WINDTECH

Pedestrian Wind Environment Study

for the proposed developments at

88 Walker Street & 77-81 Berry Street and 100 Mount Street, North Sydney

December 07, 2009

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Document Control

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1.0 Executive Summary

This report presents the results of a detailed investigation into the wind environment impact in relation to the development applications for the sites known as:

- **100 Mount Street, North Sydney**; this development application is for a single office tower which is bounded by Mount Street to the south, Walker Street to the east, and Spring Street to the north.

- **88 Walker Street & 77-81 Berry Street, North Sydney**; this development application includes two towers. The proposed office tower is bounded by Little Spring Street to the east, Spring Street to the south, Denison Street to the west and the Beau Monde residential tower to the north. The proposed hotel tower is bounded by Walker Street to the east and Little Spring Street to the west.

Wind speed measurements were carried out using a 1:400 scale model of the development. A surrounds model incorporating the neighbouring buildings and local land topography was placed around the model of the proposed developments. The surrounds model extends to a radius of 500m from the site. Testing was performed using Windtech's blockage tolerant boundary layer wind tunnel facility, which has a 3.0m wide work section and has a fetch length of 14m. Additional testing of was undertaken to measure the existing wind conditions at relevant locations around the proposed development areas for comparison.

Peak gust wind speeds were measured and related to reference velocities at a height of 200m 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 for this region to provide the equivalent full-scale wind speeds. These wind speed measurements are compared with the wind speed criteria described in the North Sydney Development Control Plan (DCP), relevant published criteria for long and short duration stationary activities and for pedestrian comfort, as well as the existing site wind conditions. The results presented in this study are based on annual maximum peak wind speeds and weekly maximum Gust Equivalent Mean (GEM) wind speeds.

The results of this study indicate that most of the outdoor areas of the various developments, including all ground level areas, will require ameliorative treatments to be implemented to result in acceptable wind conditions. Many forms of treatments have been investigated in this study to treat the adverse winds affecting the outdoor areas of the proposed development sites. A set of treatments have been recommended in this report to ameliorate these effects, and are summarised as follows:

- A strategic layout of densely foliating trees for the ground level areas within and around the two development sites.

- The addition of an awning above the street level along Walker Street for the 88 Walker & 77-81 Berry Street development.

- The addition of an awning above the street level along the eastern and southern aspects of the 100 Mount Street development.
- The addition of wind deflectors/awnings above the street level on the northern and southern aspects of the street linking Denison Street with Little Spring Street (which cuts through the podium of the 88 Walker & 77-81 Berry Street development).
- Additional awning along the western aspect of the 88 Walker & 77-81 Berry Street development or the use of evergreen trees along Denison Street.
- Strategic placement of portable 1.2m high impermeable screens within and around the Ground Level of the 100 Mount Street development site.
- Maintaining existing 1.5m high shrub at the corner of Denison and Mount Streets and the existing 1.2m high Garden Wall at the corner of Denison and Spring Streets.
- 1.2m high impermeable balustrades along the perimeter of the two terrace areas on the Restaurant Level of the 88 Walker & 77-81 Berry Street development, and a strategic layout of densely foliating shrubs.
- 1.5m high impermeable balustrades along the perimeter of the Level 8 Roof Garden terrace areas of the 100 Mount Street development.
- 1.5m high impermeable balustrade along the perimeter of the Level 20 Sky Garden terrace area of the 100 Mount Street development, setback from the edge. A densely foliating tree is also recommended for this area.

Note that for vegetation to be effective in mitigating adverse winds, particularly westerly winds which tend to occur predominantly during the winter months for the Sydney region, the trees along Denison Street and Spring Street should be of a densely foliating evergreen species as indicated in the report.

With the recommended treatments listed above included into the final design of the various developments, the wind conditions within and around the proposed development sites will be acceptable for their intended uses. The trees along Mount and Walker Streets are required to have a canopy which overlaps the recommended awning to be effective.

The effect of the proposed developments on the wind conditions in the outdoor areas pertaining to the existing neighbouring buildings were also tested in this study. This included four existing outdoor eatery areas around the 100 Mount Street development, the outdoor area within the Tower Square and Fire House Hotel buildings, and the balcony and podium areas within the Beau Monde residential tower on Berry Street. With the addition of the proposed developments it was found that wind conditions to these surrounding areas will generally be similar to or better than the existing.

2.0 Model Description

2.1 Model of the Study Building and Surrounds

This study is to measure local wind speeds of the following development applications for the North Sydney CBD:

- **100 Mount Street, North Sydney**; this development application is for a single office tower which is bounded by Mount Street to the south, Walker Street to the east, and Spring Street to the north.

- **88 Walker Street & 77-81 Berry Street, North Sydney**; this development application includes two towers. The proposed office tower is bounded by Little Spring Street to the east, Spring Street to the south, Denison Street to the west and the Beau Monde residential tower to the north. The proposed hotel tower is bounded by Walker Street to the east and Little Spring Street to the west.

Wind speed measurements were carried out using a 1:400 scale model of the various proposed developments. A surrounds model incorporating the neighbouring buildings and local land topography was placed around the study building models. The surrounds model extends to a radius of 500m from the site. Photographs of the wind tunnel model with the inclusion of the proposed tower developments are shown in Figures 1a to 1c. The model that was used to measure the existing wind conditions around the various study sites are shown in Figure 1d.

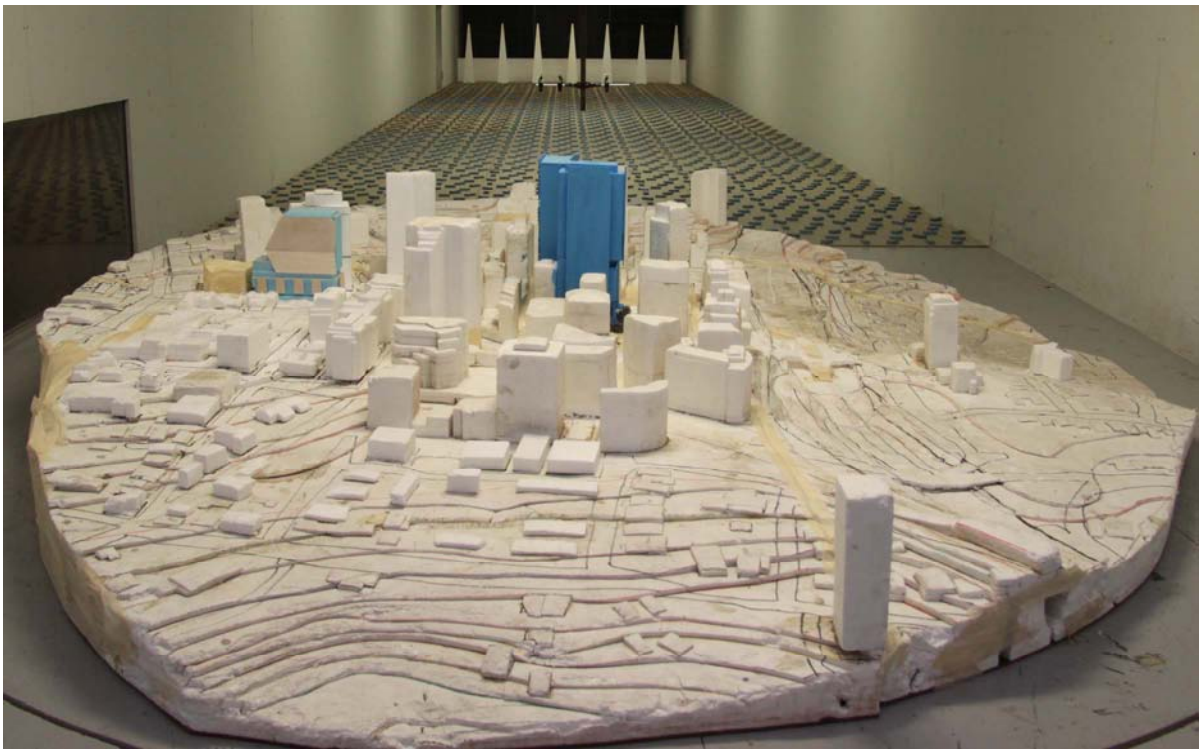

Figure 1a: Photograph of the Model in the Wind Tunnel (with the inclusion of the proposed developments)

Figure 1b: Photograph of the Model in the Wind Tunnel (with the inclusion of the proposed developments)

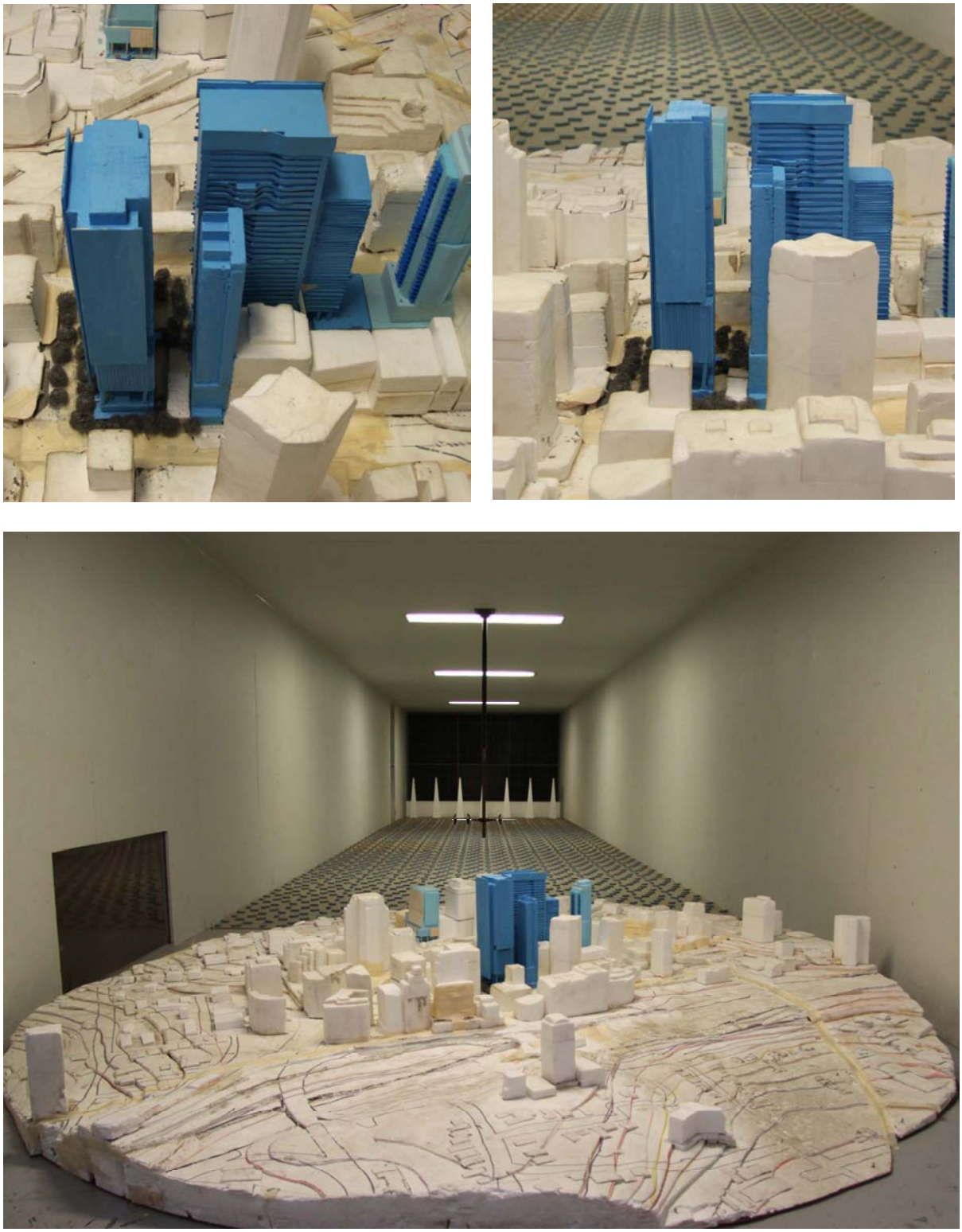

Figure 1c: Photograph of the Model in the Wind Tunnel (with the inclusion of the proposed developments)

Figure 1d: Photograph of the Model in the Wind Tunnel (existing site model)

2.2 Wind Climate Model

The boundary layer wind flows matched the model scale and the overall surrounding terrain characteristics beyond the 500m radius of the physical surrounds model tested in the wind tunnel for each wind direction tested. For the fetch beyond the extent of the surround model the wind profiles are simulated based on the Deaves and Harris model (1978). The wind profile shape is calculated based on an analysis of the surrounding terrain for each wind direction tested. Figure 2 shows an aerial image of the site and surrounds for a radius of 40*h* from the site, where *h* is the reference height of the study (150m for this study). Hence, for this project, the fetch length is 6.0km. The terrain types indicated in Figure 2 are classified as open, suburban or urban.

The length of each terrain type, and the distance each terrain type is from the site, is analysed for each wind direction tested. When the wind travels from one terrain type to another, the mean velocity profile does not change instantly. A lag occurs, and is measured as a distance by the following formula, which is adapted from Davenport et al (1997):

$$x_i = z_{0,r}\left[\frac{z}{0.3z_{0,r}}\right]^{1.25} \qquad (2.1)$$

where x_i is the lag length caused by the change in terrain type.

z is the height above ground.

$z_{0,r}$ is the larger of the two roughness lengths of the two terrain types (see Table 1).

The wind profile for each wind direction is calculated using the lag distance equation above, and the site terrain analysis data measured from the image shown in Figure 2.

For example, for wind coming from 67.5 degrees (an east-north-easterly wind), it is assumed that the approaching wind profile at the edge of the study zone (6.0km from the site for this study) is the standard Deaves and Harris (1978) open terrain profile, since this is coming from over water and open terrain. The wind continues over the open terrain until, approximately 4.2km from the site, the wind reaches the suburban terrain of Balmoral. This is where the Deaves and Harris (1978) suburban terrain is most appropriate. The wind profile then begins to adapt from the open terrain profile to the suburban terrain profile as it passes over Mosman, Cremorne and Neutral Bay. However, by the lag distance equation, at a height of 250m above ground, the profile requires 6.7km to fully change to the standard Deaves and Harris (1978) suburban terrain profile. Hence, by the time the wind reaches the site, at a height of 250m above ground, the profile is only 63% developed into the suburban wind profile from the open wind profile. At the building height, it is 100% developed into the suburban wind profile. The wind profile plot in Appendix B for wind angle 67.5 degrees shows that, by the time the wind reaches the site, the profile has already adapted to the standard suburban terrain profile for heights below the building height, and above this it is still adapting into the suburban terrain profile from the open terrain profile. The wind profiles used for this study are shown in Appendix B of this report for each wind direction tested.

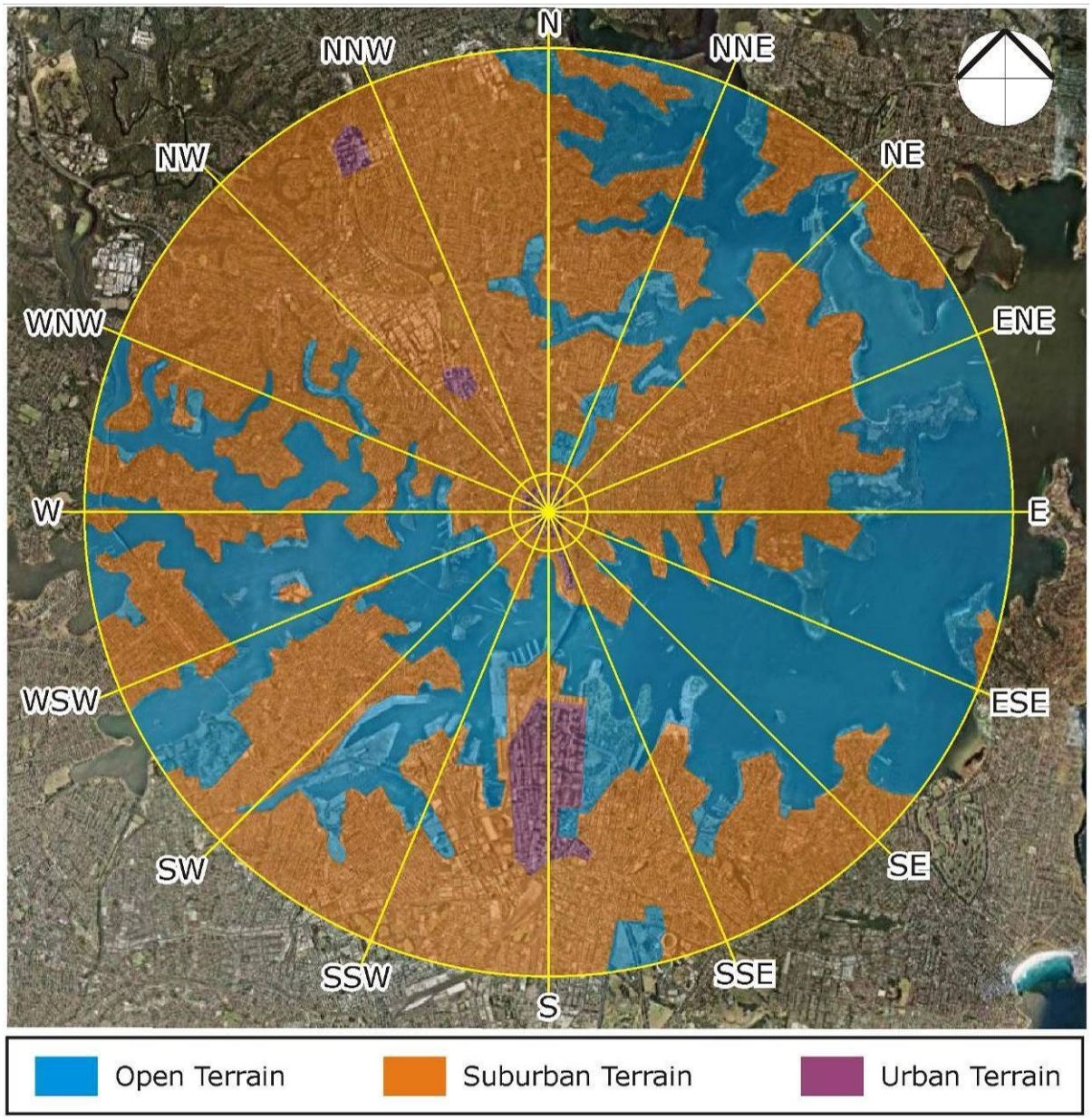

Figure 2: Aerial Image of the Site and Surrounds – 6.0km Radius (terrain category types also indicated)

Table 1: Mean and Gust Terrain and Height Multipliers and Turbulence Intensity at Building Height, and the Corresponding Roughness Length for the Standard Deaves & Harris Profiles (1978) (150m)

Terrain Description	$\overline{M}_{(z,cat)}$ at BH	$M_{(z,cat)}$ at BH	Turbulence Intensity	Roughness Length (m) $z_{0,r}$
Open	0.89	1.27	0.117	0.02
Suburban	0.78	1.21	0.150	0.2
Dense Urban	0.62	1.11	0.210	2

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 free stream wind speed at the reference height in the tunnel is approximately 11 m/sec. This corresponds to a velocity scale range of approximately 1:1.3 to 1:2.1 for the annual maximum peak wind speeds. Hence the sample length in the model scale of 12 seconds is equivalent to a range of approximately 38 minutes to 63 minutes in full-scale for the annual maximum peak wind speeds, which is suitable for this type of study.

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 wind tunnel model was tested in a suburban terrain boundary layer wind flow based on the Deaves and Harris (1978) model. The reference wind speeds were corrected for changes in the upstream building morphology and land topography.

The free stream and test-location air currents were monitored using a pair of Dantec hot wire probe anemometers. The probe support was mounted such that the probe wire was vertical 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 output from both probes was obtained using a National Instruments 12-bit data acquisition card. The signal was low-pass filtered at 32 Hz and results in peak gust being the equivalent of the 2 to 3 second gust on which the criteria are based. A sample rate of 1000 samples per second was used, which is more than adequate for the given frequency band.

The mean and the maximum 3 second duration peak gust coefficients were derived from the following relation:

$$\hat{V} = \overline{V} + g.\sigma_V$$

where g has been taken to be 3.5.

For each of the sixteen wind directions, peak gust and mean wind speeds were measured at selected points at a full-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 and peak wind speed measurements to actual mean and gust velocities, based on available meteorological data for Sydney.

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 shown in Figure 3.

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.

