CPP WIND ENGINEERING CONSULTANTS

PEDESTRIAN WIND ENVIRONMENTAL ASSESSMENT
CPP PROJECT 18907
24 JULY 2024

Tumbi Umbi Retirement Village

Tumbi Umbi, NSW

PREPARED FOR:

Mingara Leisure Group Pty Ltd
Lot 13 DP1204397
14 Mingara Drive, Tumbi Umbi
Sydney NSW Australia 2000

PREPARED BY:

Roberto Neto
CFD Project Engineer
rneto@cppwind.com

Vijay Veera
Senior CFD Engineer
vveera@cppwind.com

Christian Rohr
CFD Engineering Manager
crohr@cppwind.com

Executive Summary

CPP has been commissioned by Mingara Leisure Group Pty Ltd to provide a Pedestrian Wind Environmental Assessment and wind mitigation recommendations for the Tumbi Umbi Retirement Living Project in Tumbi Umbi, NSW.

This report is in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the State Significant Development Application (SSD-63475709) for the proposed.

This seniors housing project consists of 13 villas and 4 buildings, and regions of interest for this assessment include the street level and balconies.

Results show relatively calm conditions, with ratings ranging from *Pedestrian Standing* to *Outdoor Dining* throughout the complex.

These ratings are suitable for these spaces and no mitigation measure is recommended.

Some of the windiest conditions can be found on the penthouse balconies, although these are still appropriate for stationary activities. The main recommendation here is to move potential planned seated activities away from *Pedestrian Standing* rated regions.

Document Tracking and Version Control

CLIENT REVISION HISTORY		
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BASIS OF REPORT – CLIENT PROVIDED DOCUMENTATION			
DOCUMENT DATE	PROVIDED DATE	DRAWING NAME	FILENAME
19-Dec-2024	19-Dec-2024	Site Revit Model	16072 - MINGARA RETIREMENT VILLAGES_ARC.rvt
19-Dec-2024	19-Dec-2024	Surroundings Revit Model	16072 - MINGARA RETIREMENT VILLAGES_SURROUNDINGS.rvt
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17-Jan-2024	17-Jan-2024	Additional Revit model	240116 - MINGARA RETIREMENT VILLAGES_DETACHED_detached*
22-Jan-2024	29-Jan-2024	2D drawing set PDF	240122_Architectural Draft combined set
03-July-2024	03-July-2024	Exported geometry DWG	16072 - MINGARA RETIREMENT VILLAGES_ARC - 3D View - {3D - k_chik}

**Used to modify villas and B3 only*

Contents

1. Introduction

CPP has been commissioned by Mingara Leisure Group Pty Ltd to prepare this pedestrian wind environmental assessment in accordance with the technical requirements of Item 5 of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the State Significant Development Application (SSD-63475709).

This section introduces the project location and context, project description, and delves into the areas of interest for pedestrian wind comfort assessment.

SITE CONTEXT

The site is located at 14 Mingara Drive, Tumbi Umbi, within the Central Coast Local Government Area (LGA). The development site is legally described as Lot 13 DP1204397.

The broader Mingara Club Precinct also encompasses Lot 1 and Lot 2 in DP 1010532 and Lot 71 DP1011971 and currently contains a registered club, health and wellness centre (including aquatics, gym facilities, physio, hairdresser, beautician and martial arts studio), car parking, creche, bowling greens and green space with a regional athletics centre. A hotel is currently under construction.

Immediately surrounding the Mingara Club Precinct are fast food outlets and other restaurants, service station, car wash, retail, medical centre and a retirement village to the south and west. Industrial development is to the north of Wyong Road and residential development to the west. The specific area of the site, the subject of the proposed development, is land located to the west of the Mingara Recreation Club and south of the Athletics field. This development site is currently a vacant grassed area.

Other surrounding buildings are mostly residential houses at about the same height as the project's villas, providing some level of shielding from wind coming from all directions.

Figure 1: Overhead view showing site context.

OVERVIEW OF THE PROPOSAL

The proposed development comprises subdivision of land and the construction and operation of a seniors housing development. The proposal includes thirteen villa buildings, three multi storey independent living unit (ILU) buildings and one mixed high care and ILU building housing communal facilities together with car parking, open space and associated works including site preparation works and landscaping.

Figure 2 below illustrates the plan view of the project.

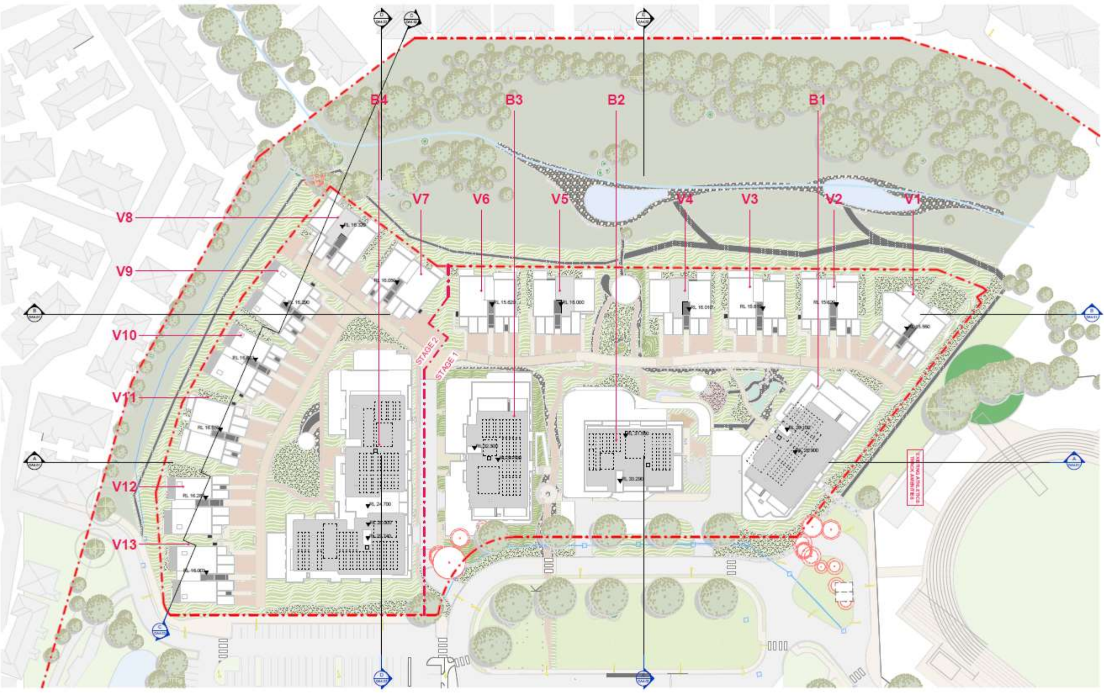

Figure 2: Plan view of site from drawing set

VILLA BUILDINGS

The villa buildings, named V1 to V13, spread along the south and west side of the site and are shown in Figure 3. The villas coloured yellow, and purple have a similar design with a variation in location of the larger rectangular shaped balcony. The blue coloured villas are characterized by similar sized balconies on the western façade. Finally, Villa V1 features a unique design compared to the others. A close-up view of a villa is shown in Figure 4. Regions of interest include the street level around the villas and two balconies per villa.

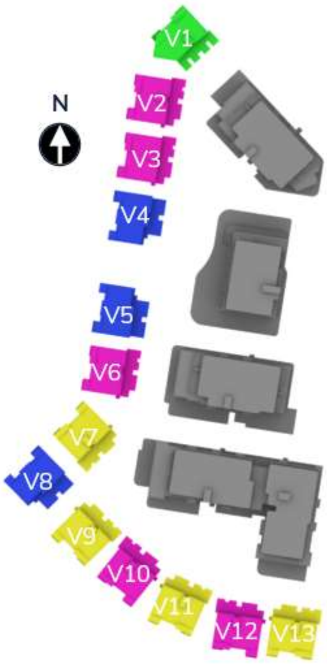

Figure 3: Plan view of the villas.

