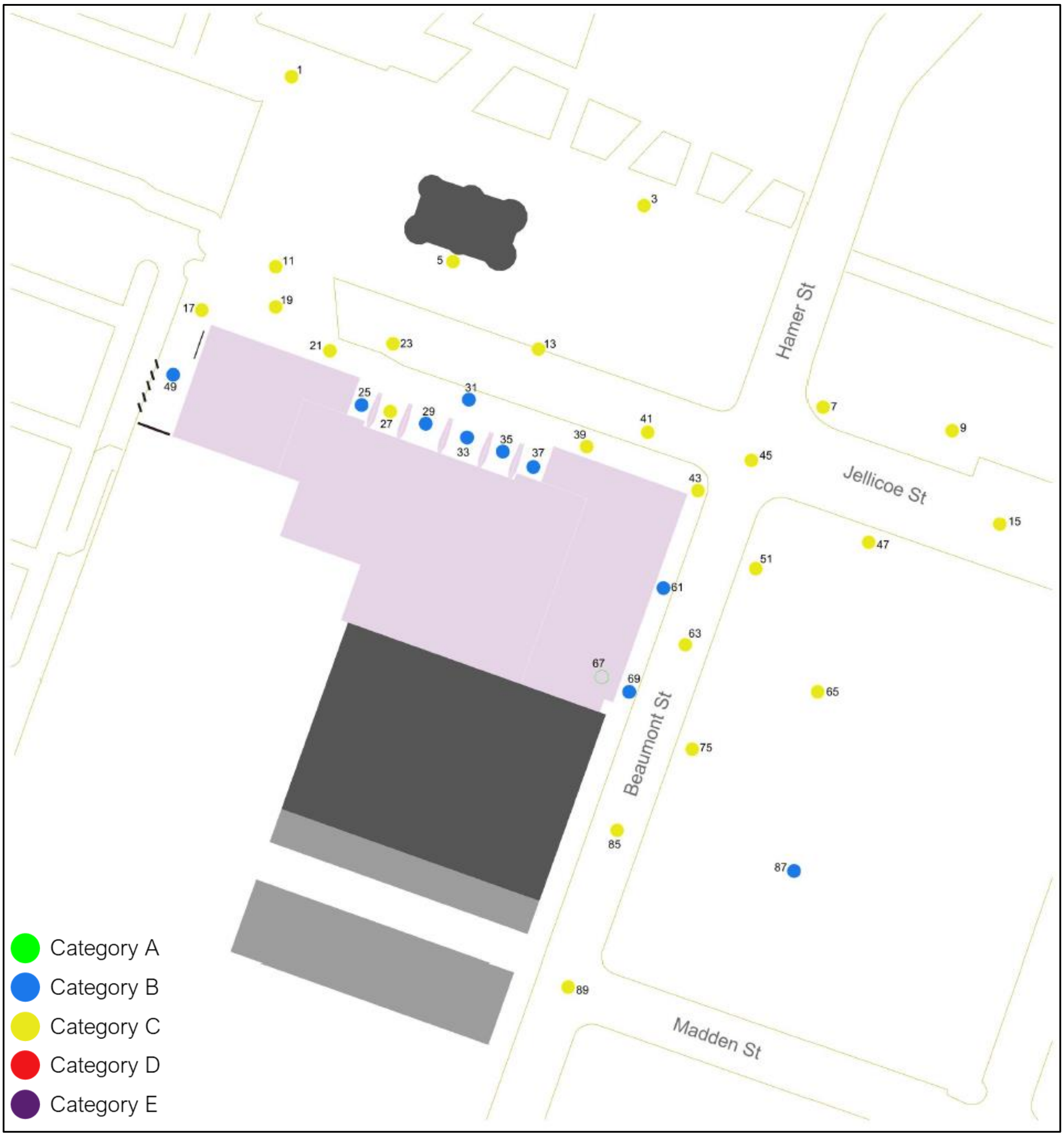

Figure A-9. Pedestrian wind **comfort** conditions of the **proposed configuration with Option #1 (pivotable fins, solid wall and balustrade),** assessed against criteria in the AUP OIP.