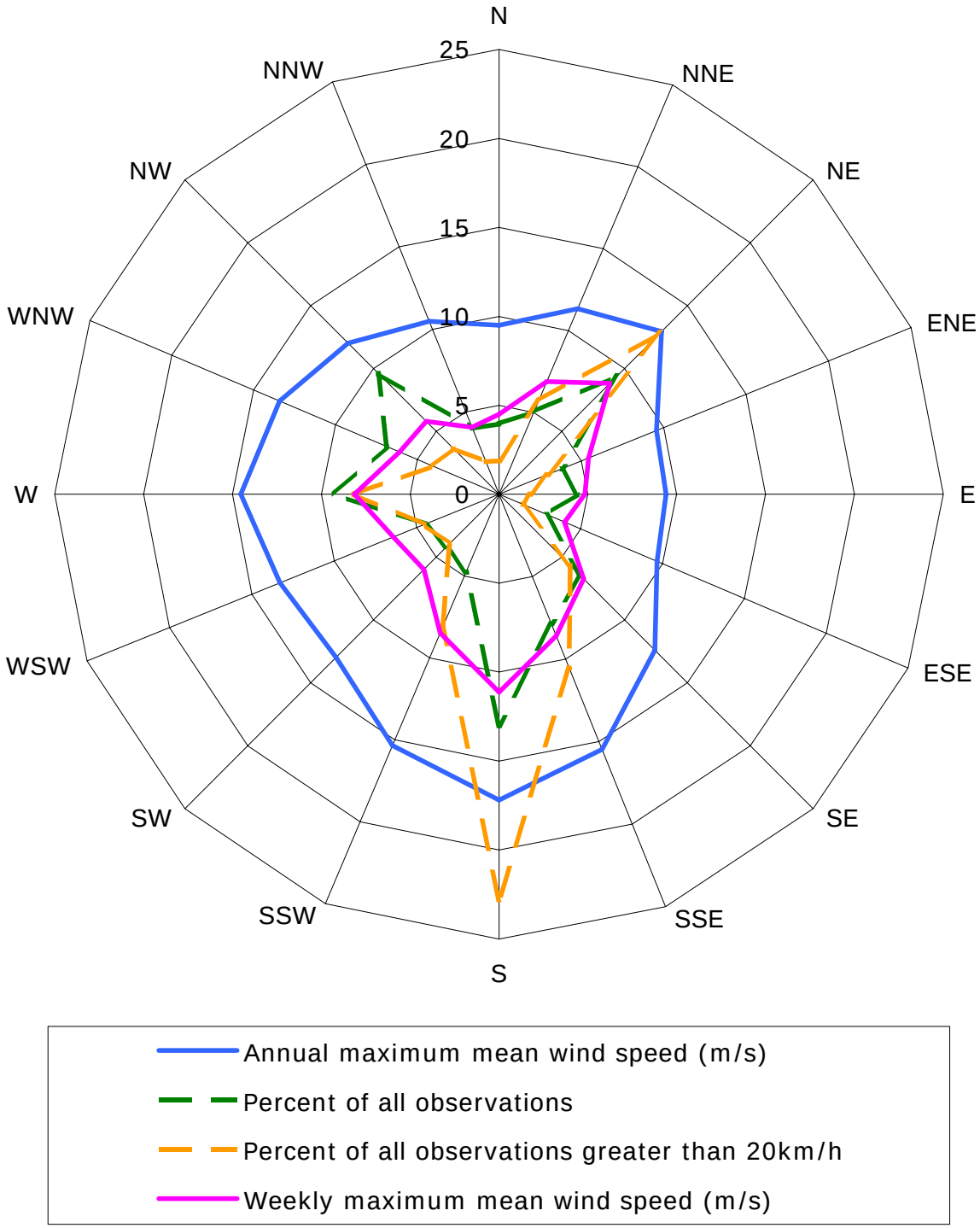

Figure 3: Reference Wind Speeds and Frequencies for Sydney (based on 3 hourly mean observations at Kingsford Smith Airport, from 1939 to 1992, corrected for 10m height in open terrain)

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 C 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. The following table (see Table 3), developed by Penwarden (1975), is a modified version of the Beaufort Scale, and describes the effects of various wind intensities on people. 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.

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

Type of Winds	Beaufort Number	Mean Wind Speed (m/s)	Effects
Calm, light air	1	0 - 1.5	Calm, no noticeable wind
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
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.
Gale	8	17.2 -20.7	Generally impedes progress, Great difficulty with balance.
Strong gale	9	20.8 – 24.4	People blown over by ***gusts***.

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.

4.1 Davenport's Criteria for Mean Wind Speeds

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	10 m/s > *u* > 7.5 m/s
Strolling, Skating	Slow walking, etc.	7.5 m/s > *u* > 5.5 m/s
Short Exposure Activities	Generally acceptable for walking & short duration stationary activities such as window-shopping, standing or sitting in plazas.	5.5 m/s > *u* > 3.5 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*

4.2 Lawson's Criteria for Mean Wind Speeds

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: 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

Table 5b: Comfort Criteria by Lawson (1975)

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

4.3 Melbourne's Criteria for Peak Wind Speeds

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 5 below. This set of criteria tends to be more conservative than criteria suggested by other researchers such as those indicated in Figure 4.

Table6: 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 and theatres and in parks.	10 m/s > *u*

4.4 Comparison of the Various Wind Speed Criteria

The criteria mentioned in Table 6, as well as other criteria, are compared on a probabilistic basis in Figure 4, below.

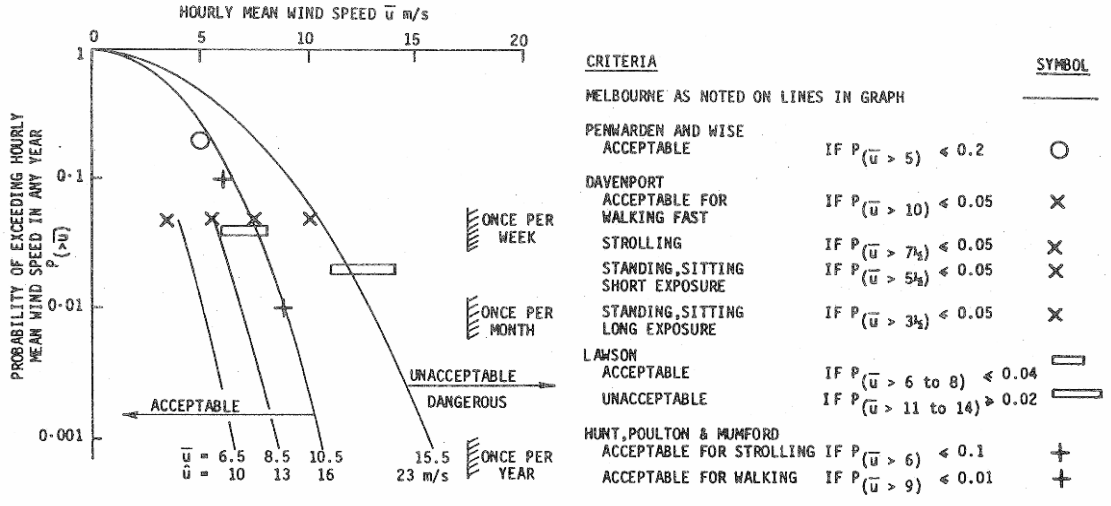

Figure 4: Comparison of Various Mean and Gust Wind Environment Criteria, assuming 15% turbulence and a Gust Factor of 1.5 (after Melbourne, 1978)

However, a comparative study presented by Ratcliff and Peterka (1990) based on measurements taken from a total of 246 locations in various urban situations tends to indicate that the criteria suggested by Melbourne (1978) can be considerably more conservative than the other criteria set out above. The results are in indicated in Figure 5. This agrees with our own observations (Rofail, 2007). This discrepancy in the criteria by Melbourne is due to the assumption of a fixed 15% turbulence intensity for all areas, which in our experience tends to be at the lower end of the range of turbulence intensities.

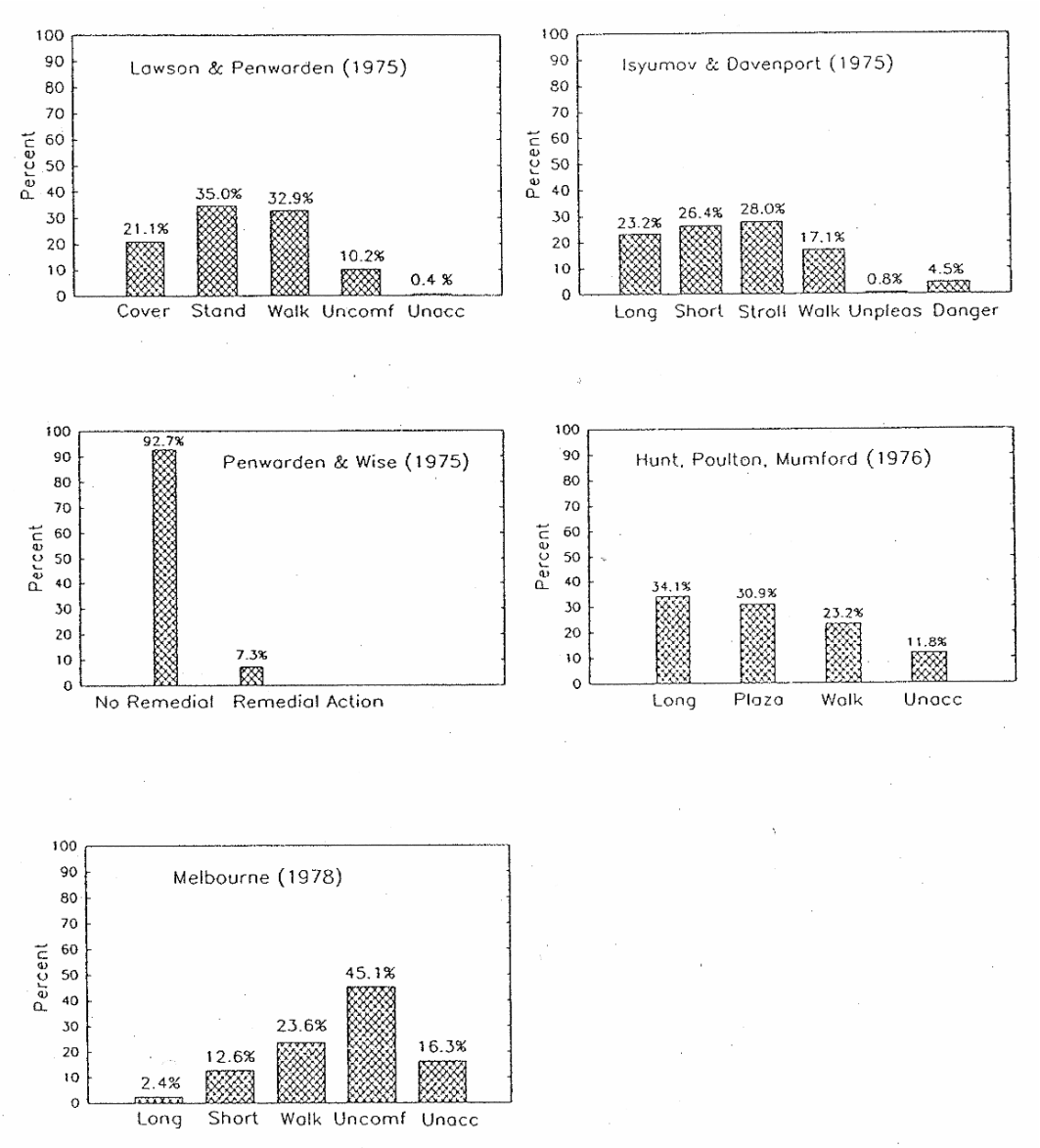

Figure 5: Distribution of Pedestrian Wind Comfort over Five Criteria for 246 locations examined in the Wind Tunnel (after Ratcliff & Peterka, 1990)

4.5 Wind Speed Criteria for the North Sydney CBD

For this study, the local wind climate has been compared against the North Sydney Development Control Plan (DCP) wind speed criteria, which is for the annual maximum peak wind speeds and is partly based on criteria by Melbourne (1978). The measured wind speeds are also compared to the corresponding existing site wind conditions. For terrace level areas the wind speeds are related to the comfort criteria by Davenport (1972), modified to correspond to a Gust Equivalent Mean (GEM) wind speed (described below), and also to the peak safety criterion.

To summarise, the wind comfort criteria used for this study are as follows;

- Wind conditions for all pedestrian accessible ground level areas within and around the proposed development sites should not exceed the existing wind conditions, or if they do they should not exceed 13m/s for the annual maximum peak wind speeds (as specified in the North Sydney DCP).

- Wind conditions for private balconies and terraces of the proposed developments should satisfy the safety limit of 23m/s for the annual maximum peak wind speeds. However, if a terrace is used frequently as a communal area (accessible by all occupants of the development), the short exposure criterion of 5.5m/s for the weekly maximum Gust Equivalent Mean (GEM) wind speeds should also be satisfied.

The locations of the selected study points for analysis are shown in the following set of figures.

Note that the abovementioned Gust Equivalent Mean (GEM) wind speed (defined below), in conjunction with the Davenport criteria (see Section 4 of this report), has proven over time and through field observations to be the most reliable indicator of pedestrian comfort. The most reliable source of data for field observation results are obtained when undertaking remedial wind environment studies. Note that the Safety Limit criterion by Melbourne (1978) of 23m/s for annual maximum peak wind speeds is also applied to all areas. This criterion is used for most areas of Australia and around the world, unless stipulated otherwise by the local government authority.

Notes:

- The GEM is defined as the maximum of the following:
    - Mean wind speed
    - Gust wind speed divided by a gust factor of 1.85
- The gust wind speed is defined as 3.5 standard deviations from the mean.
- Long Exposure criterion applies typically to outdoor dining areas in restaurants, amphitheatres, etc.
- Short Exposure criterion applies typically to areas where short duration stationary activities are involved (less than 1 hour). This includes parks and landscaped areas, swimming pool, window shopping, waiting and drop-off areas.
- Comfortable Walking criterion applies typically to main pedestrian thoroughfares.
- Fast walking criterion applies typically to infrequently used laneways, balconies, private terraces etc.

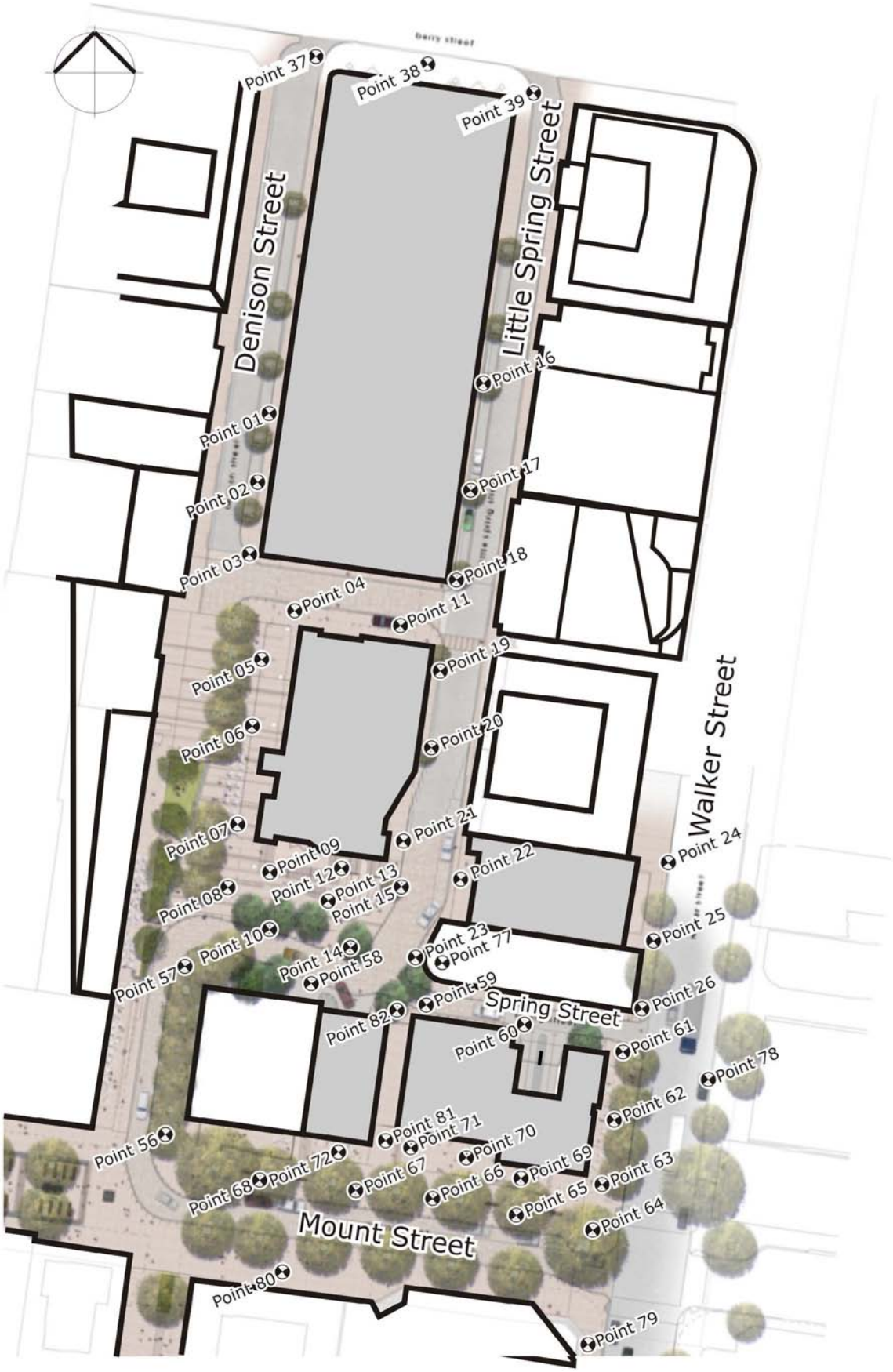

Figure 6a: Study Point Locations - Ground Level

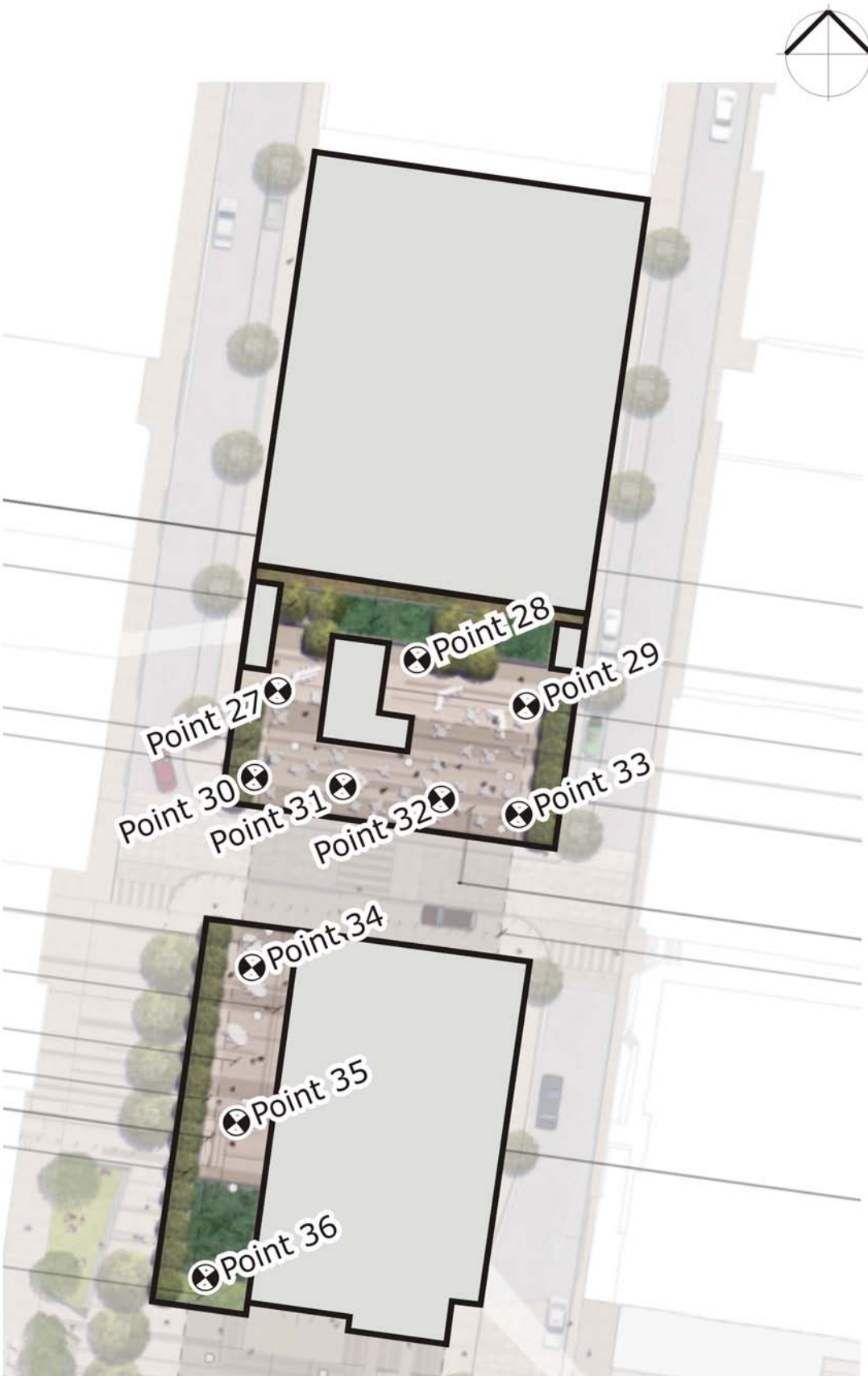

Figure 6b: Study Point Locations
Restaurant Level - 88 Walker Street & 77-81 Berry Street

