Wind Environment Study

for the proposed development known as the

Sydney Water Corporate Headquarters, Parramatta

February 27, 2007

Report Reference No. WA113-03F03(rev0)- WE Report

Sydney • Melbourne • Singapore www.windtech.com.au
WINDTECH Consultants Pty Ltd: 19 Willis St, Wolli Creek NSW 2205 Australia ABN 72 050 574 037
T: (61.2) 9567 0722 **F:** (61.2) 9567 0733 **E:** reception@windtech.com.au

Table of Contents

1.0 Executive Summary

This report presents the results of a detailed investigation into the wind environment impact in relation to the proposed development known as the Sydney Water Corporate Headquarters, Parramatta. The development is located on the north-western corner of the Smith Street and Darcy Street intersection.

Wind speed measurements were carried out using a 1:300 scale model of the proposed development. Surround models incorporating the neighbouring buildings and local land topography were placed around the model of the site. The surrounds model extends to a radius of 375m.

Testing was performed using Windtech's blockage tolerant boundary layer wind tunnel facility, which has a 2.6m wide work section and has a fetch length of 14m.

Peak gust wind speeds were measured as well as the mean wind speed. Wind speed measurements from each wind direction are related to reference velocities at a height of 200m and upstream of the proximity model. Wind speed velocity coefficients, representing the local wind speeds are derived from the wind tunnel and are combined with the meteorological data to provide the equivalent full-scale wind speeds. These wind speed measurements are compared with criteria for long and short duration stationary activities and for pedestrian comfort.

With these treatments it is expected that wind conditions for all outdoor areas of the site will be acceptable. This is expected to be confirmed with further wind tunnel testing (which is currently being undertaken).

2.0 Model Description

Wind speed measurements were carried out using a 1:300 scale model of the proposed development. A surrounds model incorporating the neighbouring buildings and local land topography were placed around the model of the study building. The surrounds model extends to a radius of 375m.

Photographs of the model tested in the wind tunnel are presented in Figures 1a to 1e.

Testing was performed using Windtech's blockage tolerant boundary layer wind tunnel, which has a 2.6m wide work section and has a fetch length of 14m. The model was placed in suburban terrain boundary layer wind flow based on the Deaves and Harris model. The reference wind speeds were corrected for changes in the upstream building morphology and land topography. The upstream terrain category types for the 16 wind directions tested are indicated in Table 1.

Figure 2 shows an aerial image of the site and the local surrounding buildings within a 2km radius of the proposed development (beyond the extend of the physical surrounds model). The fetch length of 2km is selected based on the height of the proposed development, as outlined in the AS/NZS 1170.2:2002. The terrain type within this 2km zone defines the terrain category type for each wind directions tested.

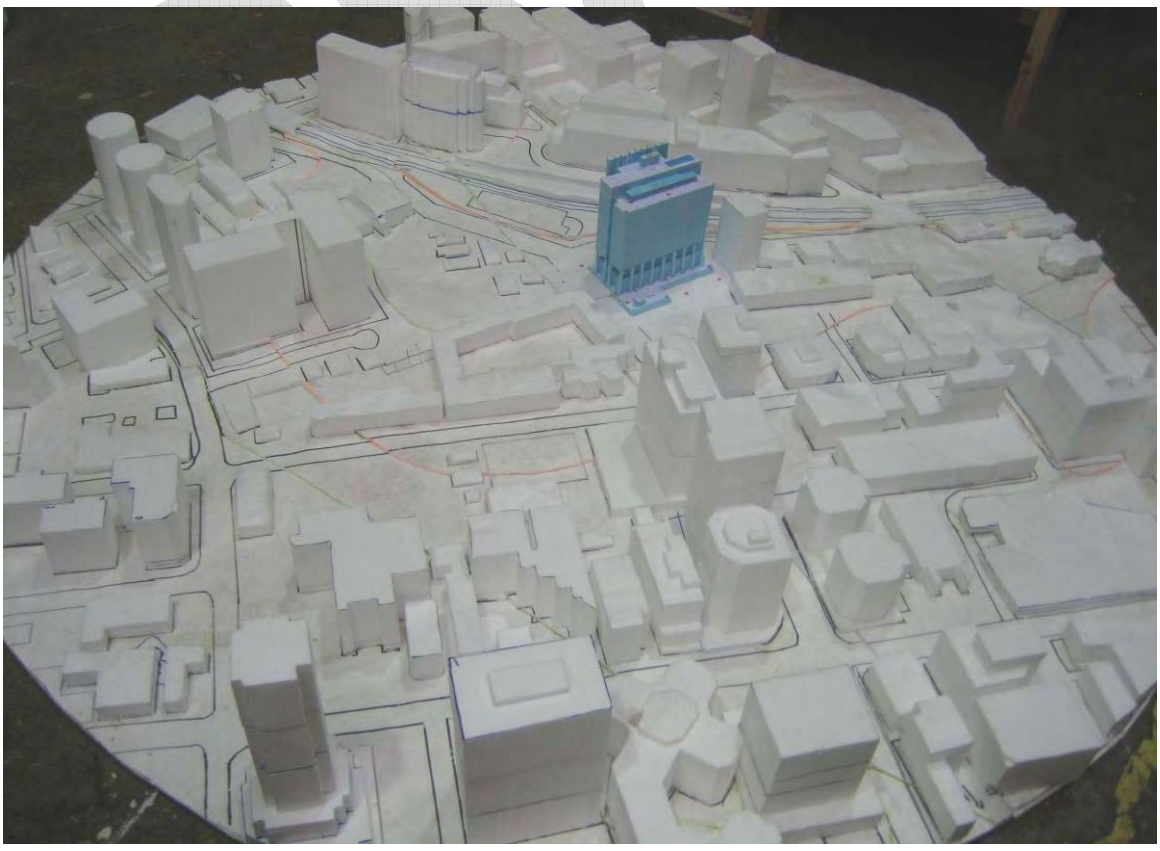


Figure 1a: Photograph of the Wind Tunnel Model (View from the North)

Figure 1b: Photograph of the Wind Tunnel Model (View from the North-East)

Figure 1c: Photograph of the Wind Tunnel Model (View from the North-West)

Figure 1d: Photograph of the Wind Tunnel Model (View from the North-West)

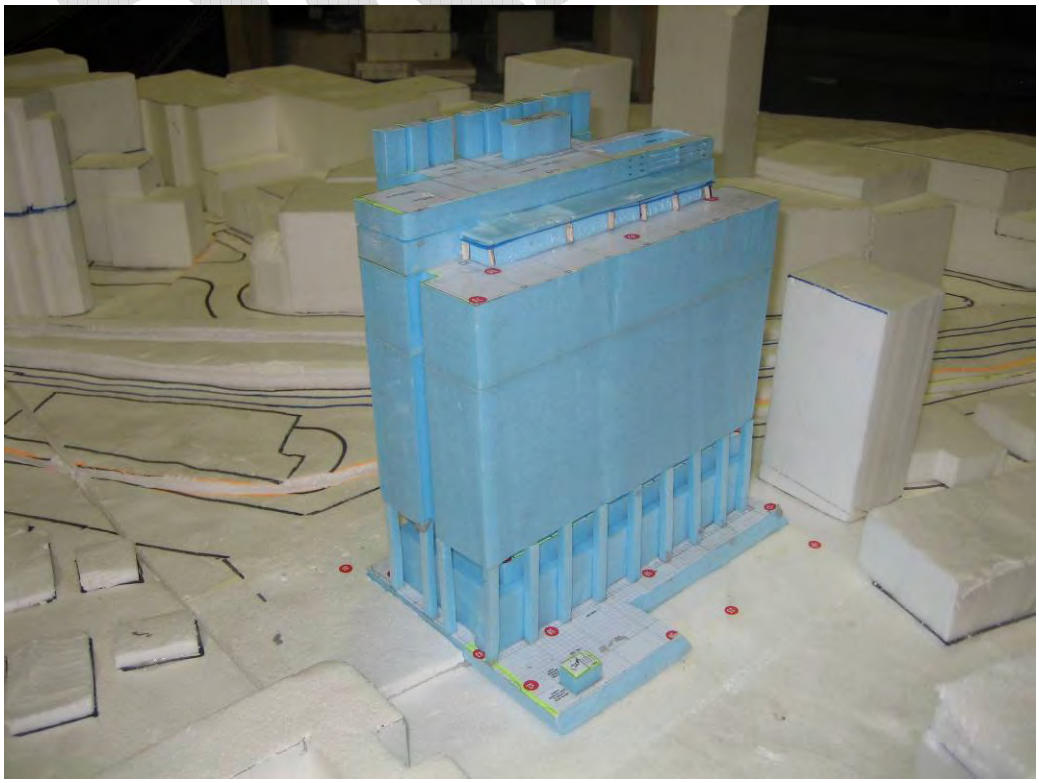


Figure 1e: Photograph of the Wind Tunnel Model (View from the East)

Table 1: Selected Terrain Categories for the Various Wind Directions

Wind Direction (Degrees)	Terrain Category (AS/NZS 1170.2:2002)
000 to 360	Terrain Category 3.0 (suburban terrain)

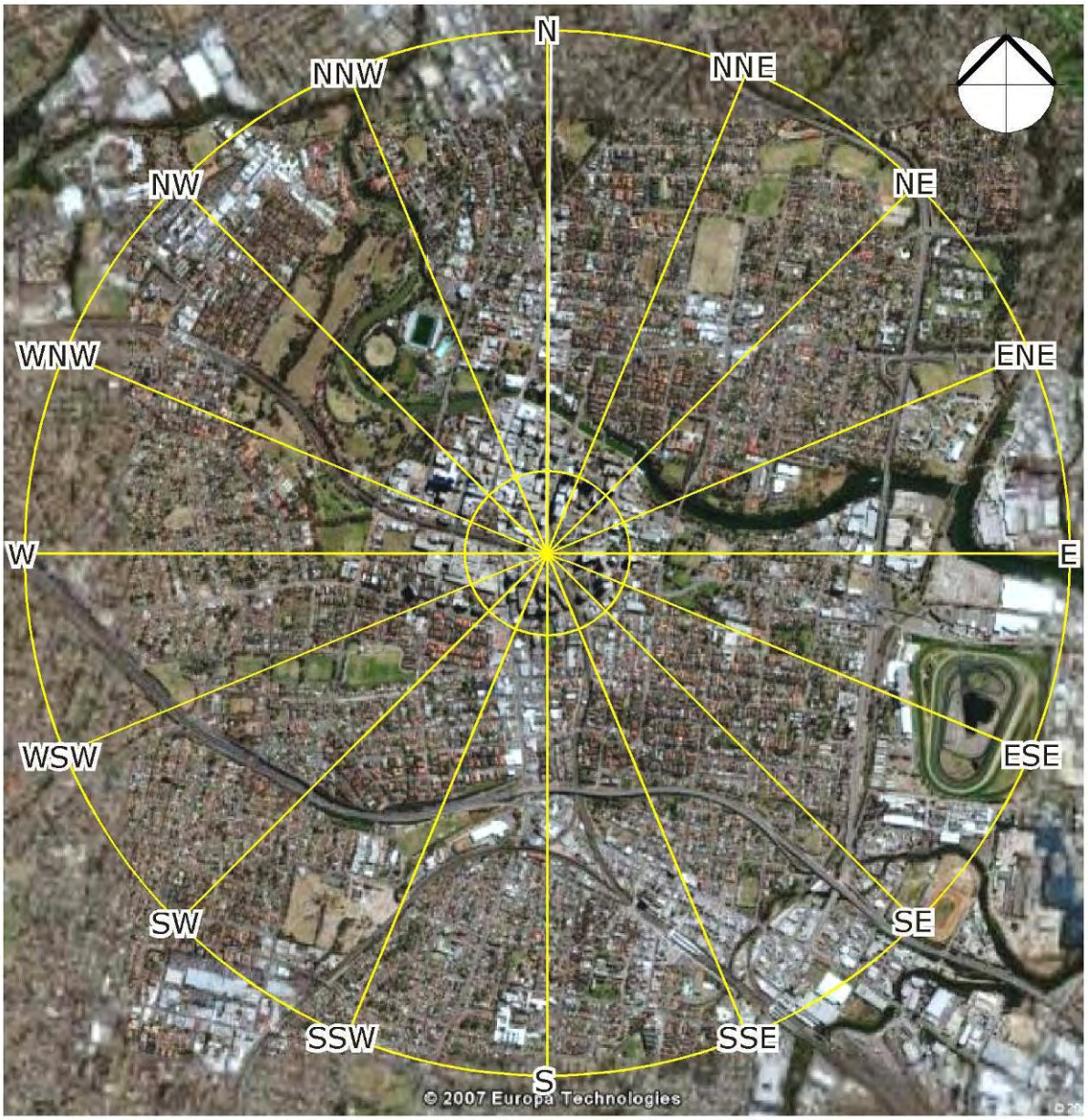


Figure 2: Aerial Image of the Site and Surrounds - 2km Radius

The figure above shows the section of terrain used in the determination of the terrain category type for the 16 wind directions tested. The smaller circle represents the extent of the physical surrounds model tested in the wind tunnel, which for this study had a radius of 375m. The larger circle, which is 2km away from the edge of the smaller circle, defines the extent of the fetch length of the development.

3.0 Test Procedure

Testing was performed in Windtech's blockage tolerant boundary layer wind tunnel facility. No correction is required for blockage effects. The mean freestream wind speed at the reference height in the tunnel is approximately 11 m/sec. This corresponds to a minimum velocity scale of approximately 1:2. Hence the sample length in the model scale of 12.0 seconds is equivalent to approximately 31 minutes in full-scale.

A detailed analysis involving sixteen wind directions at 22.5 degrees intervals was carried out. This procedure provides comprehensive information about the wind environment to be expected for the various wind directions.

The freestream and test-location air currents were monitored using a pair of Dantech hot wire probe anemometers. The probe support was set vertically as much as possible. This ensures that the measured wind speeds are independent of wind direction along the horizontal plane. In addition, care was taken in the alignment of the probe wire and in avoiding wall-heating effects.

The mean and the maximum 3 second duration peak gusts were obtained. The largest qualifying single peak was taken as the maximum gust velocity. To ensure that the largest measured peak is not a 'false' peak, the maximum peak would not qualify if it is more than 25% greater than the average of the second and third largest peaks. Any non-qualifying peak is replaced by the average of the second and third largest peaks.

For each of the sixteen wind directions, mean wind speeds were measured at selected points at a scale height of approximately 1.5m and were normalised by the mean value at a reference scale height of 200m up-wind of the model. The reference velocity measurements are used to relate the mean wind speed measurements to actual gust velocities, based on available meteorological data for Sydney. The meteorological data for Sydney was analysed statistically from frequency of occurrence tables prepared by the National Climate Centre, which are based on continuous data collected at 3 hour intervals over 53 years, ending March 1992. Data was collected from the Sydney Airport Observation Office at a height of 6 metres.

The directional distributions of the statistical mean hourly wind speeds for Sydney, corrected for suburban terrain (Terrain Category 3, as defined by AS/NZS 1170.2:2002) and a reference height of 200m are given in Figure 3.

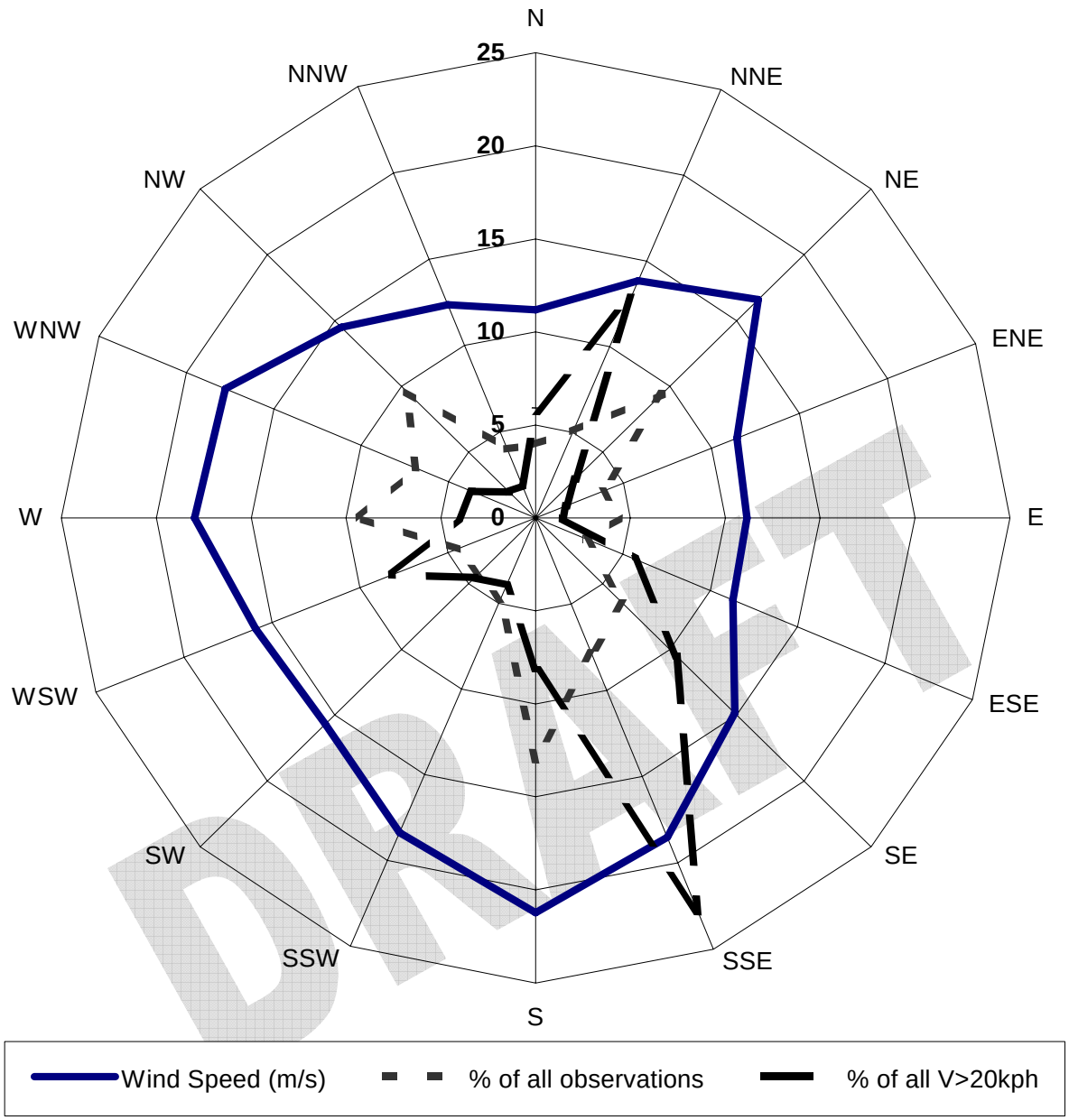


Figure 3: Annual Maximum Mean Wind Speeds for Sydney

(based on 10 minute means, corrected for suburban terrain at a reference height of 200m)

Sydney Airport Observation Office, 1939 to 1992

4.0 Environmental Wind Speed Criteria

The three principal wind directions affecting this development prevail from the North-East, South and West. Table 2 is a summary of the principal time of occurrence of these winds. A full set of wind roses for the Sydney region, obtained from Sydney Airport (1939 to 2000) at 9am and 3pm for each month throughout the year, are attached in Appendix A of this report.

Table 2: Principle Time of Occurrence of Wind for the Sydney Region

Month	Wind Direction		
	North-Easterly	Southerly	Westerly
January	X	X	
February	X	X	
March	X	X	
April		X	X
May			X
June			X
July			X
August			X
September		X	X
October	X	X	
November	X	X	
December	X	X	

The acceptability of wind in any area is dependent upon its use. For example, people walking or window-shopping will tolerate higher wind speeds than those seated at an outdoor restaurant. Table 3, developed by Penwarden (1975), is a modified version of the Beaufort Scale, and describes the effects of various wind intensities on people.

Table 3: Summary of Wind Effects on People (after Penwarden, 1975)

Type of Winds	Beaufort Number	Wind Speed (m/s)	Effects	Applicability
Calm, light air	1	0 - 1.5	Calm, no noticeable wind	Generally acceptable for stationary, long exposure activities such as in outdoor restaurants & theatres.
Light breeze	2	1.6 - 3.3	Wind felt on face	
Gentle breeze	3	3.4 - 5.4	Hair is disturbed, Clothing flaps	
Moderate breeze	4	5.5 - 7.9	Raises dust, dry soil and loose paper - Hair disarranged	
Fresh breeze	5	8.0 - 10.7	Force of wind felt on body	Generally acceptable for walking & stationary, short exposure activities such as window shopping, standing or sitting in plazas.
Strong breeze	6	10.8 - 13.8	Umbrellas used with difficulty, Hair blown straight, Difficult to walk steadily, Wind noise on ears unpleasant.	
Near gale	7	13.9 - 17.1	Inconvenience felt when walking.	Acceptable for comfortable walking as in main public accessways.
Gale	8	17.2 -20.7	Generally impedes progress, Great difficulty with balance.	Unacceptable as main public accessways.
Strong gale	9	20.8 - 24.4	People blown over by gusts.	Completely unacceptable.

Note that the applicability column related to wind conditions occurring frequently (approximately once per week on average). Higher ranges of wind speeds can be tolerated for rarer events.

Lawson(1973) quotes that Beaufort 4 wind speeds (6 to 8m/s means) would be acceptable if it is not exceeded for more than 4% of the time; and a Beaufort 6 (11 to 14m/s means) as being unacceptable if it is exceeded more than 2% of the time.

Davenport (1972) had also come up with a set of criteria in terms of the Beaufort Scale and for various return periods. The values presented in Table 4 below are based on a frequency of exceedance of once per week (a probability of exceedance of 5%).

Table 4: Criteria by Davenport (1972)

Classification	Human Activities	95 Percentile Maximum Mean (once per week)
Walking Fast	Acceptable for walking, main public accessways	7.5 m/s > *u* > 10 m/s
Strolling, Skating	Slow walking, etc.	5.5 m/s > *u* > 7.5 m/s
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	3.5 m/s > *u* > 5.5 m/s
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	3.5 m/s > *u*

Later, Lawson (1975) came up with a set of criteria very similar to those of Davenport's. These are presented in Tables 5a and 5b, below.

Table 5a: Comfort Criteria by Lawson (1975)

Classification	Human Activities	95 Percentile Maximum Mean (once per week)
Business Walking	Objective Walking from A to B	8 m/s > *u* > 10 m/s
Pedestrian Walking	Slow walking, etc.	6 m/s > *u* > 8 m/s
Short Exposure Activities	Pedestrian Standing or sitting for a short time	4 m/s > *u* > 6 m/s
Long Exposure Activities	Pedestrian sitting for a long duration	4 m/s>u

Table 5b: Safety Criteria by Lawson (1975)

Classification	Human Activities	Annual Maximum Mean
Safety (all weather areas)	Accessible by the general public	15 m/s
Safety (fair weather areas)	Private outdoor areas such as balconies, terraces etc	20 m/s

Melbourne (1978) introduced a set of criteria for the assessment of environmental wind conditions. These criteria were developed for temperatures in the range from 10^{O}C to 30^{O}C and for people suitably dressed for outside temperature conditions. These criteria are based on peak gust wind speeds. Melbourne's criteria are outlined in Table 6 below. This set of criteria tends to be ***more conservative*** than criteria suggested by other researchers such as those indicated in Figure 4.

Table 6: Criteria by Melbourne (1978)

Classification	Human Activities	Annual Maximum Gust
Limit for safety	Completely unacceptable: people likely to get blown over.	u > 23m/s
Marginal	Unacceptable as main public accessways.	23 m/s > u > 16 m/s
Comfortable Walking	Acceptable for walking, main public accessways	16 m/s > u > 13 m/s
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	13 m/s > u > 10 m/s
Long Exposure Activities	Generally acceptable for long duration stationary activities such as in outdoor restaurants & theatres and in parks.	10 m/s > u

The criteria mentioned in Table 5, as well as other criteria, are compared on a probabilistic basis in Figure 4, below.

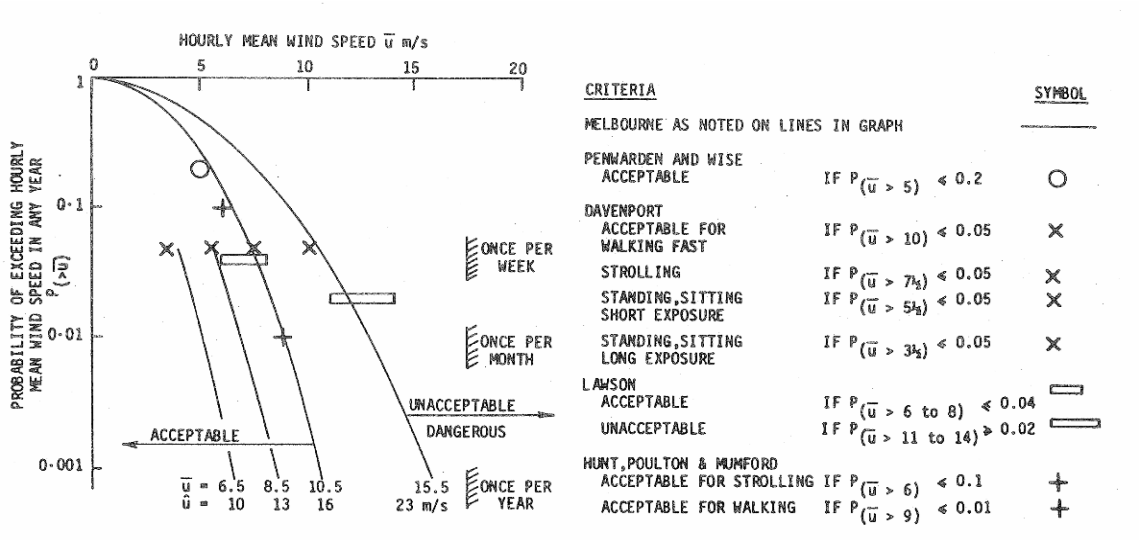


Figure 4: Comparison of Various Mean and Gust Wind Environment Criteria, assuming 15% turbulence and a Gust Factor of 1.5 (after Melbourne, 1978)

However, a comparative study presented by Ratcliff and Peterka (1990) tends to indicate that the criteria suggested by Melbourne (1978) are ***considerably more conservative*** than those by other researchers. This study is based on measurements taken from a total of 246 locations in various urban situations. The results are in indicated in Figure 5.