B.2. Options #2 and #3

Options #2 and #3 comprised the addition of a curved screen on the western side of the proposed building and a 1 m high balustrade on top of the existing seawall, respectively, in addition to the final mitigation measures described in Section 9, as shown in **Figure A-10** and **Figure A-11**.

These options were investigated to assess whether the additional measures would further improve wind comfort and safety conditions around the Project. While they resulted in slight improvements in comfort conditions, the overall wind comfort and safety categories (Section 9.1) remained similar to those achieved with the final mitigation package described in Section 9.

Figure A-10. Curved solid screen added on the western side of the proposed building, in addition to the final mitigation measures described in Section 9.

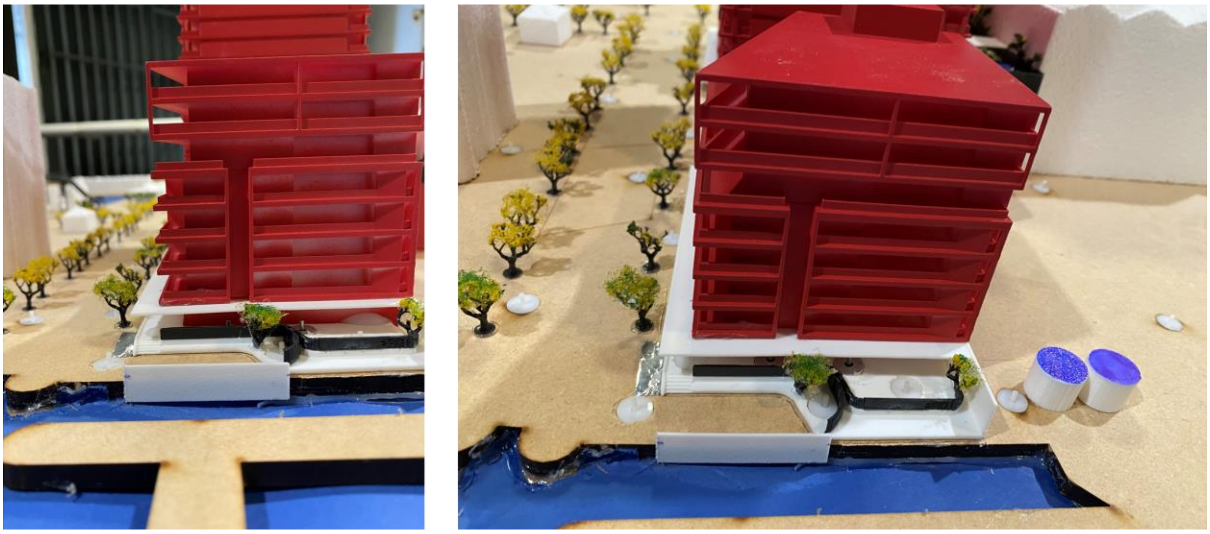

Figure A-11. A 1 m high solid balustrade on top of the existing seawall and a curved solid screen added on the western side of the proposed building, in addition to the final mitigation measures (Section 9).