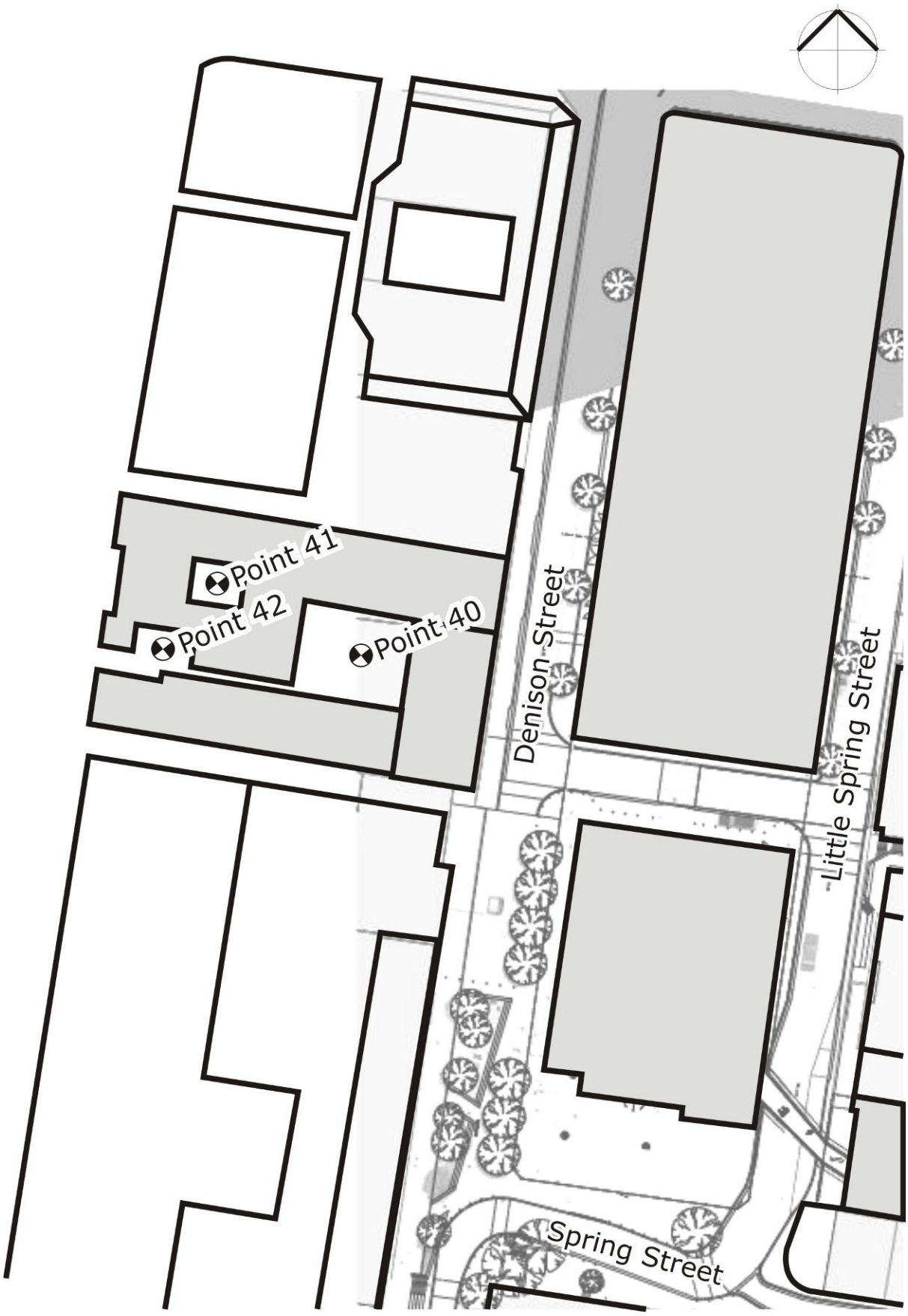

Figure 6c: Study Point Locations – Tower Square

Figure 6d: Study Point Locations – Beau Monde Residential Tower

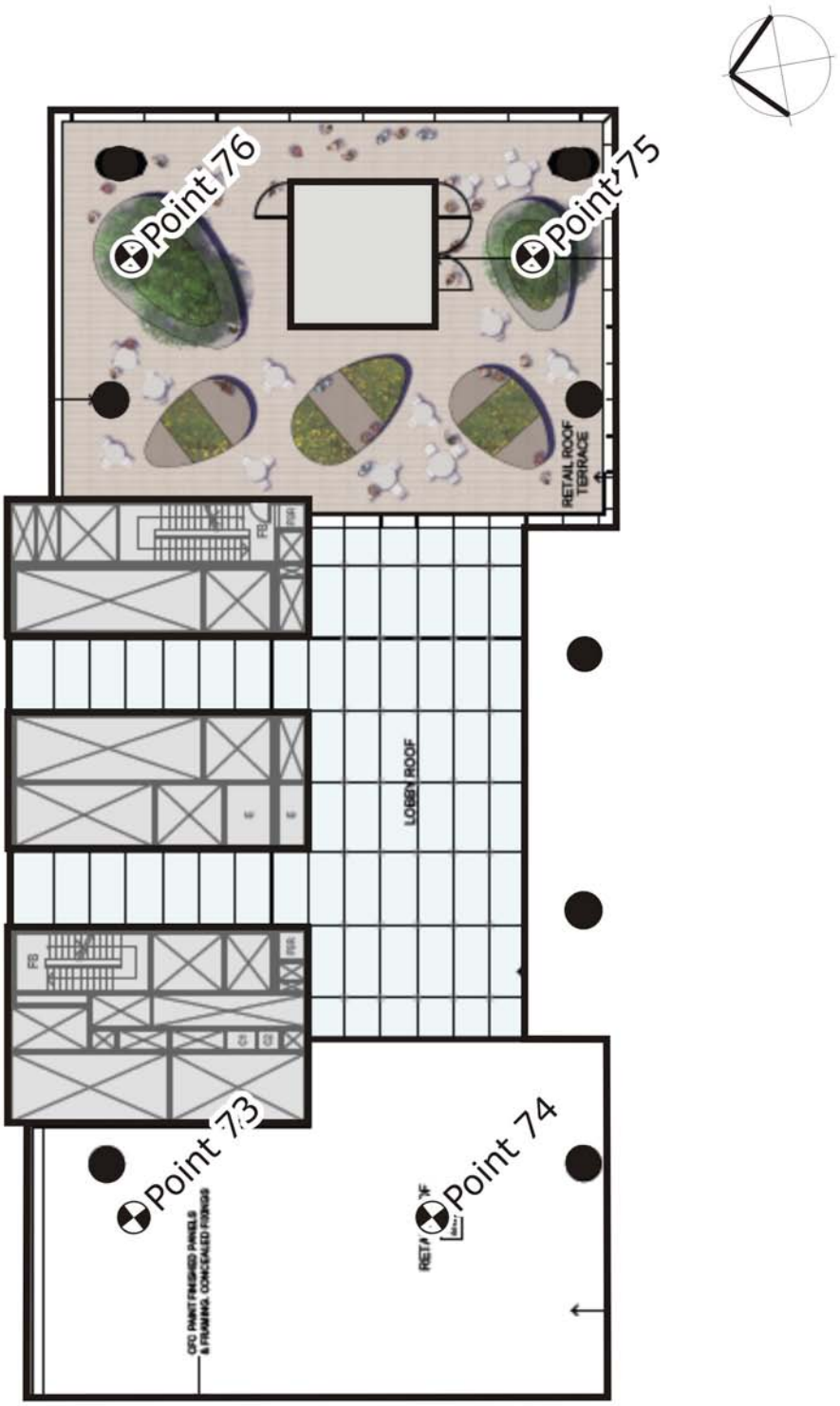

Figure 6e: Study Point Locations
Level 8 Roof Garden – 100 Mount Street

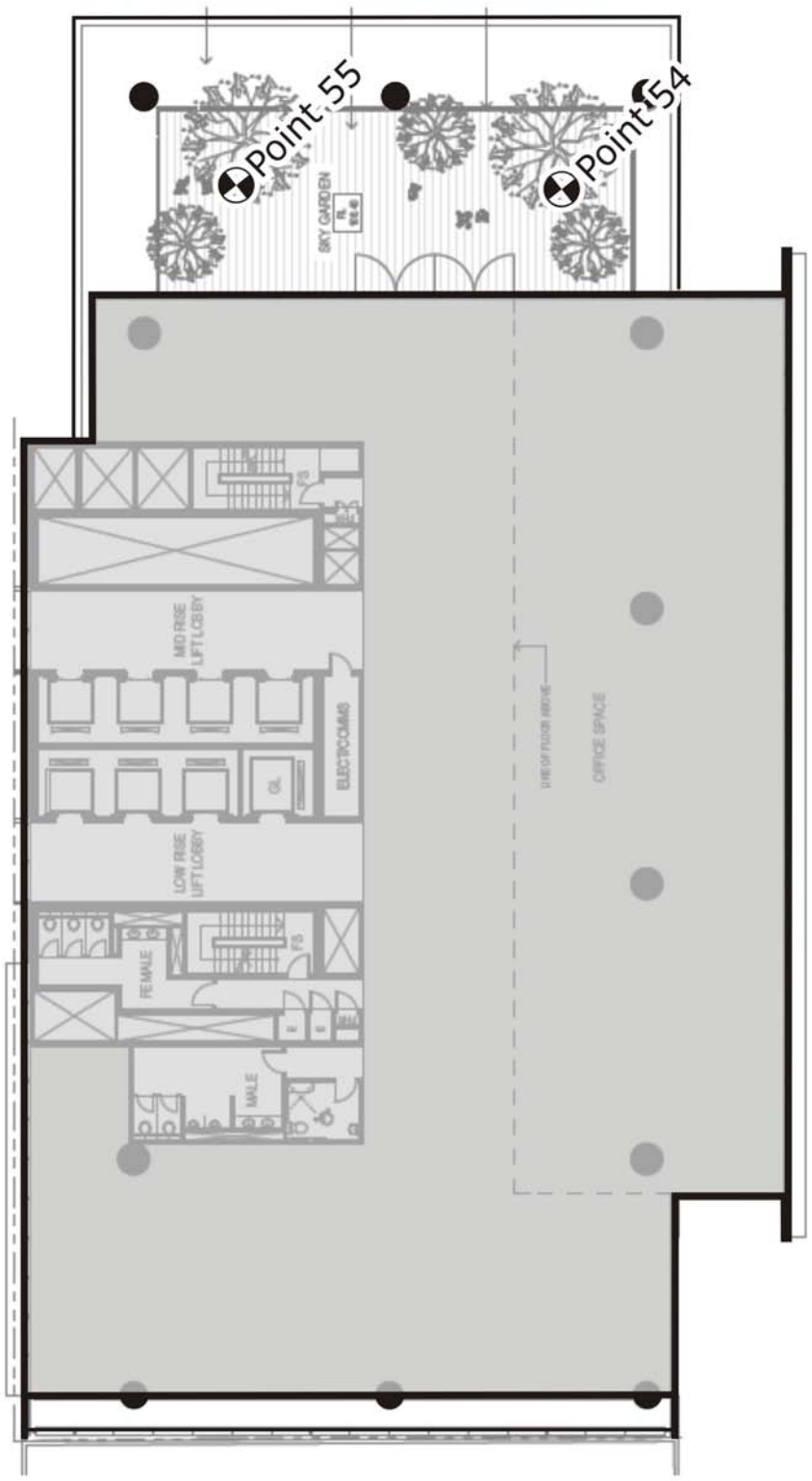

Figure 6f: Study Point Locations
Level 20 Sky Garden – 100 Mount Street

5.0 Results of Study

A detailed study of wind activity around and within the various outdoor areas of the proposed development sites and the existing neighbouring Beau Monde residential tower, Fire Station Hotel and Tower Square was carried out. A total of 82 study locations were chosen for detailed analysis as shown in Figures 6a and 6f. These include 51 ground level test point locations, 10 test point locations on various terrace areas on the Restaurant Level of the 88 Walker Street & 77-81 Berry Street development, 4 test points on the Level 8 Roof Garden of the 100 Mount Street development, and 2 test points on the Level 20 Sky Garden of the 100 Mount Street development. 15 test points were used to monitor wind conditions on the existing Tower Square, Beau Monde residential tower and Fire Station Hotel outdoor areas.

Initially the existing wind conditions were measured around the subject development sites. These tests included the effect of the existing vegetation. The wind conditions within and around the proposed development sites were then measured and, where applicable, compared with the existing results. It should be noted that the initial tests of the proposed tower developments were undertaken without the effect of any form of wind ameliorating devices such as balustrades or screens not shown in the architectural design. The initial tests with the proposed developments also ignored the effect of existing and/or proposed vegetation. For areas not achieving appropriate wind conditions retesting was undertaken with various forms of ameliorative treatments until an effective outcome was reached.

A secondary massing model case was tested for the 88 Walker Street & 77-81 Berry Street development to determine the wind effects of a building envelope which encompassed the restraints of the site limitations. This hypothetical case encompasses the height of the development to be reduced to within the North Sydney Council DLEP controls and with the consequent extension of the tower plan towards the north (also to the 18m separation limit towards the Beau Monde tower as per the draft planning controls).

Plots of results of the local directional wind speeds for the various test locations, as derived from the wind tunnel tests, are presented in the attached Appendix A. These results were assessed using the annual maximum peak wind speed criteria as required by the North Sydney Development Control Plan (DCP), as outlined in Section 4.5 of this report, for the public areas of the development. The weekly maximum GEM wind speeds are also presented and are used for the private terraces and balcony areas of the various tower developments. For the street level area, if existing conditions already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for the subject proposed developments are not to result in an exceedence of the existing wind speeds.

5.1 Pedestrian Areas along Denison Street

The Study Points

Test Points 1 to 3, 5 to 8, 56 and 57 are used to monitor the ground level wind conditions of the pedestrian footpath areas along Denison Street on the western perimeter of the proposed development. The location of each Test Point is shown in Figure 6a.

Applicable Criteria

Test Points 1 to 3, 5 to 8, 57 and 58 represent the ground level pedestrian areas along Denison Street that are accessible by pedestrians. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results with the inclusion of the proposed developments indicate that wind conditions at all of the study point locations along Denison Street will exceed the 13m/s requirement of the North Sydney DCP for the annual maximum peak wind speeds. Retests were undertaken with the addition of the vegetation scheme indicated in the architectural drawings. The results of the retest indicate that the vegetation scheme was effective in mitigating the adverse wind conditions for most of these study point locations.

Additional tests were performed for Test Points 7 and 8, which are still exposed to adverse westerly to southerly winds, with additional densely foliating trees. Test Points 56 and 57, which are still exposed to adverse southerly and north-easterly winds, were also retested with the inclusion of an impermeable balustrade at the corner of Denison and Spring Street similar to what is currently in place and a 1.2m high shrub at the corner of Denison and Mount Streets. These treatments are shown in Figure 7a. The results of these retests indicates that these additional treatments will be effective in mitigating the adverse winds affecting these locations, and the wind speeds will be better than the corresponding existing wind conditions.

Due to the westerly winds, the trees along Denison Street should be of a densely foliating evergreen variety to be effective in mitigating the westerly winds which are predominant during the winter months for Sydney. Alternatively, a 2 metre deep awning along the western aspect of the development at Level 1 from the Street between Denison Street and Little Spring Street to the north of the site with densely foliating trees would be required.

5.2 Pedestrian Areas along the Street between Denison Street and Little Spring Street

The Study Points

Test Points 4 and 11 are used to monitor the ground level wind conditions of the pedestrian footpath areas along the street linking Denison Street with Little Spring Street, which cuts through the podium of the 88 Walker & 77-81 Berry Street proposed development. The location of each Test Point is shown in Figure 6a.

Applicable Criteria

Test Points 4 and 11 represent the ground level pedestrian areas along the street across the proposed development site from Denison Street to Little Spring Street. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The street through the site connecting Little Spring and Denison Street does not currently exist as this is a proposed street to be added as part of the development.

The initial test results for Test Points 4 and 11 indicate this area of the site is exposed to strong westerly and north-easterly winds being downwashed and funnelled through the street which cuts through the podium and under the main tower across the site. Test Point 4 and 11 were retested with the addition of an awning on the northern and southern aspects of the street at Level 1. The result of these retests indicates that this wind deflector/awning will be effective in mitigating the adverse north-easterly and south-easterly winds from being downwashed to this location, however the results also indicated that there will be no improvement to the adverse westerly winds in these locations. An additional tree was modelled at the south-western corner of the street, as indicated in Figure 7a. Points 4 and 11 were retested, and the results indicated that with an awning on the southern and northern aspects of the street, and with an additional densely foliating evergreen tree at the south-western corner of the street, wind conditions at these locations will be equivalent to the existing conditions, and are acceptable.

5.3 Pedestrian Areas along Spring Street

The Study Points

Test Points 9 to 10, 12 to 15 and 58 to 60 are used to monitor the ground level wind conditions of the pedestrian footpath areas along Spring Street between the proposed two developments. The location of each Test Point is shown in Figure 6a.

Applicable Criteria

Test Points 9 to 10, 12 to 15 and 58 to 60 represent the ground level pedestrian areas along Spring Street that are accessible by pedestrians. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results with the inclusion of the proposed developments indicate that wind conditions at Study Points 9, 10, 12 to 15 and 58 to 60 will exceed the 13m/s requirement of the North Sydney DCP for the annual maximum peak wind speeds. Retests were undertaken with the addition of the trees indicated in the architectural drawings. The results of the retest indicate that the trees are effective in improving wind conditions. The results for Test Point 9 indicate that wind conditions will be within 13m/s for the annual maximum gust wind speeds. The retest results for Point 10, 58 and 60 indicated that wind conditions will be better than the corresponding existing wind conditions at that location. Hence, with the addition of the trees in the locations as indicated in the architectural drawings, wind conditions at Test Points 9, 10, 58 and 60 will be acceptable.

The results of the retest indicated that the vegetation scheme was not effective in ameliorating the adverse westerly to southerly and north-easterly winds at Test Points 12 to 15 and 58. These locations were again retested, this time with the addition of a row of densely foliating trees along the northern boundary of Spring Street and western boundary of Little Spring Street, and a single densely foliating tree on the southern side of Spring Street (opposite Little Spring Street), as indicated in Figure 7a. The results of these retests indicate that the additional densely foliating trees were effective in mitigating the wind conditions affecting Test Points 12 to 15 and 58 so that the 13m/s criterion is satisfied for the annual maximum peak wind speeds.

5.4 Pedestrian Areas along Little Spring Street

The Study Points

Test Points 16 to 23 are used to monitor the ground level wind conditions of the pedestrian footpath areas along Little Spring Street between the 88Walker and 77-81 Berry Street development. The location of each Test Point is shown in Figure 6a.

Applicable Criteria

Test Points 16 to 23 represent the ground level pedestrian areas along Little Spring Street that are accessible by pedestrians. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results with the inclusion of the proposed developments indicate that wind conditions for all of the test points along Little Spring Street will exceed the 13m/s requirement of the North Sydney DCP for the annual maximum peak wind speeds. The test points located along Little Spring Street and underneath the bridge link are exposed to adverse north-easterly and westerly to southerly winds. These study locations were retested with the addition of a row of densely foliating trees along Little Spring Street as indicated in Figure 7a. The results of this retest indicate that these densely foliating trees are effective in mitigating the adverse wind conditions observed at Test Points 16 to 21, although the measured wind conditions at Test Points 17 and 19 still exceed the 13m/s criterion. However, with the addition of the trees the wind conditions at Test Points 17 and 19 were ameliorated such that the wind speeds are better than the corresponding existing wind conditions. Hence, with the recommended treatments as indicated in Figure 7a, wind conditions along the pedestrian footpaths of Little Spring Street will be acceptable.

The bridge over Little Spring Street is removed from the current design, the wind conditions on the ground level around this area is expected to be improved, as previously the wind was funnelling underneath the bridge.

5.5 Pedestrian Areas along Walker Street

The Study Points

Test Points 24 to 26 and 61 to 63 are used to monitor the ground level wind conditions of the pedestrian footpath areas along Walker Street at the eastern side of the proposed developments. The location of each Test Point is shown in Figure 6a.

Applicable Criteria

Test Points 24 to 26 and 61 to 63 represent the ground level pedestrian areas along Walker Street that are accessible by pedestrians. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results with the inclusion of the proposed developments indicate that wind conditions at all of these study point locations will exceed the 13m/s requirement of the North Sydney DCP for the annual maximum peak wind speeds. Retests were undertaken with the addition of the existing trees at the corner of Walker and Spring Streets. The results of the retest indicate that the trees are effective in mitigating the adverse westerly to southerly winds at Test Points 24 and 25, and that the measured wind speeds will be better than the corresponding existing wind conditions at these locations.

The results of the retest for Test Point 26 indicate that this location was still exposed to adverse westerly to southerly winds. This location was again retested with the addition of another densely foliating tree north of the point. The result of this retest indicates that the additional densely foliating tree will be effective in mitigating the adverse winds affecting Point 26, and will result in wind conditions which will be better than the existing wind conditions for that location.

Since the existing trees along Walker Street are of a deciduous species, an alternative treatment options were sought to ameliorate the adverse westerly winds which tend to occur during the winter months (westerly winds occur predominantly during the winter months for the Sydney region, as indicated in Table 2). The inclusion of the existing 1.2m high impermeable parapet on the neighbouring building to the south and an awning on Level 1 of the 88 Walker Street hotel tower proposed development were tested. With these treatments, wind conditions along Walker Street during the winter months, even when the deciduous streets are not effective in wind mitigation, will be better than the measured existing wind conditions.