The Davenport criteria have been modified to relate to the Gust Equivalent Mean (GEM) wind speeds.

The GEM is the greater of either the mean wind speed or the gust wind speed divided by a gust factor.

The gust factor is determined using the measured turbulence intensity at the subject study point.

Using the abovementioned Davenport criteria in conjunction with the GEM wind speeds defined above has proven over time to be the most reliable indicator of pedestrian comfort based on input received when undertaking remedial wind environment studies.

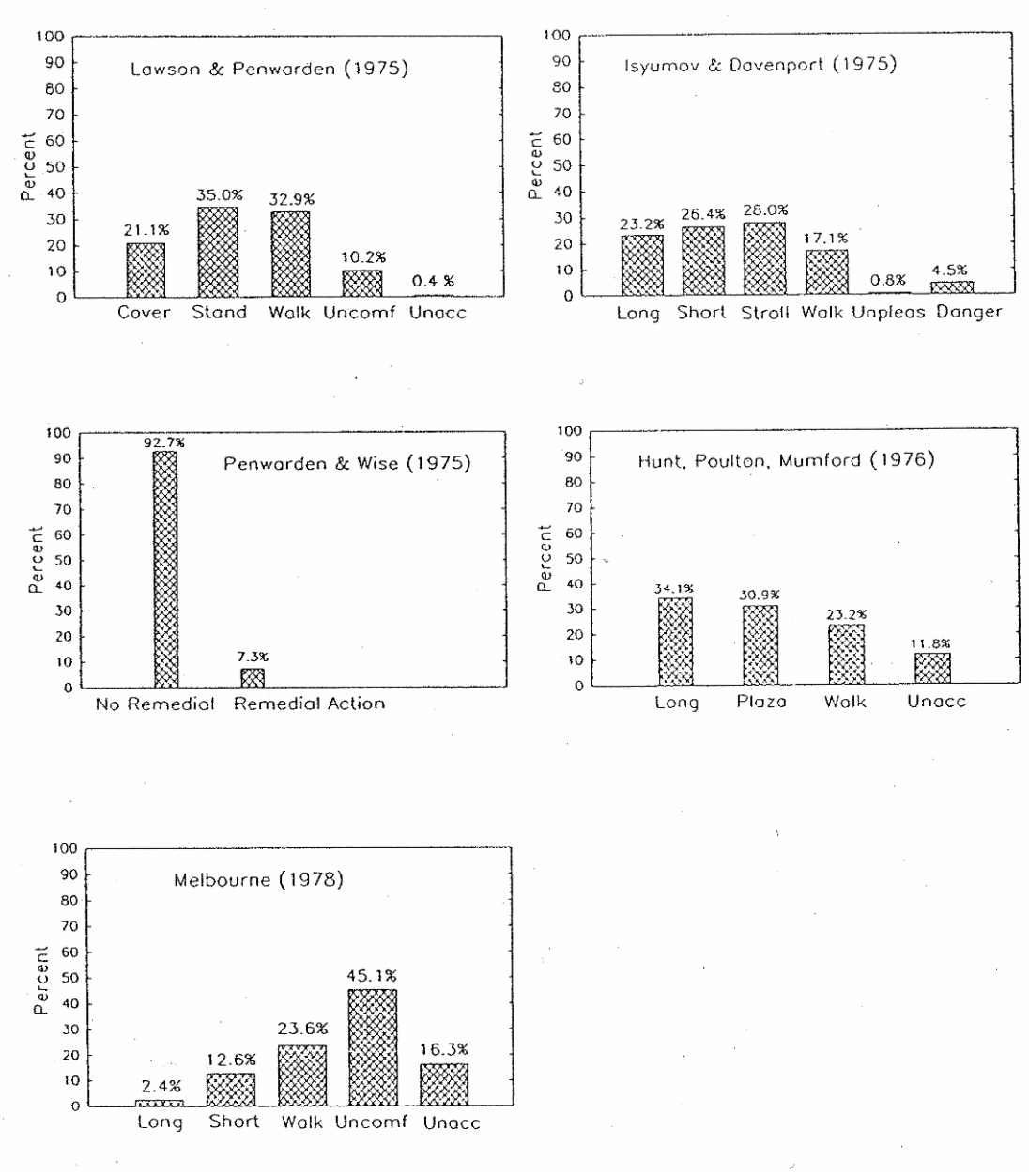


Figure 5: Distribution of Pedestrian Wind Comfort over Five Criteria for 246 locations examined in the Wind Tunnel (after Ratcliff & Peterka, 1990)

With regards to site specific wind speed criteria for this project, the relevant local government authority does not stipulate a specific set of criteria. Hence the assessment of local wind climate has been based on two sets of criteria. These are as follows:

- Private balconies and terraces on the tower sections of the development are compared to the Melbourne (1978) Safety Limit criteria of 23m/s for an annual maximum peak wind speed (See Table 6).

- Maximum weekly Gust Equivalent Mean (GEM) wind speeds for all other pedestrian and public terrace areas are compared against the Davenport (1972) criteria for GEM wind speeds (See Table 4).

5.0 Results of Study

A detailed study of wind activity around and within the proposed development was carried out. A total of 30 study locations were chosen for detailed analysis, as shown in Figures 6a to 6c. The proposed development was initially tested without the effect of any wind ameliorating devices, such as vegetation or additional screens/awnings not shown on the architectural drawings. For areas not achieving the appropriate wind conditions, retests will be conducted with some form of treatment.

Plots of the results for the local directional wind speeds for the various test point locations, as derived from the wind tunnel tests, are presented in Appendix B of this report. These results are separated into two plots; maximum weekly GEM wind speeds based on the Davenport (1972) criteria, and annual maximum peak wind speeds based on the Melbourne (1978) criteria.

5.1 Pedestrian Footpaths on Smith and Darcy Streets

Points 1 to 10 monitored wind conditions along the pedestrian footpaths on Smith and Darcy Streets, on the eastern and southern edges of the site. These study point locations are also indicated in Figure 6a.

Applicable Criteria:

Pedestrian footpaths are intended primarily as pedestrian thoroughfares. The wind conditions along all of the pedestrian footpaths should satisfy the Davenport (1972) comfortable walking criterion for Gust Equivalent Mean maximum weekly wind speeds. All areas should also satisfy the Melbourne (1978) safety limit of 23m/s for annual maximum peak wind speeds.

Results and Recommendations:

The Davenport (1972) comfortable walking criteria for maximum weekly Gust Equivalent Mean wind speeds is generally being satisfied by all study points except Point 10, which is exposed to strong south-south-easterly winds. Melbourne's (1978) safety limit of 23m/s for annual maximum peak wind speeds is exceeded at Points 6 to 10, generally caused by strong southerly and westerly winds.

It is noted on the architectural drawings that trees are proposed along the Darcy Street footpath. To ameliorate the adverse winds along Darcy Street, it is recommended that these trees are included into the final landscape plan for the site, as indicated in Figure 7a. These trees should be of a densely foliating evergreen species to ensure their effectiveness during the winter months, and be capable of growing with a canopy height of approximately 5m above the ground and a width of approximately 4m.

With these trees, it is expected that wind conditions at Points 6 to 10 will be acceptable, and will be confirmed with further wind tunnel testing (which is currently being undertaken).

5.2 Civic Place

Points 11 to 21 monitored wind conditions within the Civic Place pedestrian mall. Points 19 to 21 also represent outdoor seating areas. These study point locations are also indicated in Figure 6a.

Applicable Criteria:

Wind conditions within a pedestrian mall such as Civic Place should satisfy the Davenport (1972) short exposure criterion for Gust Equivalent Mean maximum weekly wind speeds. Wind conditions for the areas with proposed outdoor seating, represented by Points 19 to 21, should satisfy the Davenport (1972) long exposure criterion for Gust Equivalent Mean maximum weekly wind speeds. All areas should also satisfy the Melbourne (1978) safety limit of 23m/s for annual maximum peak wind speeds.

Results and Recommendations:

The Davenport (1972) short exposure criteria for maximum weekly Gust Equivalent Mean wind speeds is generally being satisfied by all study points in Civic Place, however Melbourne's (1978) safety limit of 23m/s for annual maximum peak wind speeds is exceeded at Points 12, 14 and 15. Points 12 and 15 are exposed to strong westerly winds, Point 14 is exposed to strong south-westerly winds. These results indicate that the north-western corner of the proposed development is causing wind to shear off it and adversely affect these three points.

To ameliorate this effect, it is recommended to add four trees along the stairs in Civic Place at the north-western end of the site, as indicated in Figure 7a. These trees should be of a densely foliating evergreen species to ensure their effectiveness during the winter months, and be capable of growing with a canopy height of approximately 5m above the ground and a width of approximately 4m.

With these trees, it is expected that wind conditions at Points 12, 14 and 15 will be acceptable, and will be confirmed with further wind tunnel testing (which is currently being undertaken).

5.3 Level 4 Terrace

Points 22 to 25 monitored wind conditions within the outdoor terrace area on Level 4 of the proposed development. These study point locations are also indicated in Figure 6b.

Applicable Criteria:

The wind conditions for this area should satisfy the Melbourne (1978) safety limit of 23m/s for annual maximum peak wind speeds.

Results and Recommendations:

The results of the initial tests of these points indicated that, with the exception of Points 22 and 25, the wind conditions for all areas will be acceptable. Point 22 is exposed to strong westerly winds. Point 25 is

exposed to strong south-easterly and westerly winds. For both points, these adverse winds cause wind conditions at each location to exceed the safety limit of 23m/s for annual maximum peak wind speeds.

Hence it is recommended that 2m high impermeable screens be implemented around the edge of the terrace at the south-western and north-western corners, as indicated in Figure 7b. With these screens, it is expected that wind conditions at Points 22 and 25 will be acceptable, and will be confirmed with further wind tunnel testing (which is currently being undertaken).

5.4 Level 16 Terrace

Points 26 to 30 monitored wind conditions within the outdoor terrace area on Level 16 of the proposed development. These study point locations are also indicated in Figure 6c.

Applicable Criteria:

The wind conditions for this area should satisfy the Melbourne (1978) safety limit of 23m/s for annual maximum peak wind speeds.

Results and Recommendations:

The results of the initial tests of these points indicated that, with the exception of Point 29, the wind conditions for all areas will be acceptable. Point 29 is exposed to strong southerly and westerly winds, causing wind conditions to exceed the safety limit of 23m/s for annual maximum peak wind speeds.

Hence it is recommended that a 2m high impermeable screen be implemented around the edge of the terrace area at this location, as indicated in Figure 7c. With this screen, it is expected that wind conditions at Point 29 will be acceptable, and will be confirmed with further wind tunnel testing (which is currently being undertaken).