Appendix C: Minor Plan Setbacks at Levels 9 and 16

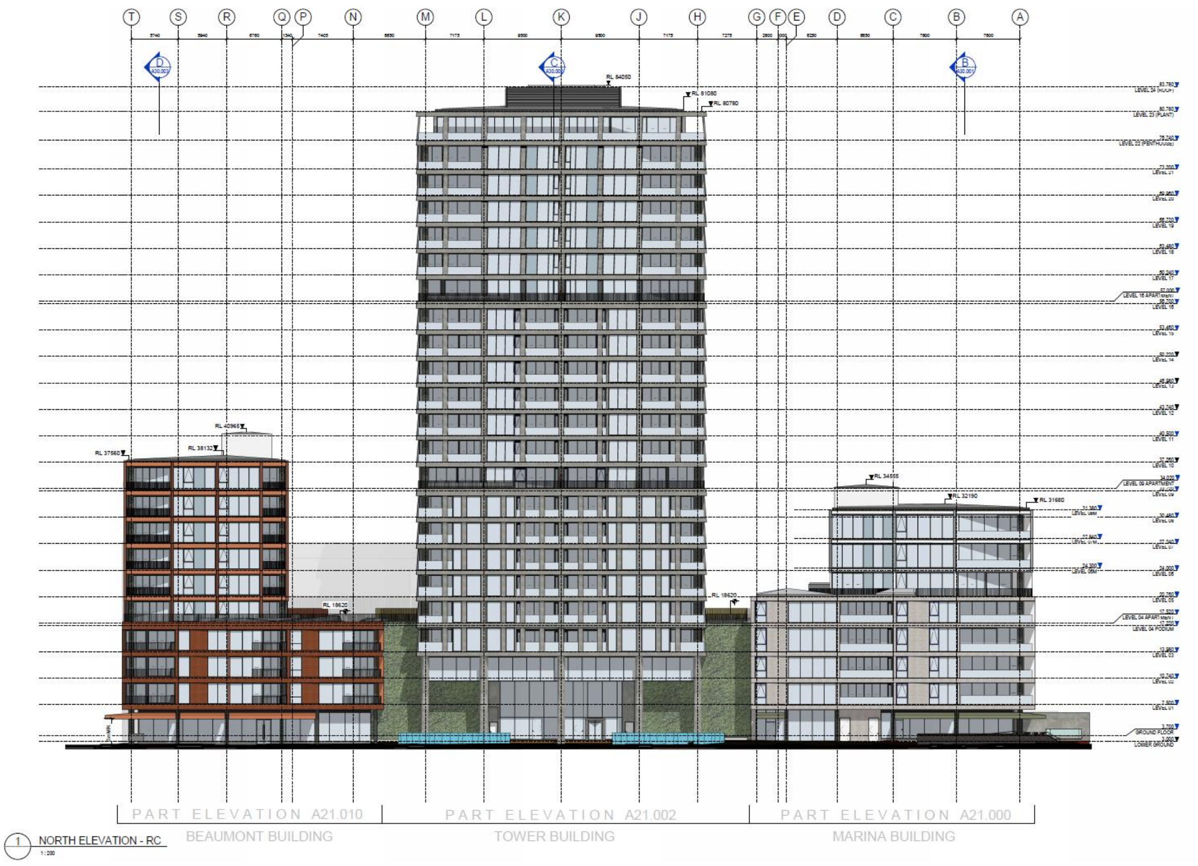

Figure A-12. North elevation of the proposed building (Source: Warren and Mahoney, 19 December 2025)