The initial test results indicate that Test Points 61 to 63 will all exceed their applicable wind comfort criterions due to strong northerly and southerly winds. Retests were undertaken with the addition of an awning at the south-eastern corner of the development. The results of the retest indicate the awning was effective in partially ameliorating the wind conditions at Test Points 61 to 63. Unfortunately, the Test Points still exceeded their applicable wind comfort criterion. The Test Points were retested with additional tree plantings along Mount and Walker Street as indicated in Figure 7a. The results of the retests indicate that the trees and awnings would be effective in reducing wind conditions to be within existing conditions. As this area is proposed as a café area, the use of portable 1.2m high impermeable screens is advisable during events of strong southerly or north-easterly winds. These portable screens would need to be placed at the corner of Mount and Spring Street as well as on Mount Street, as indicated in Figure 7a.

5.6 Pedestrian Areas along Mount Street

The Study Points

Test Points 64 to 72 are used to monitor the ground level wind conditions of the pedestrian footpath areas along Mount Street at the southern perimeter of the proposed 100 Mount Street development. The location of each Test Point is shown in Figure 6a.

Applicable Criteria

Test Points 64 to 72 represent the ground level pedestrian areas along Mount Street that are accessible by pedestrians. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results indicate that the wind conditions at all of the Test Points with the exception of Test Point 69 are equivalent to or better than that of the existing wind conditions for the respective areas without the requirement of additional ameliorative devices.

The results indicate Test Point 69 is susceptible to adverse wind conditions from the westerly to southerly and north-easterly wind directions. It was noted that the southerly winds were downwashing from the middle of the southern aspect of the proposed tower (above the main entry) and sidestreaming under the proposed awning and around the corner of Mount and Walker Streets. Test Point 69 was retested with the addition of a 4m deep awning on the south-eastern corner of the development, as proposed. The results of the retest indicate that the awning was not effective in mitigating the adverse wind conditions at Test Point 16. Retests were performed with the extension of the awning along Mount Street to meet the adjacent building to the west of the site. However the downwashed winds above the main entrance were being deflecting by the extended awning and directed under the awning on the eastern side towards Walker St.

This was finally retested with the inclusion of the trees along Mount Street, similar to that indicated in the Public Domain Landscape drawings, making sure that the canopies of the trees overlapped the awning for all areas along Mount Street. The retests indicate the combination of awning and trees were effective in mitigating wind conditions at Test Point 69 to be within the existing wind conditions. With the inclusion of these treatments, Test Point 67 will also satisfy the short exposure criterion of 13m/s for annual maximum peak wind speeds.

Due to the size of the trees required along Mount Street to be able to overlap the awning, retests were conducted for Test Point 69 to model the effect of the trees at the time of their initial growth (prior to reaching maturity). The retests indicated that the smaller tree sizes can be temporarily supplemented by portable 1.2m high screens, east of Test Point 16, similar to that shown in Figure 7a until the trees reach maturity. The results of the retest indicate the combination was effective in mitigating the wind conditions at Test Point 16 from all directions, satisfying the short exposure wind comfort criterion until the trees along Mount Street have grown to a size where their performance in wind mitigation takes full effect.

5.7 Pedestrian Areas along Berry Street

The Study Points

Test Points 37 to 39 are used to monitor the ground level wind conditions of the pedestrian footpath areas along Berry Street located to the north of the entry to the existing Beau Monde residential tower. The location of each Test Point location is shown in Figure 6a.

Applicable Criteria

Test Points 37 to 39 represent the ground level pedestrian areas along Berry Street that are accessible by pedestrians. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results for Test Points 37 and 39 indicate this area of Berry Street, without the inclusion of any trees, is exposed to strong north-easterly, westerly and southerly winds. With the inclusion of the proposed developments, westerly winds are funnelled along Denison Street while south-easterly winds are funnelled along Little Spring Street, causing wind conditions on Berry Street to exceed the current wind conditions. With the inclusion of the recommended tree planting scheme along Little Spring Street and Denison Street as indicated in Figure 7a, wind conditions along Berry Street will be similar to or better then the existing wind conditions.

5.8 Ground Level Pedestrian Through Site Link (Mount and Spring Street)

The Study Points

Test Points 81 and 82 are used to monitor the ground level wind conditions of the pedestrian through site link connecting Mount and Spring Street in the middle of the site. The location of each Test Point location is shown in Figure 6a.

Applicable Criteria

Test Points 81 and 82 represent the ground level pedestrian through site link. These areas are primarily used as pedestrian thoroughfares. If existing wind conditions at the entrances to the through site link already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results indicate that Test Points 81 and 82 will exceed the short exposure wind comfort criterion, with Test Point 82 exceeding the Safety Limit for north-westerly winds. Test Point 82 was retested with the inclusion of trees at the corner of Spring Street and Little Spring Street as indicated in Figure 7a and found to be within existing wind conditions.

Retests for Test Point 81 was conducted with the inclusion of an awning over the entrance area for the development which was found to make wind conditions for the through link worse due to an entrapment of the downwashed winds from the tower section above and funnelling through the site link. Retests were then conducted with the inclusion of the awning and also tree planting along Mount

Street similar to that indicated in the Public Domain Landscaping Plan, making sure the tree canopy overlaps the recommended awnings. With the combination of these two treatments, wind conditions would generally satisfy the Comfortable Walking Criterion of 16m/s for annual maximum peak wind speeds. With the inclusion of densely foliating shrubs at the base of the trees on Mount Street, wind conditions at the entrance to the through site link are expected to satisfy the short exposure criterion of 13m/s for annual maximum peak wind speeds.

5.9 Restaurant Level Outdoor Terrace Areas of the 88 Walker & 77-81 Berry Streets Development

The Study Points

Test Points 27 to 36 are used to monitor the wind conditions on the various outdoor terrace areas on the Restaurant Level of the proposed development. Note that this area was tested for two cases; with the proposed 88 Walker & 77-81 Berry Streets design, and with the design based on the council massing model limitations for the site. The locations of the Test Point are shown in Figure 6b.

Applicable Criteria

Test Points 27 to 36 represent the communal garden terrace areas on the Restaurant Level. These areas are accessible by tenants of the development and are used primarily as an outdoor dining area. Hence the appropriate wind comfort criterion to be satisfied for this area is the short exposure criterion of 5.5m/s for weekly maximum GEM wind speeds.

The appropriate wind comfort criteria for these areas are also indicated in Figure 6b. Note that the safety limit of 23m/s for annual maximum peak wind speeds should also be satisfied for all study points.

Results and Recommendations

The initial test results with the inclusion of the proposed 88 Walker & 77-81 Berry Streets design indicate that only Test Point 35 will satisfy the recommended short exposure wind comfort criterion for the weekly maximum GEM wind speeds. The results indicate that the outdoor dining area is exposed to strong north-easterly and westerly winds. This area was retested with the addition of a 1.2m high impermeable balustrade along the perimeter of the terrace as well as the trees and shrubs in the landscaping plan, as indicated in Figure 7b. A 1.2m high impermeable balustrade was also added to the perimeter of the proposed terrace along the western side of the development to assist in mitigating the adverse winds affecting that area.

The results of the retests indicate that the 1.2m high impermeable balustrade and landscaping plan were effective in ameliorating the adverse wind conditions to these areas. Hence it is recommended that the impermeable balustrades and landscaping plan be included into the final design of the proposed development,

and that with this recommendation these areas will be suitable for their intended uses.

Additional tests were undertaken for the design based on the council massing model limitations for the site. The results indicate that wind conditions for the Restaurant Level terrace area will be similar to or worse than the measured wind conditions with the current proposed design. The adverse wind effects are due to the increased aspect of the building producing a larger surface area to downwash and funnel the westerly and easterly winds building and the podium beneath. Ameliorative treatments for this alternate site design were not examined in this scope of work.

5.10 Level 8 Roof Garden Terrace of the 100 Mount Street Development

The Study Points

Test Points 73 to 76 are used to monitor the wind conditions on the Level 8 Roof Garden terrace of the proposed 100 Mount Street development. The locations of the Test Point are shown in Figure 6e.

Applicable Criteria

Test Points 73 to 76 represent the communal Roof Garden terrace areas above the Retail Level of the proposed 100 Mount Street development. These areas are accessible by retail customers and tenants of the development and are used primarily for pedestrian activities. Hence the appropriate wind comfort criterion to be satisfied for this area is the comfortable walking criterion of 7.5m/s for weekly maximum GEM wind speeds.

The appropriate wind comfort criteria for these areas are also indicated in Figure 6e. Note that the safety limit of 23m/s for annual maximum peak wind speeds should also be satisfied for all study points.

Results and Recommendations

The initial test results for Test Point locations 73 to 76 indicate these areas of the development are exposed to strong north-easterly and southerly winds that are funnelled through the void between the terrace and the tower above. Retests were undertaken with the addition of a 1.5m high impermeable balustrade around the perimeter of the terrace areas as illustrated in Figure 7c. The results of the retest indicate the impermeable screen is effective in ameliorating the adverse wind conditions and desired comfortable walking wind comfort criterion is satisfied. Hence it is recommended that these treatments be included into the final design of the proposed development so that these areas will be suitable for their intended uses. Note that tests were conducted with and without the 4.6m high glass enclosed feature on the eastern end of the Roof Garden. It was found that without a feature of similar size and shape to disturb the wind flow, and with the 1.5m high screens included, wind conditions at the eastern end of the Roof Garden will exceed the recommended wind comfort criterion. The inclusion of densely foliating trees and shrubs as indicated on the

architectural is expect to further improve wind conditions for their intended uses.

If the western end of the Level 8 Podium area is raised by 1 Level, it is recommended that a full height screen be implemented along the northern edge of the western podium area to mitigate any adverse winds from downwashing from the tower above and funnelling between the tower and podium of the development.

5.11 Level 20 Sky Garden Terrace of the 100 Mount Street Development

The Study Points

Test Points 54 and 55 are used to monitor the wind conditions at the Level 20 Sky Garden terrace area at the eastern aspect of the proposed 100 Mount Street development. The locations of the Test Point are shown in Figure 6f.

Applicable Criteria

Test Points 54 and 55 represent wind conditions for the communal Sky Garden terrace. This area is accessible by tenants of the development and is used primarily as for pedestrian activities. Hence the appropriate wind comfort criterion to be satisfied for this area is the comfortable walking criterion of 7.5m/s for weekly maximum GEM wind speeds.

The appropriate wind comfort criteria for these areas are also indicated in Figure 6f. Note that the safety limit of 23m/s for annual maximum peak wind speeds should also be satisfied for all study points.

Results and Recommendations

The initial test results for Test Point locations 54 and 55 indicate this area of the proposed 100 Mount Street development is exposed to strong northerly and southerly winds caused by direct exposure and a lack of shielding provided by neighbouring buildings at this height above ground. Retests were undertaken with the addition of 1.5m high impermeable balustrades along the northern, eastern and western aspects setback from the edge of the Sky Garden terrace area. The results of the retest indicate the impermeable balustrade was effective in ameliorating the adverse wind conditions at Test Point 54 but was not sufficient to satisfy the desired wind comfort criterion for Test Point 55.

Test Point 55 were retested with the addition of a densely foliating tree located at the northern end of the Sky Garden, similar to that indicated in Figure 7c. The results of the retest indicated that this treatment scheme was effective in ameliorating the adverse winds, and conditions will be acceptable for the intended uses of that area.

5.12 Tower Square Outdoor Areas

The Study Points

Test Points 40 to 42 were used to monitor the wind conditions for existing outdoor areas located in the Tower Square building located on Denison Street to the west of the proposed development sites. The locations of these Test Points are shown in Figure 6c.

Applicable Criteria

Test Points 40 to 42 represent the nearby outdoor areas located in the Tower Square building. These areas are expected to be used for short duration activities. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The results indicate that, with the addition of the proposed developments, wind conditions at Test Points 40 to 42 will satisfy the 13m/s wind speed criterion of the North Sydney DCP. The results also indicate that wind conditions will be similar to or better than the current existing conditions for these outdoor areas. Hence these areas will continue to be suitable for their intended uses with the addition of the proposed developments.

5.13 Beau Monde Residential Tower Balcony and Podium Areas

The Study Points

Test Points 43 to 53 were used to monitor the wind conditions at existing outdoor balcony and podium areas located on the southern aspect of the existing Beau Monde residential tower located to the north of the development sites. The locations of the Test Point are shown in Figure 6d.

Applicable Criteria

Private balconies are generally used infrequently, and the wind criterion typically applied to these is the safety limit of 23m/s for the annual maximum gust wind speeds. Note that the use of light-weight furniture or other light-weight items is not recommended for high-rise balcony areas where there is a risk of these types of items being carried by the wind.

Results and Recommendations

Testing of the current wind conditions on the podium and in the various critical balcony areas located on the southern aspect of the Beau Monde building, indicate that the existing conditions are within the safety limit with the exception of the mid to upper level corner balconies.

With the inclusion of the two proposed developments, wind conditions on the podium and the various critical balcony locations of the Beau Monde tower are generally equivalent to or better than the current wind conditions.

Additional testing was performed to investigate the effect of a hypothetical case where the massing for the 88 Walker Street & 77-81 Berry Street development is altered such that the height is reduced to be within the North Sydney Council DLEP controls and with the consequent extension of the tower plan towards the north (also to the 18m limit to the Beau Monde residential tower of the draft planning controls). The hypothetical model results in a slight overall improvement of the wind conditions in the southern corner balconies of the Beau Monde tower. However the Beau Monde balconies located in the middle of the southern aspect (for the various levels of the tower) experienced increased wind speeds due to the narrower gap between the two buildings.

5.14 Nearby Outdoor Ground Level Eateries

The Study Points

Test Points 77 to 80 were used to monitor the wind conditions at existing outdoor ground level eateries linked to adjacent buildings around the development sites as indicated by the client. The locations of the Test Point are shown in Figure 6a.

Applicable Criteria

Test Points 77 to 80 represent the nearby outdoor eateries. These areas are used for short duration activities. If existing wind conditions for these areas already exceed the criteria of the North Sydney DCP of 13m/s for the annual maximum peak wind speeds, then wind conditions for these areas with the proposed development are not to result in an exceedence of the existing wind speeds.

Results and Recommendations

The initial test results with the inclusion of the proposed developments indicate that wind conditions at Test Points 77 and 80 will generally satisfy the 13m/s wind speed requirement by the North Sydney DCP. Although the wind conditions at Test Points 78 and 79 exceeded 13m/s, they were generally either equivalent to or better than the maximum values recorded for the existing wind conditions. Hence with the addition of the proposed developments these areas will continue to be suitable for their intended uses.

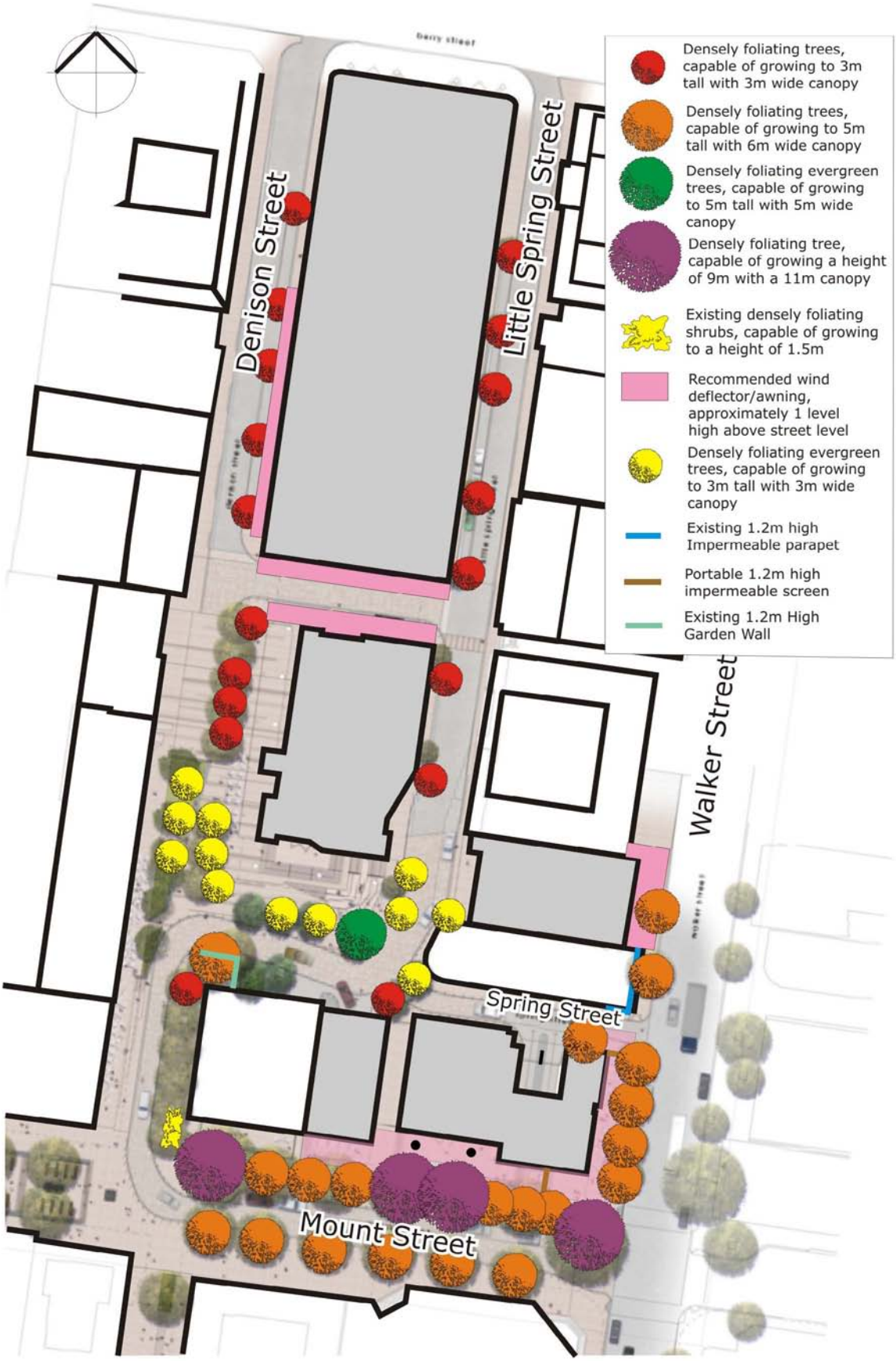

Figure 7a: Recommended Treatments - Ground Level

Figure 7b: Recommended Treatments
Restaurant Level - 88 Walker & 77-81 Berry Streets

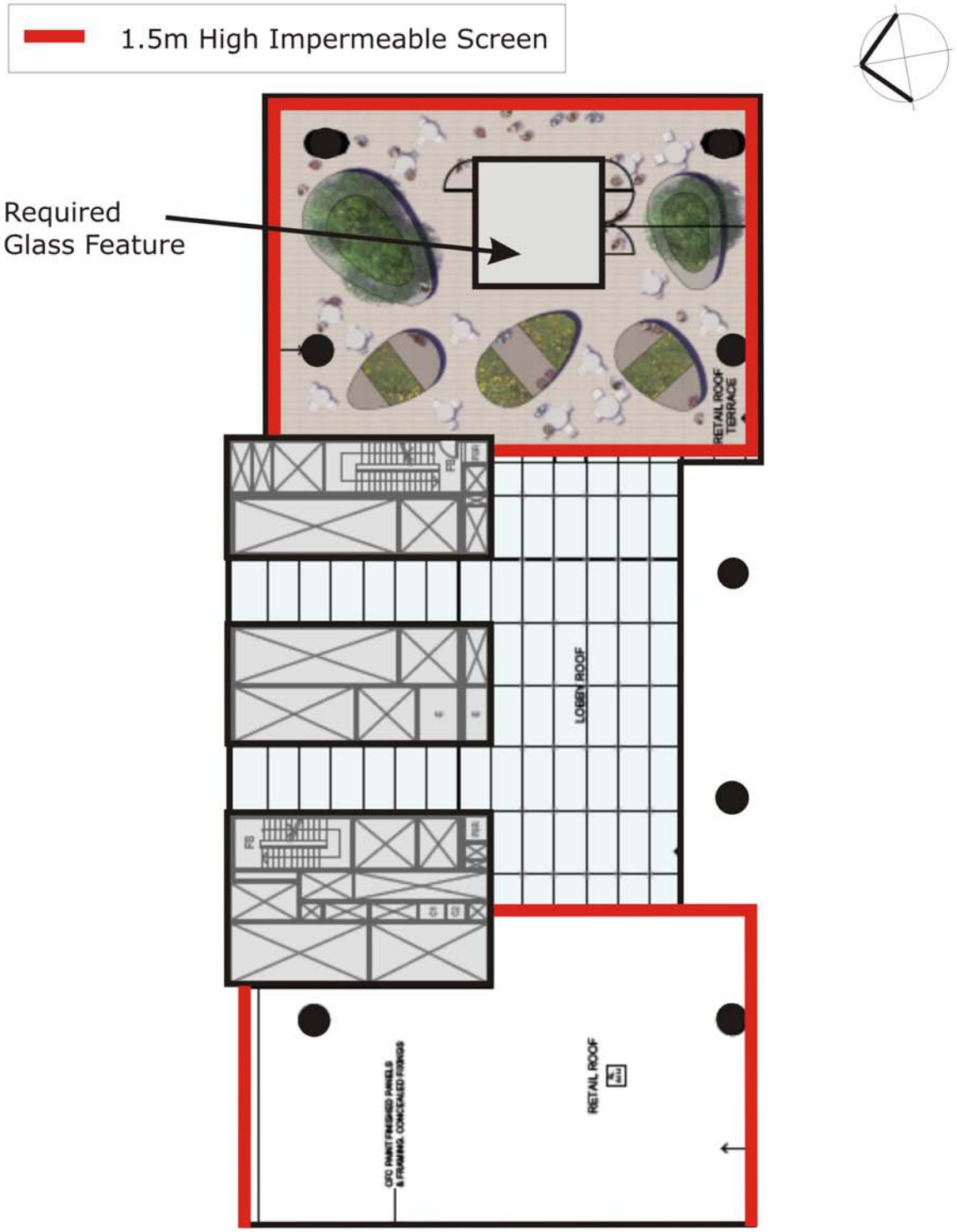

Figure 7c: Recommended Treatments
Level 8 Roof Garden – 100 Mount Street

Figure 7d: Recommended Treatments
Level 20 Sky Garden – 100 Mount Street

6.0 Conclusion

The results of this wind tunnel study indicate that most of the outdoor areas of the various developments, including all ground level areas, will require ameliorative treatments to be implemented to result in acceptable wind conditions. Many forms of treatments have been investigated in this study to treat the adverse winds affecting the outdoor areas of the proposed development sites. A set of treatments have been recommended in this report to ameliorate these effects, and are summarised as follows:

- A strategic layout of densely foliating trees for the ground level areas within and around the two development sites.
- The addition of an awning above the street level along Walker Street for the 88 Walker & 77-81 Berry Street development.
- The addition of an awning above the street level along the eastern and southern aspects of the 100 Mount Street development.
- The addition of wind deflectors/awnings above the street level on the northern and southern aspects of the street linking Denison Street with Little Spring Street (which cuts through the podium of the 88 Walker & 77-81 Berry Street development).
- Additional awning along the western aspect of the 88 Walker & 77-81 Berry Street development or the use of evergreen trees along Denison Street.
- Strategic placement of portable 1.2m high impermeable screens within and around the Ground Level of the 100 Mount Street development site.
- Maintaining existing 1.5m high shrub at the corner of Denison and Mount Streets and the existing 1.2m high Garden Wall at the corner of Denison and Spring Streets.
- 1.2m high impermeable balustrades along the perimeter of the two terrace areas on the Restaurant Level of the 88 Walker & 77-81 Berry Street development, and a strategic layout of densely foliating shrubs.
- 1.5m high impermeable balustrades along the perimeter of the Level 8 Roof Garden terrace areas of the 100 Mount Street development.
- 1.5m high impermeable balustrade along the perimeter of the Level 20 Sky Garden terrace area of the 100 Mount Street development, setback from the edge. A densely foliating tree is also recommended for this area.