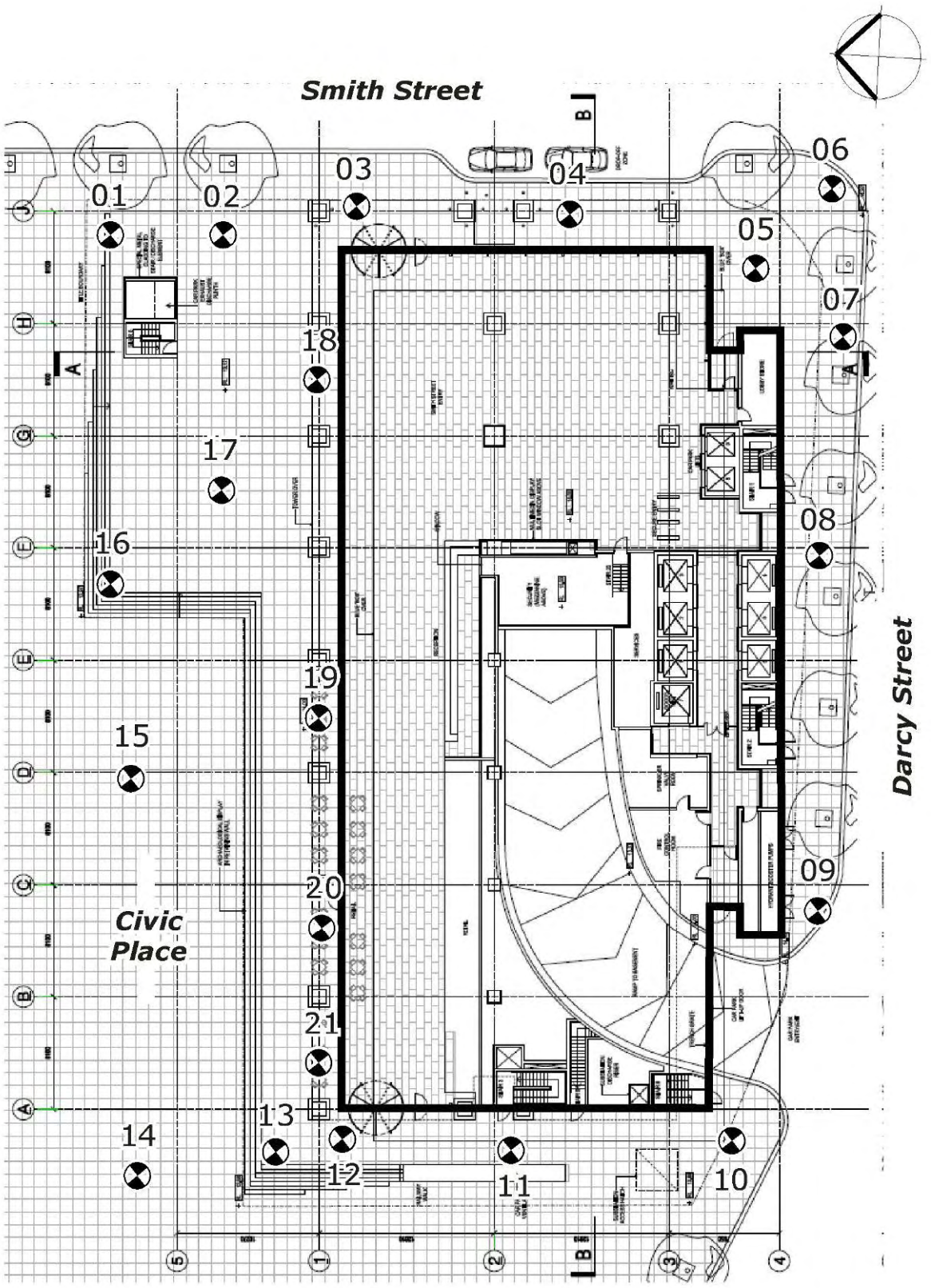


Figure 6a: Study Point Locations – Ground Level

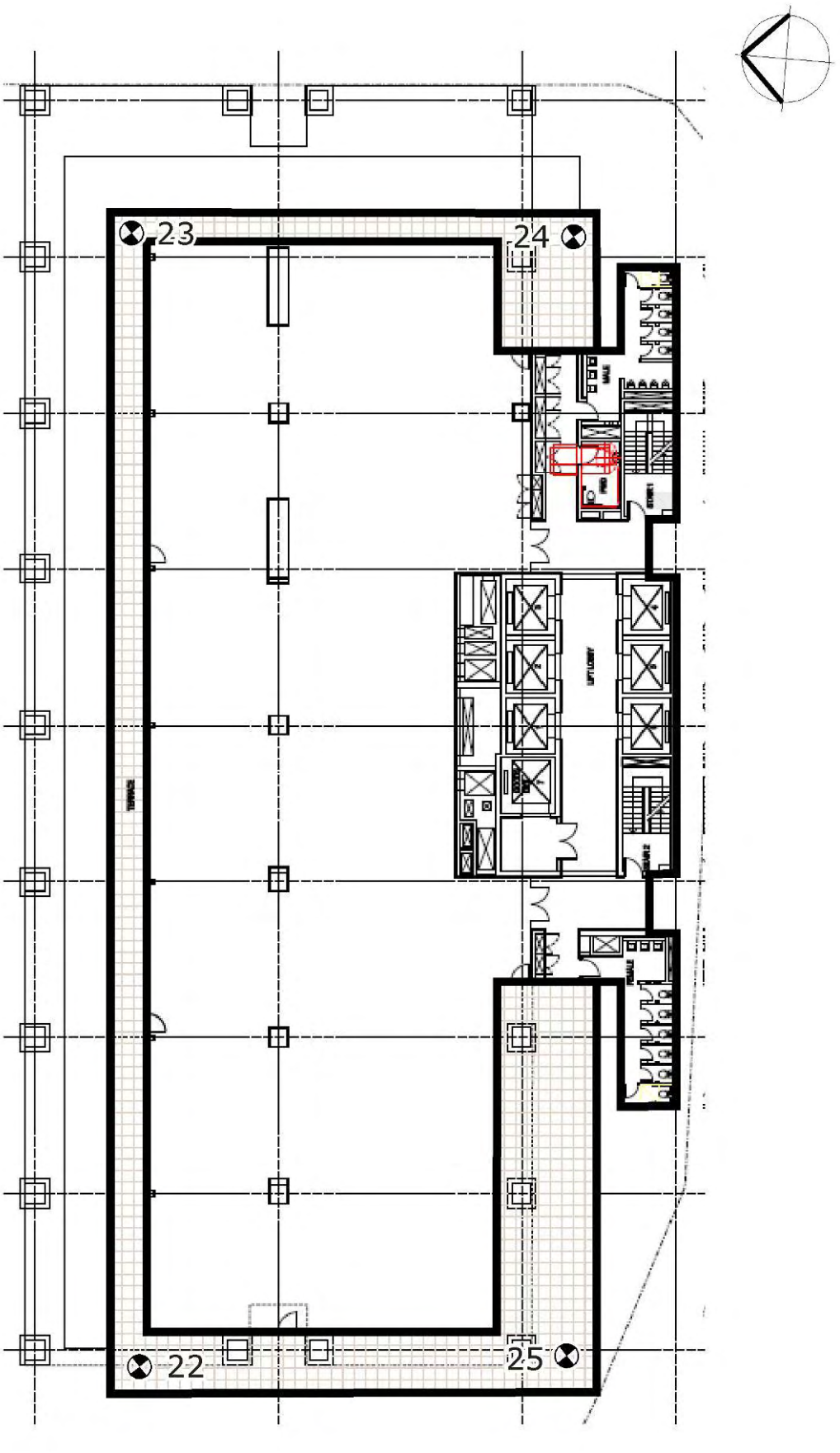


Figure 6b: Study Point Locations –Level 4 Terrace

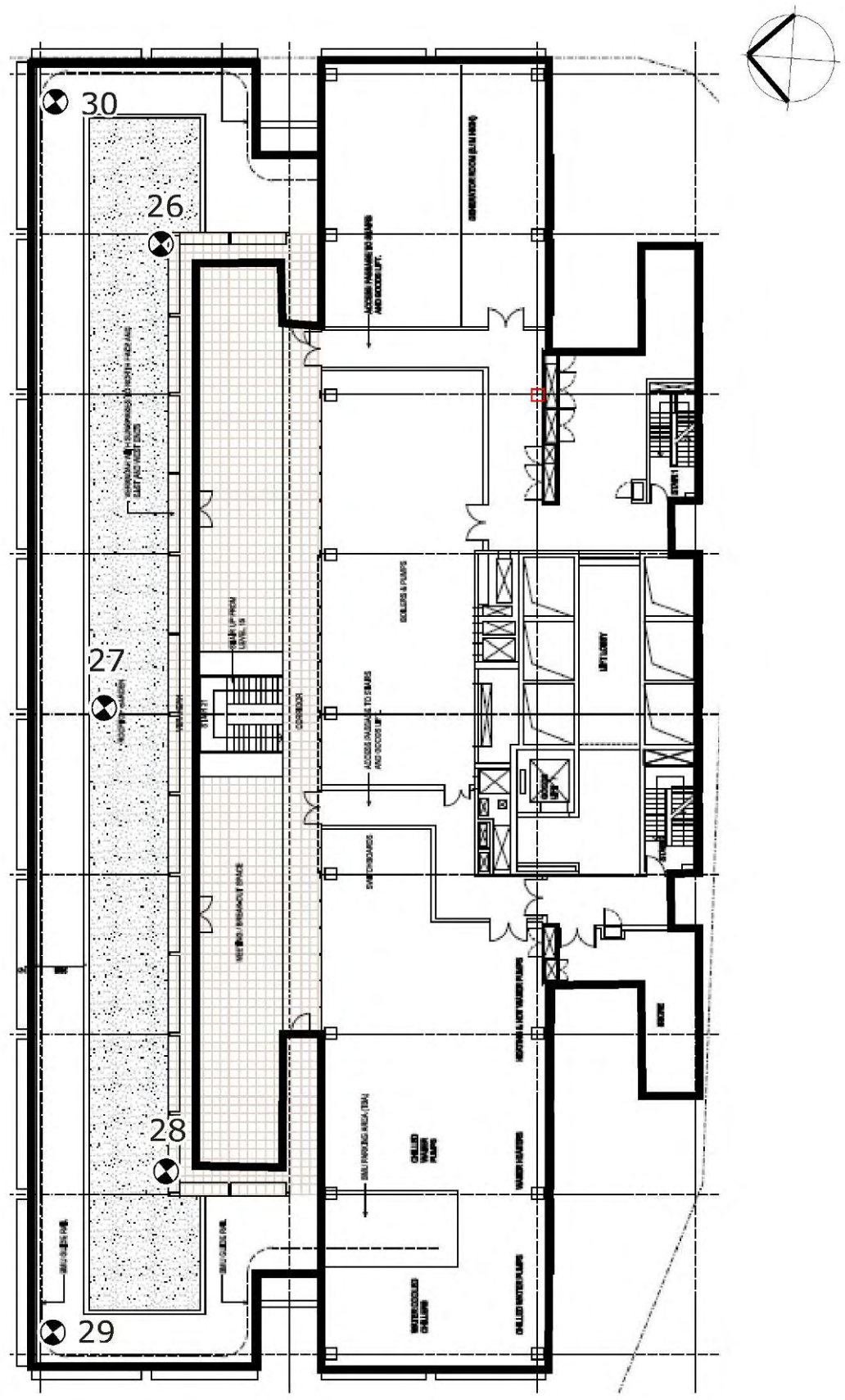


Figure 6c: Study Point Locations –Level 16 Terrace

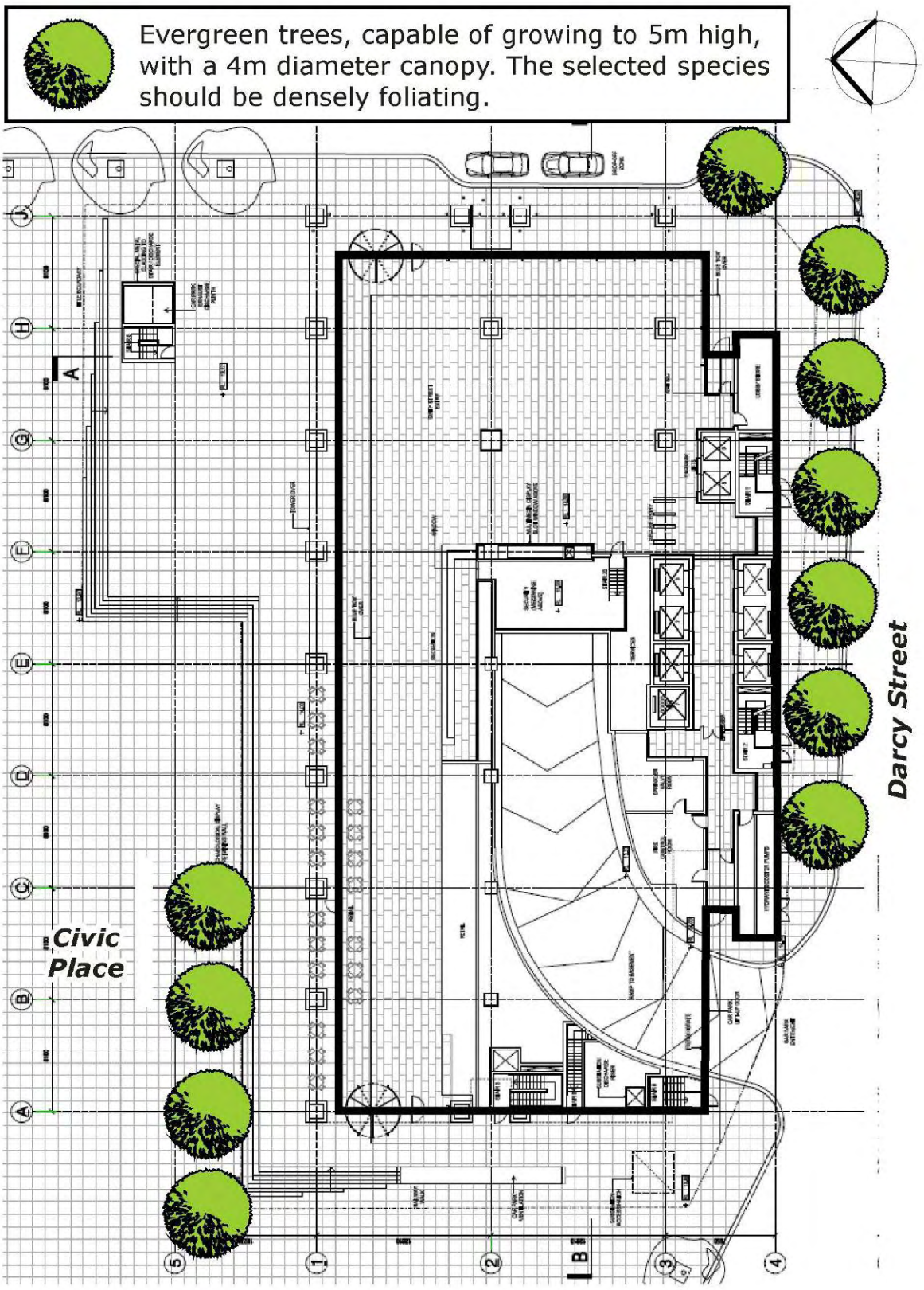


Figure 7a: Recommended Treatments – Ground Level

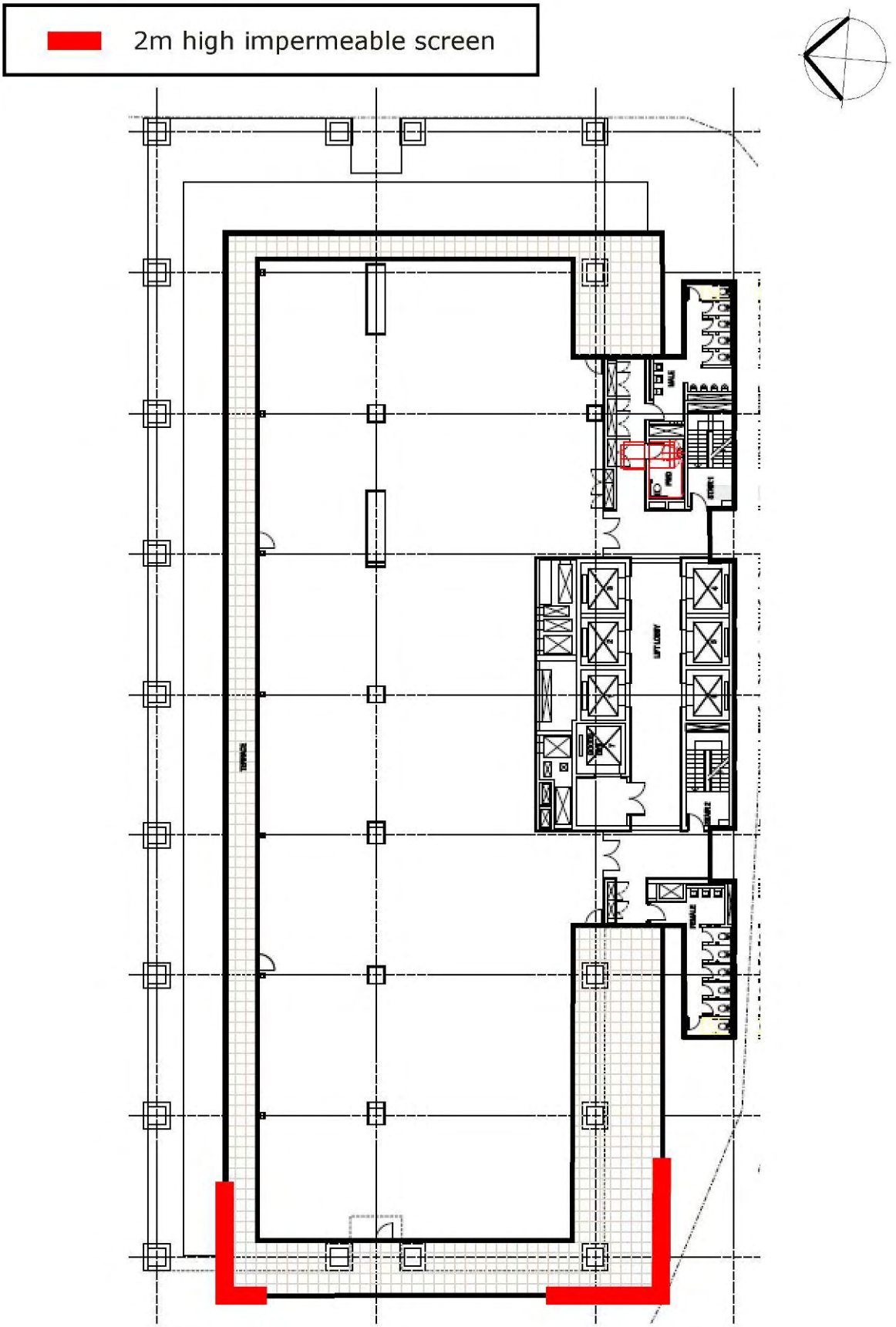


Figure 7b: Recommended Treatments – Level 4 Terrace

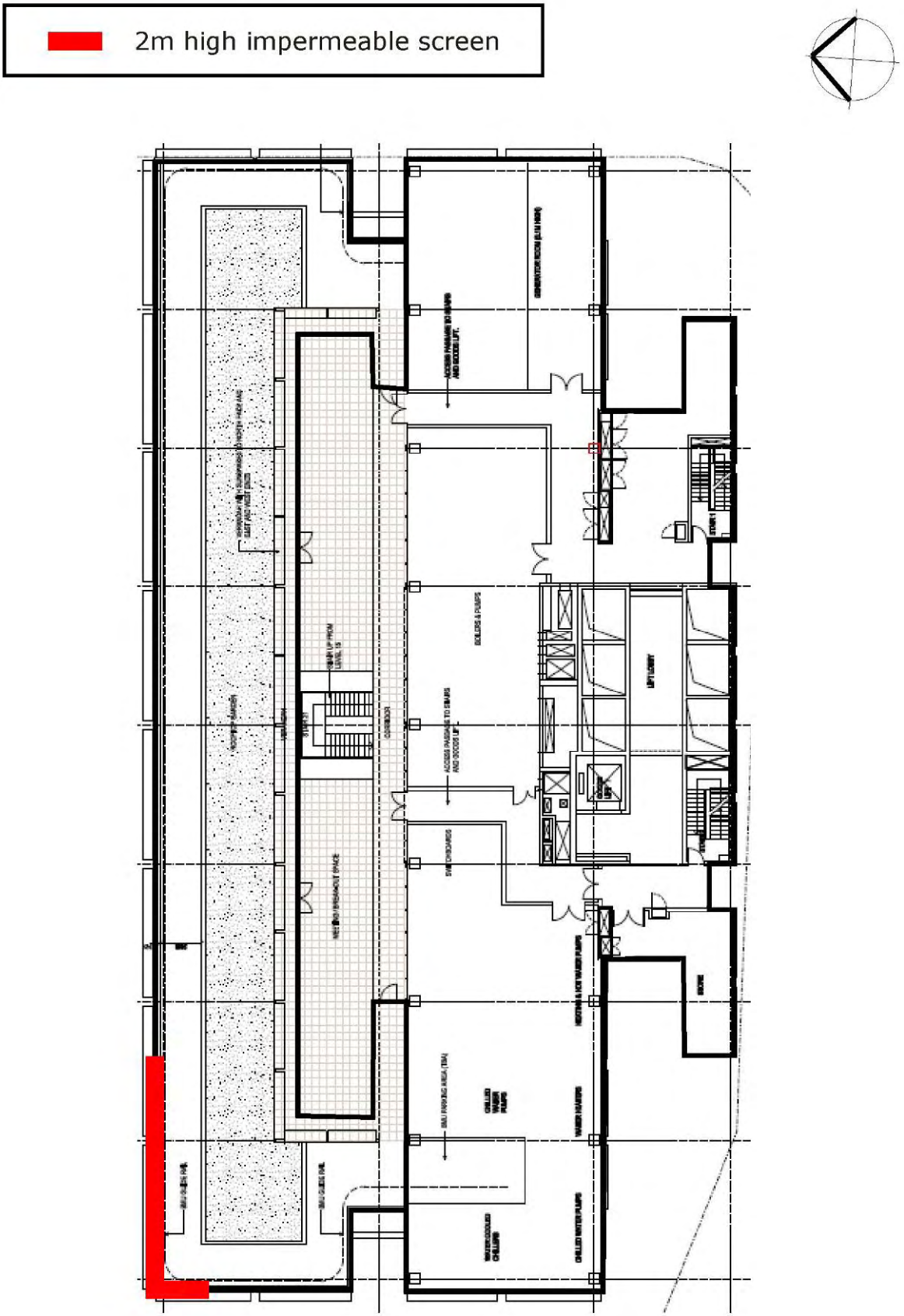


Figure 7c: Recommended Treatments – Level 16 Terrace

6.0 Conclusion

A wind tunnel study has been carried out to investigate the wind environment effects pertaining to the proposed development known as the Sydney Water Corporate Headquarters, Parramatta.

The results of the wind tunnel study indicate that wind conditions for most of the outdoor areas of the site will be acceptable. Some areas of the site require some form of treatment to ameliorate the adverse winds. Recommendations for treatments have been made in this report, with these treatments it is expected that wind conditions for all outdoor areas of the site will be acceptable. These treatments include the strategic planting of trees around the ground level areas of the site, and 2m high impermeable screens on the southern corners of the terrace areas of the proposed development.

With these treatments it is expected that wind conditions for all outdoor areas of the site will be acceptable. This is expected to be confirmed with further wind tunnel testing (which is currently being undertaken).

References

Aynsley, R.M., Melbourne, W., Vickery, B.J., 1977, “Architectural Aerodynamics”, Applied Science Publishers.

Davenport, A.G., 1972, “An approach to human comfort criteria for environmental conditions”, Colloquium on Building Climatology, Stockholm.

Lawson, T.V., 1973, “The wind environment of buildings: a logical approach to the establishment of criteria”, Bristol University, Department of Aeronautical Engineering.

Lawson, T.V., 1975, “The determination of the wind environment of a building complex before construction”, Bristol University, Department of Aeronautical Engineering.

Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions", Journal of Wind Engineering and Industrial Aerodynamics, vol.3, pp.241-249.

Melbourne, W.H., 1978, "Wind Environment Studies in Australia", Journal of Wind Engineering and Industrial Aerodynamics, vol.3, pp.201-214.

Penwarden, A.D., and Wise A.F.E., 1975, "Wind Environment Around Buildings", Building Research Establishment Report, London.

Ratcliff, M.A. and Peterka, J.A., 1990, “Comparison of Pedestrian Wind Acceptability Criteria", Journal of Wind Engineering and Industrial Aerodynamics, vol.36, pp.791-800.

Appendix A

Wind Roses for the Sydney Region

Sydney Airport, 1939-2000

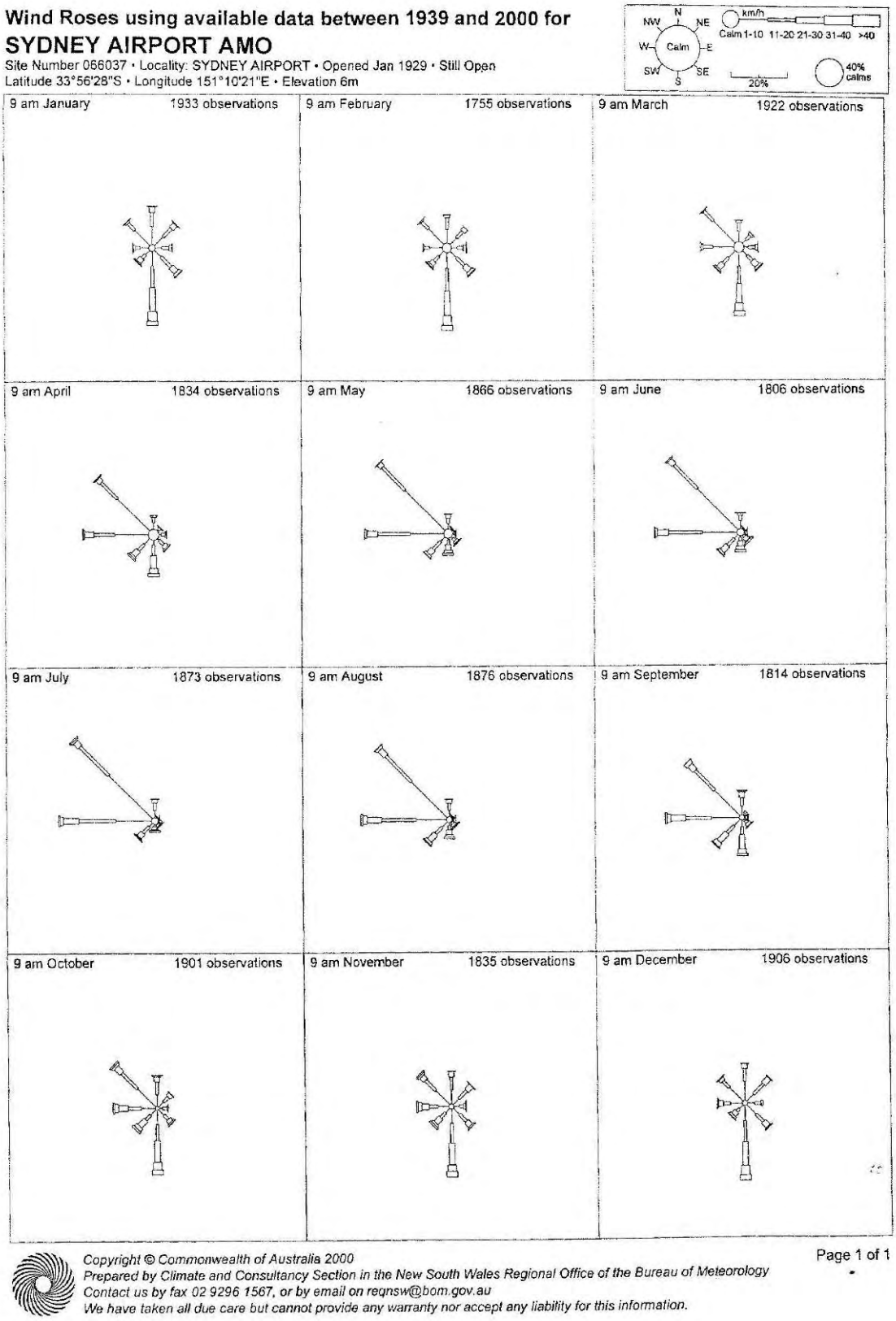


Figure A1: Monthly Wind Roses for the Sydney Region, at 9am (1939 to 2000)

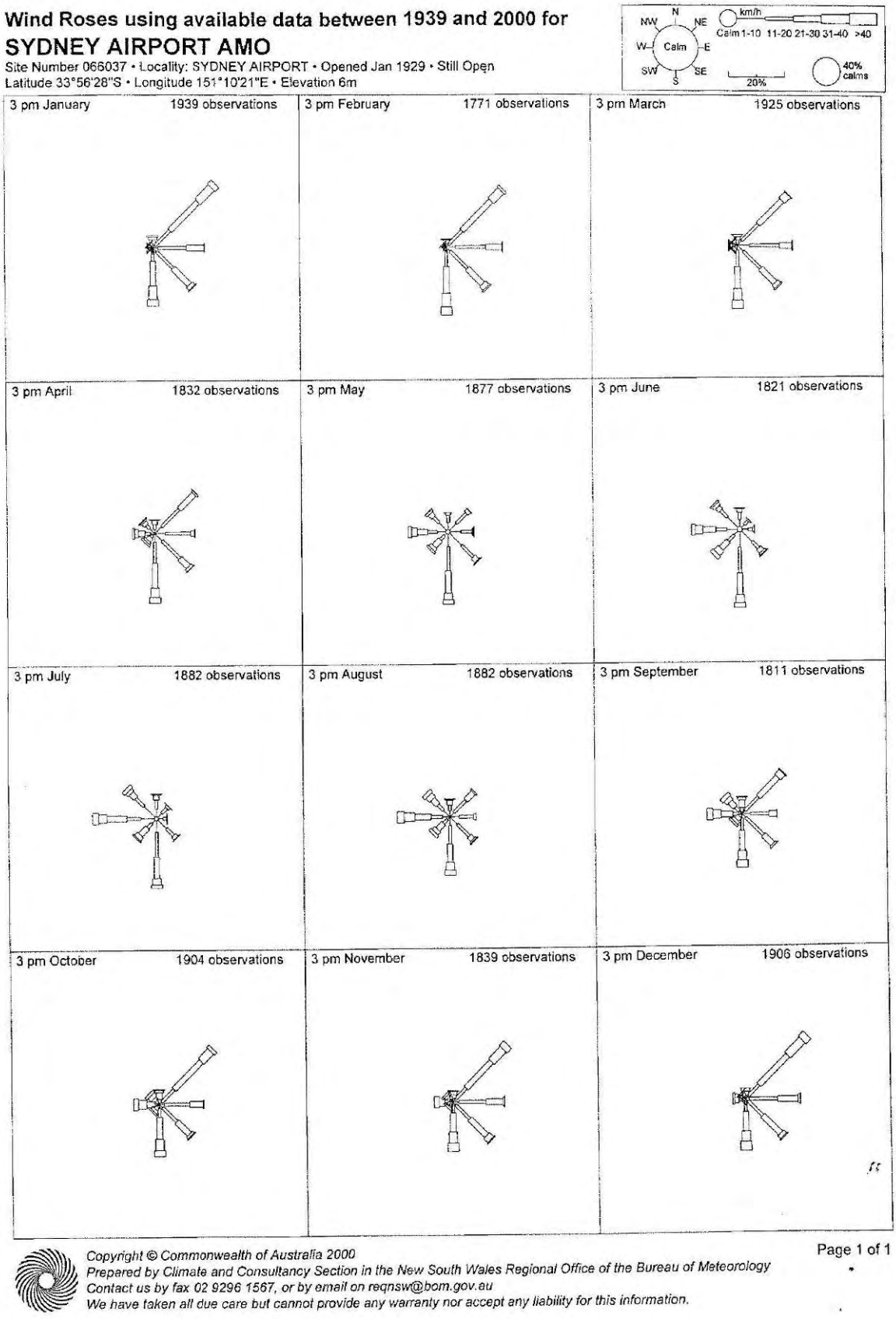


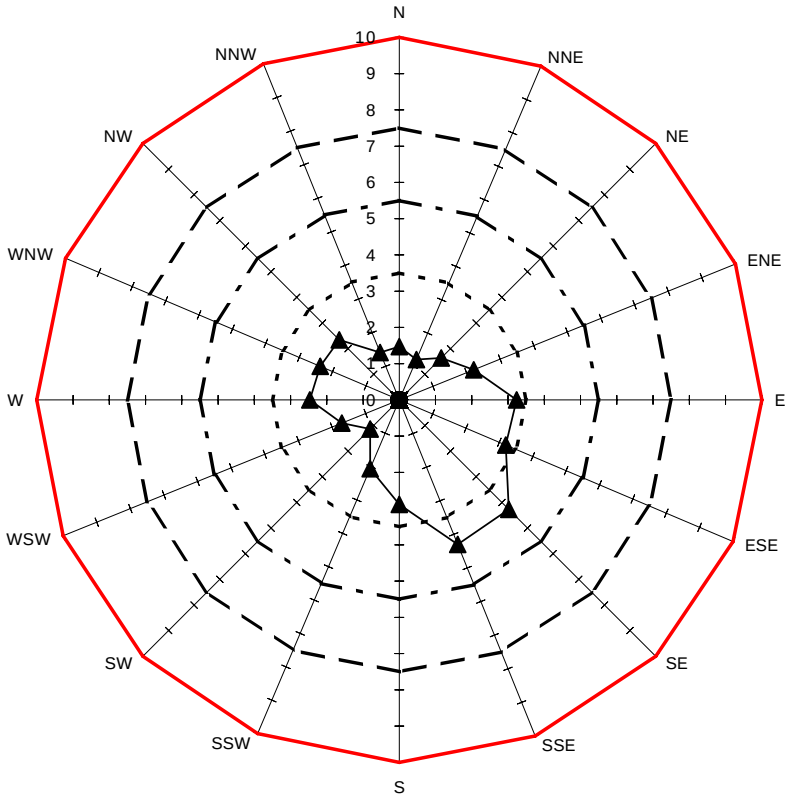
Figure A2: Monthly Wind Roses for the Sydney Region, at 3pm (1939 to 2000)

Appendix B

Plots of the Wind Tunnel Results

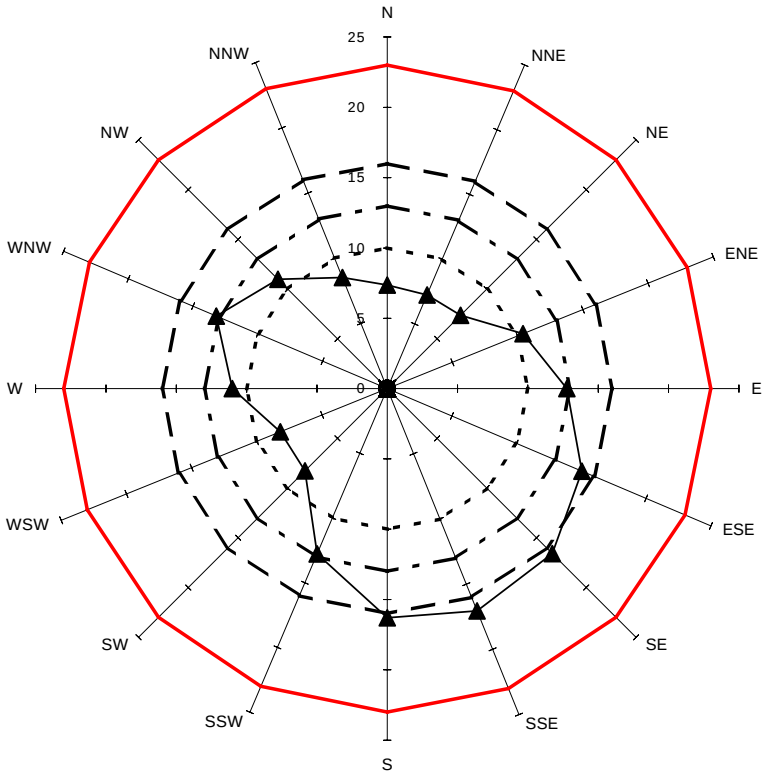
Measured Wind Speeds at Point 01

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

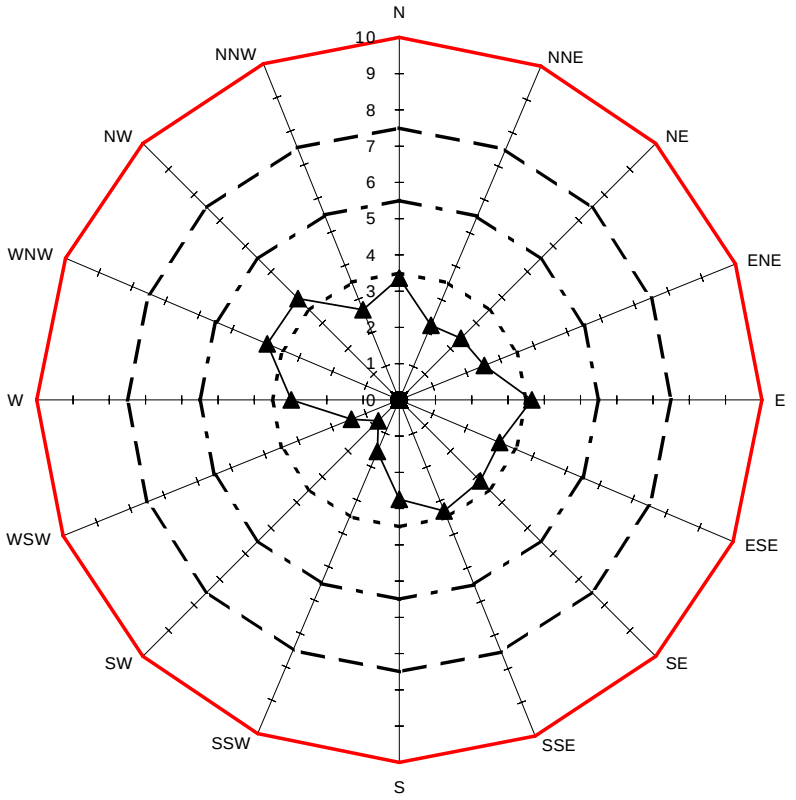
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