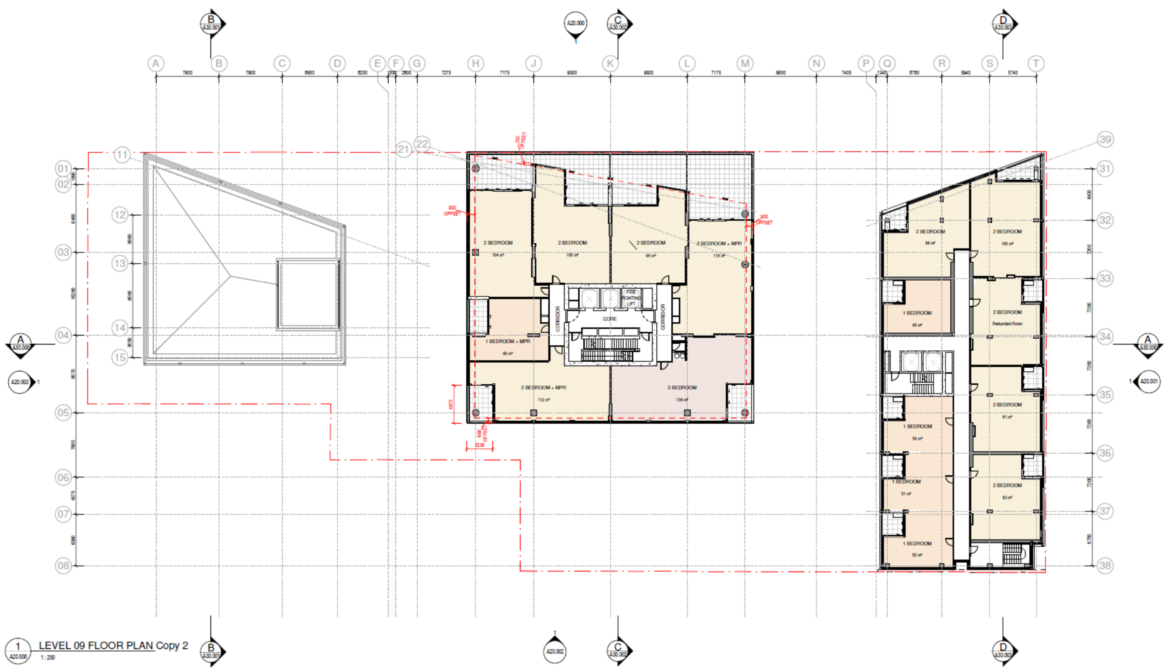

Figure A-13. Setbacks at level 9 of the main tower of the proposed building (Source: Warren and Mahoney, 12 November 2025)

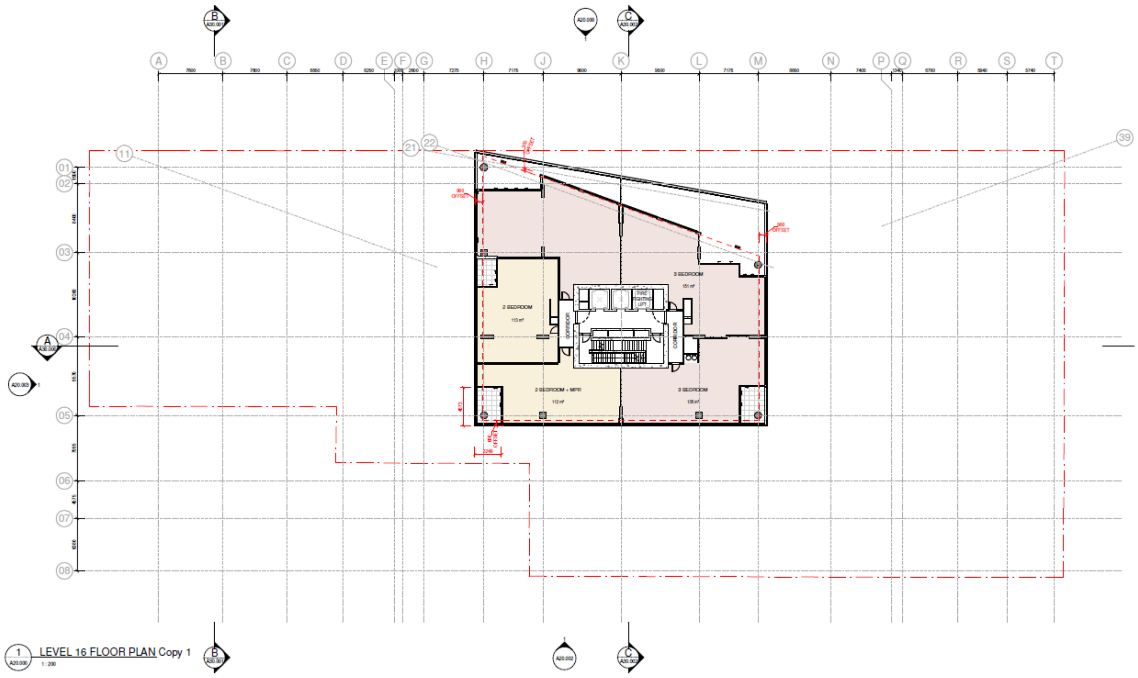

Figure A-14. Setbacks at level 16 of the main tower of the proposed building (Source: Warren and Mahoney, 12 November 2025)