Note that for vegetation to be effective in mitigating adverse winds, particularly westerly winds which tend to occur predominantly during the winter months for the Sydney region, the trees along Denison Street and Spring Street should be of a densely foliating evergreen species as indicated in the report.

With the recommended treatments listed above included into the final design of the various developments, the wind conditions within and around the proposed development sites will be acceptable for their intended uses. The trees along Mount and Walker Streets are required to have a canopy which overlaps the recommended awning to be effective.

The effect of the proposed developments on the wind conditions in the outdoor areas pertaining to the existing neighbouring buildings were also tested in this study. This included four existing outdoor eatery areas around the 100 Mount Street development, the outdoor area within the Tower Square and Fire House Hotel buildings, and the balcony and podium areas within the Beau Monde residential tower on Berry Street. With the addition of the proposed developments it was found that wind conditions to these surrounding areas will generally be similar to or better than the existing.

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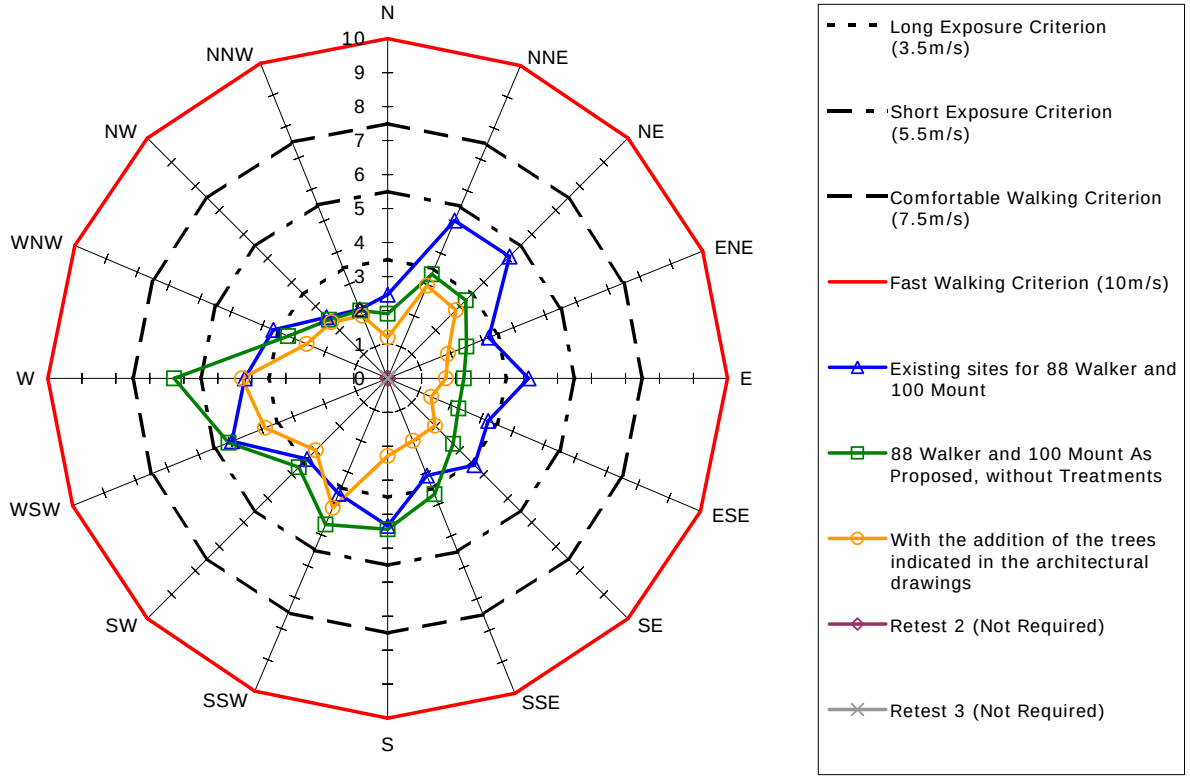
Appendix A

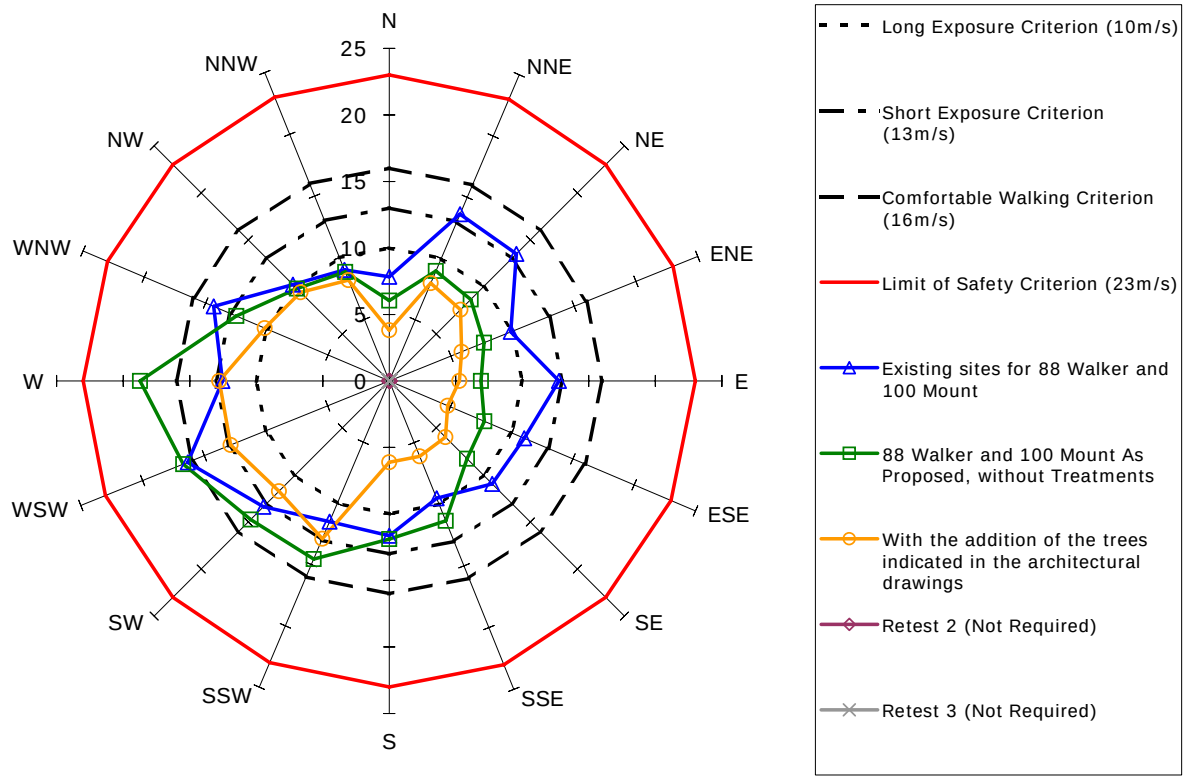
Plots of Wind Tunnel Results

Measured Wind Speeds at Point 01

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

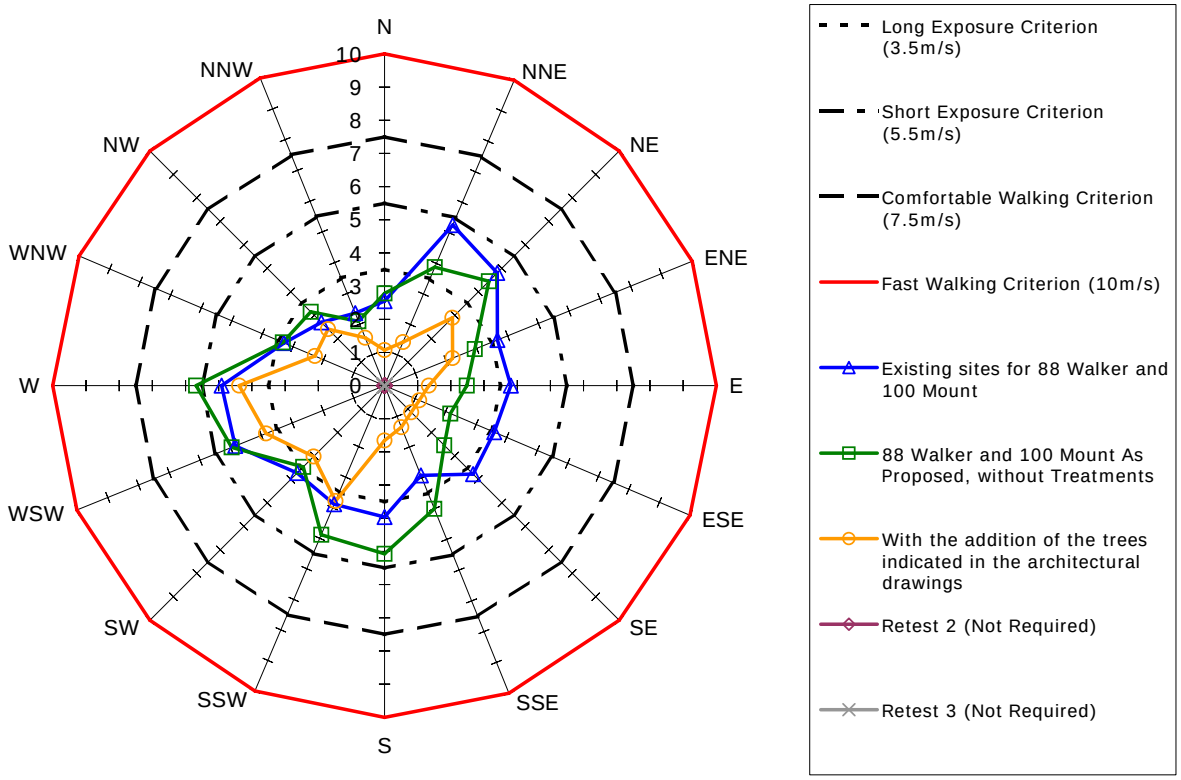


Annual Maximum Gust Wind Speeds (m/s)

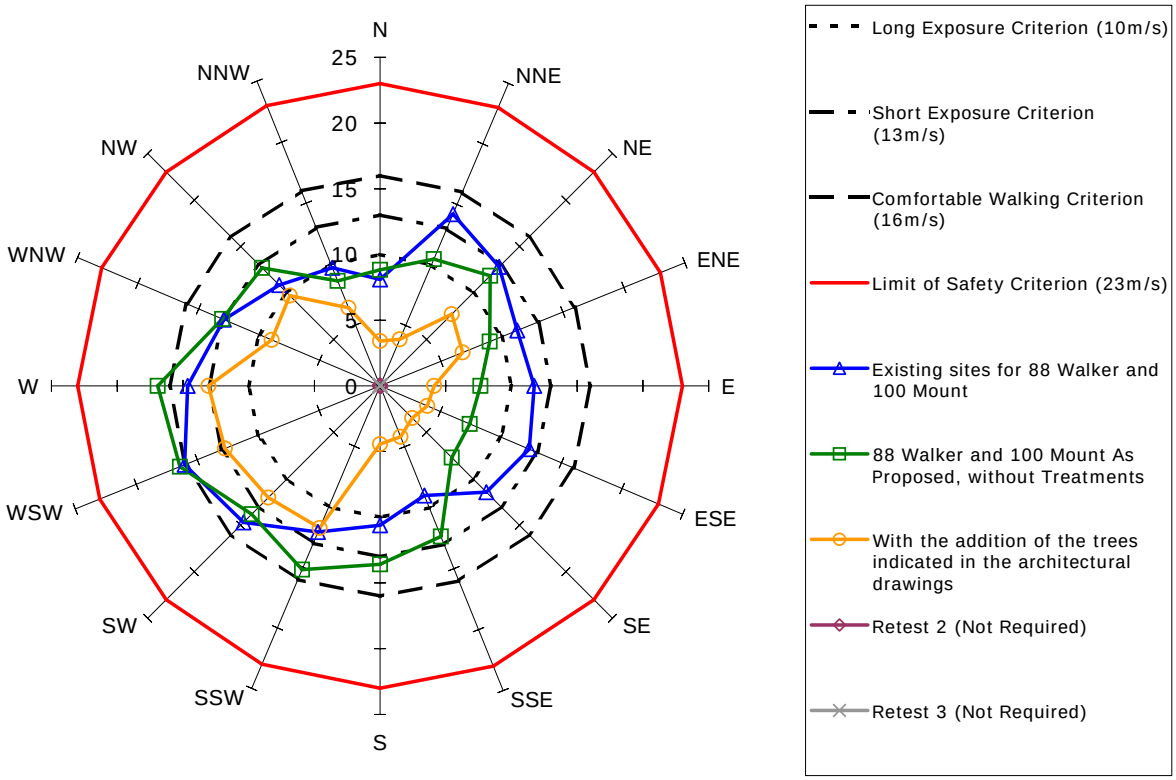


Measured Wind Speeds at Point 02

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

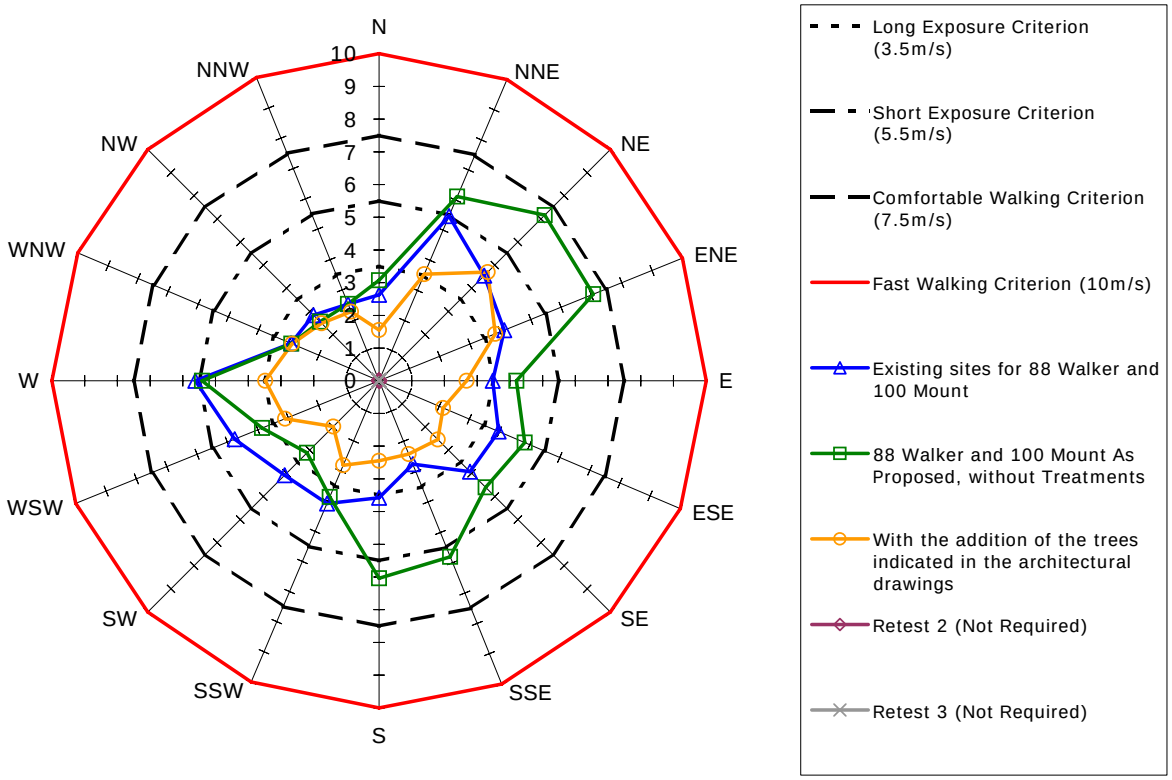


Annual Maximum Gust Wind Speeds (m/s)