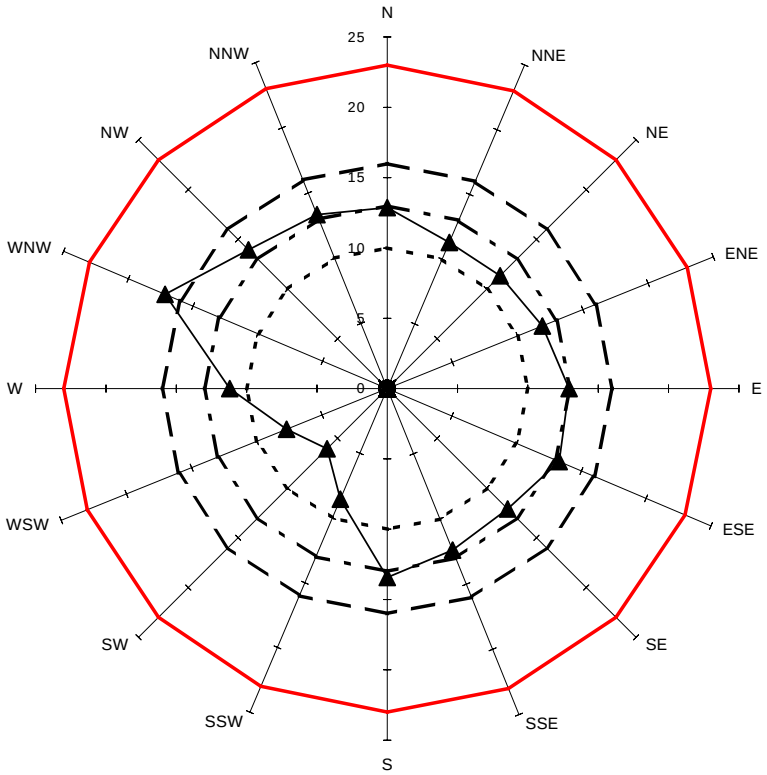
Measured Wind Speeds at Point 02

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

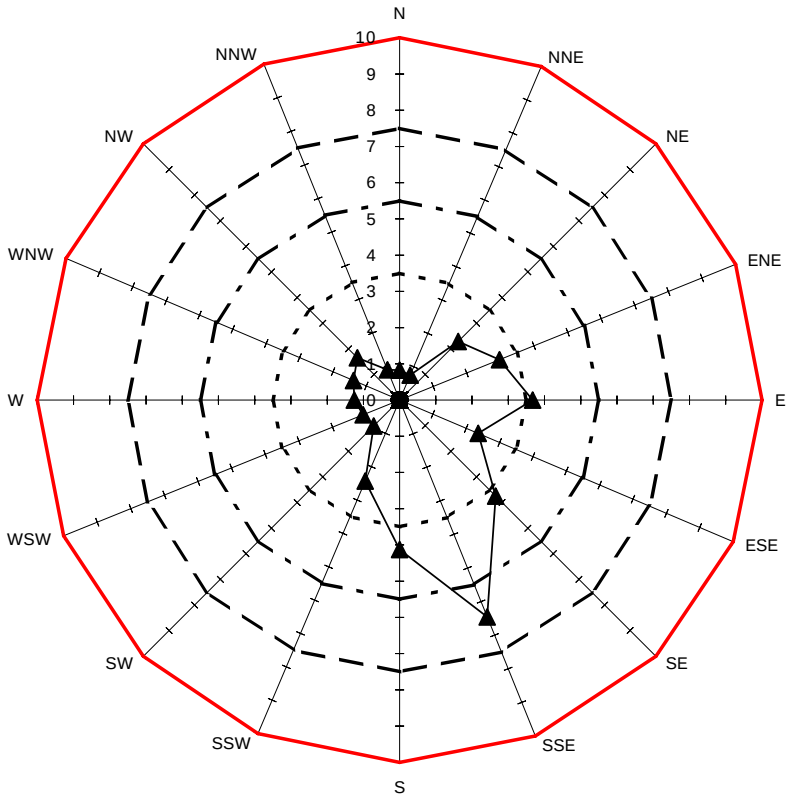
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

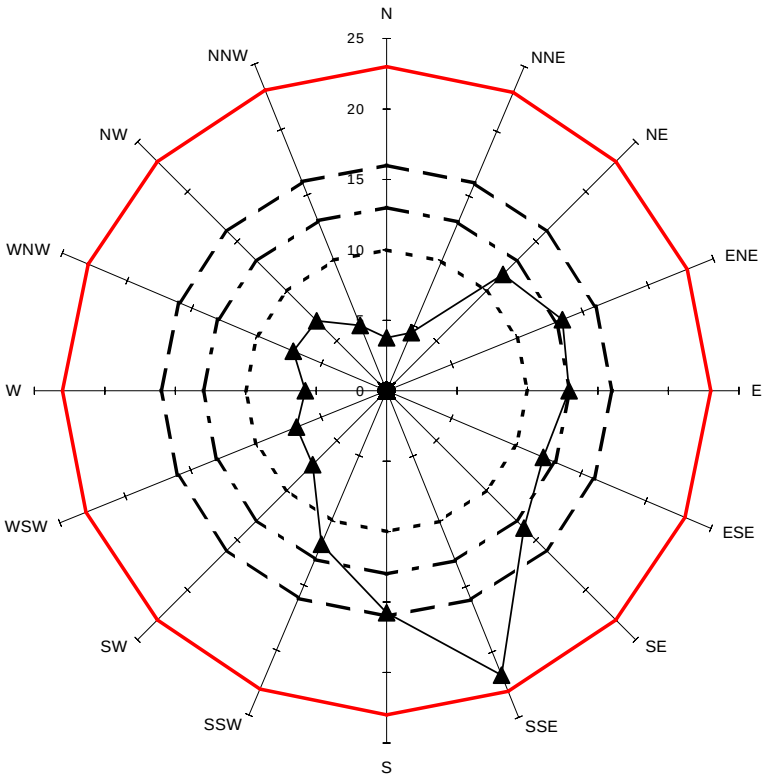
Measured Wind Speeds at Point 03

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

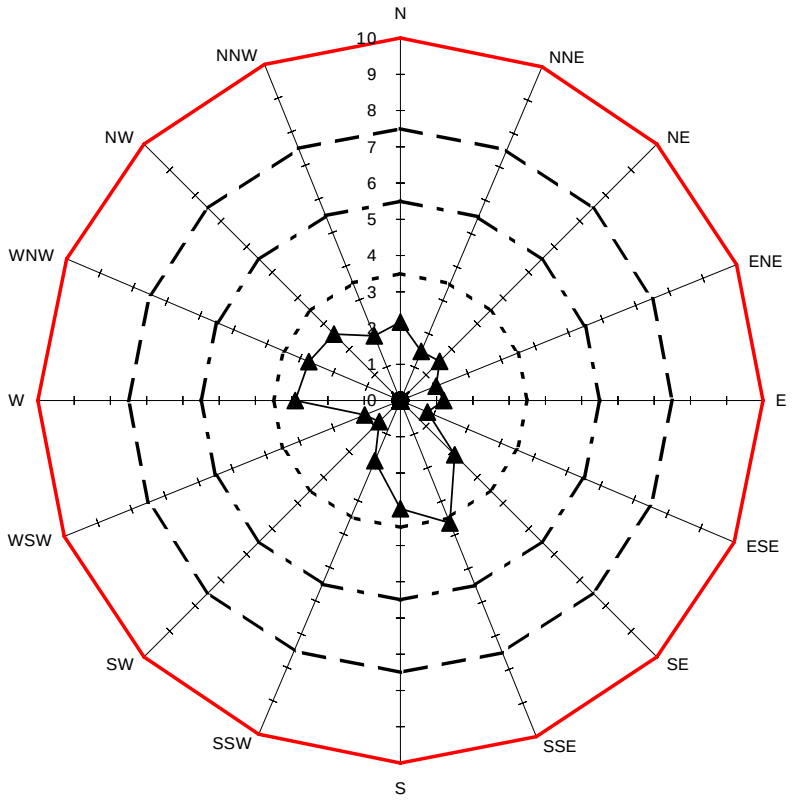
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

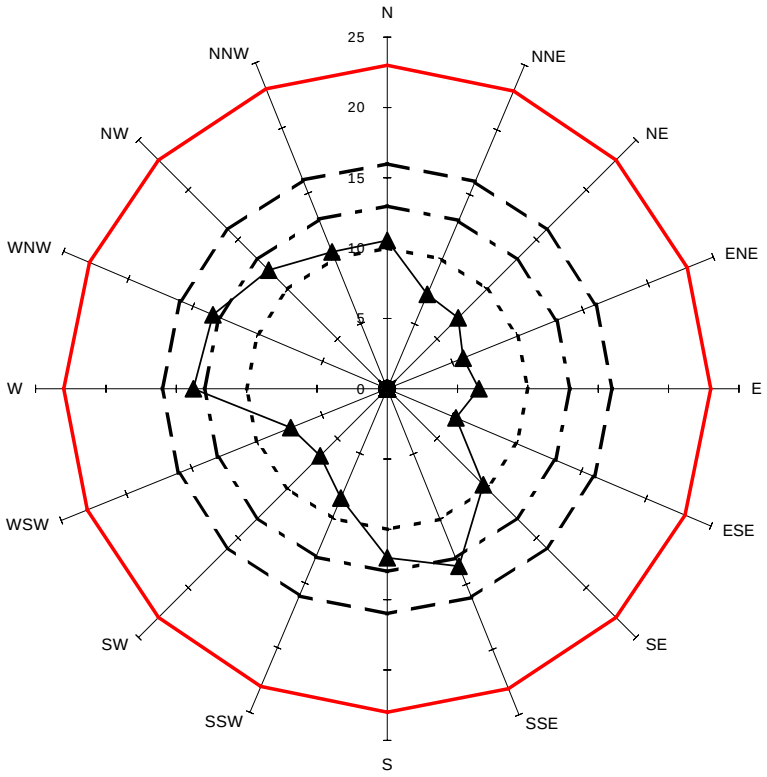
Measured Wind Speeds at Point 04

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

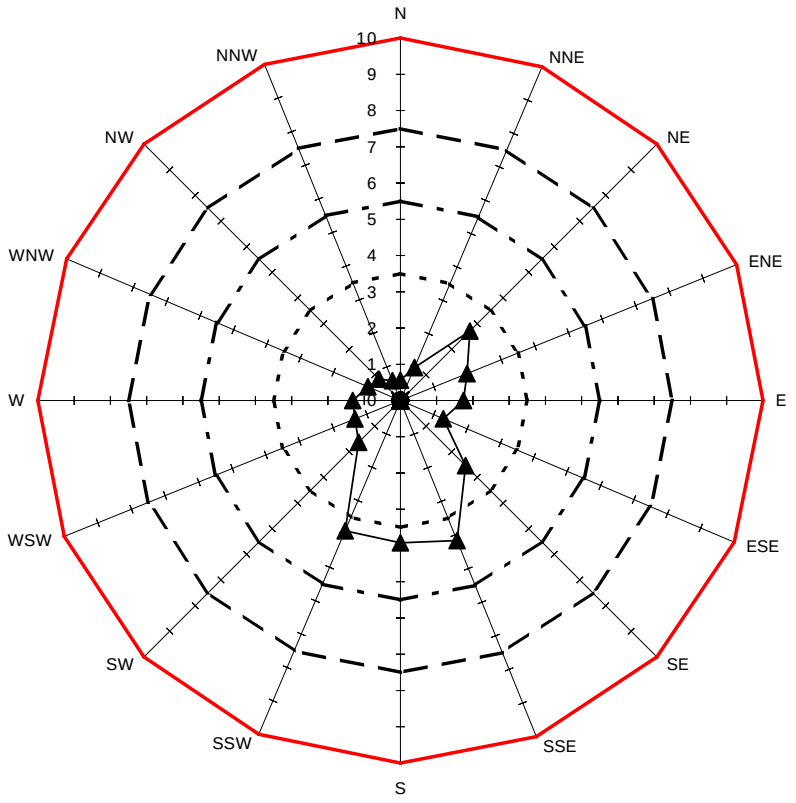
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

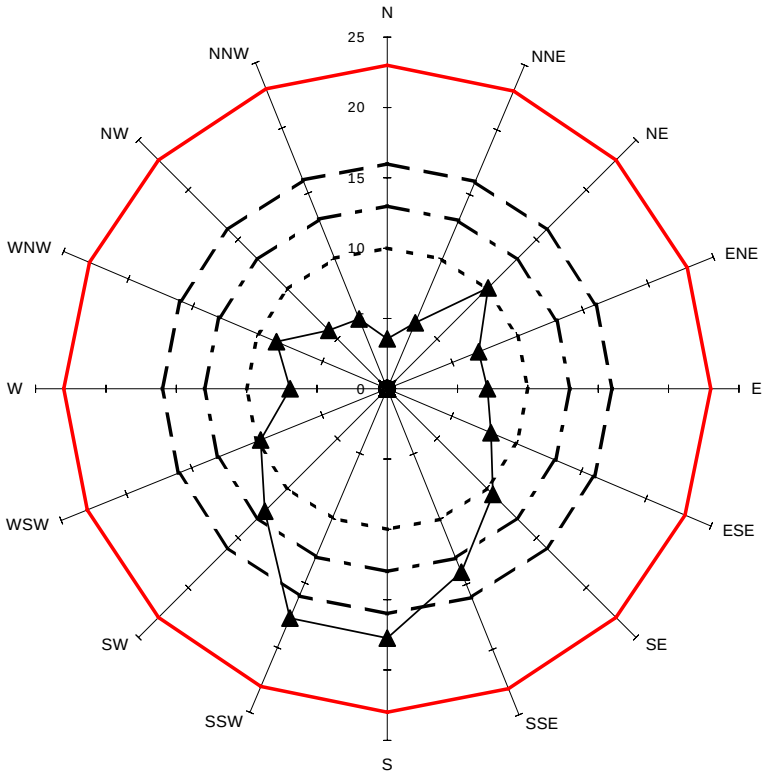
Measured Wind Speeds at Point 05

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

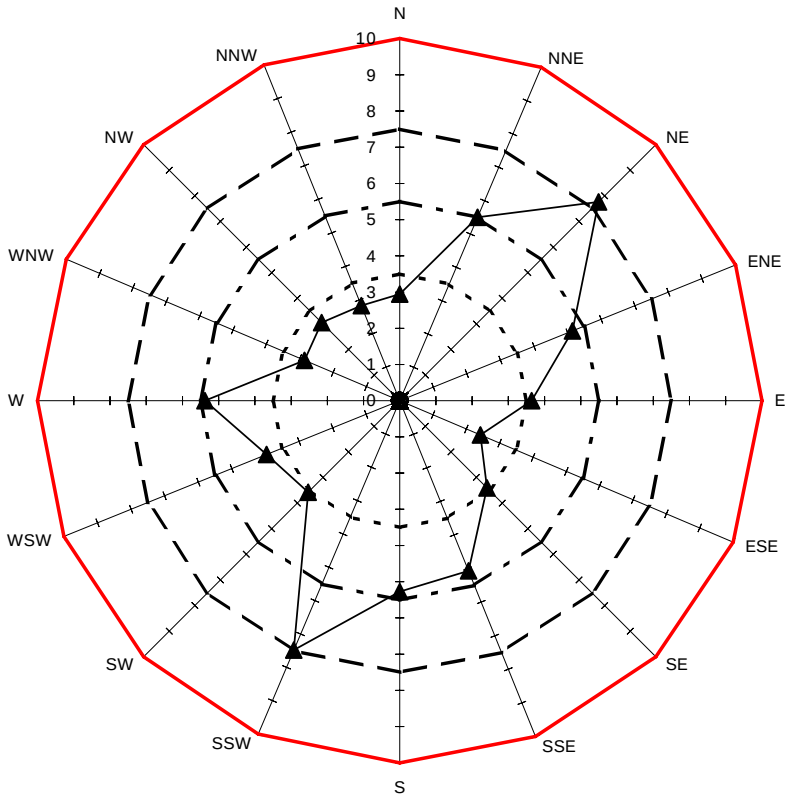
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

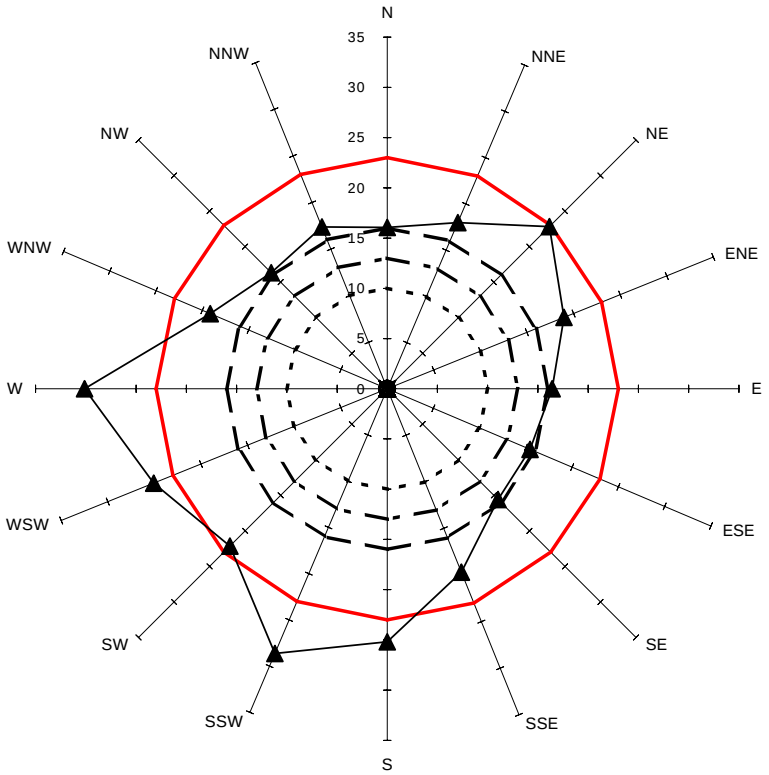
Measured Wind Speeds at Point 06

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

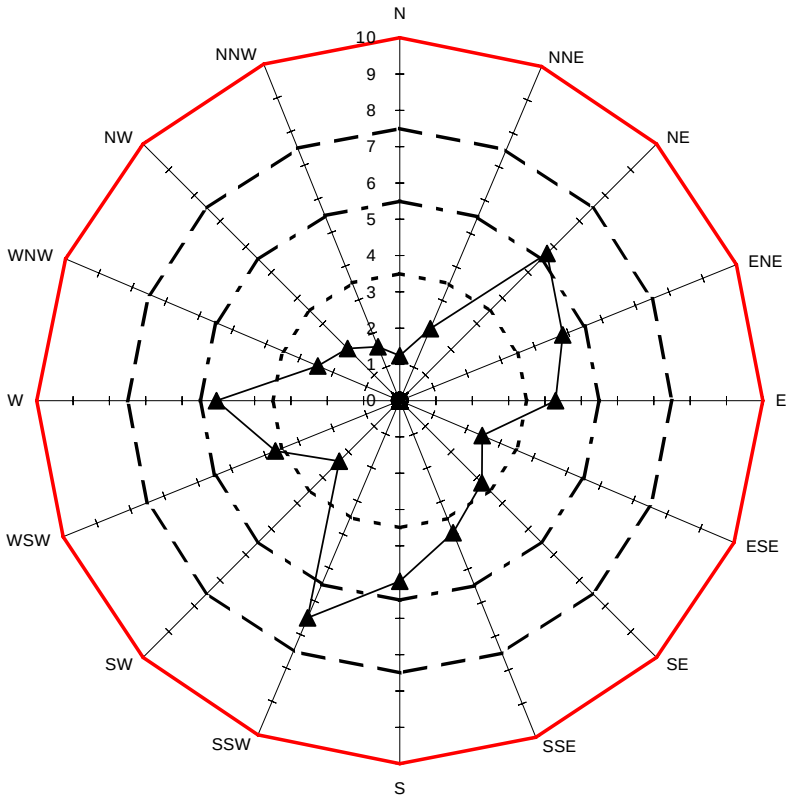
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

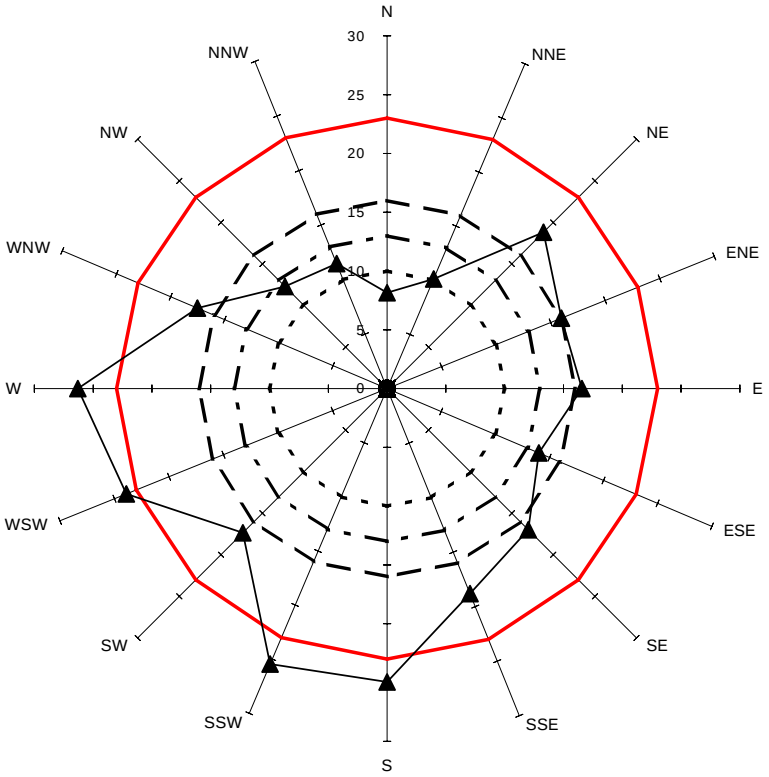
Measured Wind Speeds at Point 07

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

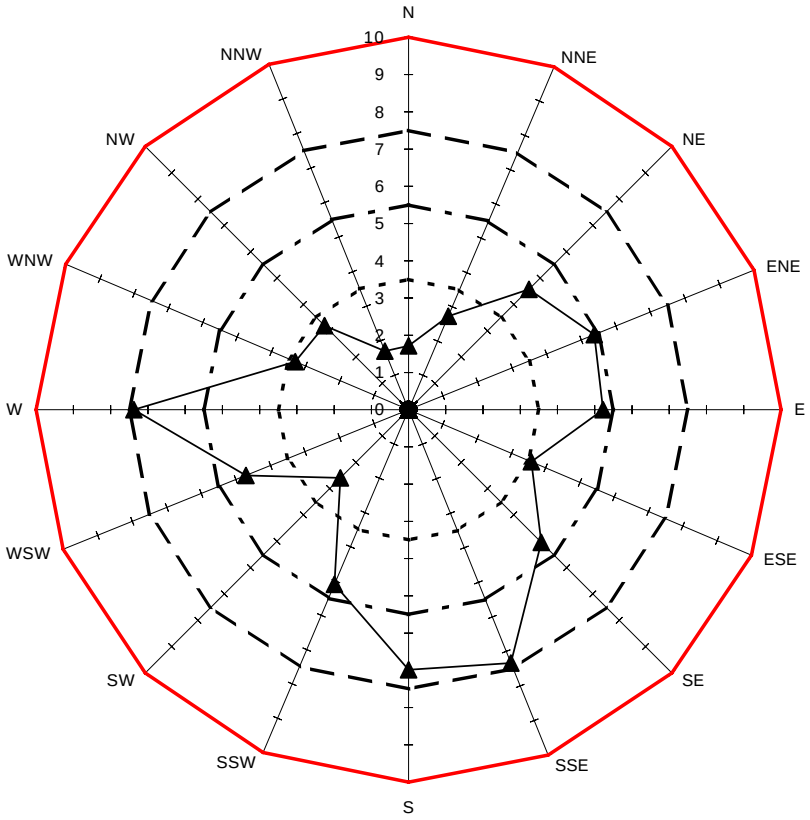
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

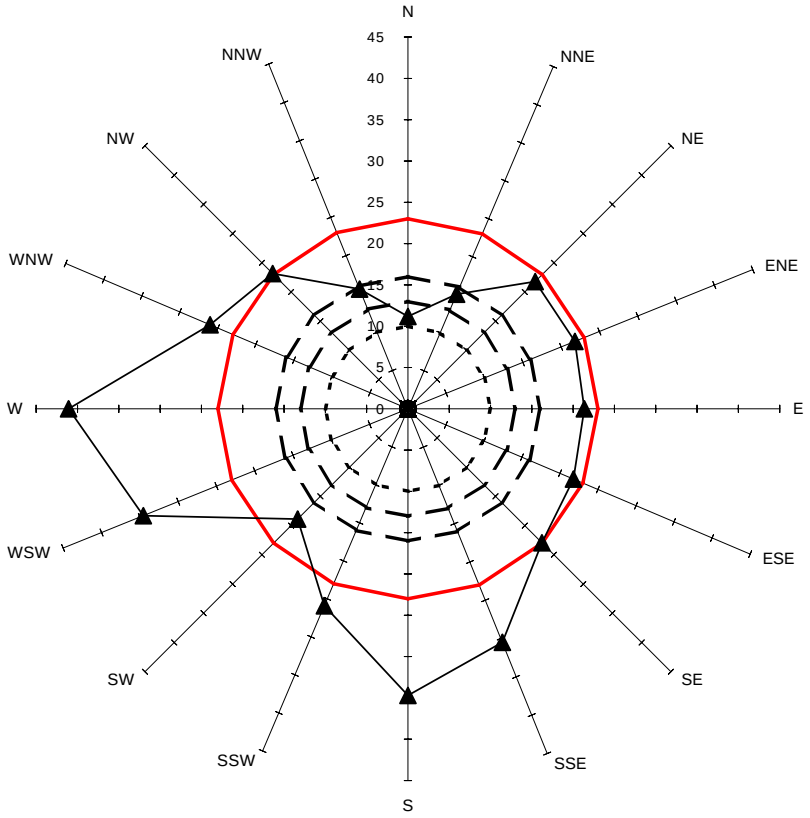
Measured Wind Speeds at Point 08

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

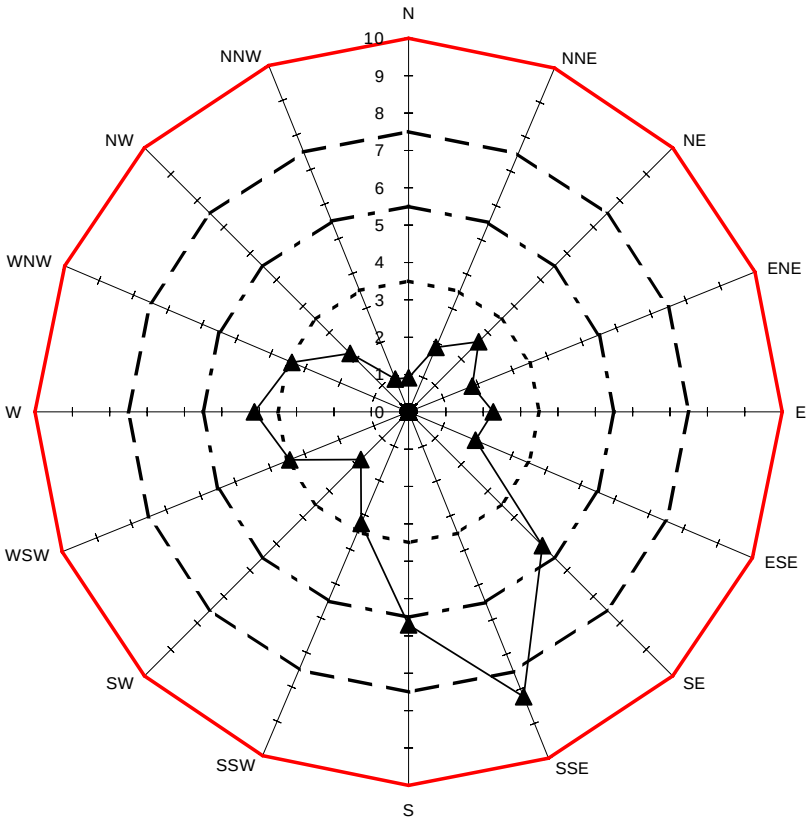
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