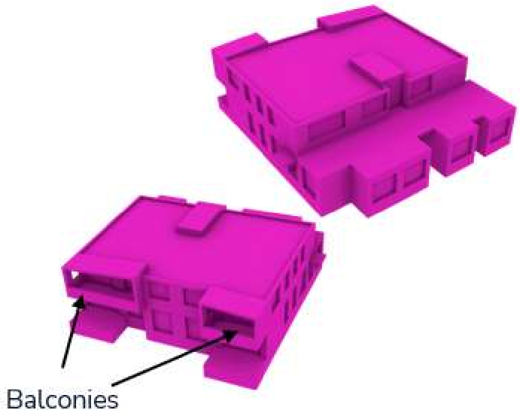

Figure 4: Perspective view of a typical villa.

ILU BUILDINGS

The proposal also includes three multi storey independent living unit (ILU) buildings and one mixed high care and ILU building housing communal facilities together with car parking, named B1, B2, B3 and B4, each with a unique design. Figures Figure 5 and Figure 6 show these buildings.

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Regions of interest include the street level around the buildings and all their balconies.

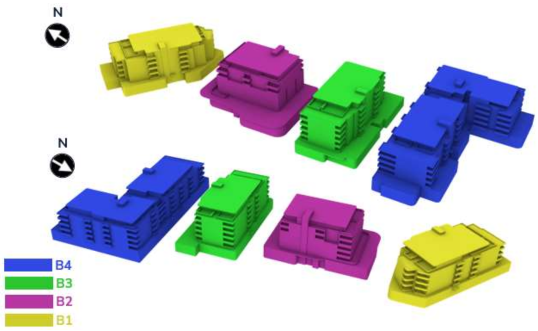


Figure 5: Perspective view of the buildings.

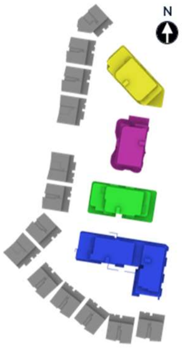


Figure 6: Plan view of the buildings.

2. Methodology

WIND CLIMATE

Wind climate statistics are sourced from Norah Head Lighthouse, which is 16 kilometres to the northeast of the site. An approach roughness correction is applied to the data[1] to account for the differences between the lighthouse and site surroundings.

The anemometer where the data was taken sits at the top of a cliff, which affects the wind speeds recorded as wind accelerates over the topography in different ways depending on the approach wind direction. A topographic study was conducted to correct the historical climate data to remove the influence of topography. The data presented here has subsequently been corrected for the cliff. See appendix B for more information.

The wind comfort analysis presented in this report is based on the annual all hours wind climate and the associated wind rose is depicted by Figure 7. Winds are calm approximately 1.4% of the time. Prevailing strong winds are from the general south direction, with other strong winds coming from the northeast. Strong winds are represented by the orange and red bars on the wind rose. Lighter winds, represented by blue or green bars on the wind rose, are biased towards the northwest.

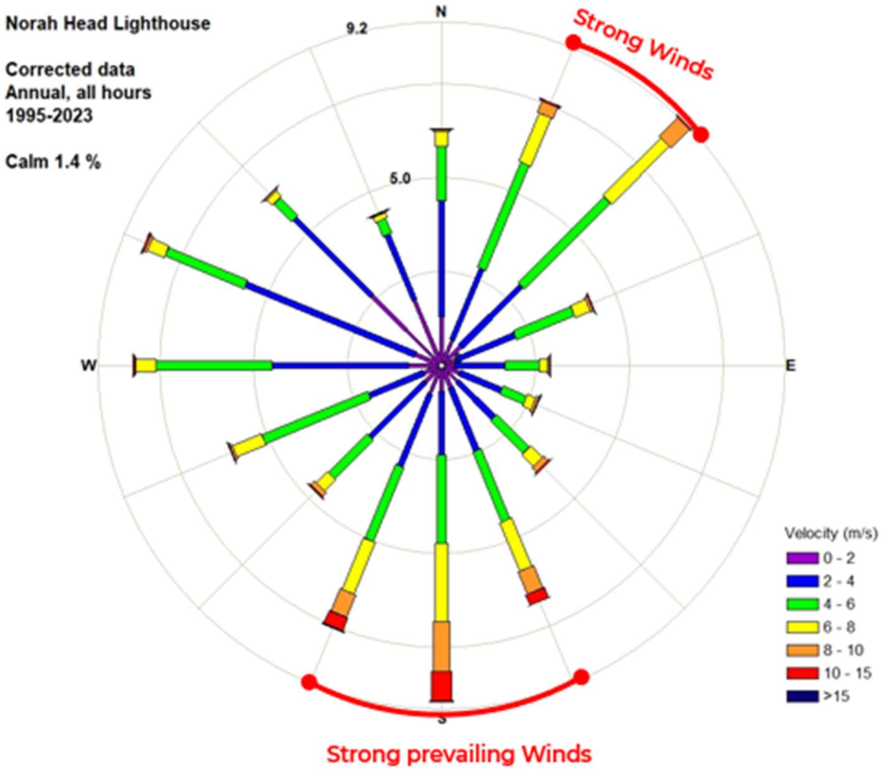


Figure 7: Probability of wind speeds by direction – Norah Head Lighthouse (1995-2023, All hours)

WIND ASSESSMENT CRITERIA

The Computational Wind Engineering simulations are conducted for 16 wind directions. These simulations generate estimates of mean wind speed and turbulent kinetic energy that can be combined with the wind climate statistics presented previously to determine the probability of a specific wind speed being exceeded, for each wind direction.

The Lawson criteria establish a relationship between the maximum of the mean or "gust-equivalent" mean and the level of comfort that can be expected from that location when the speed is below a threshold at least 95% of the time. The gust equivalent mean factors down the predicted gust speed so it can be compared against the same criteria as the mean.

This report presents results at all relevant locations as coloured contour plots showing the Lawson rating. These are defined below in Table 1, with examples of activities that would be appropriate in each level.

Table 1: Lawson Comfort Criteria.

THRESHOLD (M/S)		LAWSON RATING	EXAMPLE ACTIVITIES
2	(purple)	Outdoor Dining*	Long-term sitting with high expectations of comfort, and with little or no opportunity to move to another location. Napkins should not blow away and hair is not ruffled.
4	(blue)	Pedestrian Sitting	Casually eating food, reading a magazine on a bench, quick coffee, pool decks
6	(green)	Pedestrian Standing	Short-term standing activities, such as queueing or waiting for a bus. Pedestrians will feel comfortable enough to stop and look into shop windows
8	(yellow)	Pedestrian Walking	In transit, but some wind comfort desired, e.g., walking through a park
10	(orange)	Business Walking	Any activities where the person intends to transit through the space where comfort and leisure is not a requirement, such as crossing a road
> 10	(red)	Uncomfortable	People will purposefully avoid the space

* Experience based rating developed by CPP

SIMULATION GEOMETRY

The conducted simulation includes all relevant buildings up to a radius of approximately 530 m. This is inclusive of the terrain within the surrounding area and is blended to a common elevation at the edge of the domain.