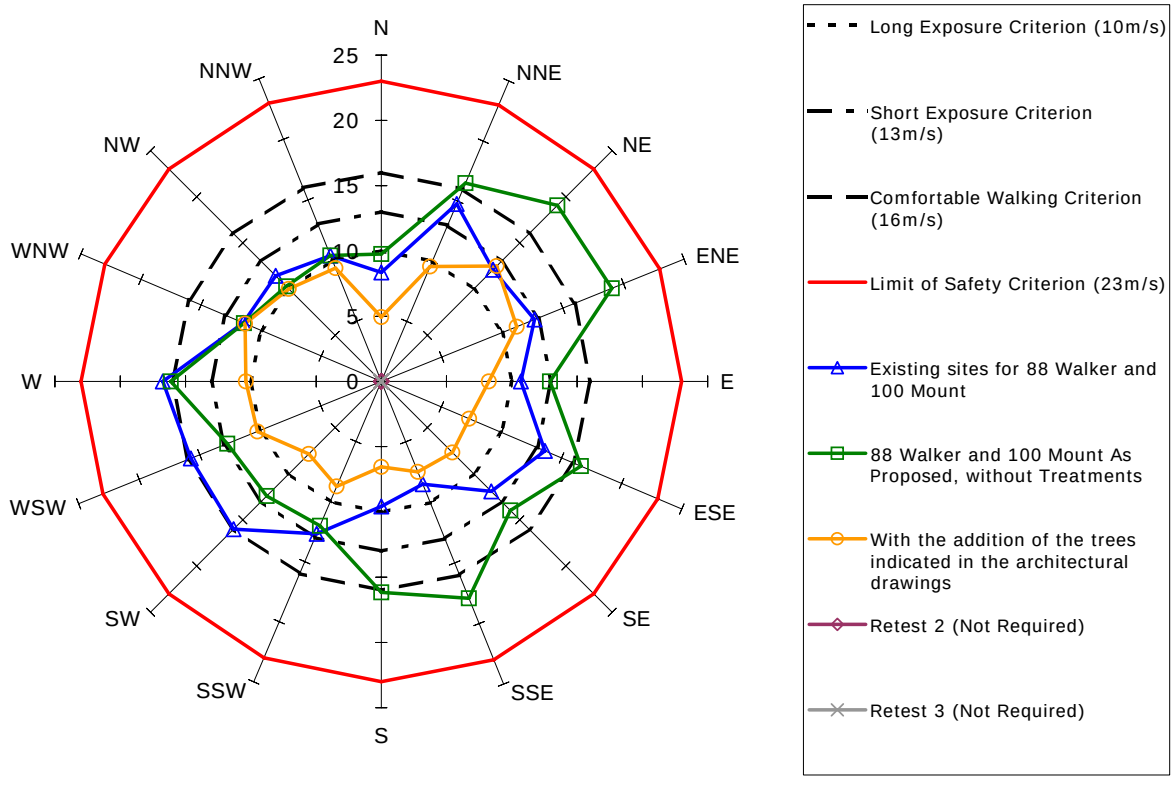


Measured Wind Speeds at Point 03

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

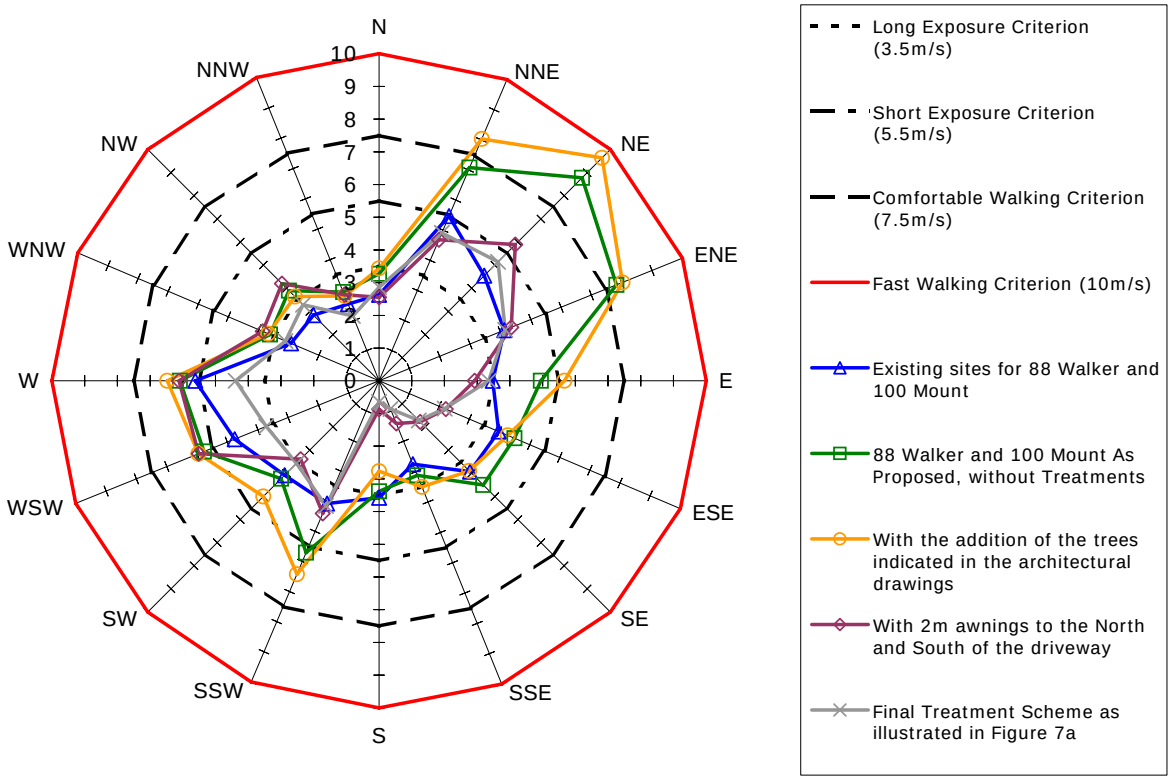


Annual Maximum Gust Wind Speeds (m/s)

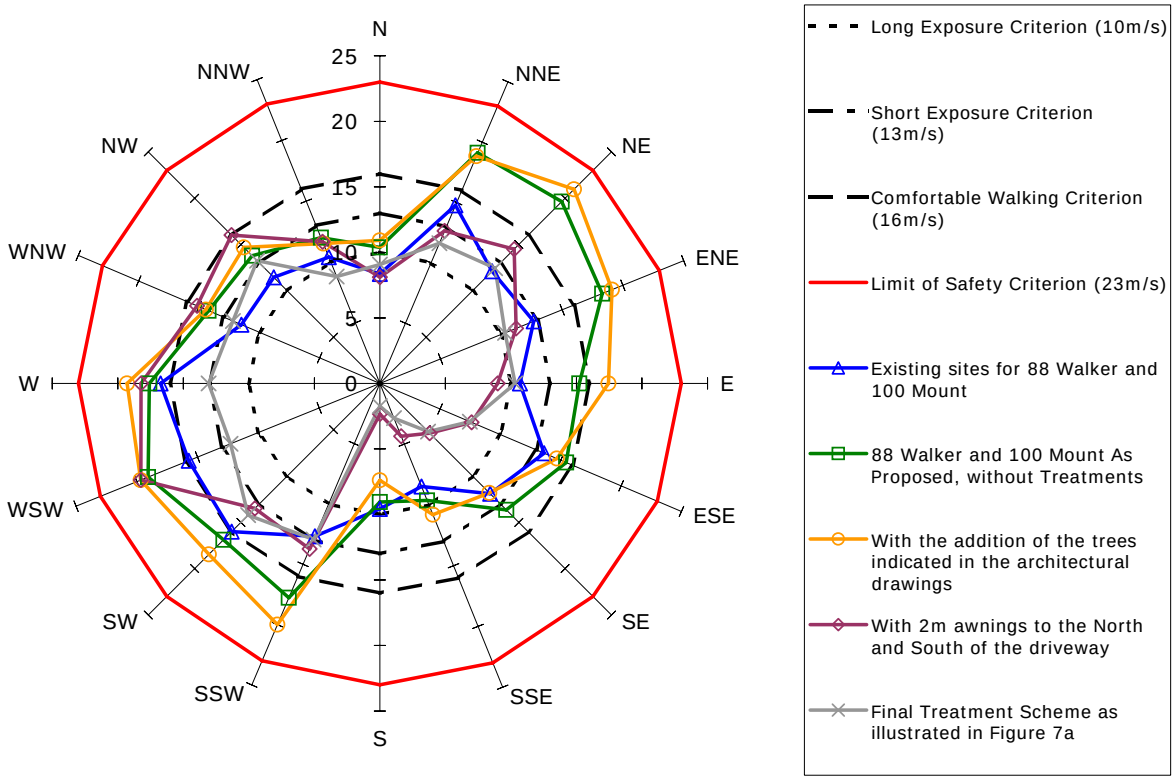


Measured Wind Speeds at Point 04

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

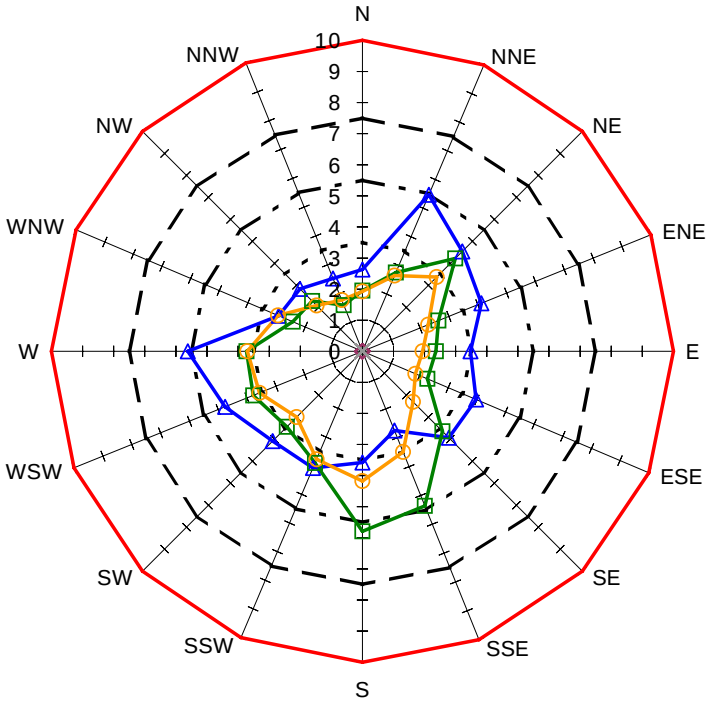


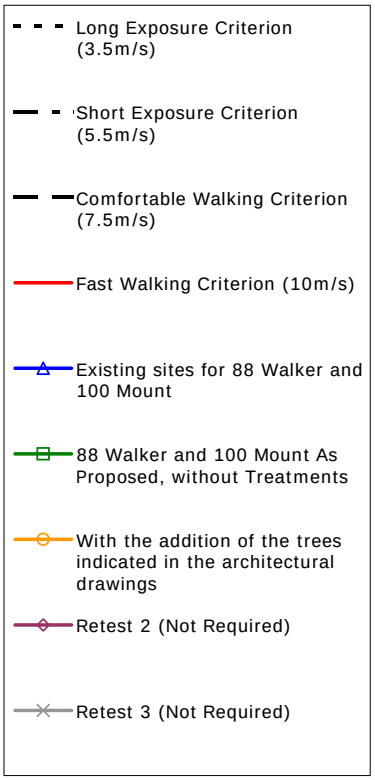
Annual Maximum Gust Wind Speeds (m/s)



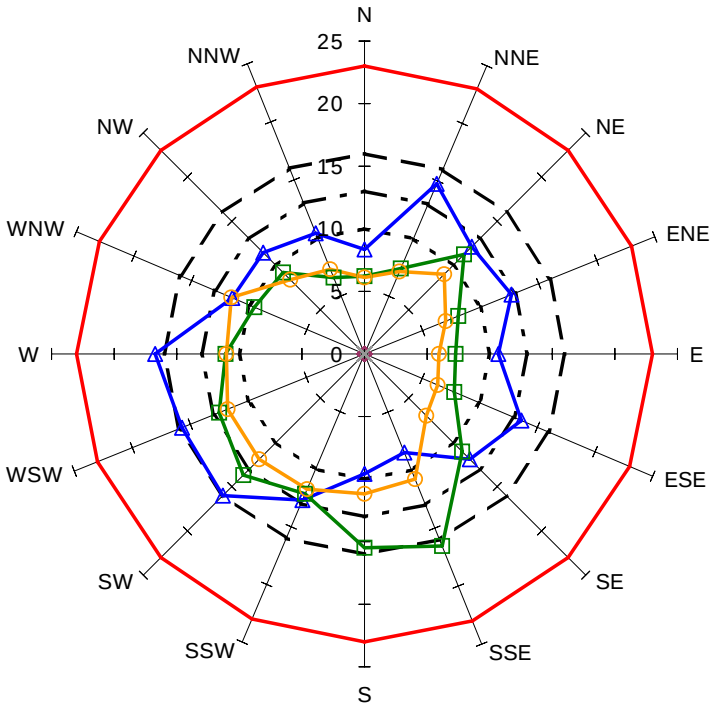
Measured Wind Speeds at Point 05

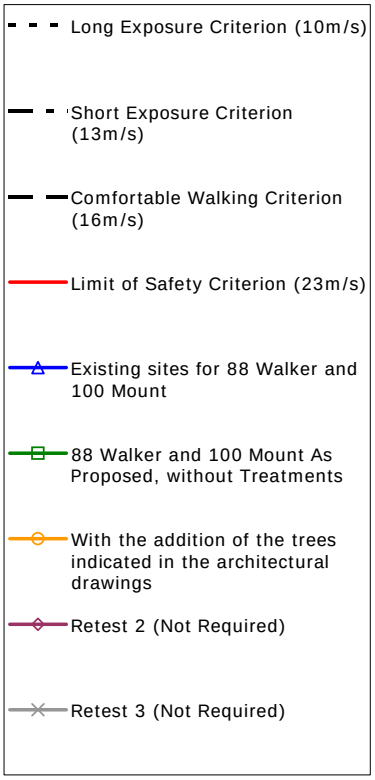
Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)





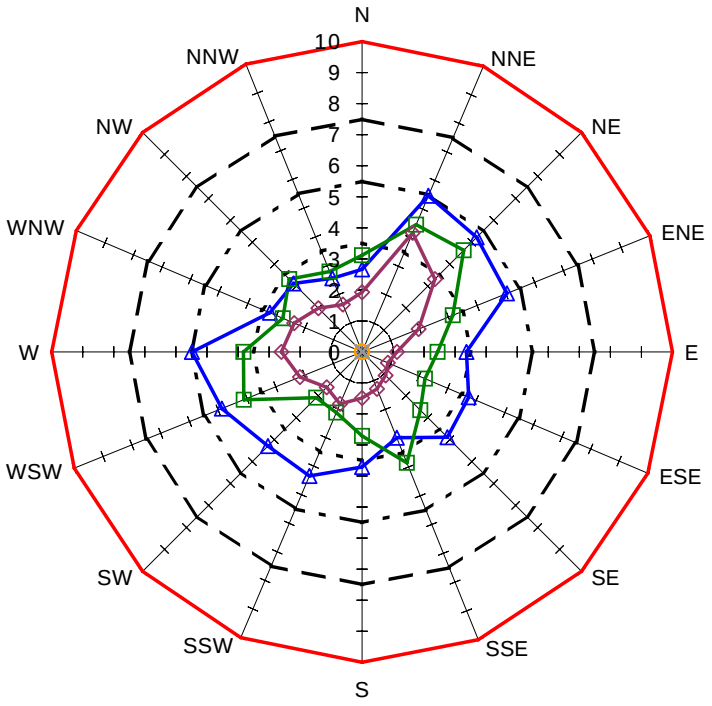
Annual Maximum Gust Wind Speeds (m/s)





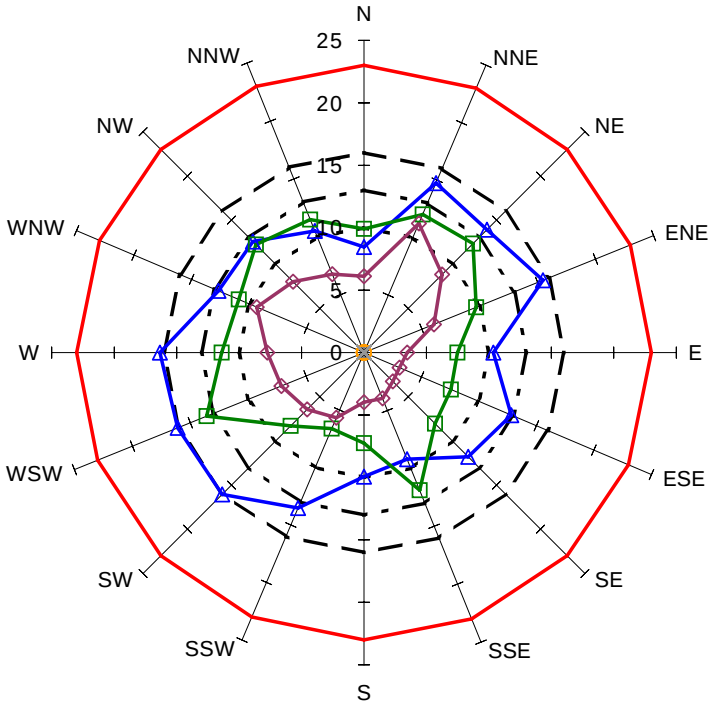
Measured Wind Speeds at Point 06

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- Retest 2 (Not Required)
- Final Treatment scheme as indicated in Figure 7a
- Retest 4 (Not Required)

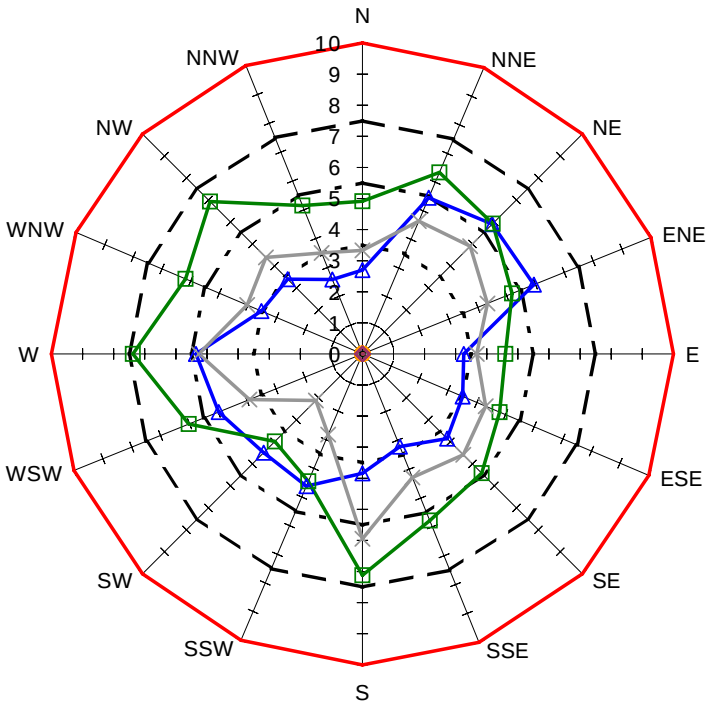
Annual Maximum Gust Wind Speeds (m/s)



- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- Retest 2 (Not Required)
- Final Treatment scheme as indicated in Figure 7a
- Retest 4 (Not Required)

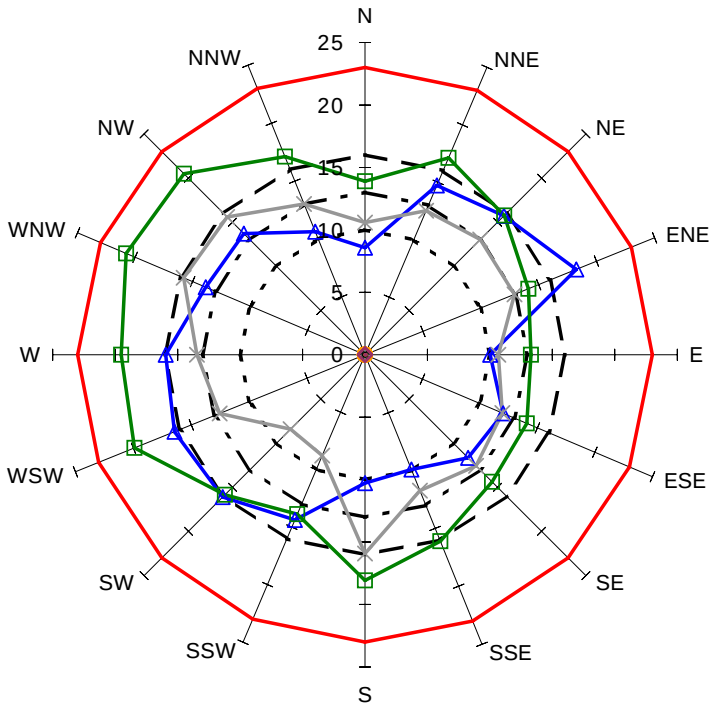
Measured Wind Speeds at Point 07

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Final Treatment Scheme as illustrated in Figure 7a

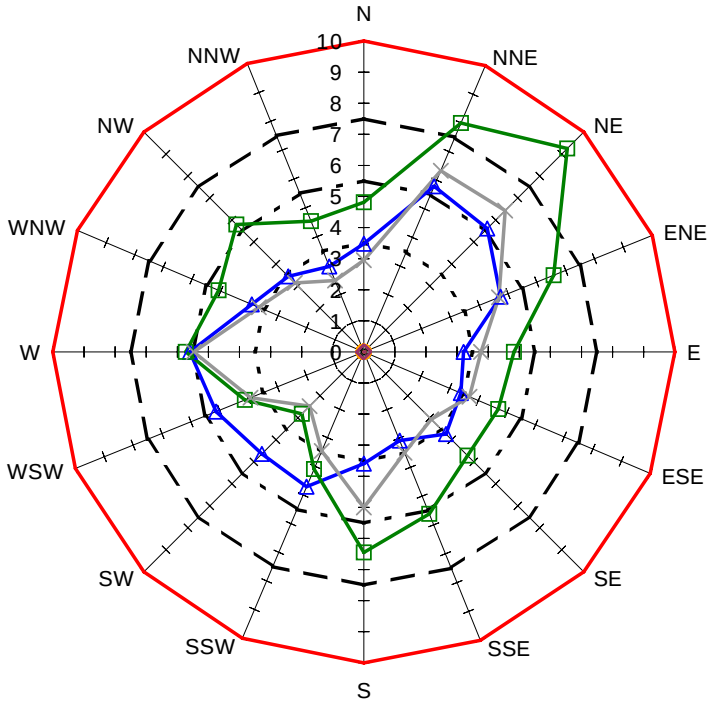
Annual Maximum Gust Wind Speeds (m/s)



- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Final Treatment Scheme as illustrated in Figure 7a