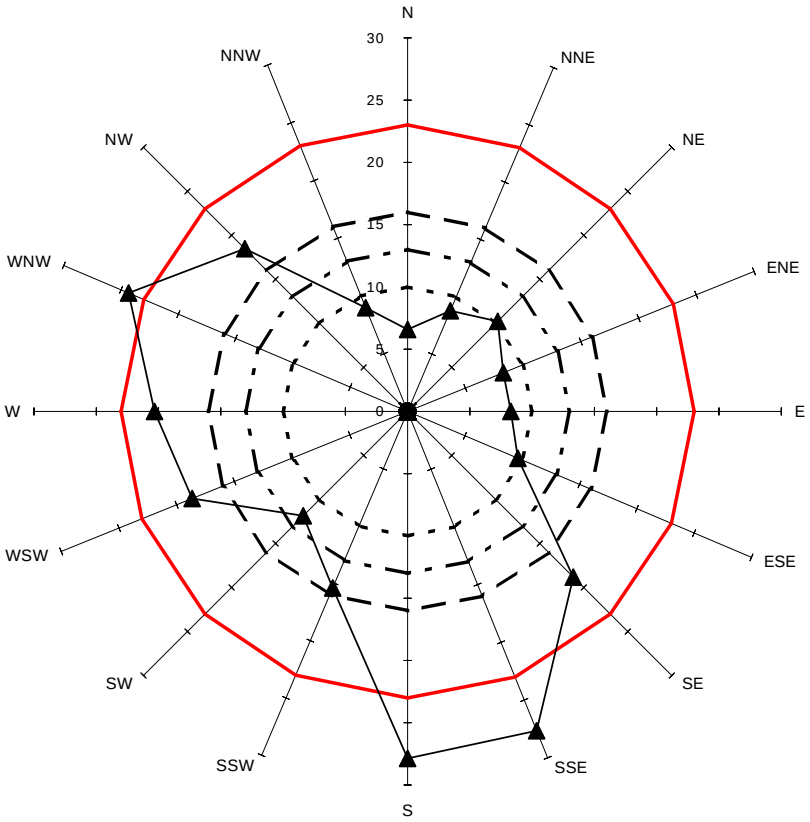
Measured Wind Speeds at Point 09

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

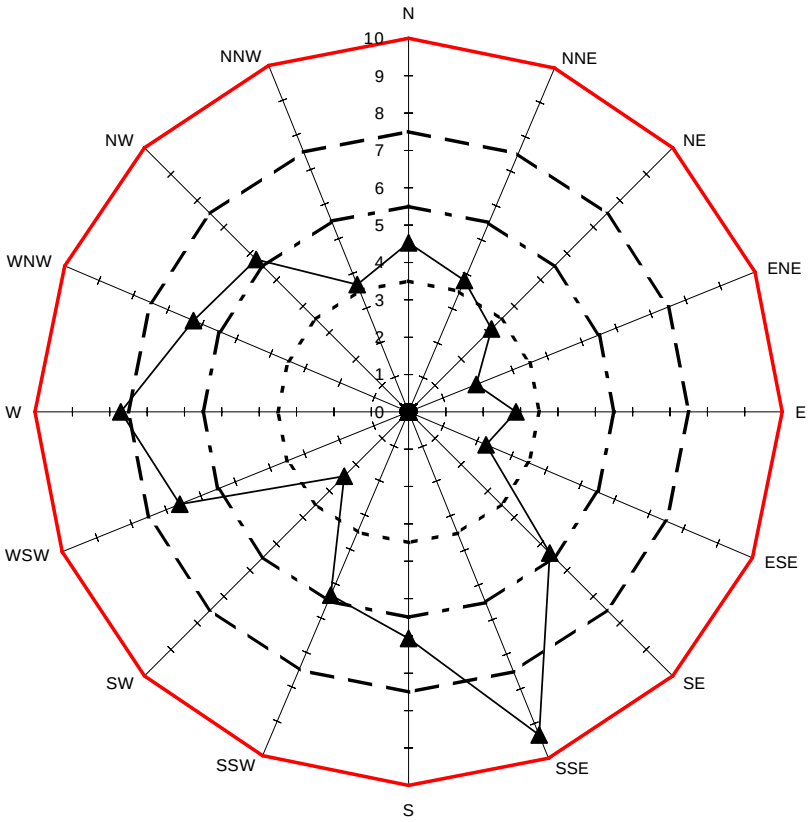
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

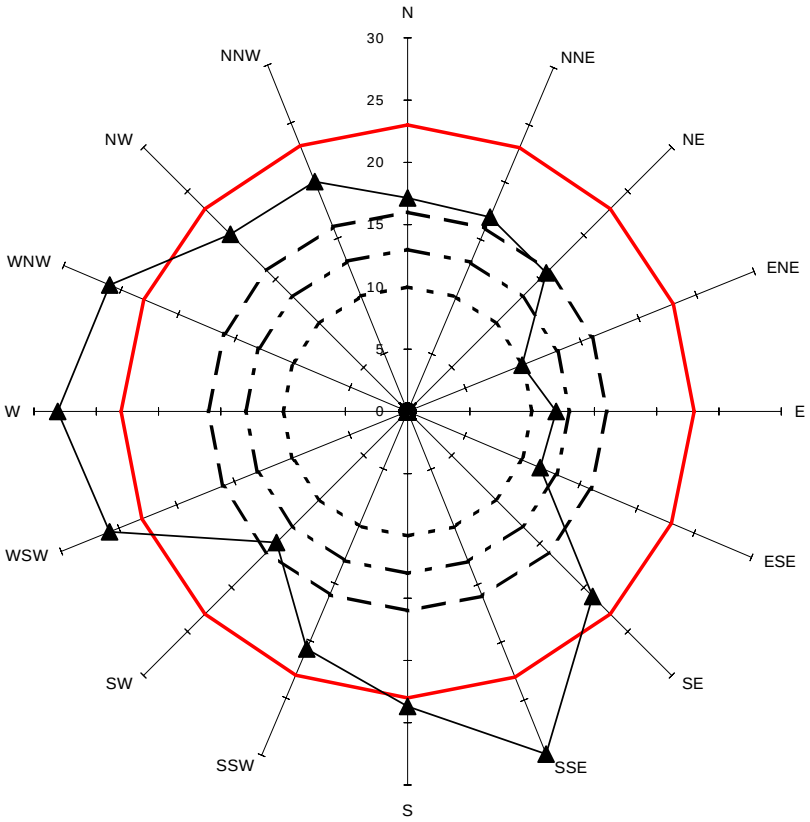
Measured Wind Speeds at Point 10

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

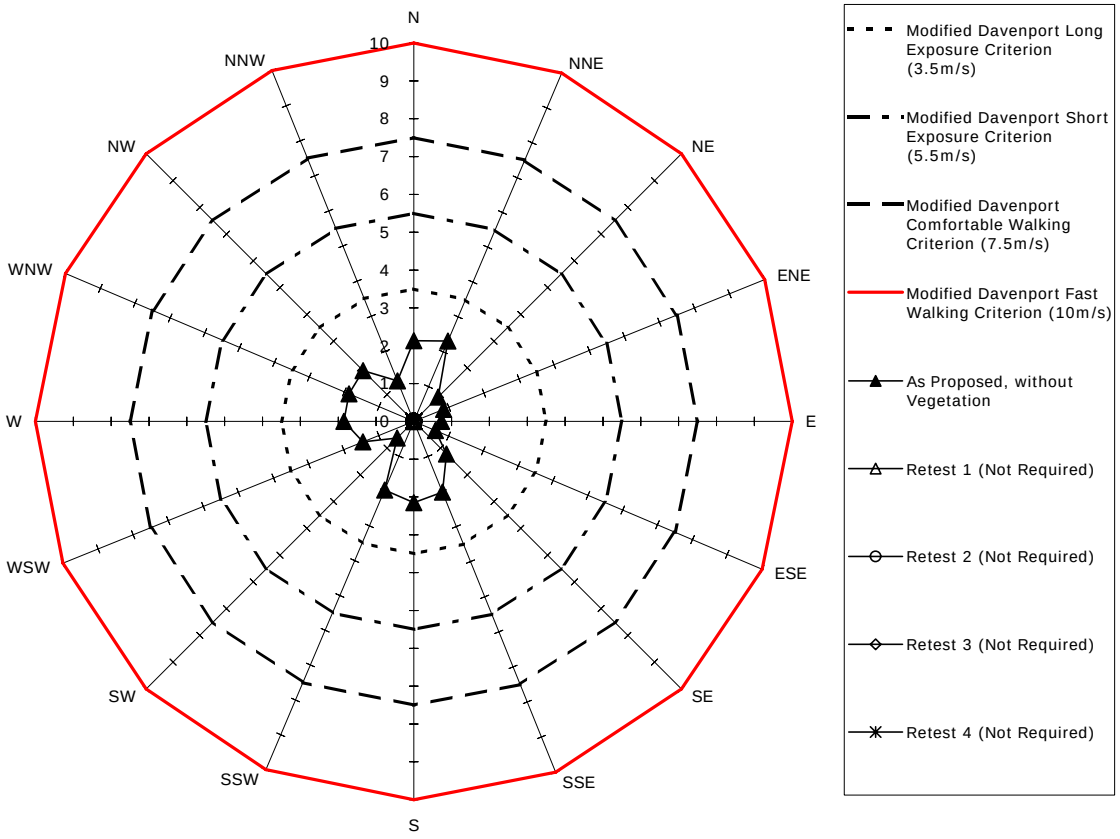
Annual Maximum Gust Wind Speeds (m/s)



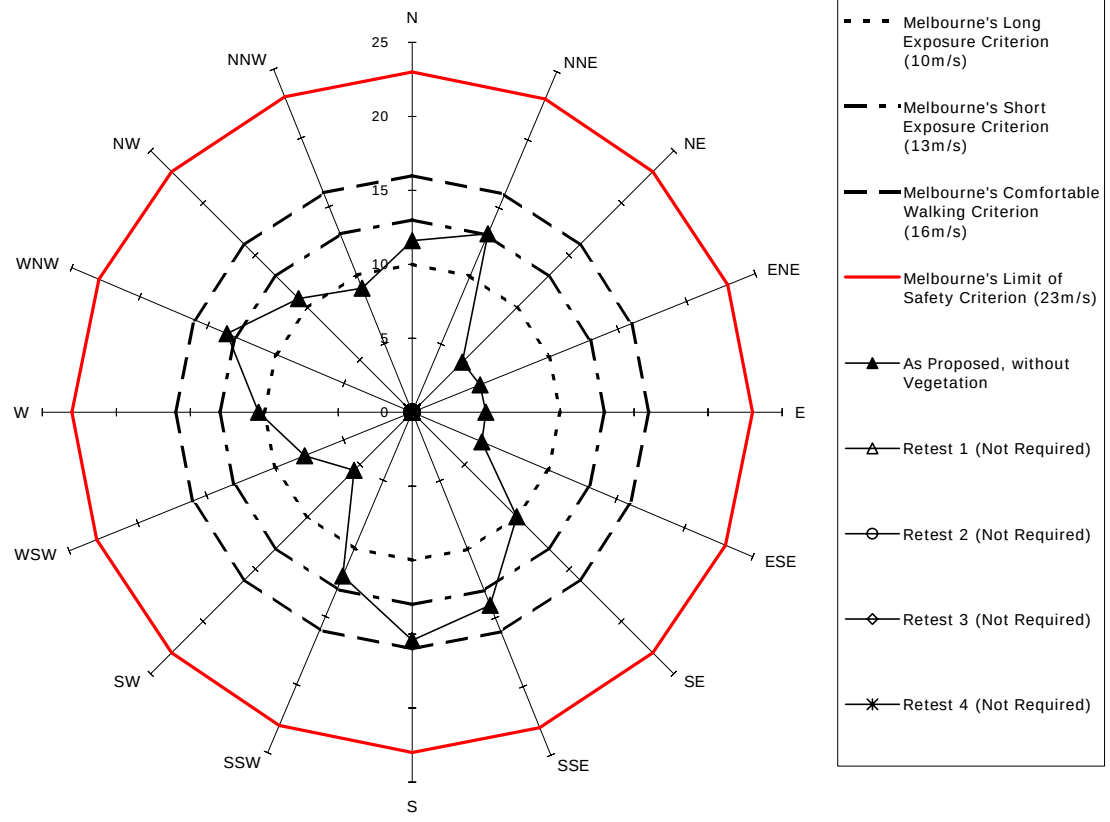
- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

Measured Wind Speeds at Point 11

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

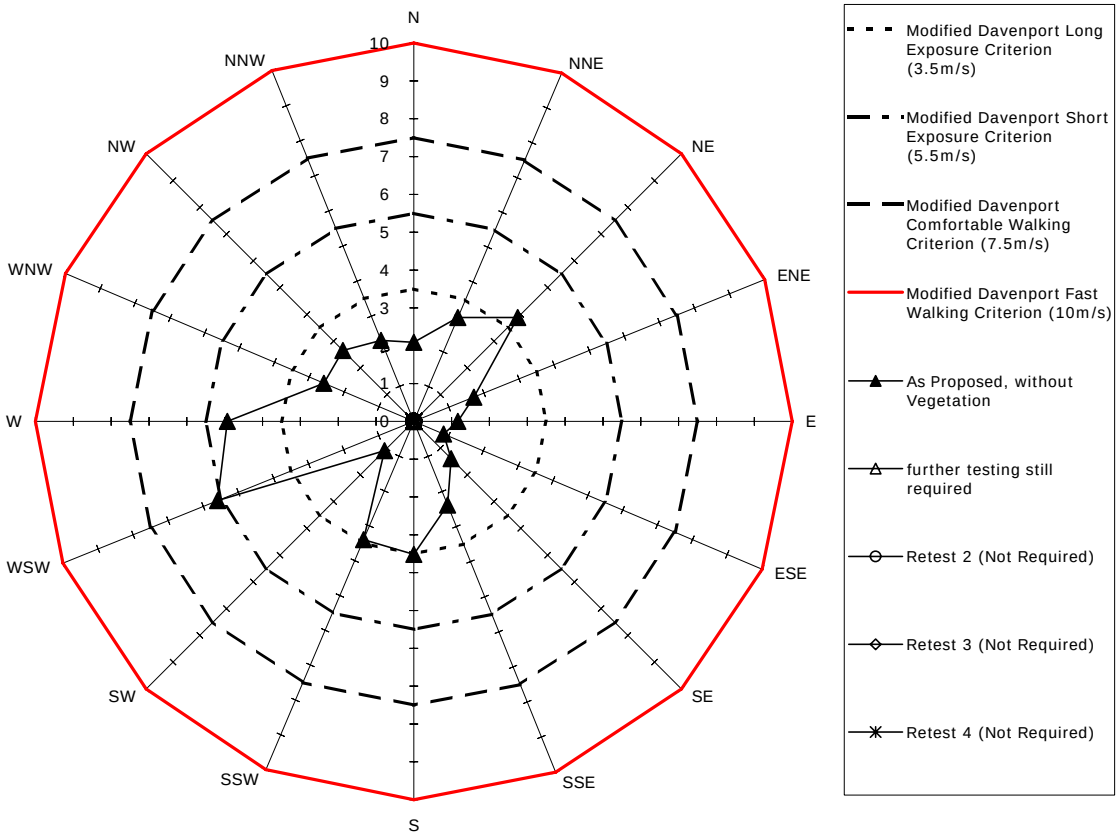


Annual Maximum Gust Wind Speeds (m/s)

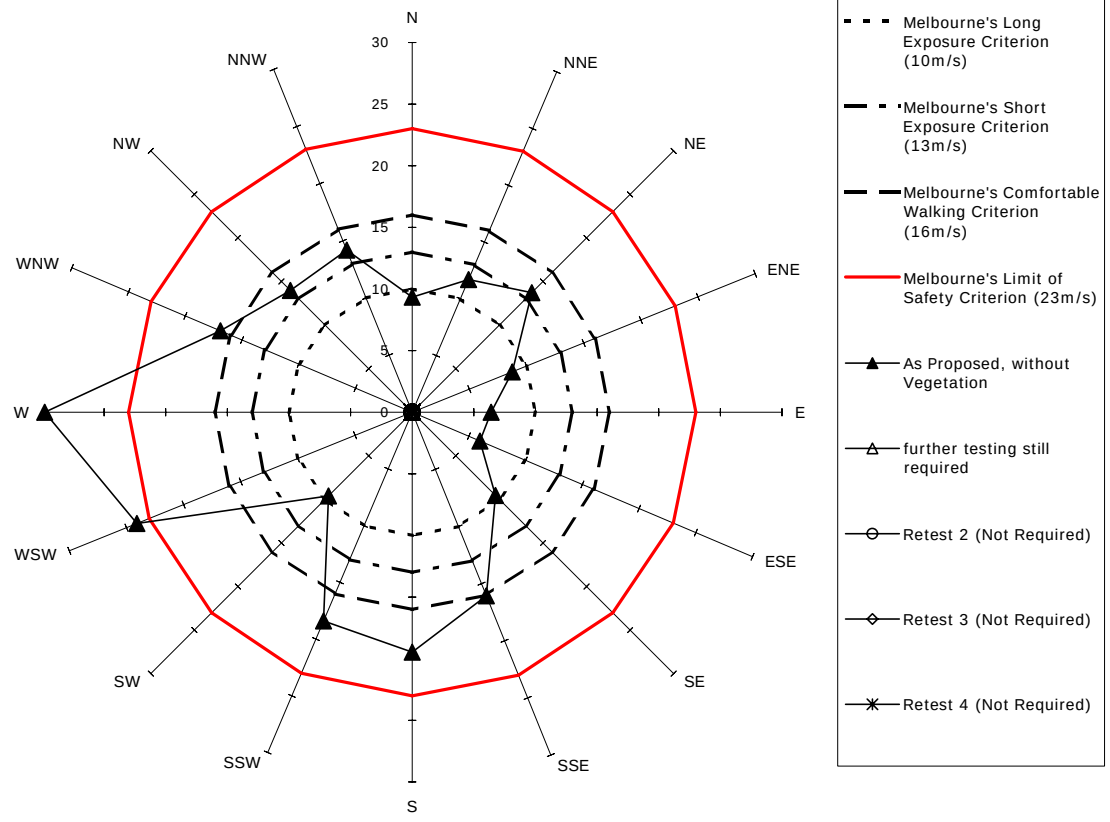


Measured Wind Speeds at Point 12

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

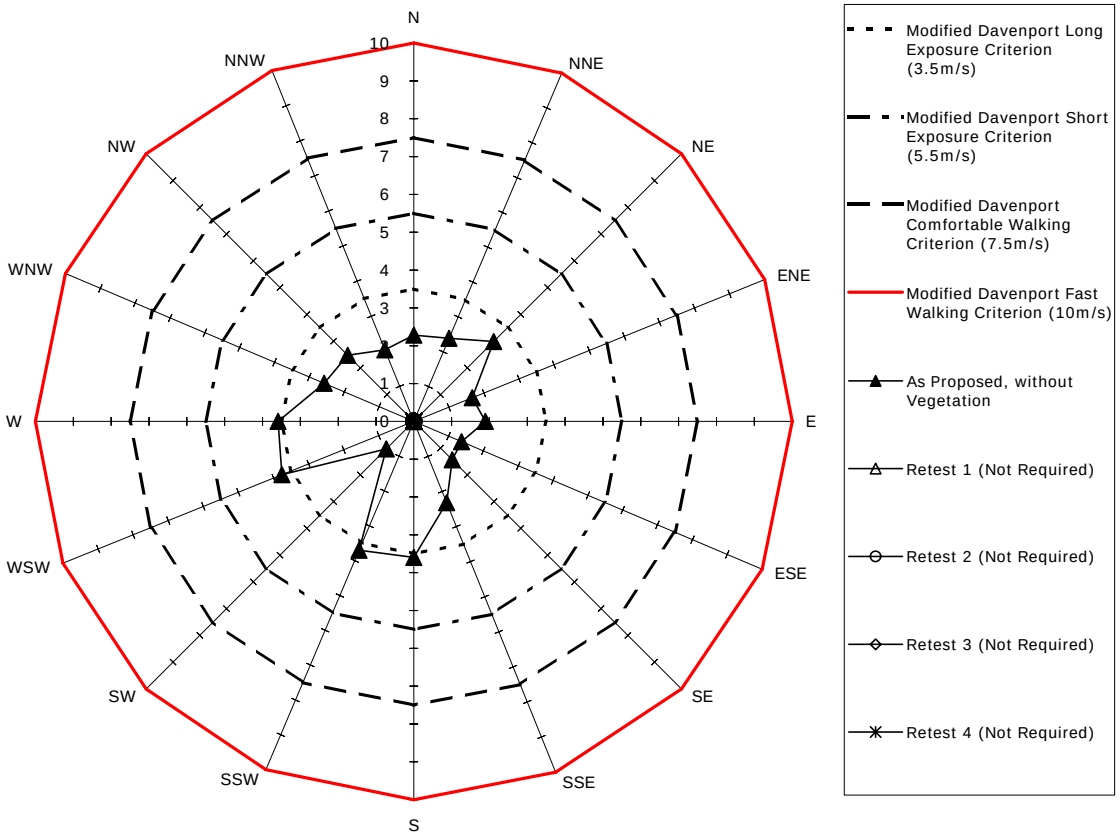


Annual Maximum Gust Wind Speeds (m/s)

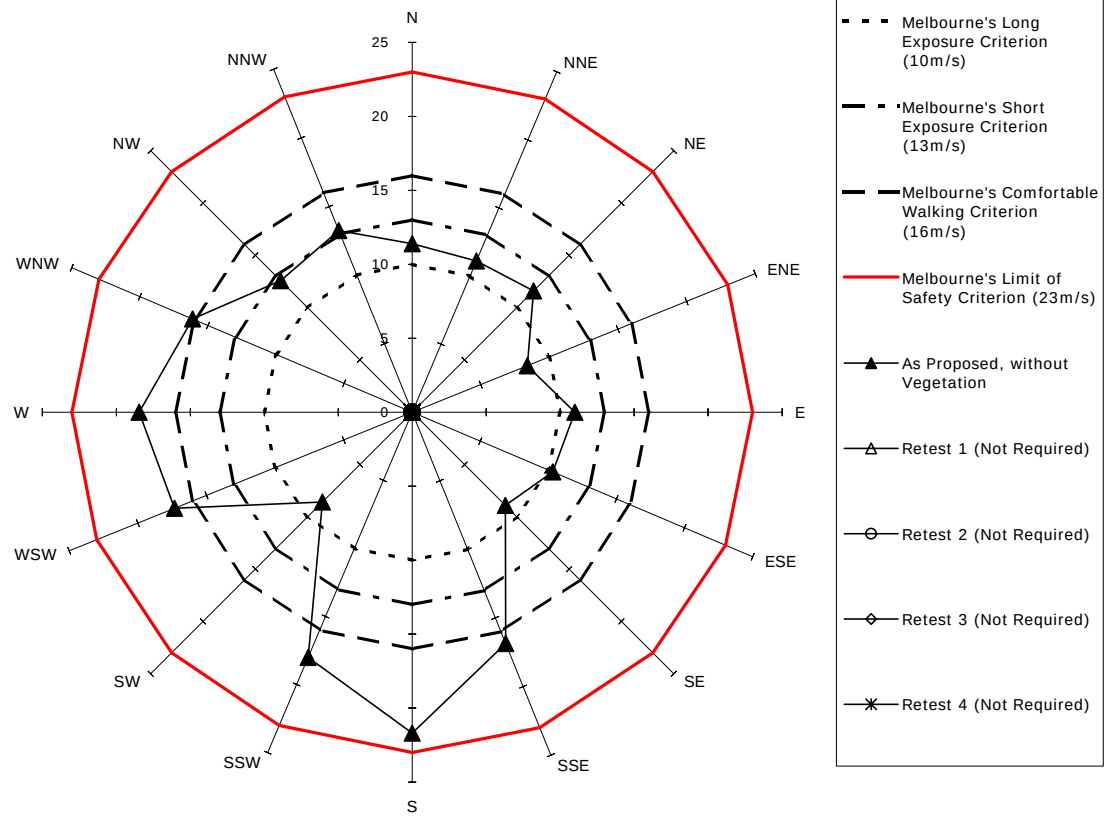


Measured Wind Speeds at Point 13

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

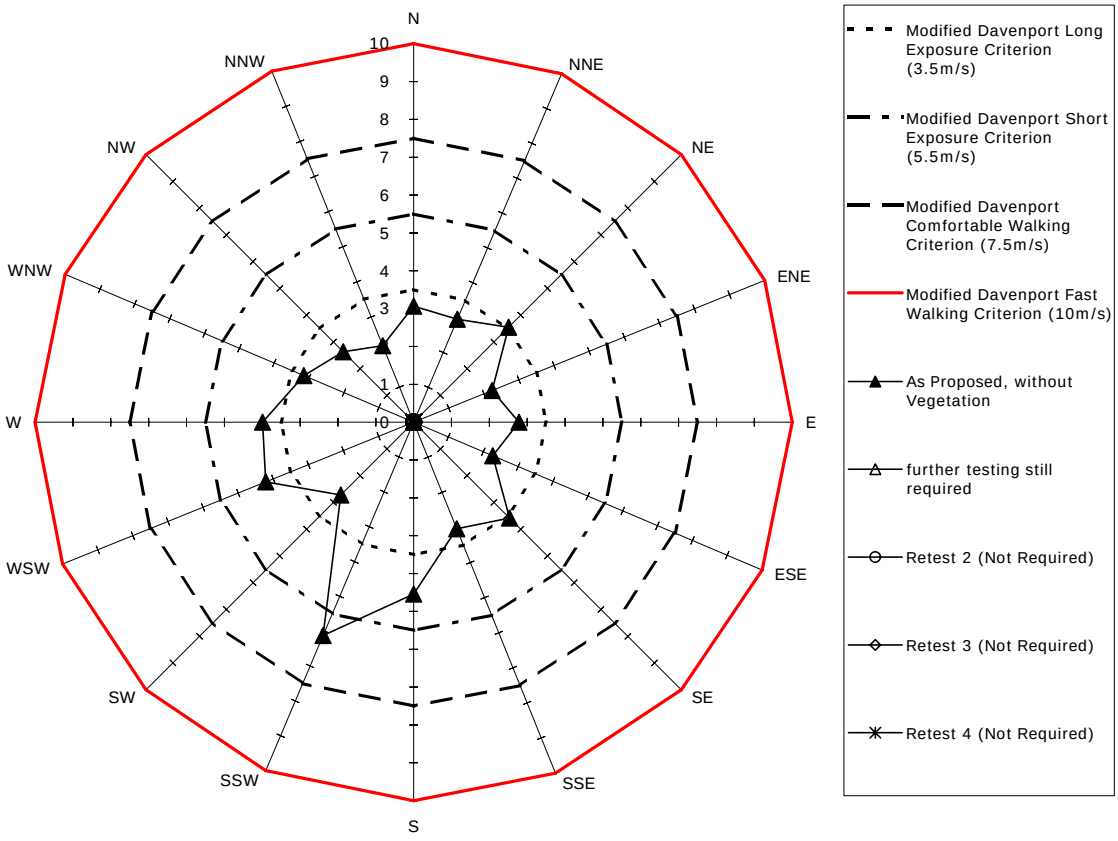


Annual Maximum Gust Wind Speeds (m/s)