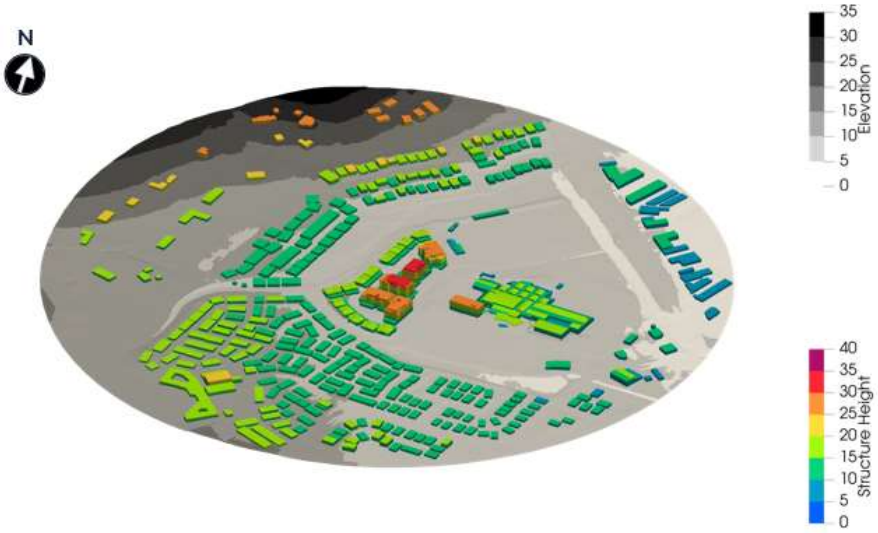


Figure 8: Modelled surrounds and terrain, colored by elevation.

Representative roughness outside of the modelled surrounds included to a radius of approximately 1060 m. The domain height is approximately 1000 m.

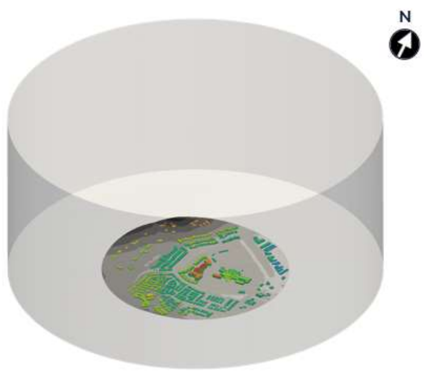


Figure 9: Entire simulation domain, viewed from southeast.

Figure 10 below illustrates the project's exposure to a prevailing wind direction for reference.

Figure 10: South elevation showing project's exposure to a prevailing wind direction.

3. Results and Discussion

This section presents the results of the computational analysis and provides discussion for pedestrian wind comfort assessment at locations surrounding the site and for areas of interest of the project.

SURROUNDS

Comfort ratings in the surrounds are given to show the relative conditions around the site[1]. Wind conditions in the surrounds are mostly driven by winds from the south. Winds from the northeast are the second most relevant.

Exposed areas are rated as Pedestrian Walking, while more remote regions seen at the northwest are rated as Pedestrian Standing. Relatively calmer conditions can be found closer and in between buildings, as built structures provide some level of shielding. In these locations, wind comfort can vary from Pedestrian Sitting up to Outdoor Dining.

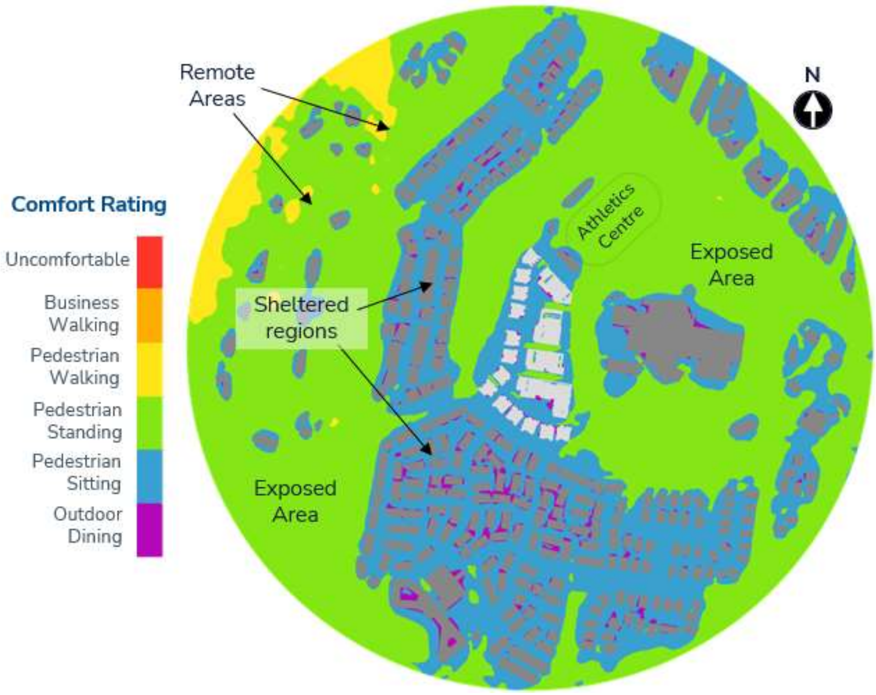


Figure 11: Plan view of site and modelled surrounds coloured by Lawson Comfort Rating.

1 – Results on the perimeter are less reliable than those within the turntable near the site.

SITE GROUND LEVEL

Wind comfort within the site is mostly driven by winds from the south and northeast directions. However, the site receives significant shelter from south winds due to the belt of residential buildings at the south, and the site buildings are not aligned with the northeasterly winds. Hence, winds at the site are calmer than in the surrounding area.

Wind comfort at the site is rated as *Pedestrian Standing* to *Pedestrian Sitting*, with *Outdoor Dining* rated areas near the buildings. The walkways between B1 & B2, B2 & B3, and B3 & B4, are largely rated *Pedestrian Standing* due to channelling of winds and in some other small localised regions. All building entrances are rated as *Pedestrian Standing* or better, while all Villas entrances are rated as *Pedestrian Sitting* or better. The entrances are circled in red (only showing entrances for V6 as other villas are similar).

These ratings are suitable for both pedestrian transit and stationary activities.

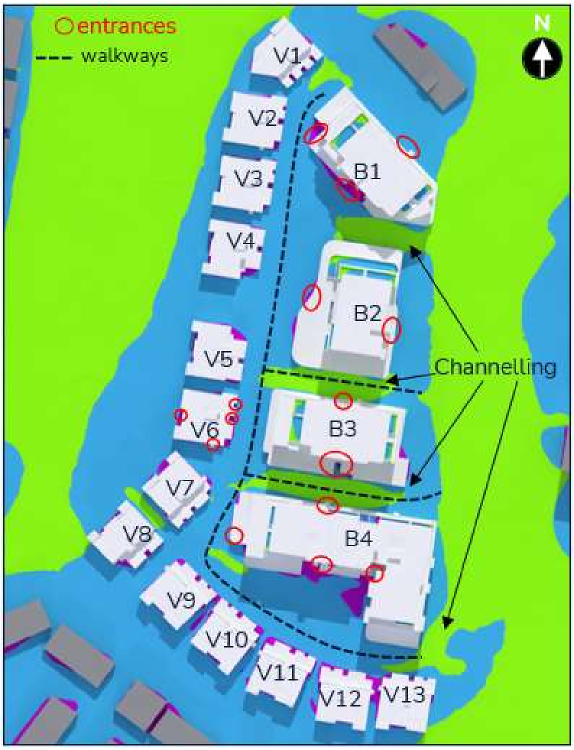


Figure 12: Plan view of site colored by Lawson Comfort Rating.

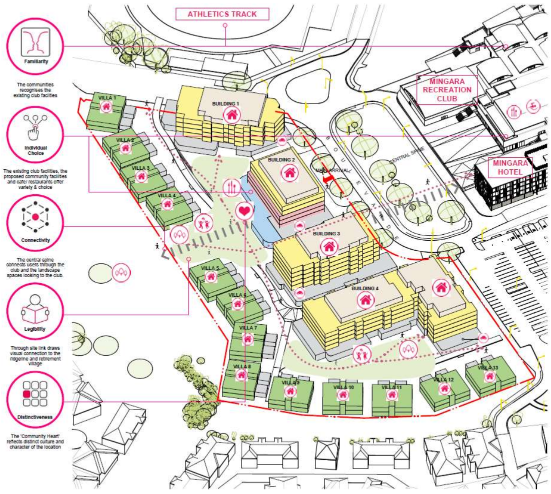


Figure 13: Client issued draft for coordination.