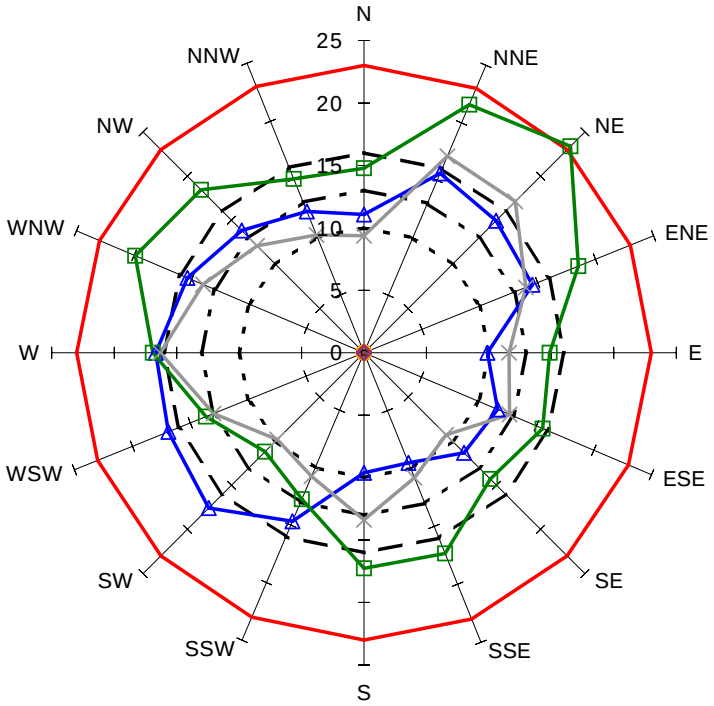
Measured Wind Speeds at Point 08

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Final Treatment Scheme as illustrated in Figure 7a

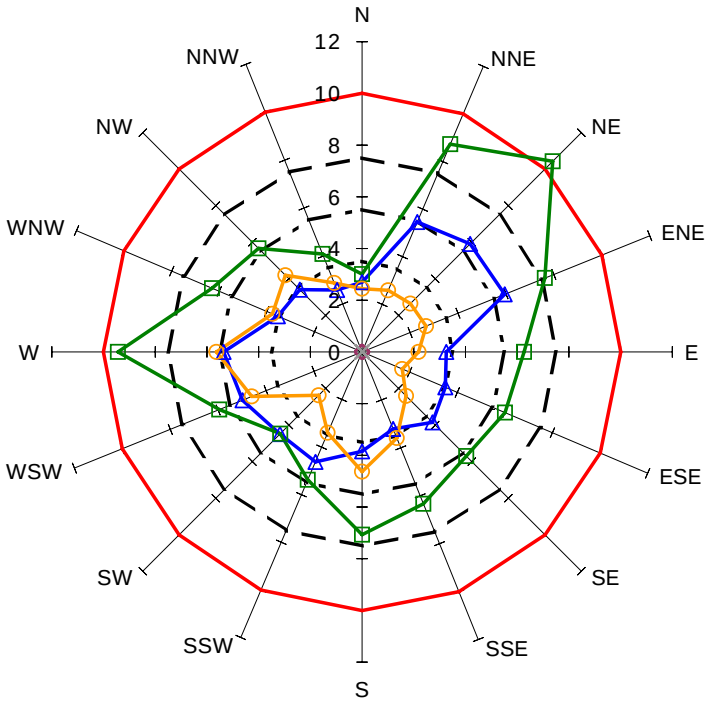
Annual Maximum Gust Wind Speeds (m/s)



- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- Retest 2 (Not Required)
- Retest 3 (Not Required)
- Final Treatment Scheme as illustrated in Figure 7a

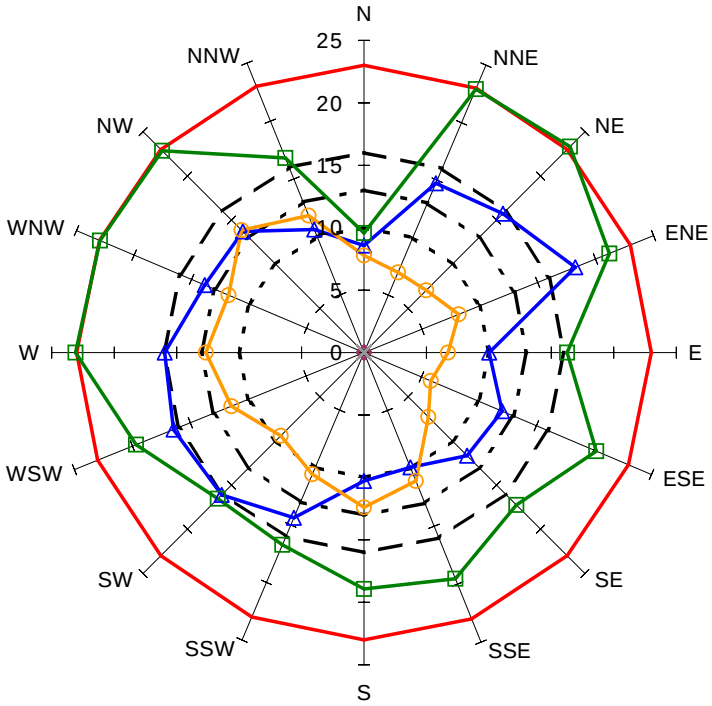
Measured Wind Speeds at Point 09

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- With the addition of the trees indicated in the architectural drawings
- Retest 3 (Not Required)
- Retest 4 (Not Required)

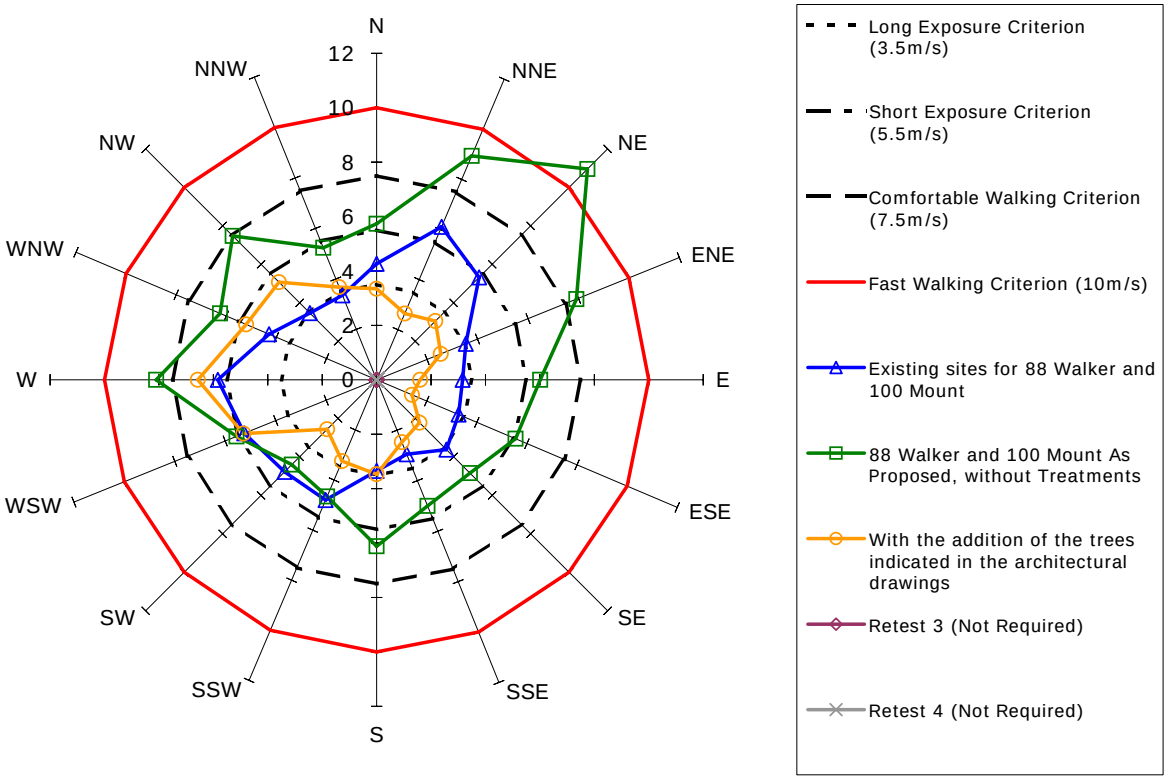
Annual Maximum Gust Wind Speeds (m/s)



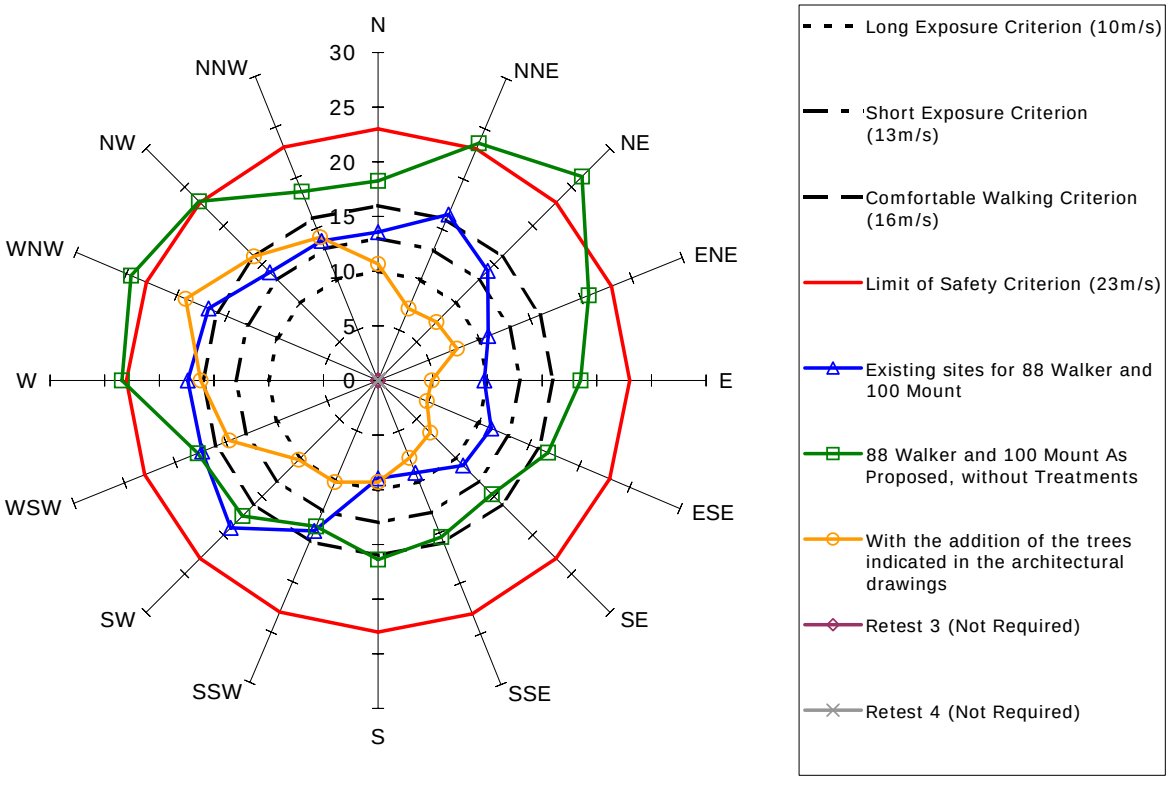
- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed, without Treatments
- With the addition of the trees indicated in the architectural drawings
- Retest 3 (Not Required)
- Retest 4 (Not Required)

Measured Wind Speeds at Point 10

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

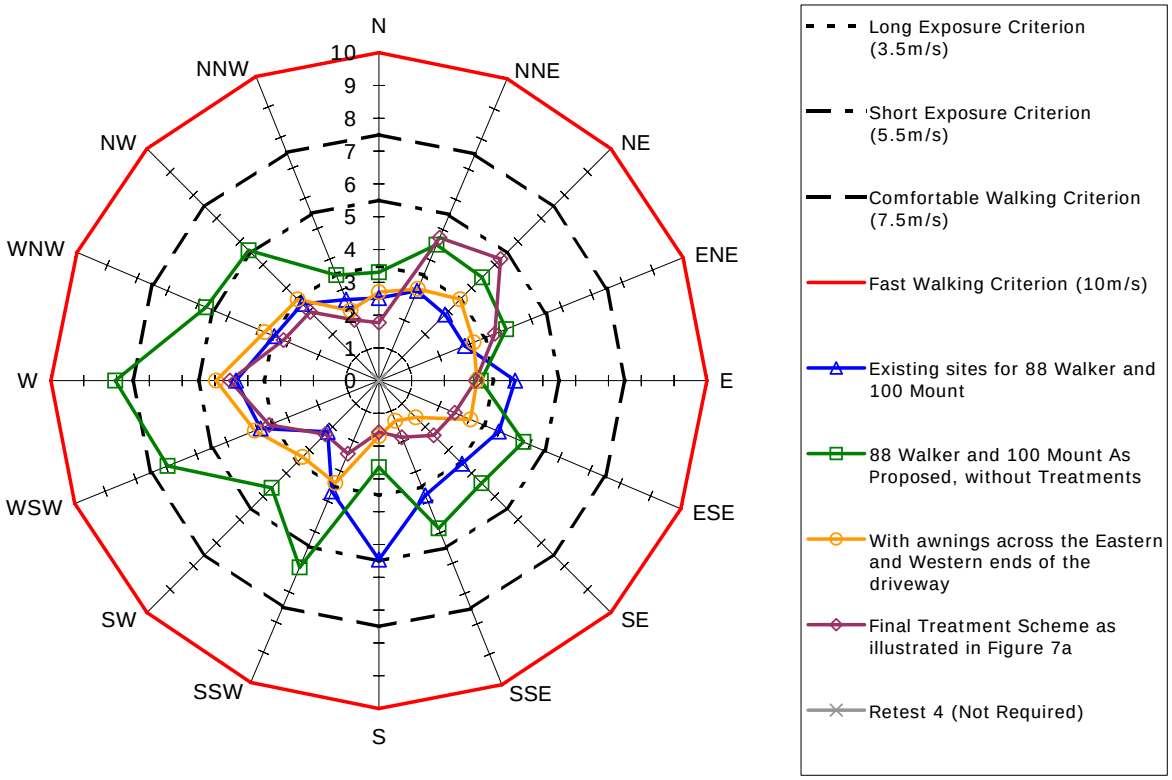


Annual Maximum Gust Wind Speeds (m/s)

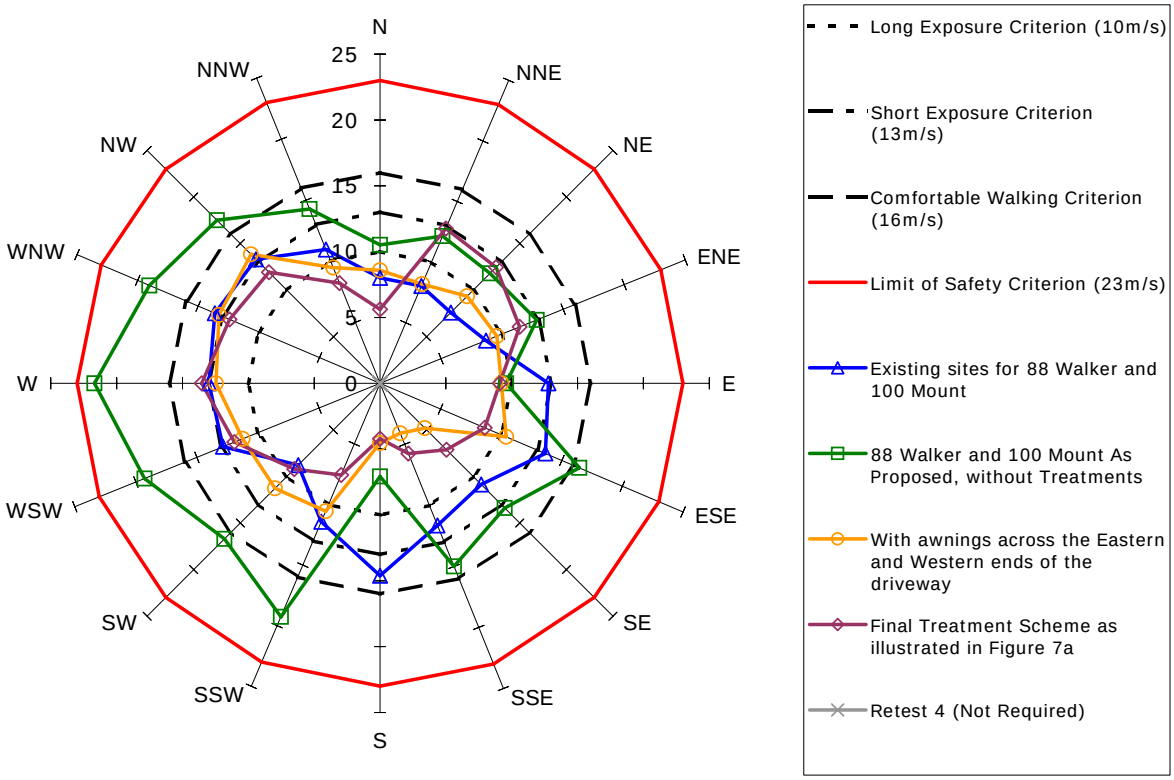


Measured Wind Speeds at Point 11

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

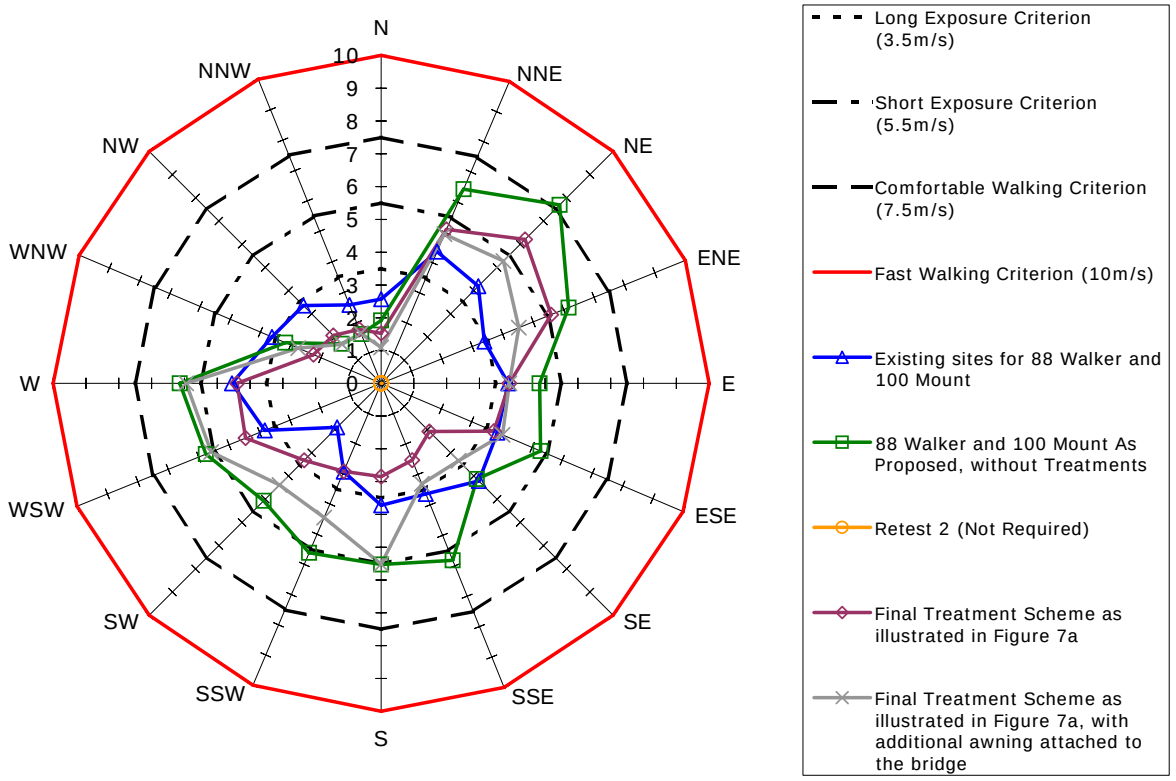


Annual Maximum Gust Wind Speeds (m/s)