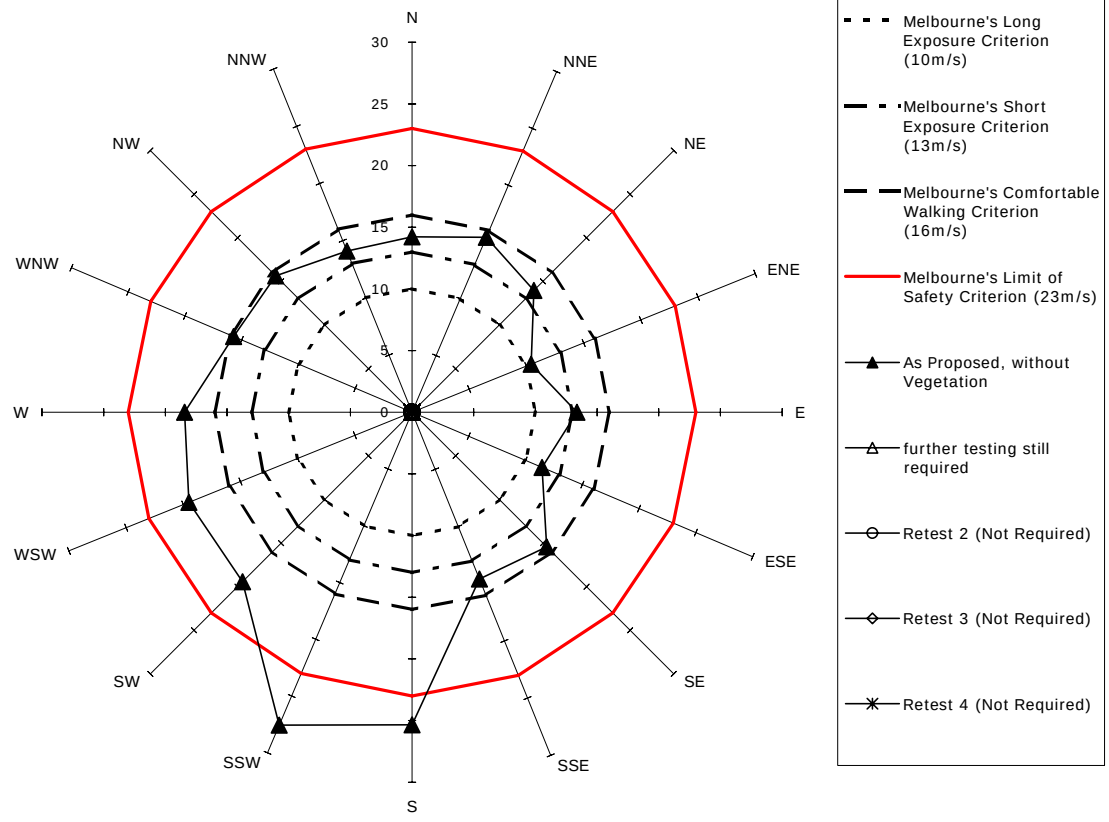


Measured Wind Speeds at Point 14

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

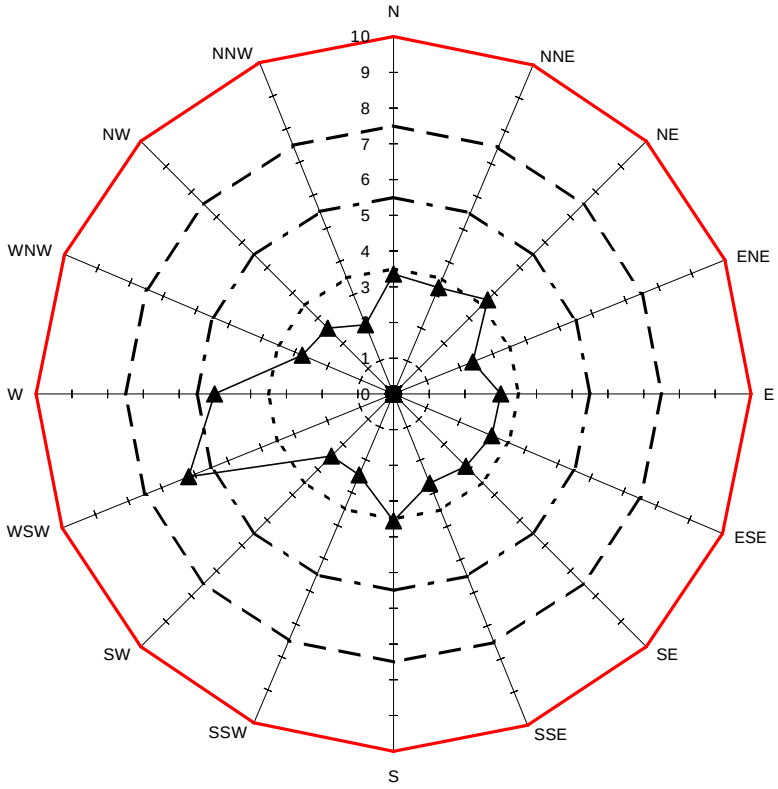


Annual Maximum Gust Wind Speeds (m/s)



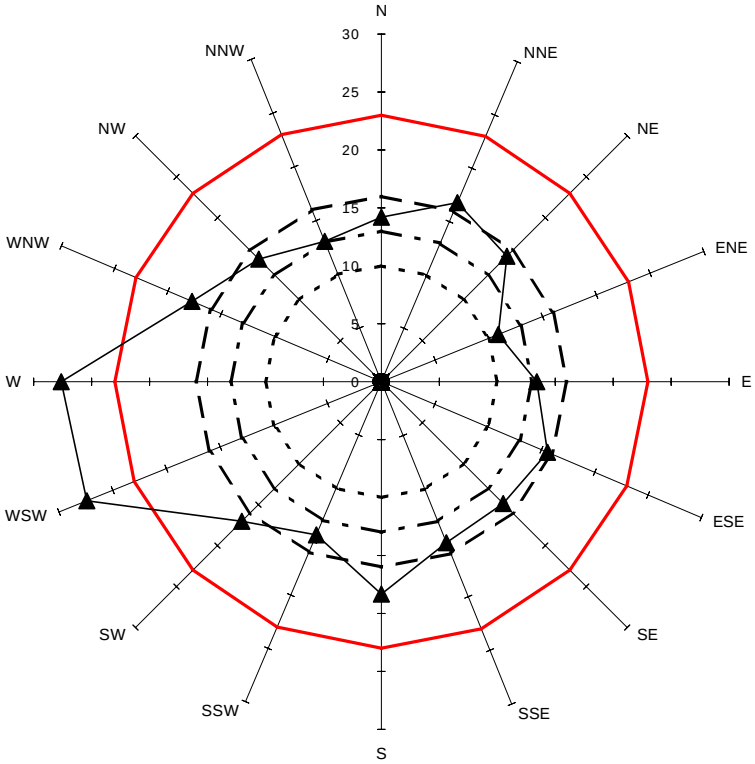
Measured Wind Speeds at Point 15

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

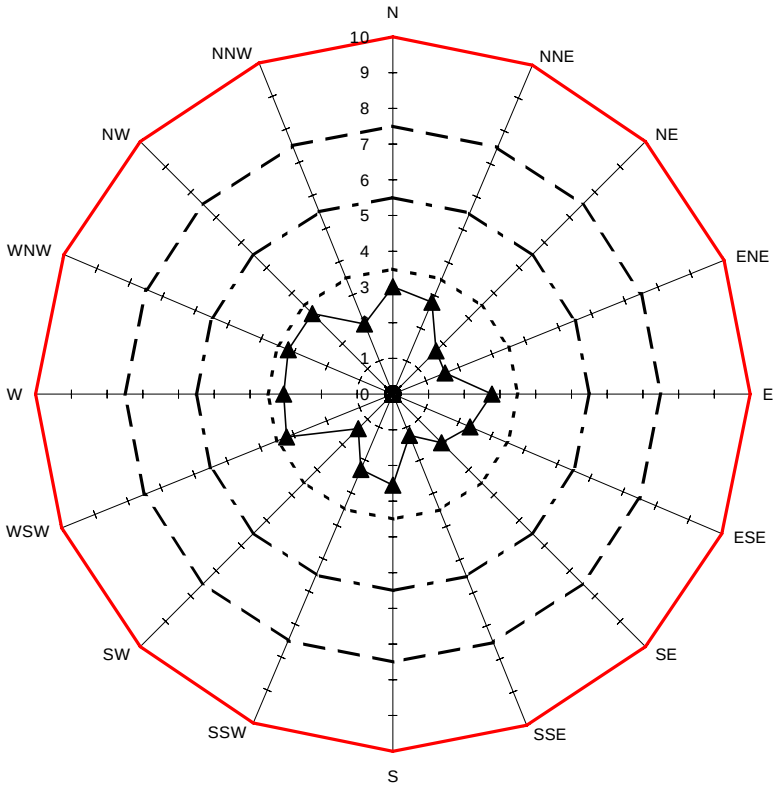
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

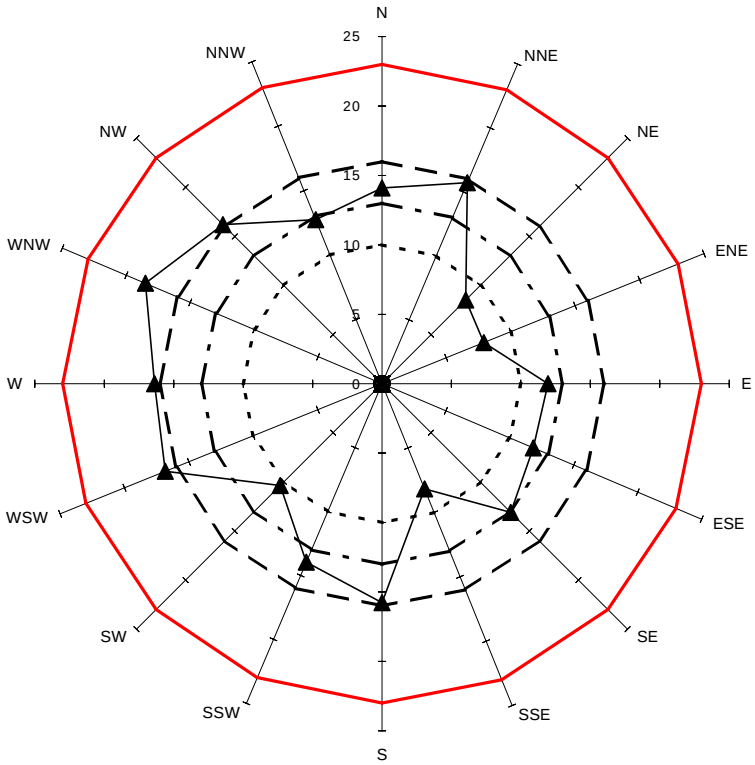
Measured Wind Speeds at Point 16

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

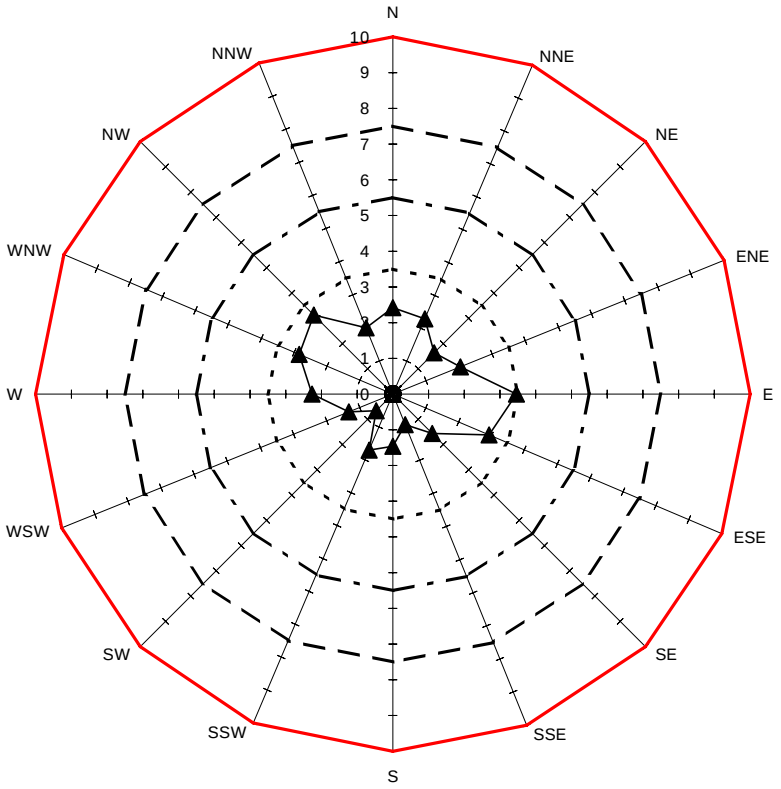
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

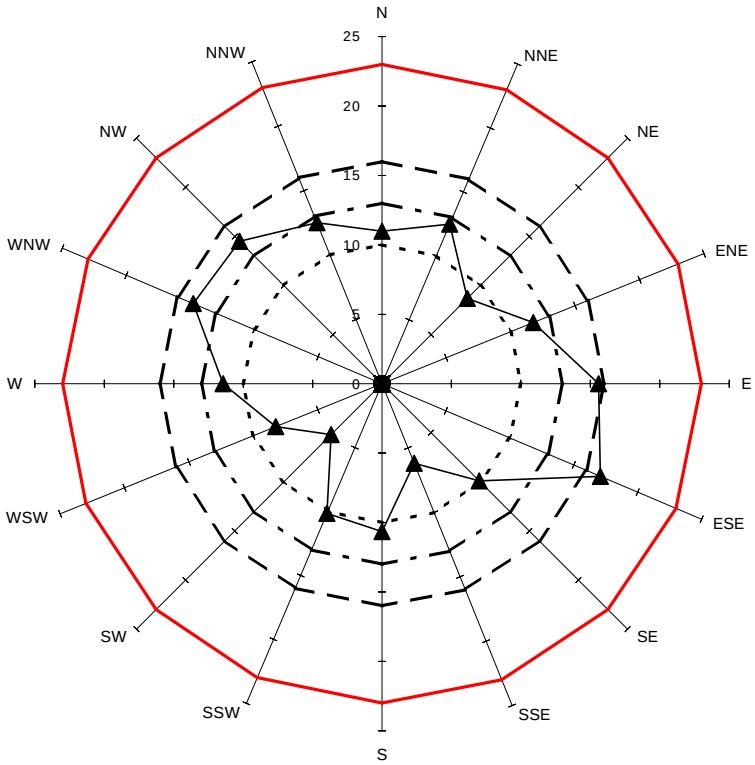
Measured Wind Speeds at Point 17

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

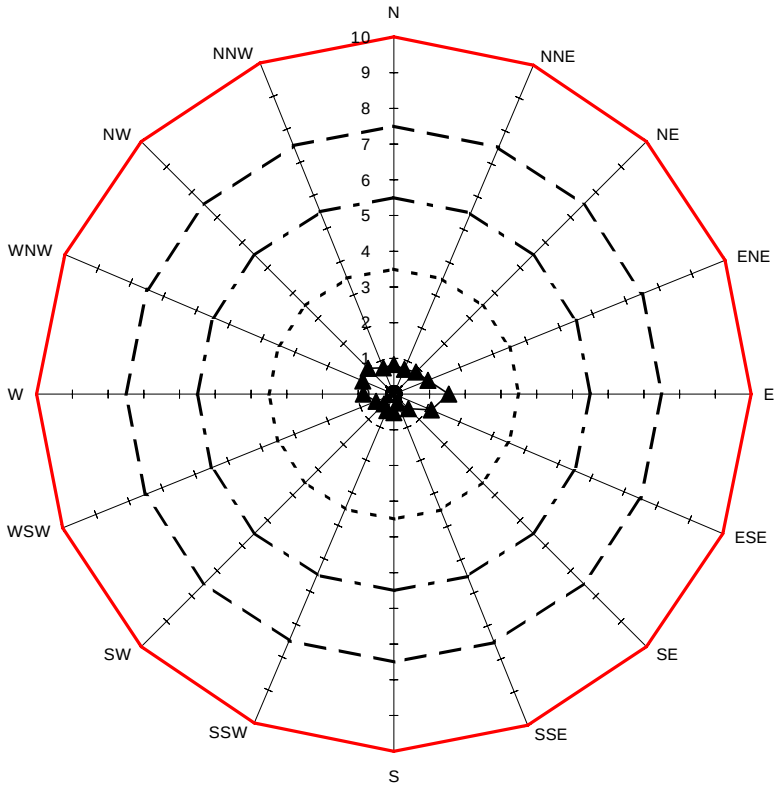
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

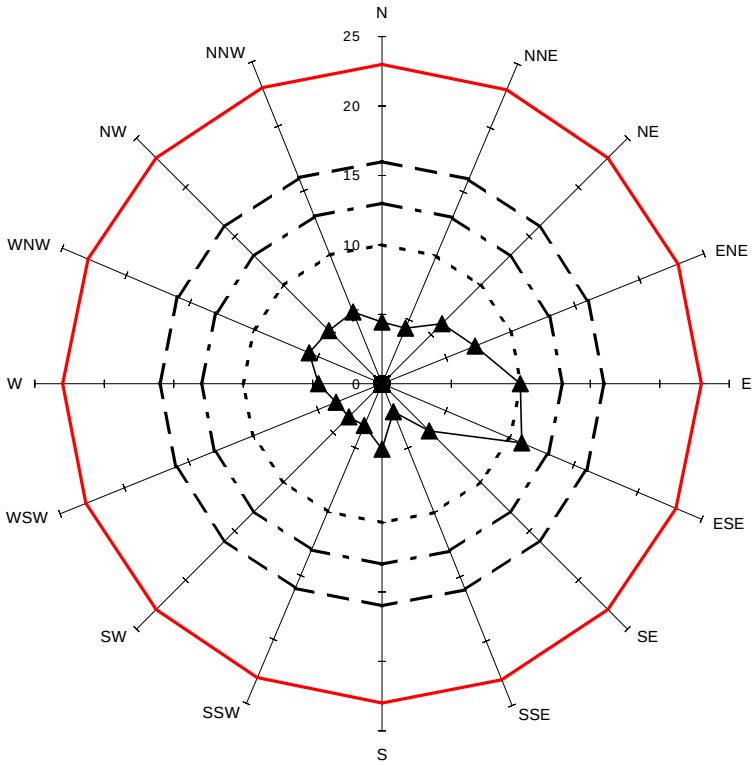
Measured Wind Speeds at Point 18

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

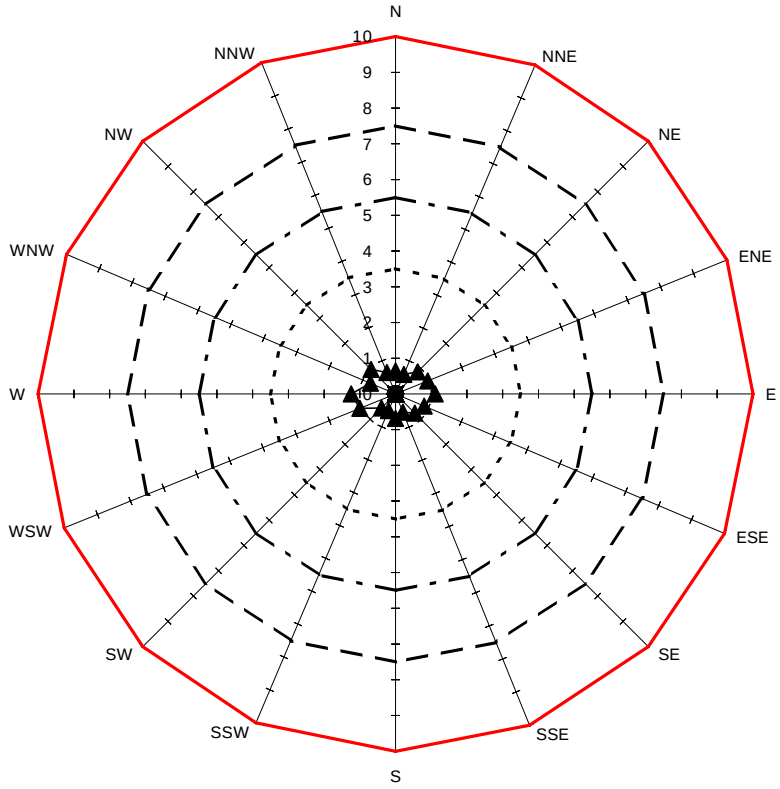
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

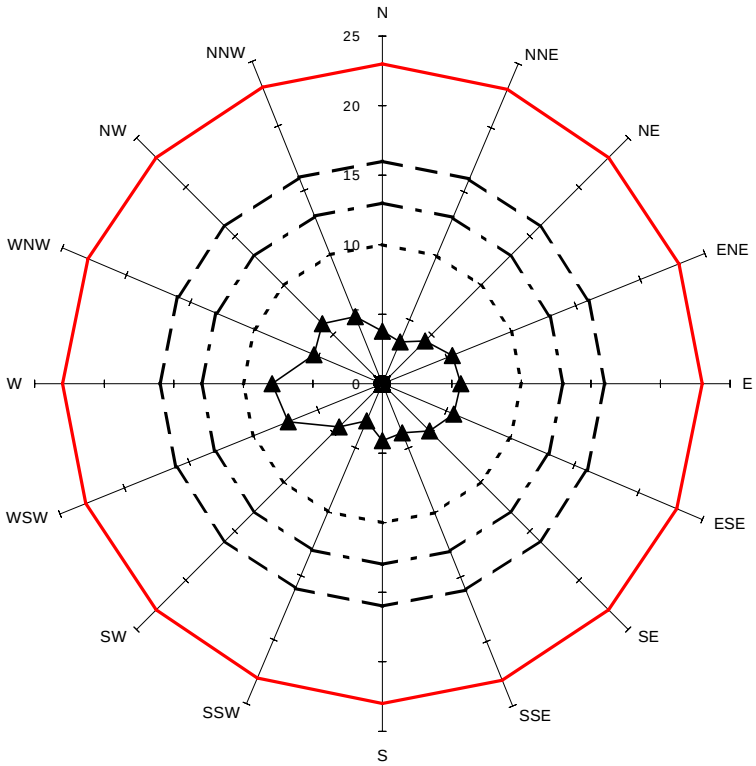
Measured Wind Speeds at Point 19

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

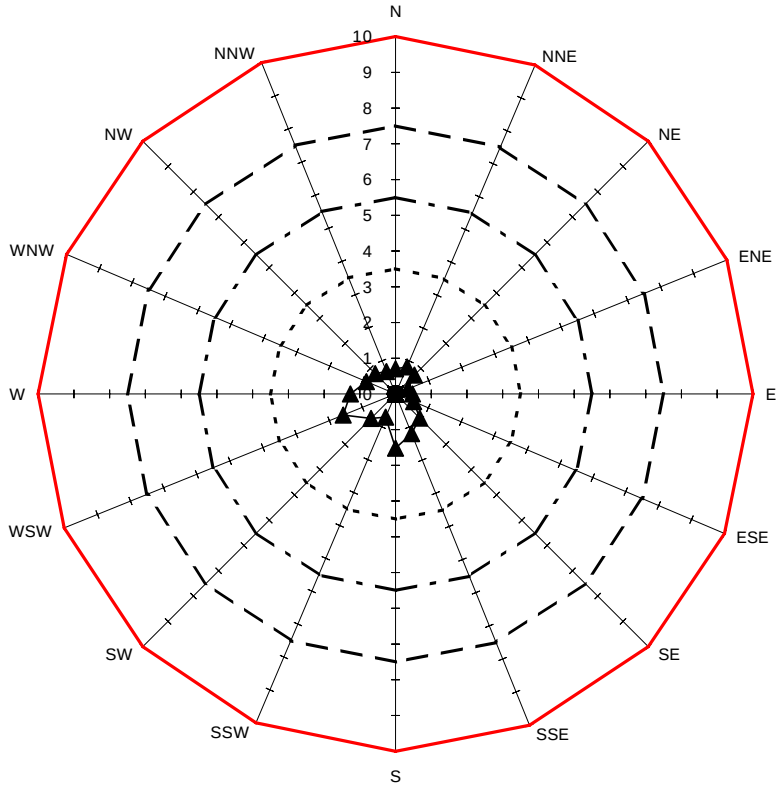
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