BALCONIES

VILLAS

The Villa balconies are mostly rated as *Outdoor Dining*. The exceptions are the corner balconies of V1, V4, V5 and V8 Villas. These are rated from *Pedestrian Sitting* to *Outdoor Dining*, with a small *Pedestrian Standing* rated area at the edge of the V8 corner balcony. These ratings are suitable for stationary activities.

The observed Lawson comfort ratings are suitable for the intended use of the space.

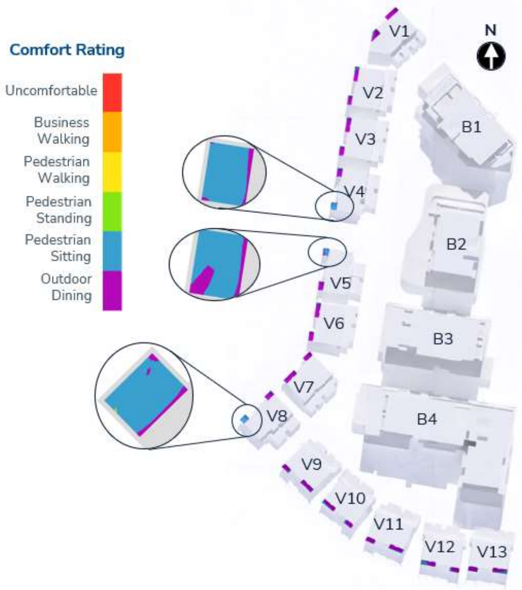


Figure 14: Plan view of the villa balconies coloured by Lawson Comfort Rating.

B4

Wind comfort on the balconies of B4 level 4 is rated from *Pedestrian Sitting* to *Outdoor Dining*, with some localized *Pedestrian Standing* regions near the edge of some balconies. The balconies at the levels below have identical geometry and wind comfort results are either similar or better than the results at level 4. These results are appropriate for balconies.

The rooftop accessible area is primarily rated *Pedestrian Sitting* with localised areas of *Outdoor Dining* and *Pedestrian Standing* in the northeast and southeast corners. Any planned seated activities should be planned away from the small patches of *Pedestrian Standing* areas.

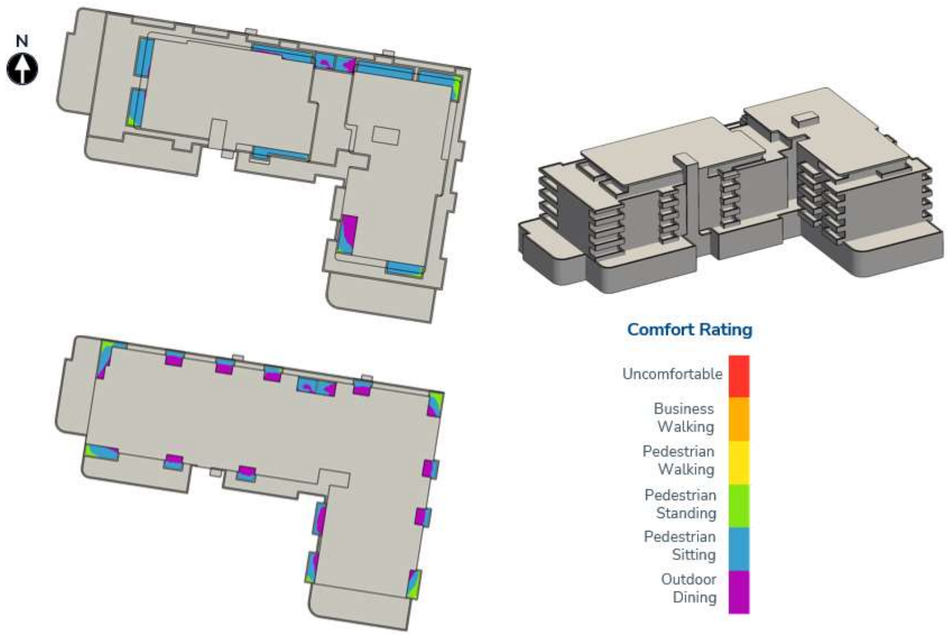


Figure 15: Plan view of B4 rooftop (top left) and B4 level 4 (bottom left).

B3 AND B1

Wind comfort on the balconies of level 5 of B3 and B1 is similar to that of B4 building balconies. Regions close to the edge of the balconies have some localized *Pedestrian Standing* regions while those closer to the façade are rated *Pedestrian Sitting* to *Outdoor Dining*.

Balcony layout at levels 1-4 have identical geometry to level 5 with wind comfort results here being similar or better than the results at level 5.

Rooftop balcony ratings range mostly between *Pedestrian Sitting* to *Pedestrian Standing*. These results are suitable for stationary activities. However, any potential seated activities should be planned to be within the *Pedestrian Sitting* and *Outdoor Dining* rated regions, avoiding *Pedestrian Standing* rated areas.

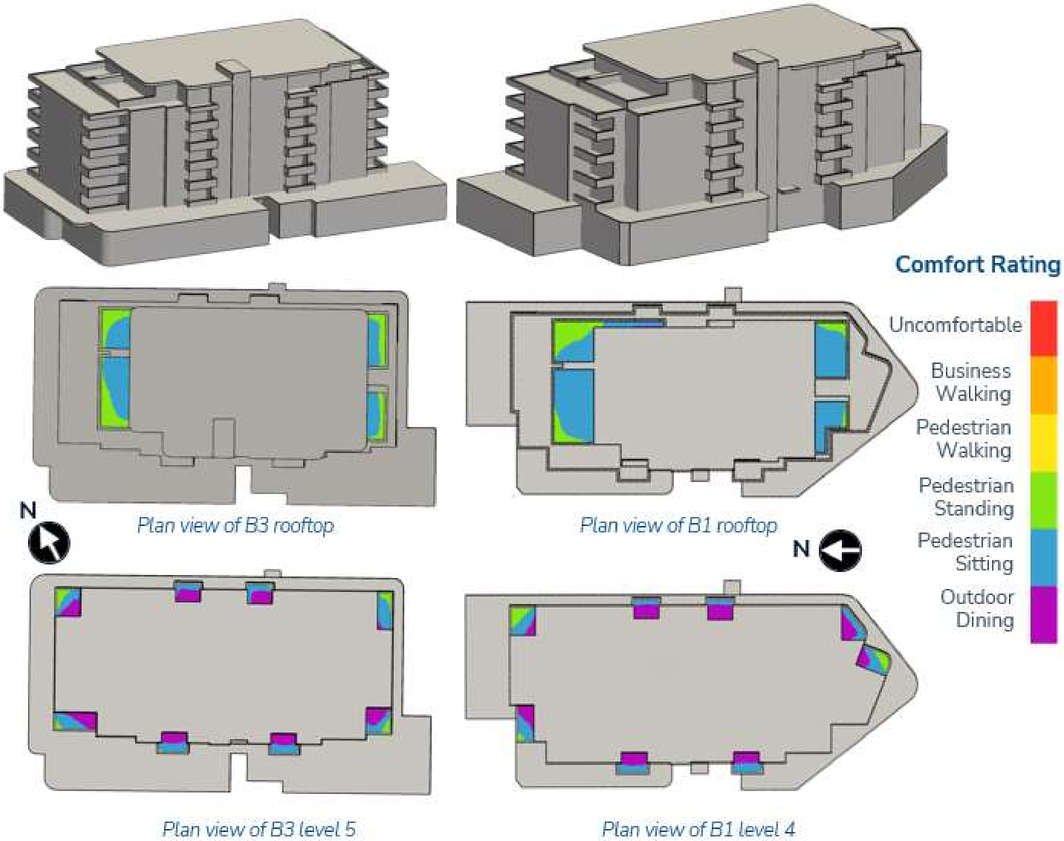


Figure 16: Plan view of B3 and B1 for rooftop and level 5 coloured by Lawson Comfort Rating.

B2

Wind comfort on B2 balconies range from *Pedestrian Standing* to *Outdoor Dining*, with calmer conditions at lower-level balconies.