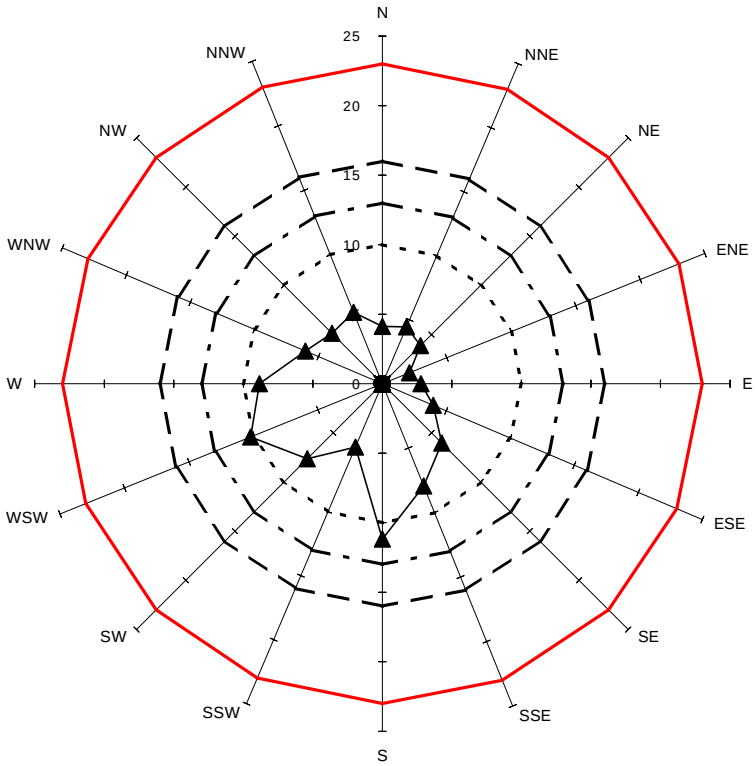
Measured Wind Speeds at Point 20

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

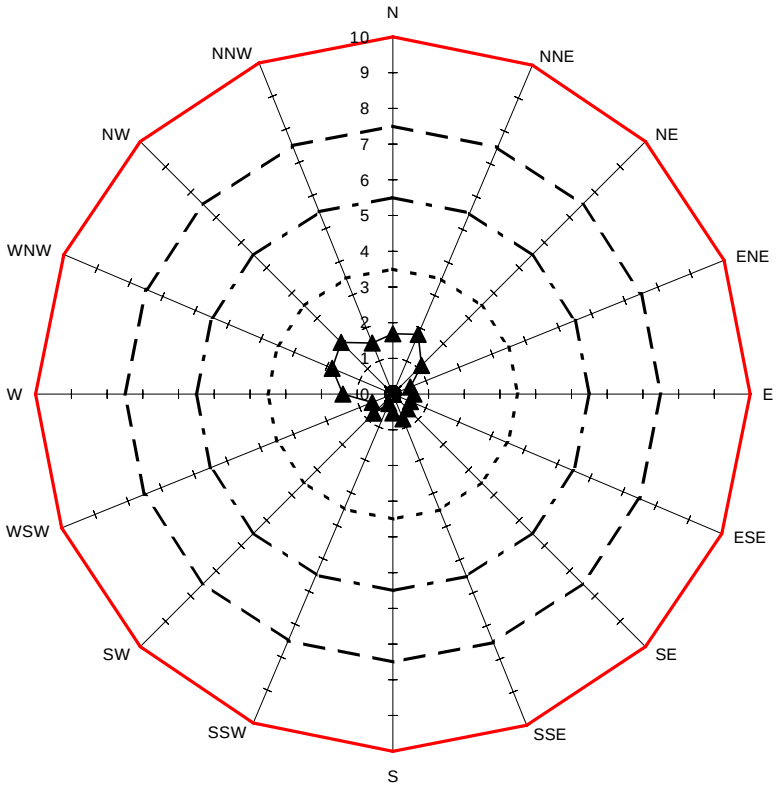
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

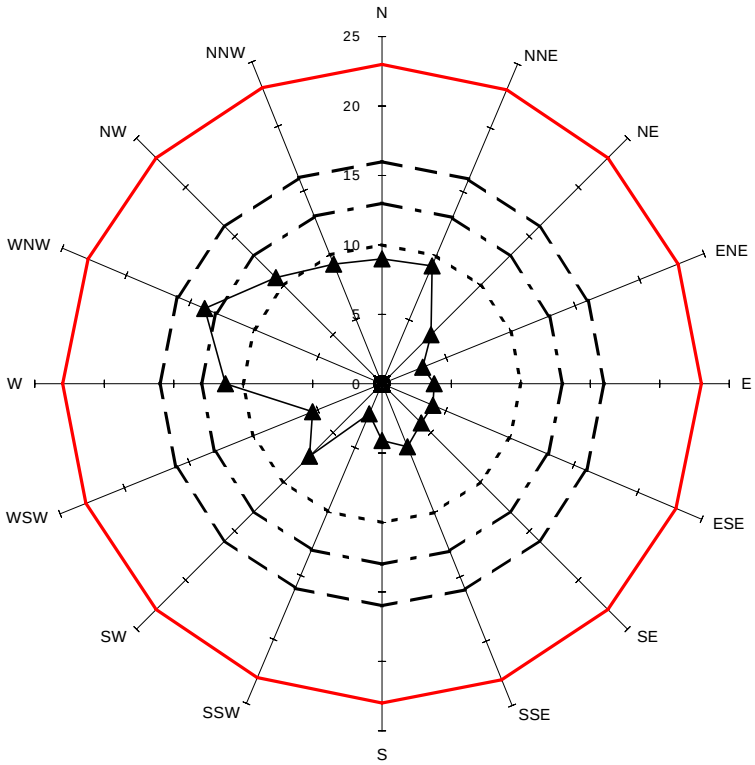
Measured Wind Speeds at Point 21

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

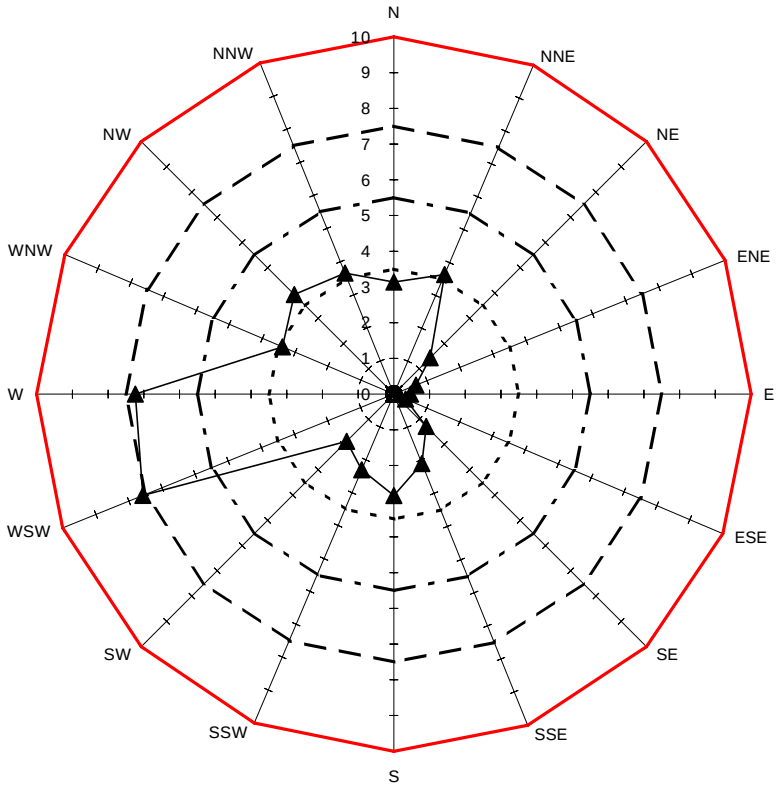
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

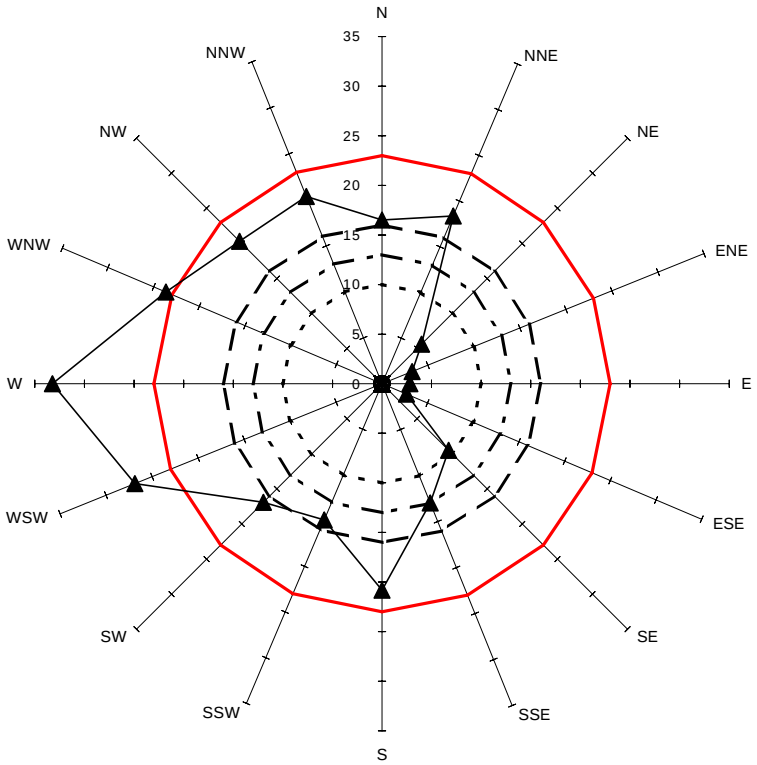
Measured Wind Speeds at Point 22

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

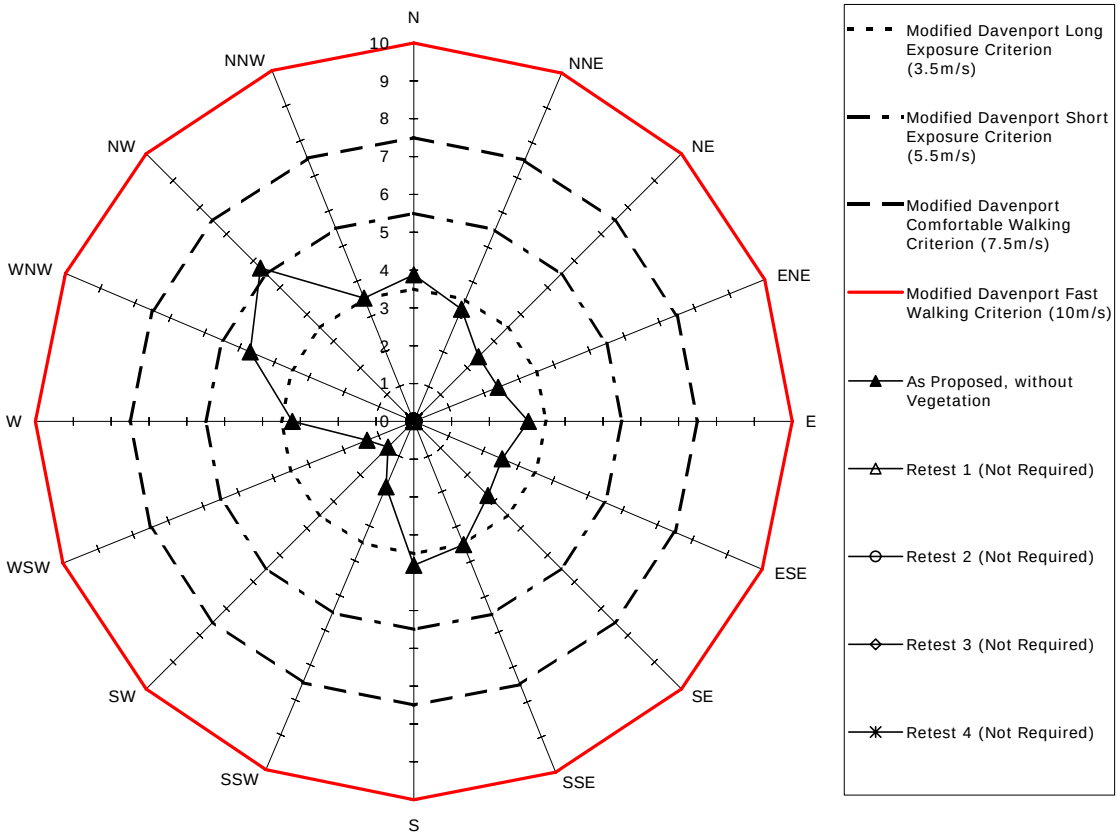
Annual Maximum Gust Wind Speeds (m/s)



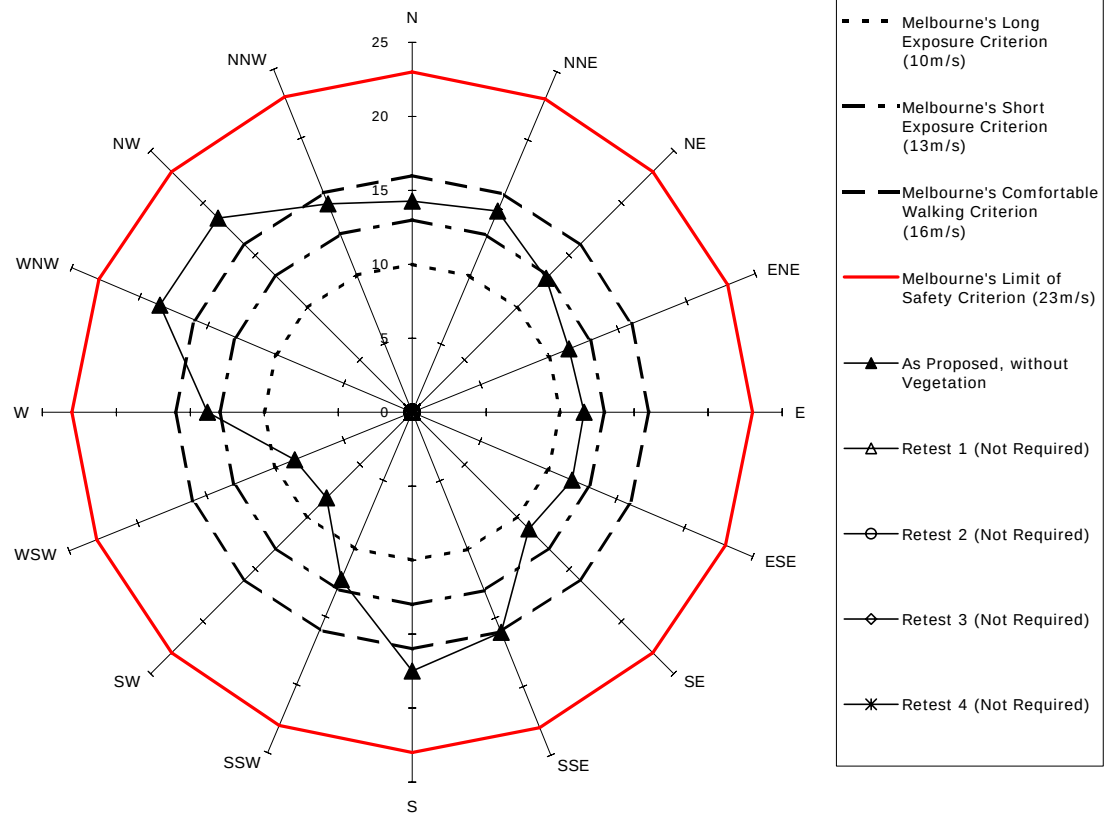
- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

Measured Wind Speeds at Point 23

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

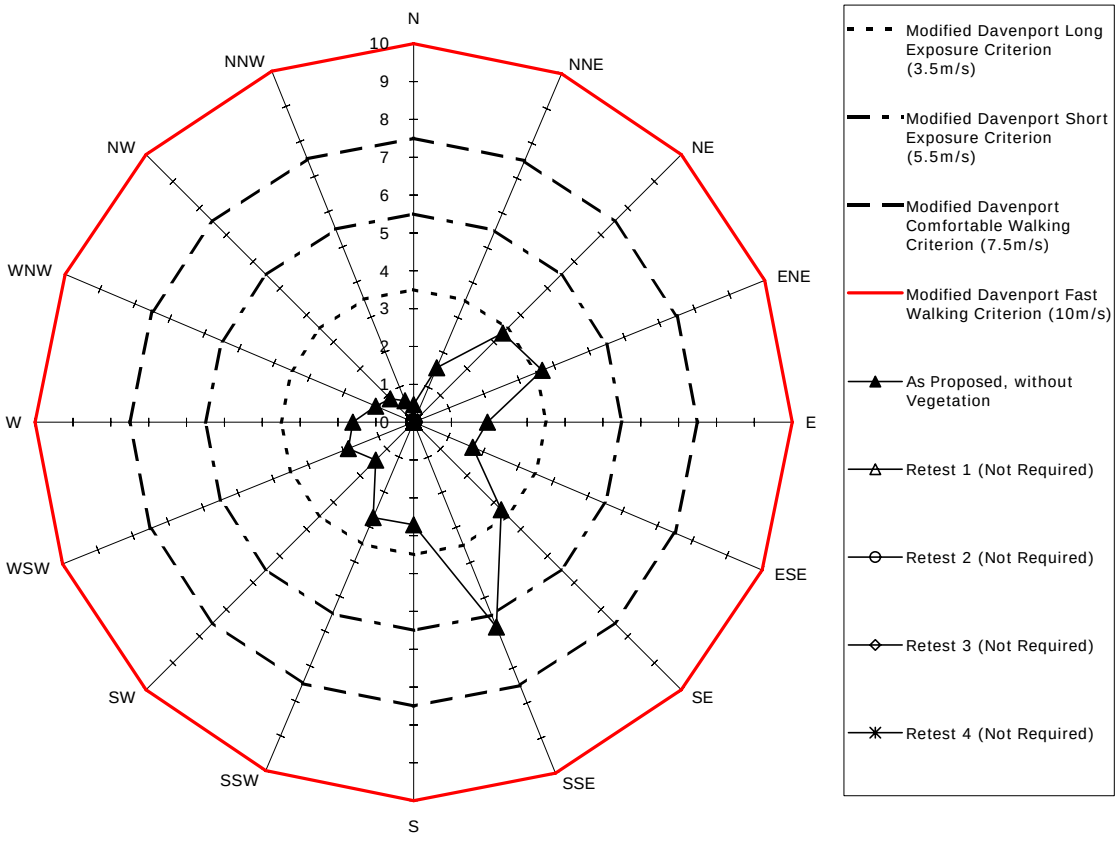


Annual Maximum Gust Wind Speeds (m/s)

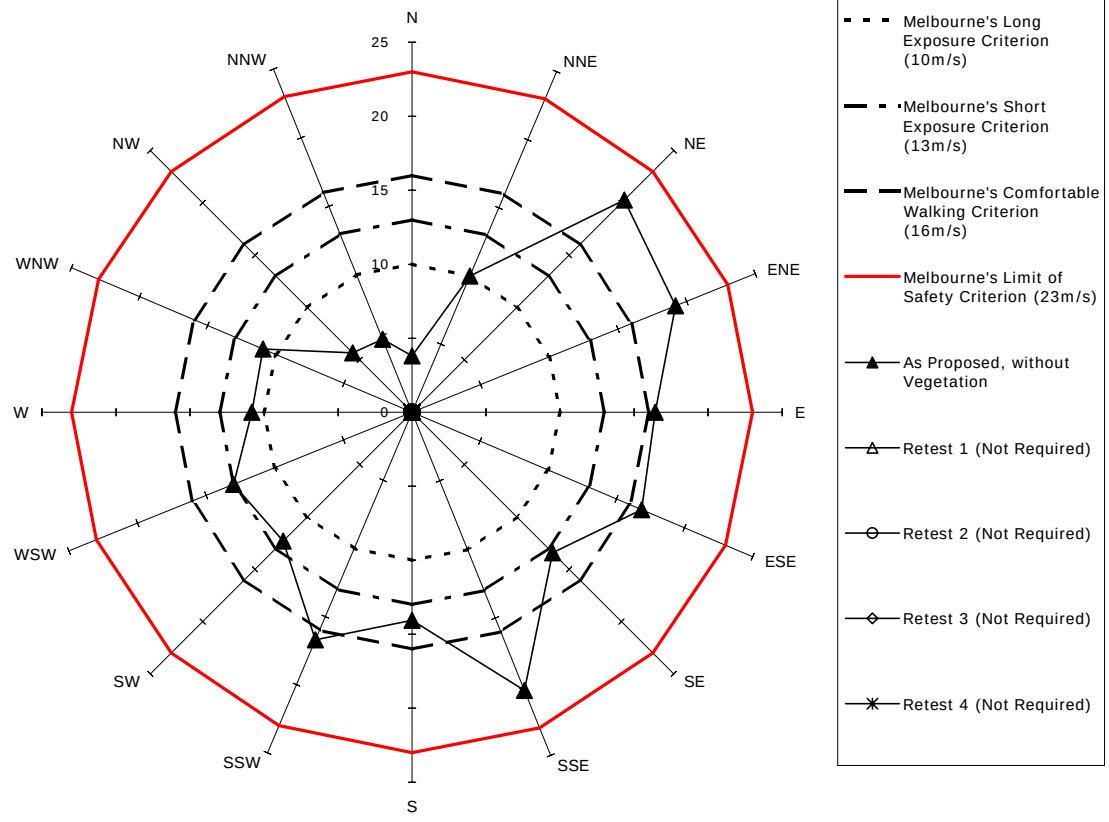


Measured Wind Speeds at Point 24

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

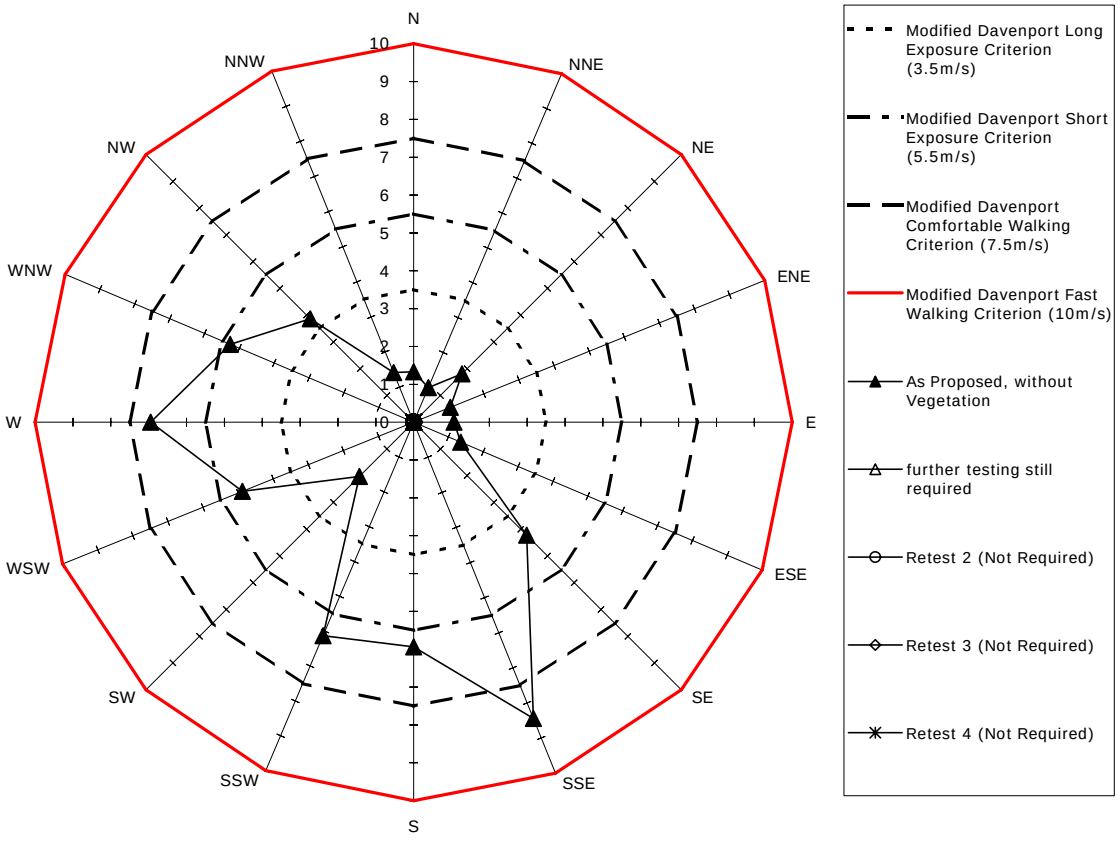


Annual Maximum Gust Wind Speeds (m/s)