Building B2 has 4 sets of unique balconies. Results showed here refer to the top balconies of each set. Wind comfort on the balconies below is similar or better than the ones at the top of the set.

These results are appropriate for balconies.

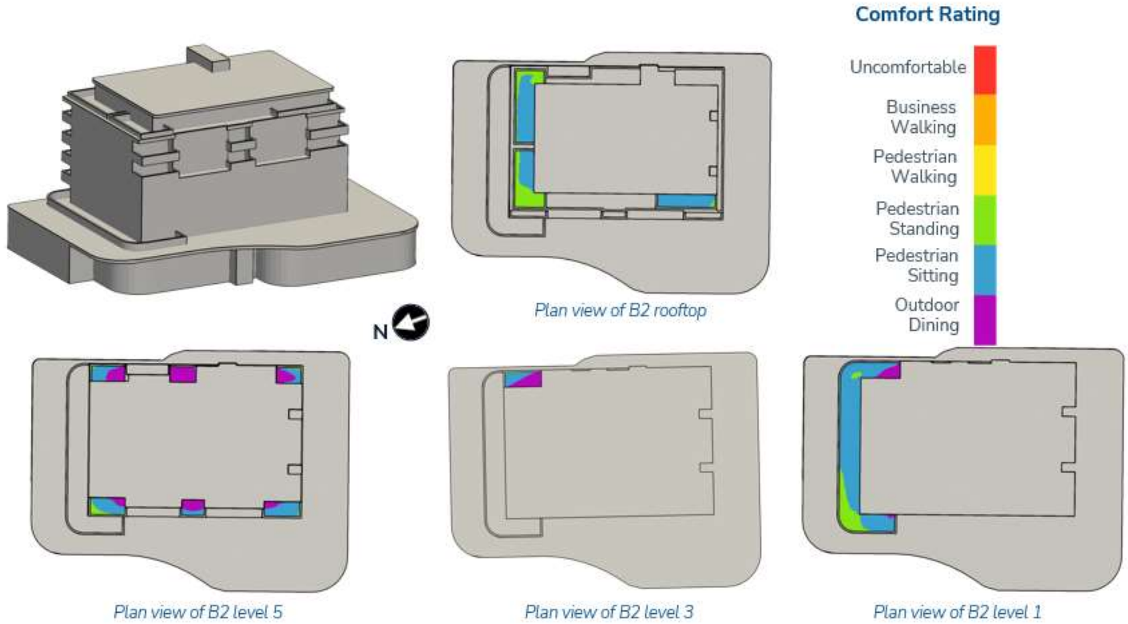


Figure 17: Plan view of B2 coloured by Lawson Comfort Criteria.

5. Conclusion

CPP has conducted a computational simulation to assess the pedestrian wind comfort of Tumbi Umbi Retirement Village. The wind comfort conditions around the site and at areas of interest such as balconies and rooftops have favourable wind comfort conditions for the intended use of the space. Any seated activities on balconies are recommended to be located within areas rated *Outdoor Dining*. Overall, no mitigation measures are recommended.

Appendix A – Computational Model Details

WIND CLIMATE AND SITE ROUGHNESS CORRECTIONS

Dir (°)	A	K	C (m/s)	$C_{ref,site}$ (m/s)	C_1[1]	C_2[1]	z_0[1]
0	0.063	1.90	4.25	3.49	0	1	0.3
22.5	0.076	2.55	5.70	5.51	0	1	0.3
45	0.092	2.62	6.33	5.96	0	1	0.3
67.5	0.043	2.43	5.18	4.53	0	1	0.3
90	0.029	2.20	4.92	4.19	0	1	0.3
112.5	0.027	2.00	4.89	4.23	0	1	0.3
135	0.038	2.06	5.29	4.50	0	1	0.3
157.5	0.068	2.21	6.43	5.80	0	1	0.3
180	0.090	2.24	7.67	6.34	0	1	0.3
202.5	0.076	2.00	6.50	5.35	0	1	0.3
225	0.048	1.95	4.35	3.95	0	1	0.3
247.5	0.061	2.10	3.84	4.63	0	1	0.3
270	0.082	1.93	3.52	4.08	0	1	0.3
292.5	0.086	1.48	2.57	3.32	0	1	0.3
315	0.065	1.28	2.32	2.34	0	1	0.3
337.5	0.044	1.37	2.95	2.44	0	1	0.3

$\boldsymbol{H_{ref}}$	24 m
$\bar{V}_{ref}$	10 m/s

Probability of the wind speed v exceeding V m/s:

$$\Pr(v > V) = \sum_{1}^{16} A_i \exp\left[-\left(\frac{V}{C_{\mathrm{ref,site},i} V_{r,i}}\right)^{k_i}\right]$$

where V_r is the velocity ratio, as obtained from the CFD simulations.

1-Yi Yang, Ming Gu, Suqin Chen, and Xinyang Jin. New inflow boundary conditions for modelling the neutral equilibrium atmospheric boundary layer in computational wind engineering. Journal of Wind Engineering and Industrial Aerodynamics,

CFD MESH

The mesh is refined on areas around the site to capture the flow mechanisms in the areas of interest. Five inflation layers are used on all walls to adequately resolve near wall velocity gradients.

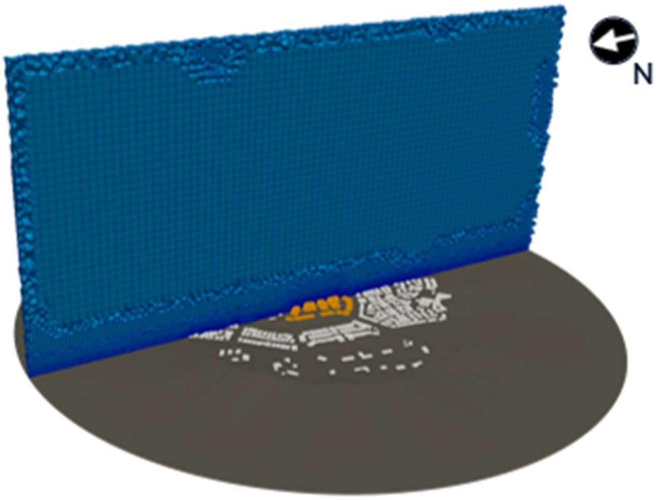


Figure 18: Vertical slice through domain showing whole volume mesh.

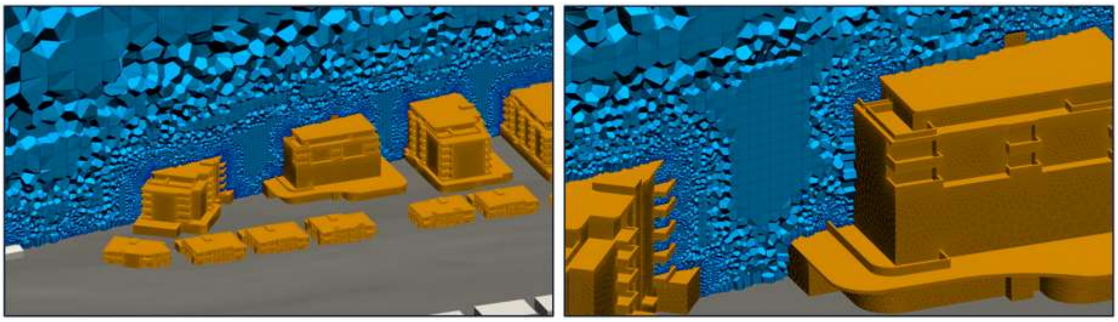


Figure 19: Volumetric mesh showing refinement around building edges and areas of interest (left) and volumetric mesh showing inflation layers on wall (right).

SIMULATION DETAILS

The computational fluid dynamics simulation was set-up using the following settings.

Numerics

- Wind directions: 16 equally spaced
- Turbulence model: Realizable k-epsilon (steady-state)
- Pressure and turbulence gradients: 2nd order blended
- Momentum divergence: 2nd order blended
- Pressure-velocity coupling: semi-implicit pressure linked equations
- Point monitors for convergence monitoring: 9
- Iterations for convergence: 2000

Domain geometry

- Sized for blockage ratio < 5 %
- Cylindrical domain
- Terrain gradually blended to a constant elevation beyond turntable to domain perimeter
- Distance from boundary conditions to modelled structures is at least the greatest of all combinations of 5H where H is each building height.

Atmospheric Boundary Layer

- Velocity profile follows a log-law with z_0 parameter derived from nearest local code profile category to predicted profile from ESDU roughness analysis[1]
- Turbulent kinetic energy constant with height[2]
- Turbulent dissipation rate derived[2] from turbulent kinetic energy and z_0

Mesh resolution

Total cells: 22 million

Ground:

- Maximum lateral size: 3 m
- Maximum vertical size: 0.63 m
- Cells below 1.5 m: at least 2

Street canyons and structures

- Cells across each dimension: at least 10 (min. 1 m in size)
- Smaller features resolved with at least 3 cells

ATMOSPHERIC BOUNDARY LAYER CALIBERATION

Ensuring the propagation of the Atmospheric Boundary Layer (ABL) profile into the domain is a key requirement of conducting reliable CWE simulations. This requirement was achieved for all wind directions.

The plots show an example of the variation of both mean wind speed and turbulence intensity with height on approach to the explicitly modelled area for a prevailing wind direction S.

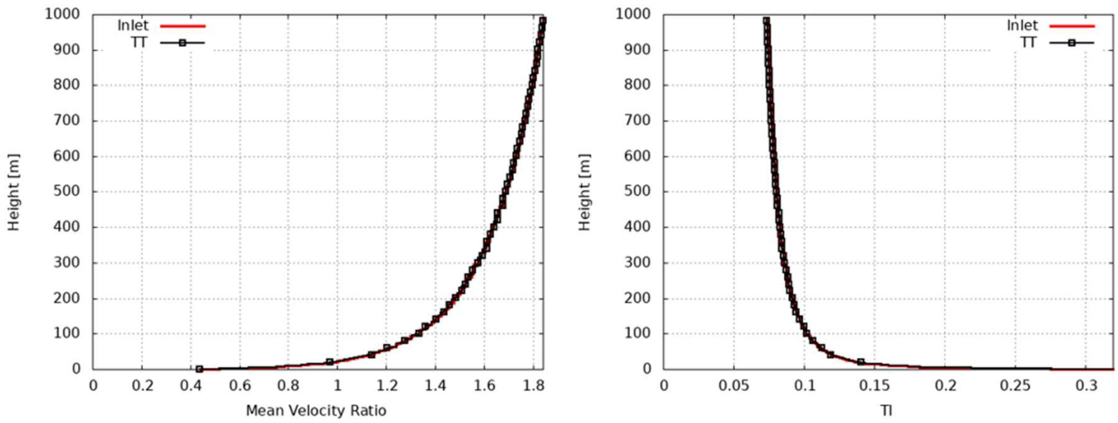


Figure 20: Variation of mean wind speed wtih height (left) and variation of turbulence intensity with height (right) on approach to modelled area for the South prevailing wind direction.

Appendix B – Topographic Study

OBJECTIVE

One of the key variables of any pedestrian wind comfort study is the wind climate at the site region, and where that data is extracted from. Based on this project location, we identified a few different sources of wind climate data, with the most reliable being the anemometer near the Norah Head Lighthouse, located at Norah Head, NSW, about 15.5 km away from the Tumbi Umbi project site.

However, the anemometer is located at the edge of a cliff near the coast. This means that wind coming from the sea accelerates as it goes over the terrain, polluting the wind speed data recorded by the anemometer. To overcome this issue, a topographic study was conducted. The goal of this study is to find how much the wind speed changes over the cliff, in order to correct the anemometer data.

Figure 21: Overhead view showing location of wind data extraction site and anemometer.

SIMULATION GEOMETRY

Terrain is included to a radius of approximately 600 m. This terrain is divided into three categories: inland, coast and sea.

A unique representative roughness was assigned for each category, and 12 different wind directions coming from the sea were simulated.

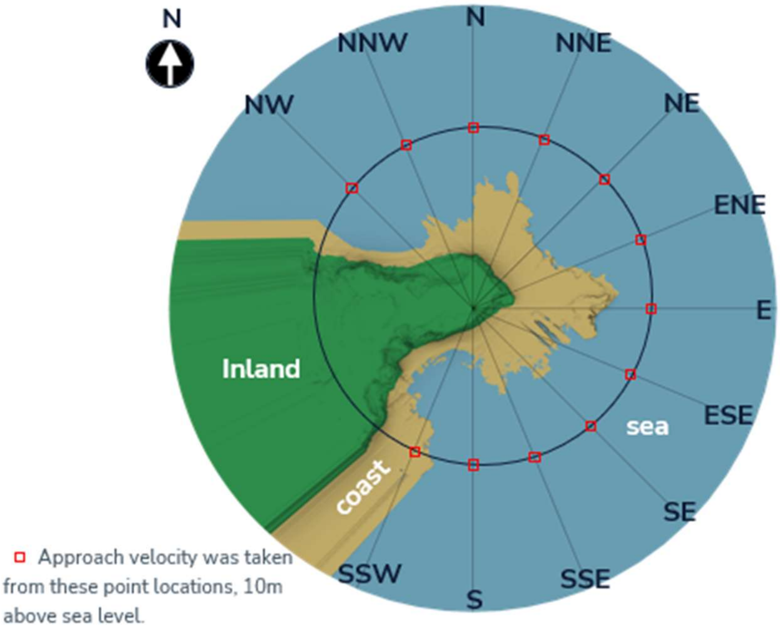


Figure 22: Modelled terrain and wind directions simulated.

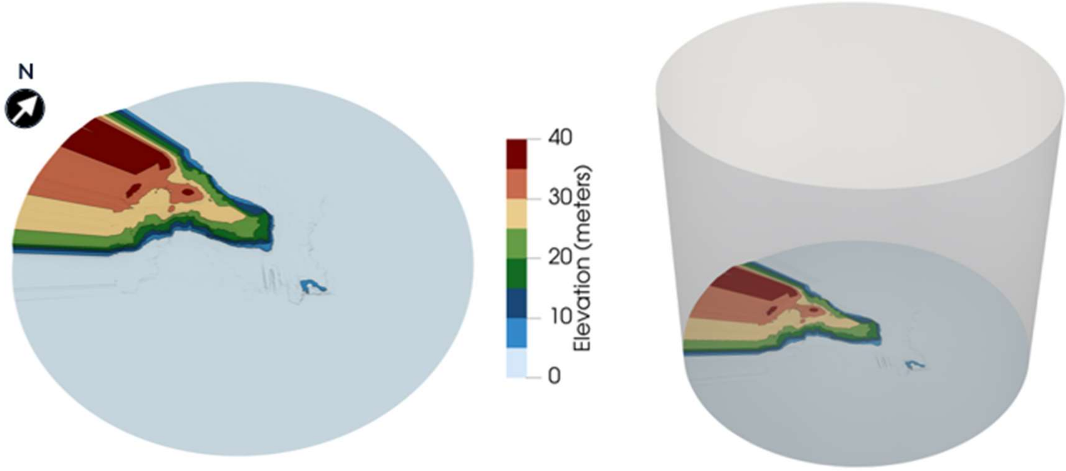


Figure 23: Model surrounds and terrain (left) coloured by elevation and entire simulation domain viewed from southeast (right).

CFD MESH

Refined mesh resolution inside the BOI (body of influence) to capture the flow mechanisms near the anemometer.

Ten inflation layers on the ground to adequately resolve near wall velocity gradients.