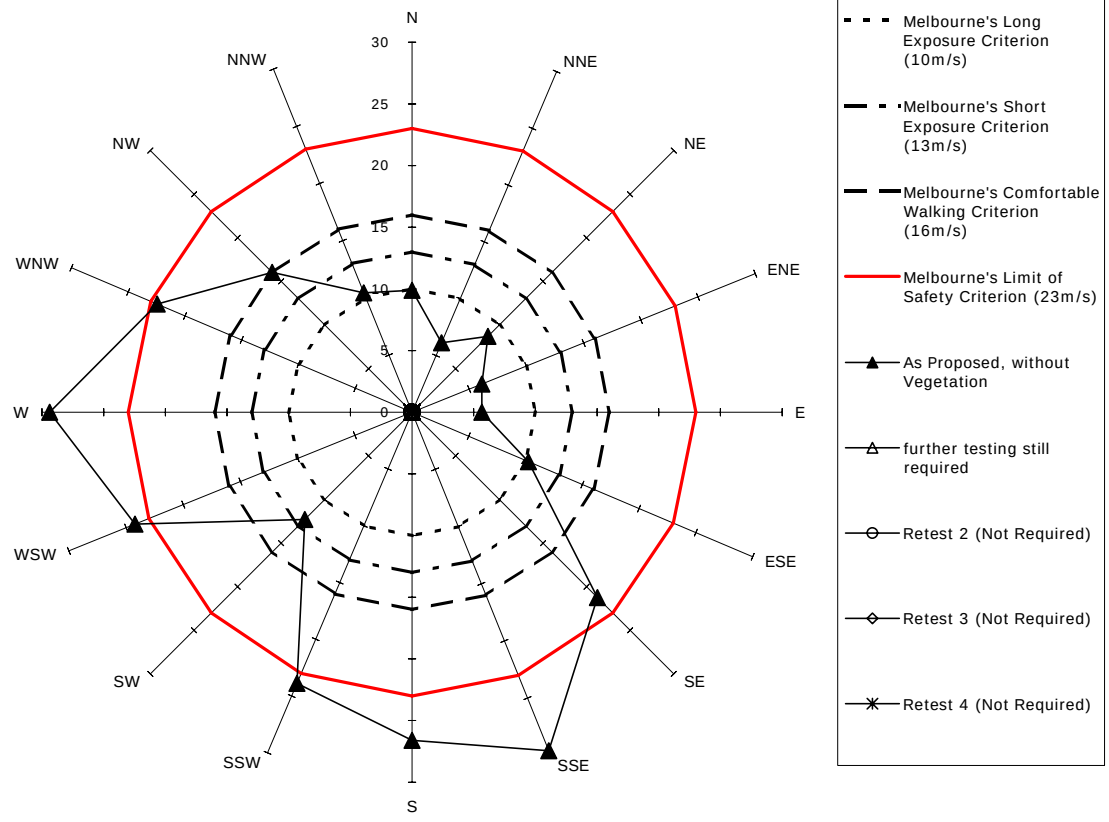


Measured Wind Speeds at Point 25

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

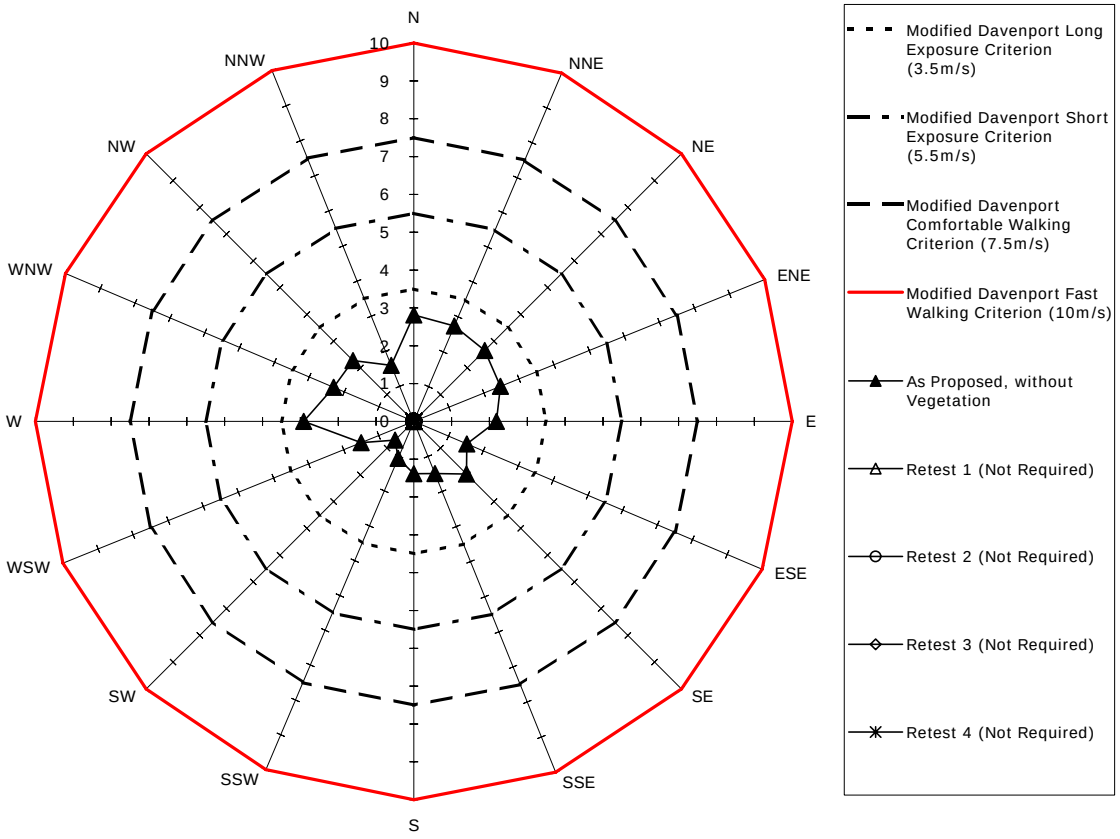


Annual Maximum Gust Wind Speeds (m/s)

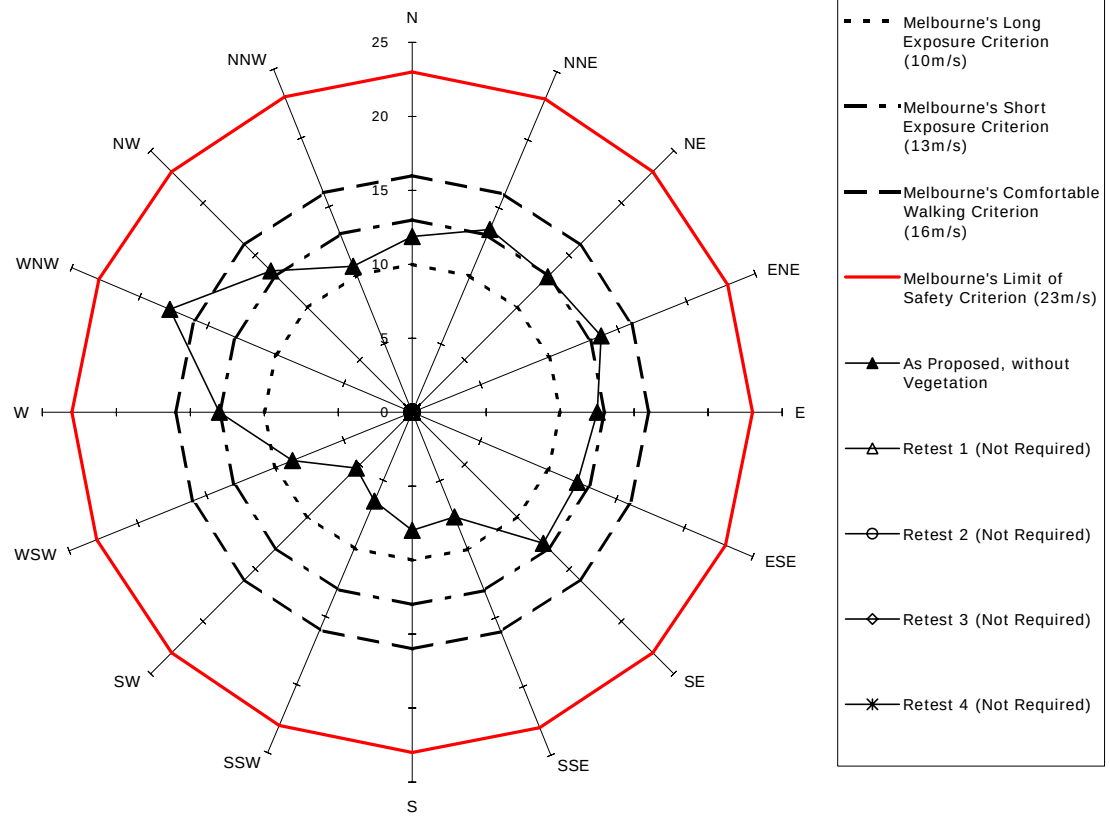


Measured Wind Speeds at Point 26

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)

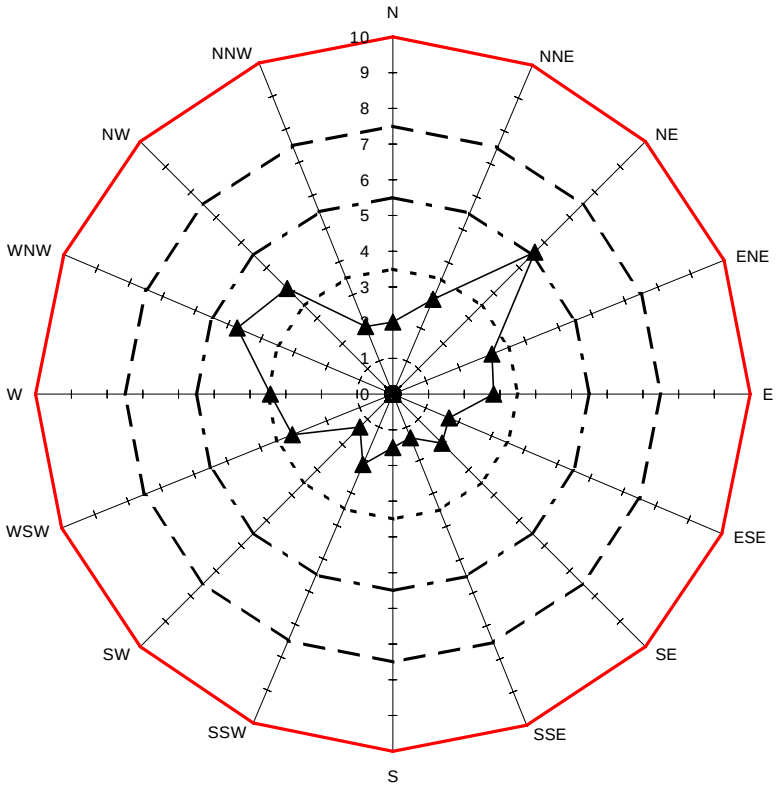


Annual Maximum Gust Wind Speeds (m/s)



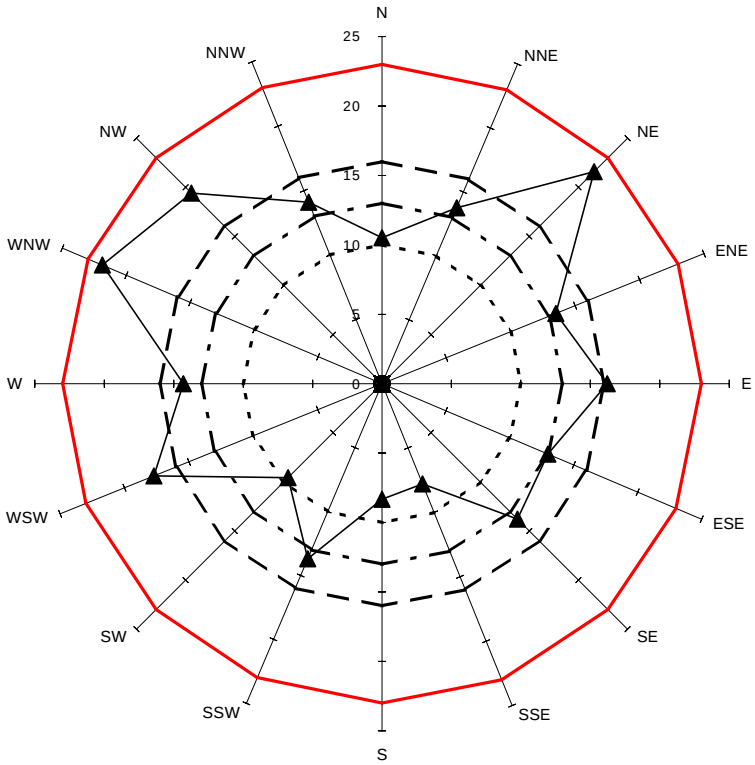
Measured Wind Speeds at Point 27

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

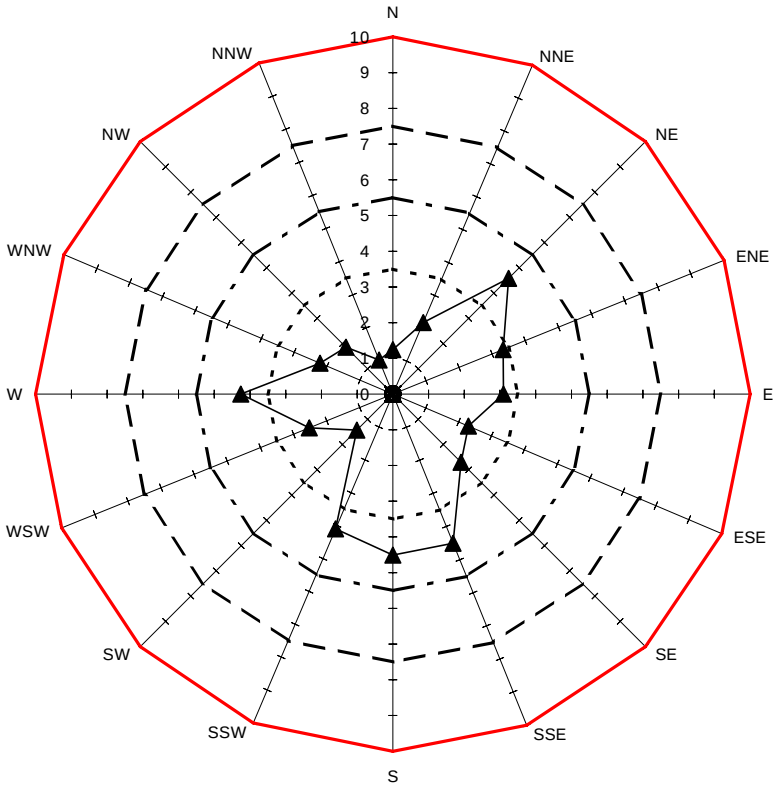
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

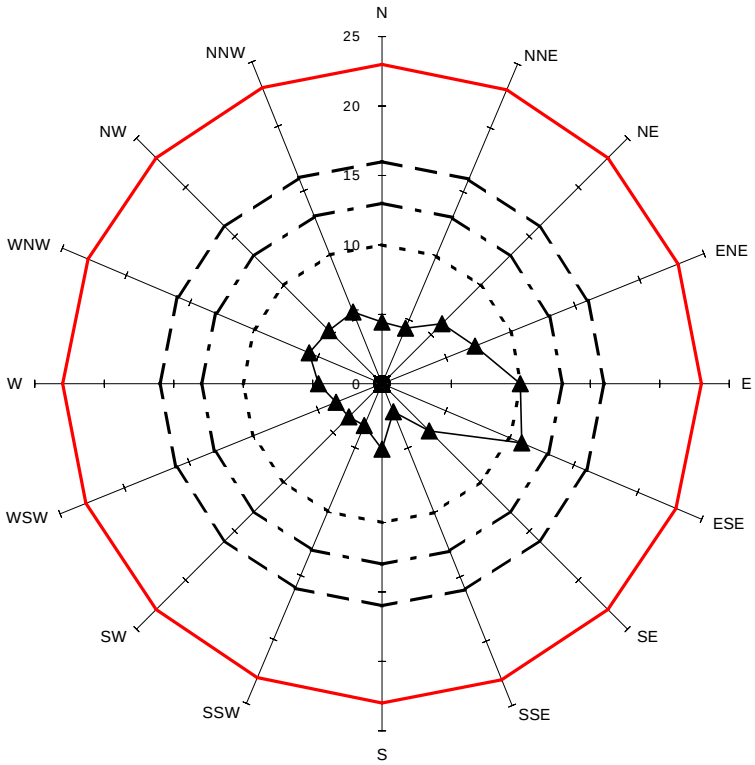
Measured Wind Speeds at Point 28

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

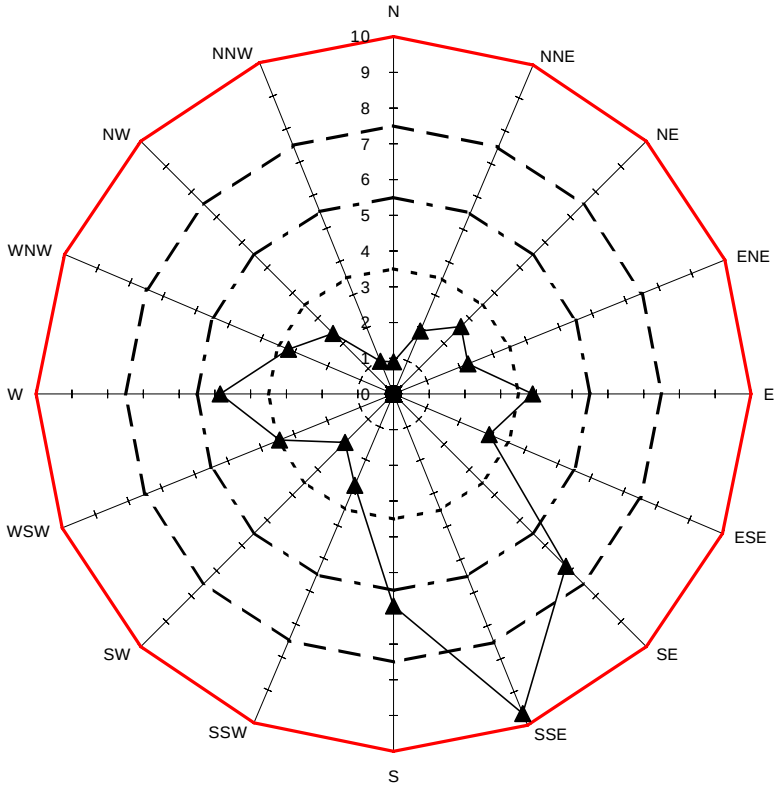
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

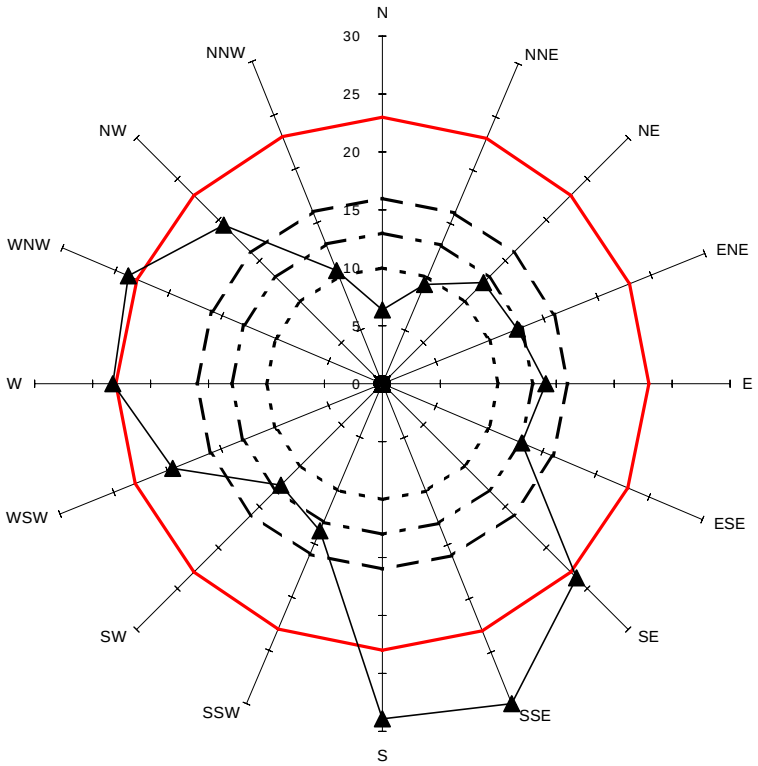
Measured Wind Speeds at Point 29

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

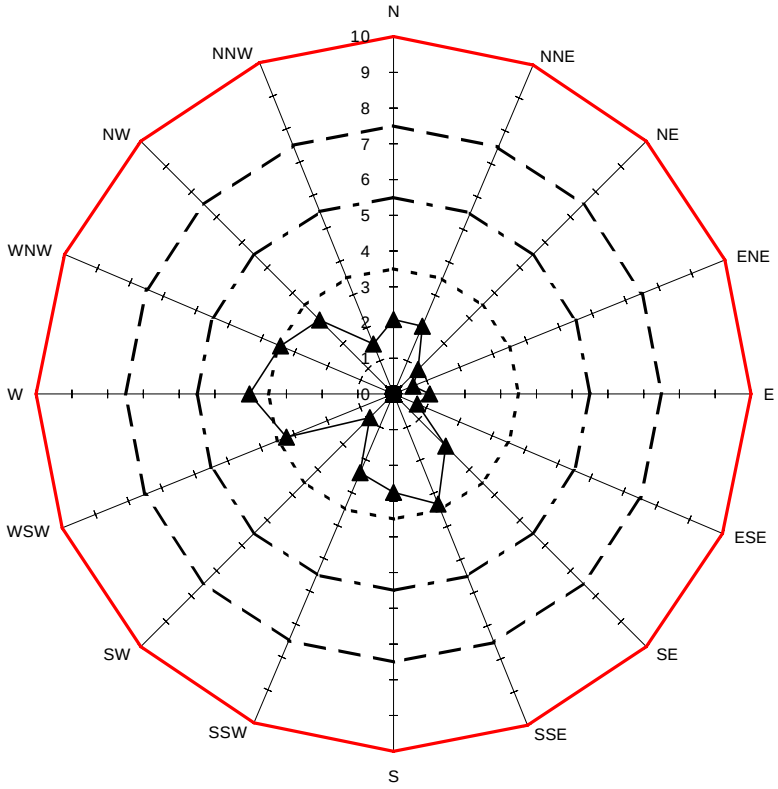
Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- further testing still required
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

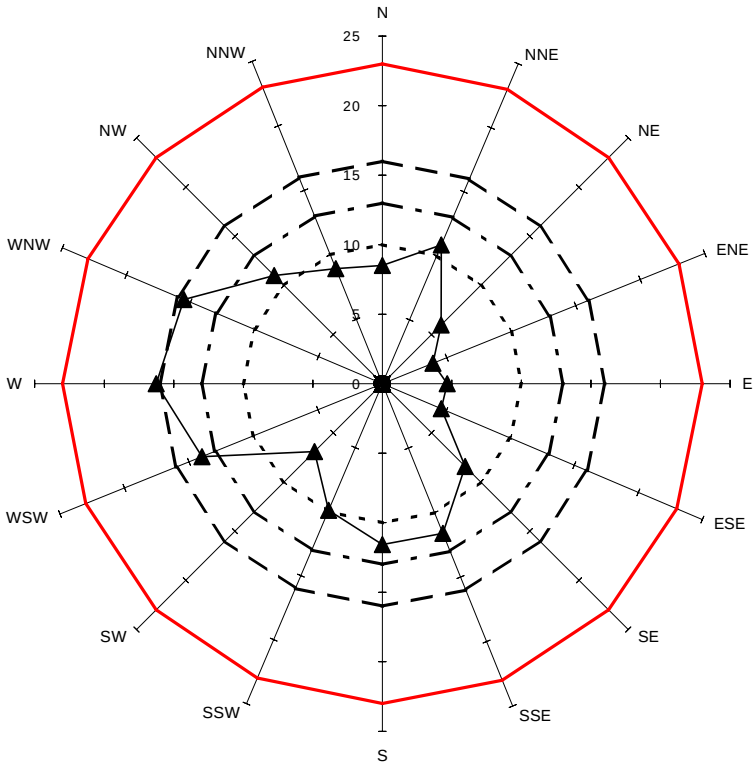
Measured Wind Speeds at Point 30

Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)



- Modified Davenport Long Exposure Criterion (3.5m/s)
- Modified Davenport Short Exposure Criterion (5.5m/s)
- Modified Davenport Comfortable Walking Criterion (7.5m/s)
- Modified Davenport Fast Walking Criterion (10m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)

Annual Maximum Gust Wind Speeds (m/s)



- Melbourne's Long Exposure Criterion (10m/s)
- Melbourne's Short Exposure Criterion (13m/s)
- Melbourne's Comfortable Walking Criterion (16m/s)
- Melbourne's Limit of Safety Criterion (23m/s)
- As Proposed, without Vegetation
- Retest 1 (Not Required)
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Retest 4 (Not Required)