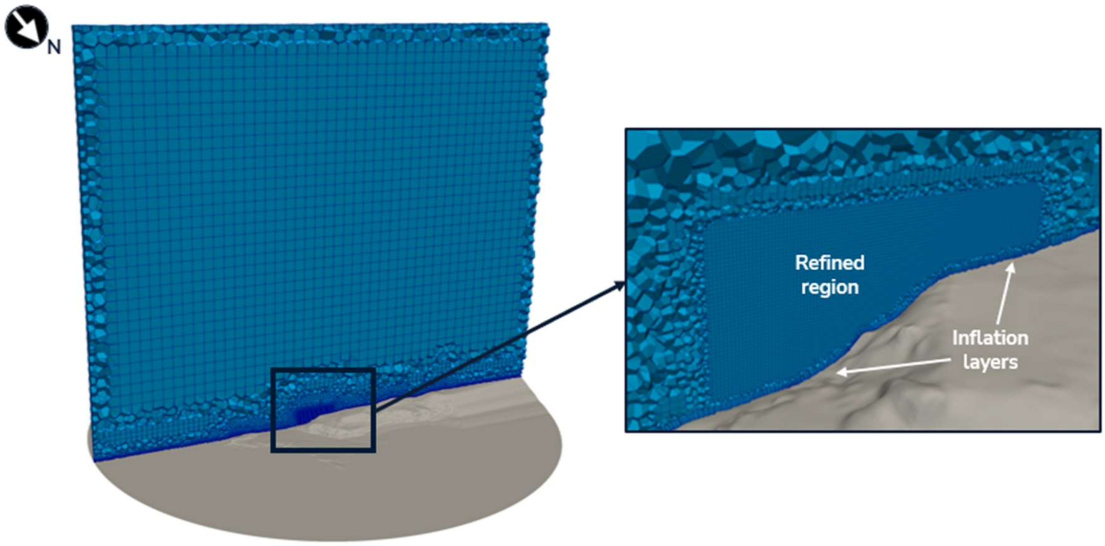


Figure 24: Vertical slice through domain showing whole volume mesh (left) and volumetric mesh showing inflation layers and refined region (right).

SIMULATION DETAILS

The computational fluid dynamics simulation for the topographic study is set-up using the following settings.

Numerics

- Wind directions: 12
- Turbulence model: Realizable k-epsilon (steady-state)
- Pressure and turbulence gradients: 2nd order blended
- Momentum divergence: 2nd order blended
- Pressure-velocity coupling: semi-implicit pressure linked equations
- Point monitors for convergence monitoring: 8
- Iterations for convergence: 2000

Domain geometry

- Sized for blockage ratio < 5 %
- Cylindrical domain
- Terrain gradually blended to a constant elevation beyond turntable to domain perimeter
- Distance from boundary conditions to modelled structures is at least the greatest of all combinations of 5H where H is each building height.

Atmospheric Boundary Layer

- Velocity profile follows a log-law with z_0 parameter derived from nearest local code profile category to predicted profile from ESDU roughness analysis[1]
- Turbulent kinetic energy constant with height[2]
- Turbulent dissipation rate derived[2] from turbulent kinetic energy and z_0

Mesh resolution

Total cells: 5 million

- Ground:
    - Maximum lateral size: 3.5 m
    - Maximum vertical size: 0.3 m
    - Cells below 10 m: at least 10
- BOI around anemometer region: 0.8 vertical cell size

FLOW PATTERNS – NORTHERLY WINDS

Northerly wind flow patterns are shown as an example to help visualize wind velocity increase over the cliff.

Unobstructed northerly winds accelerate on the steep cliff slopes towards the top, where the anemometer is located.

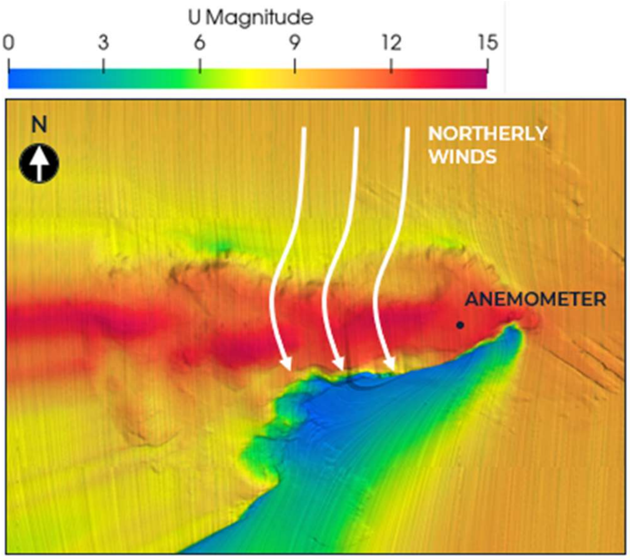


Figure 25: View from north - velocity contours.

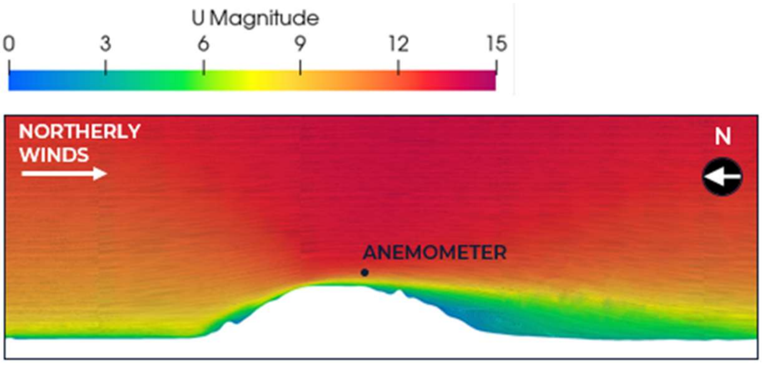


Figure 26: Side cross section view of the cliff - velocity contours.

RESULTS

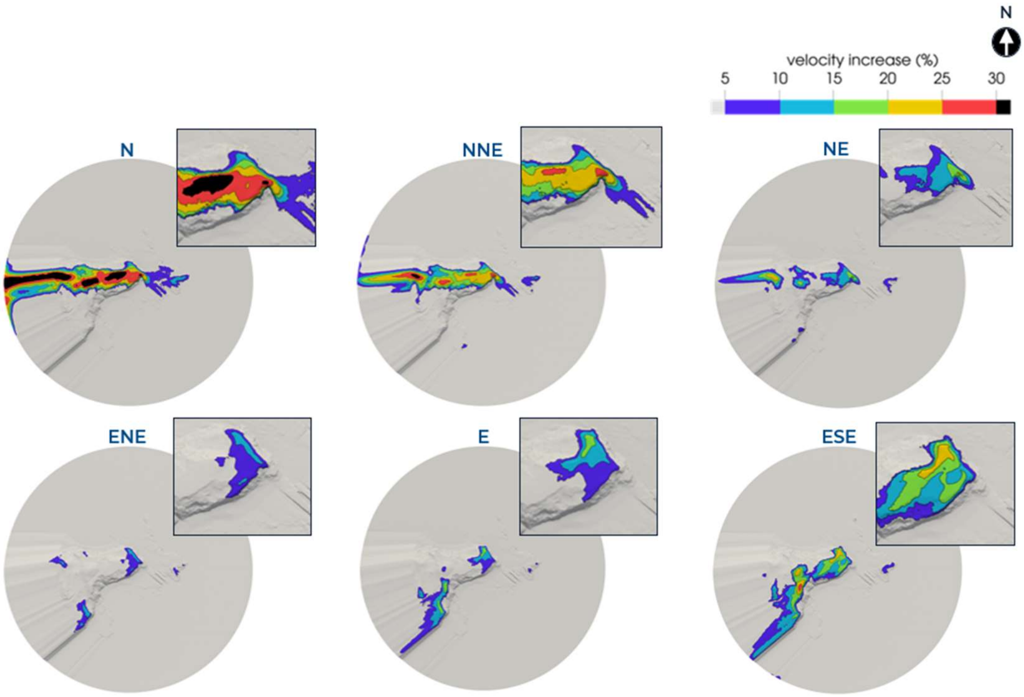
For each direction, *C anemometer* is the wind speed data taken from the anemometer, and it is multiplied by the *cliff correction factor* from the topographic study to obtain the *C corrected for the cliff* wind speeds, which are the wind speeds later used on the CFD Tumbi Umbi wind comfort simulation. The *speed up factor* is just the wind speed increase due to the cliff, as a percentage.

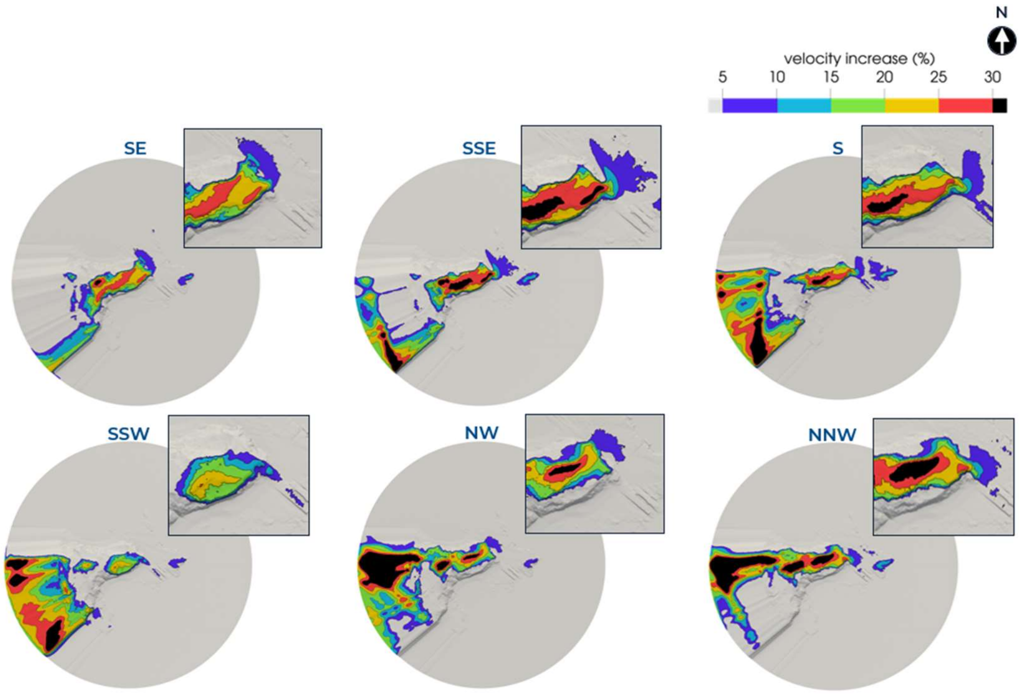
To obtain the *cliff correction factor*, the topographic study approaching wind speeds - 180 meters away from the anemometer, upstream, 10 meters above sea level - were divided by the wind speeds at the anemometer position. See page 17 figure for approaching wind speeds point location.

Table 2: Results of topographic study.

Dir (°)	C anemometer (m/s)	Cliff correction factor	C corrected for the cliff (m/s)	Speed up factor (%)
0	5.55	0.77	4.25	30.59
22.5	7.30	0.78	5.70	28.01
45	7.60	0.83	6.33	20.09
67.5	5.86	0.88	5.18	13.21
90	5.49	0.90	4.92	11.55
112.5	5.73	0.85	4.89	17.20
135	6.62	0.80	5.29	25.22
157.5	8.39	0.77	6.43	30.41
180	9.10	0.84	7.67	18.55
202.5	7.15	0.91	6.50	10.00
315	4.35	0.84	2.32	19.28
337.5	3.84	0.78	2.95	27.86

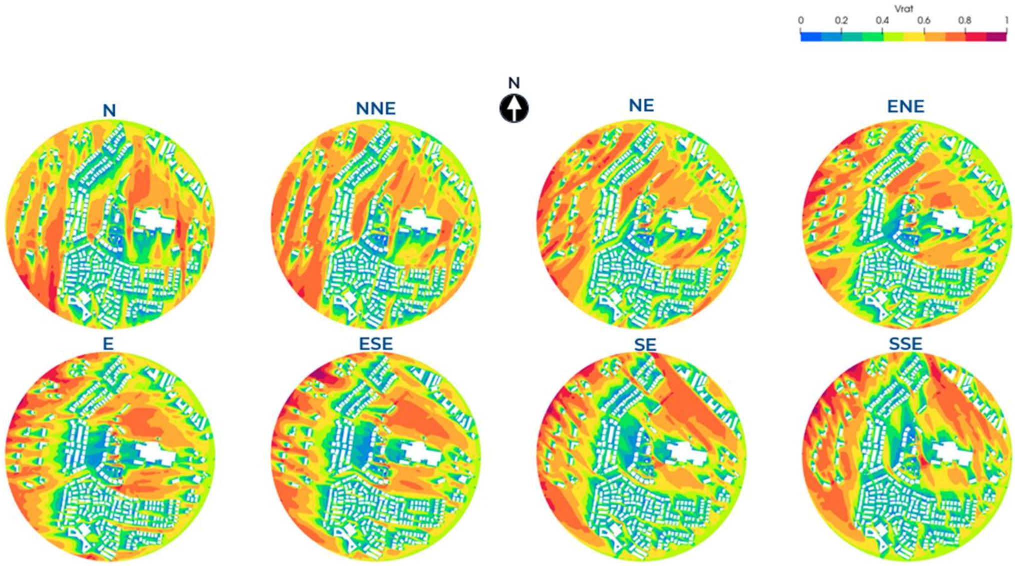
VELOCITY INCREASE AT 10 METERS HEIGHT

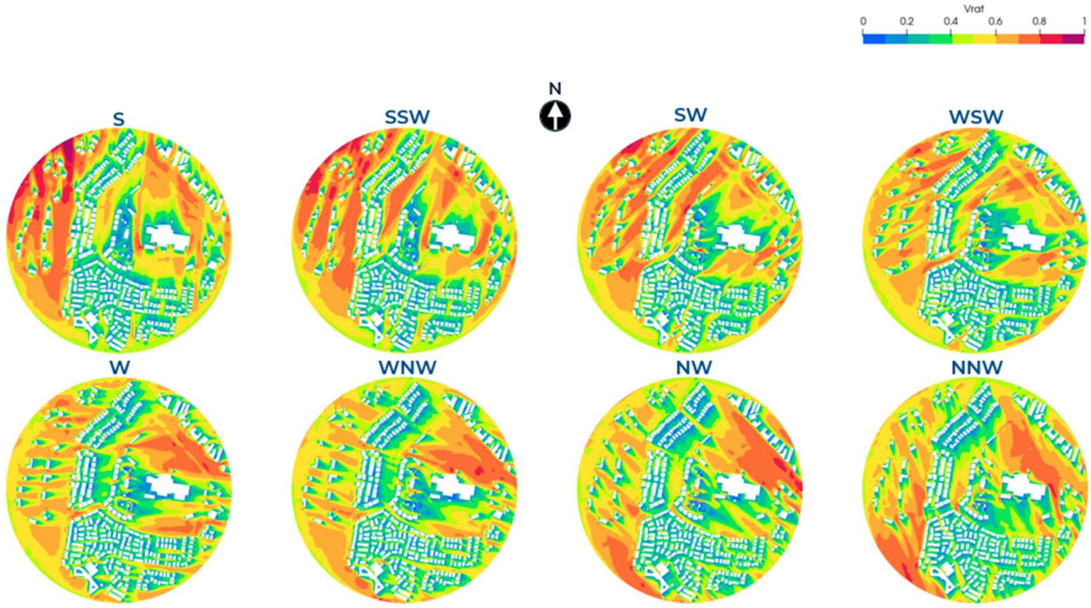




Appendix C – Velocity Ratio Contours

SURROUNDS





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CLOSE UP