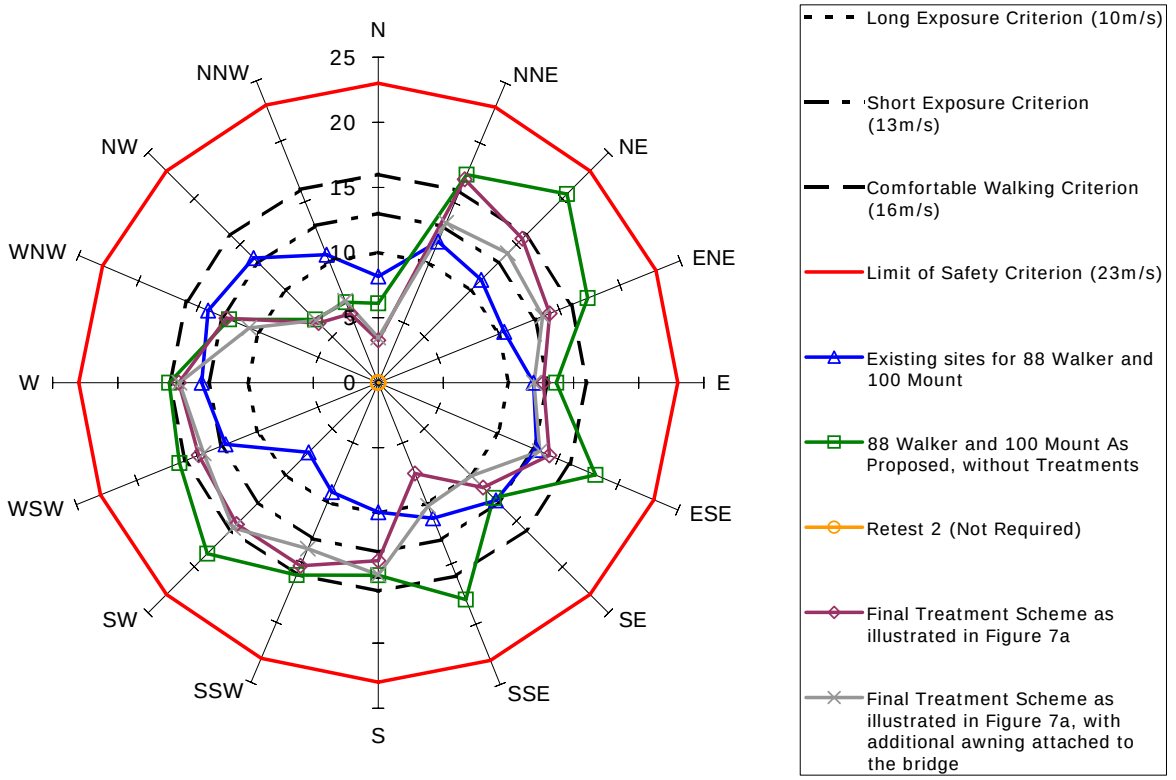


Measured Wind Speeds at Point 12

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

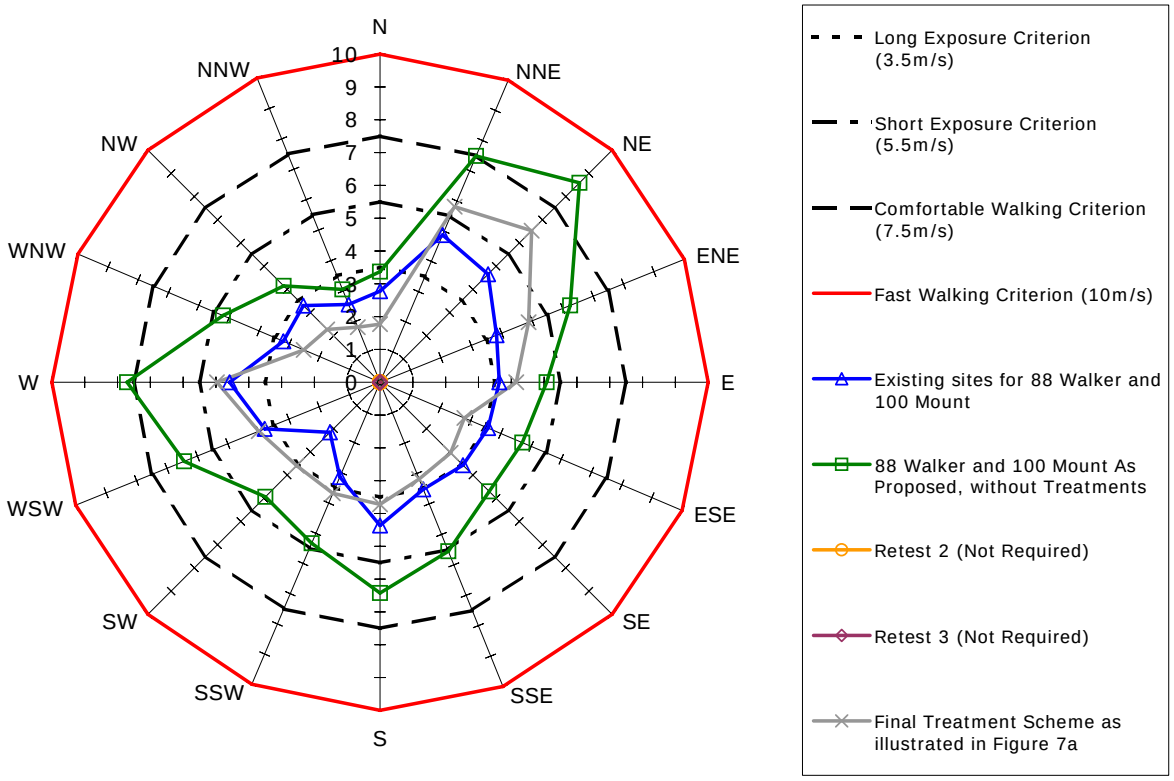


Annual Maximum Gust Wind Speeds (m/s)

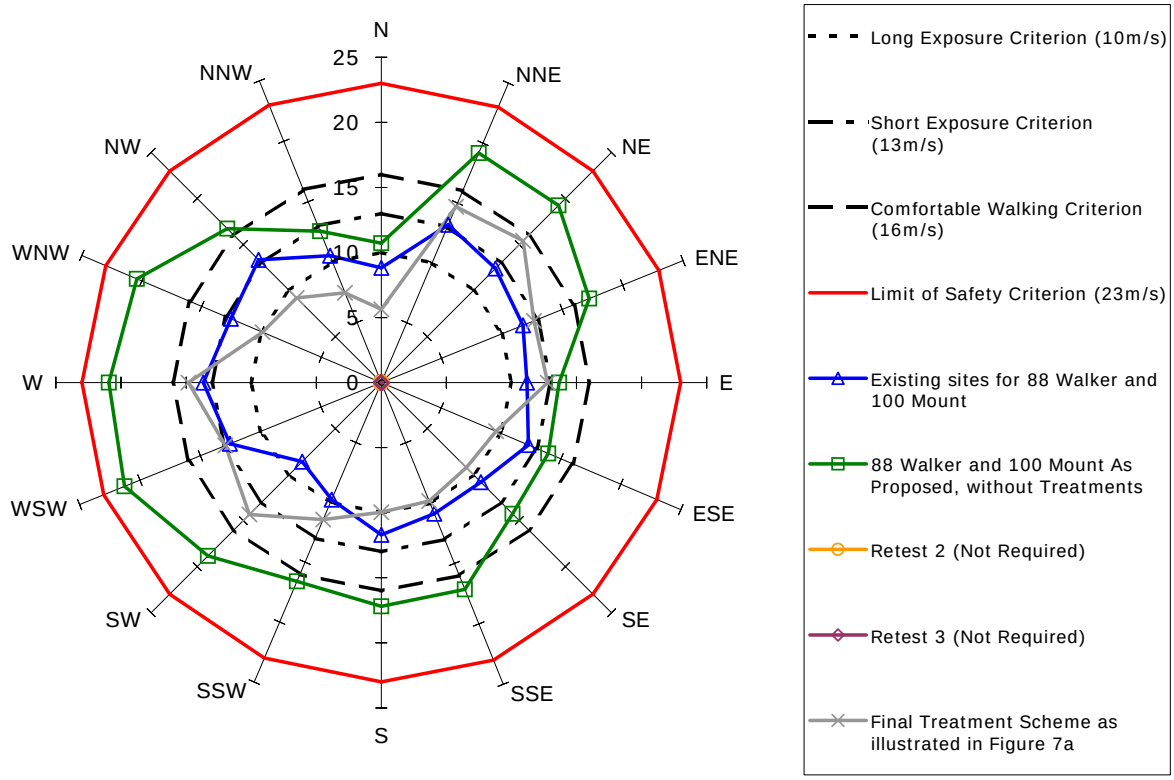


Measured Wind Speeds at Point 13

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

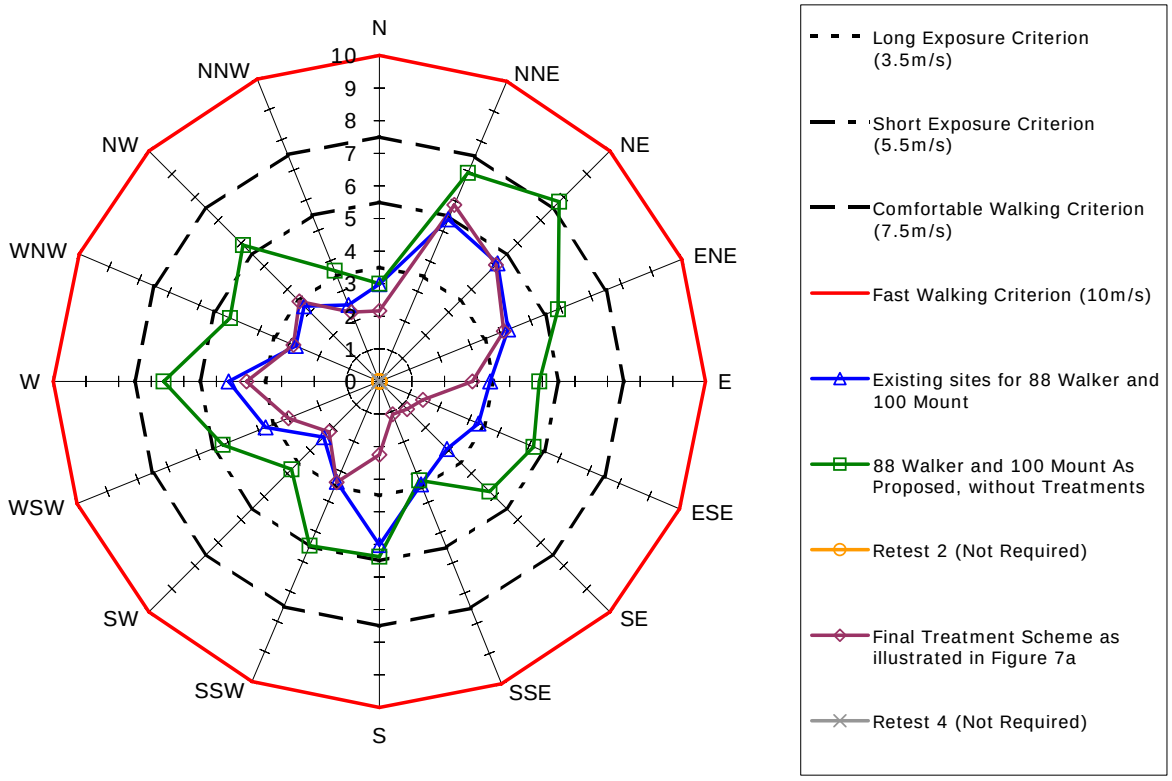


Annual Maximum Gust Wind Speeds (m/s)

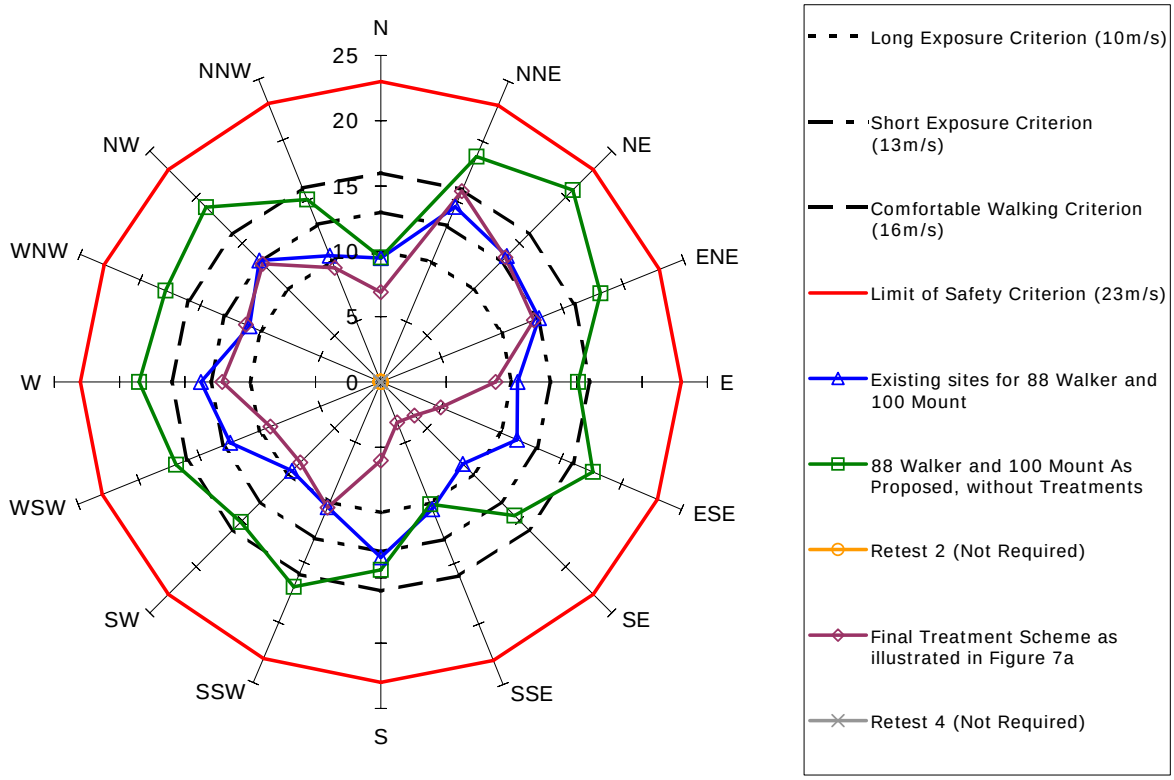


Measured Wind Speeds at Point 14

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

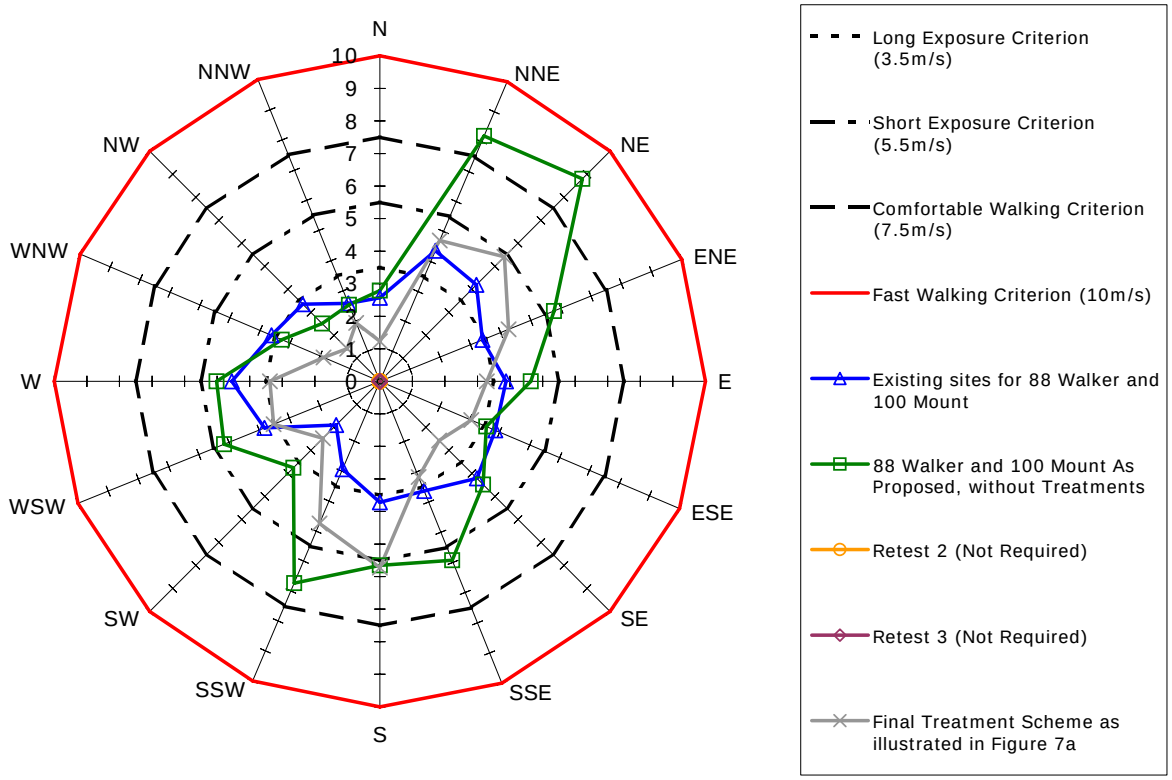


Annual Maximum Gust Wind Speeds (m/s)

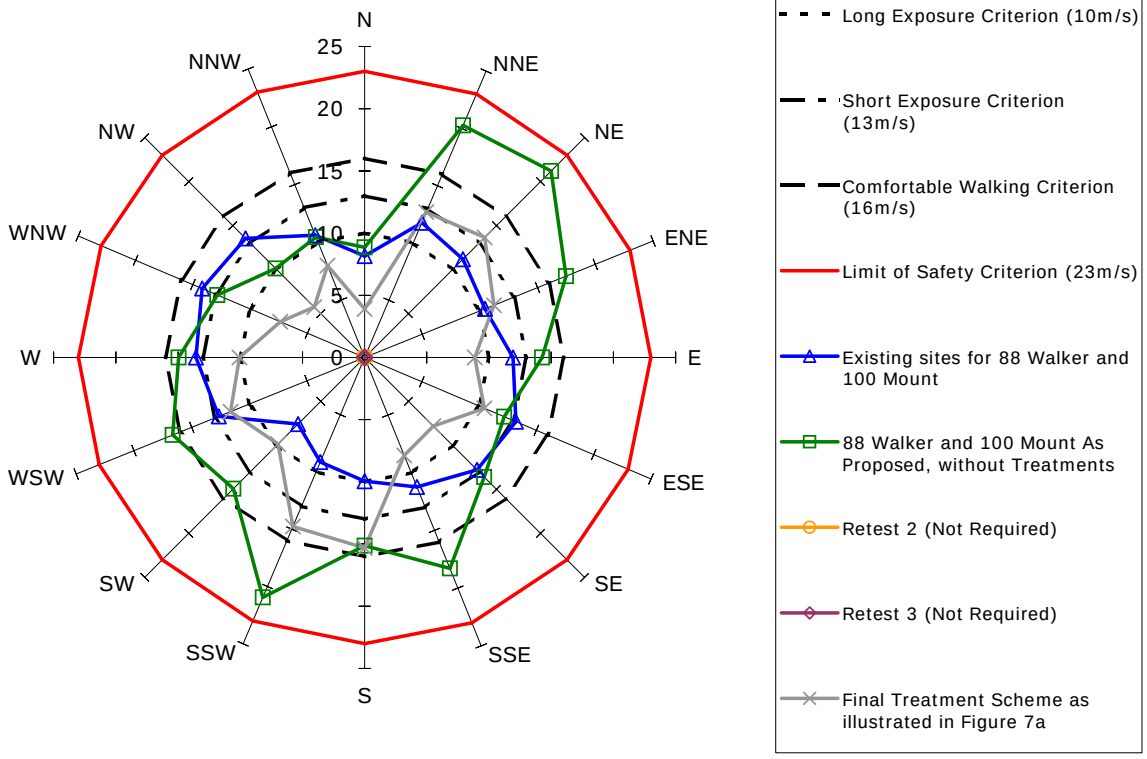


Measured Wind Speeds at Point 15

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

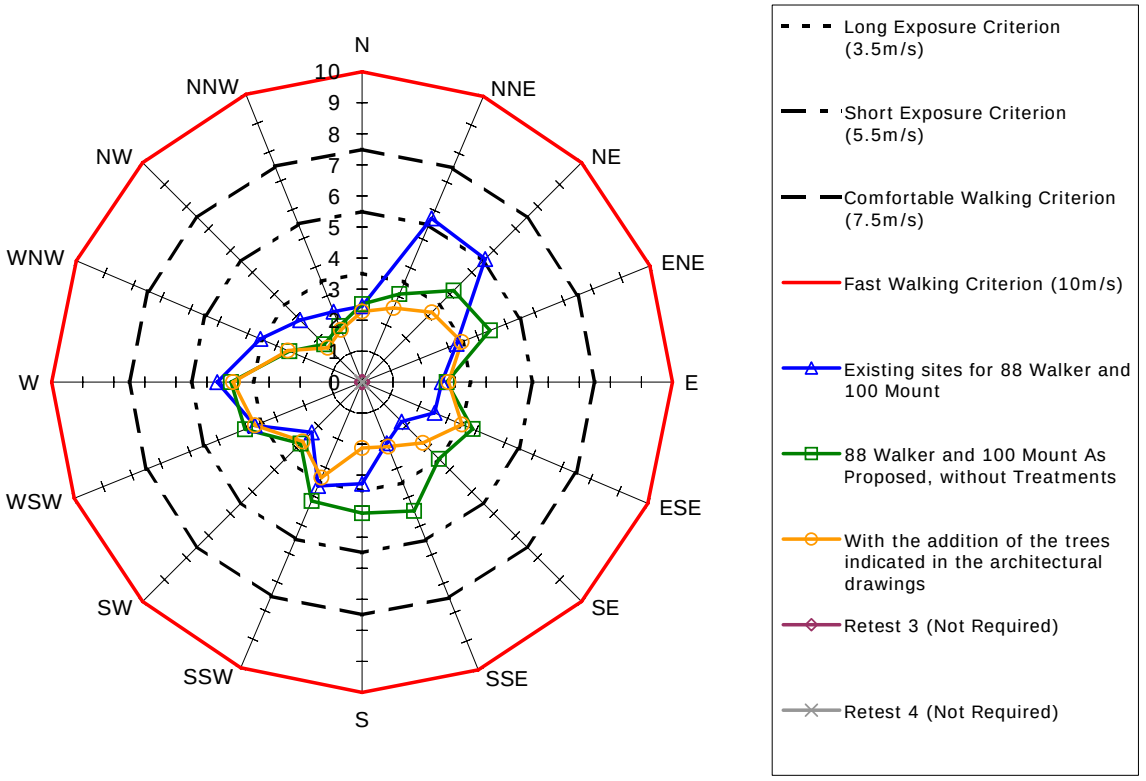


Annual Maximum Gust Wind Speeds (m/s)

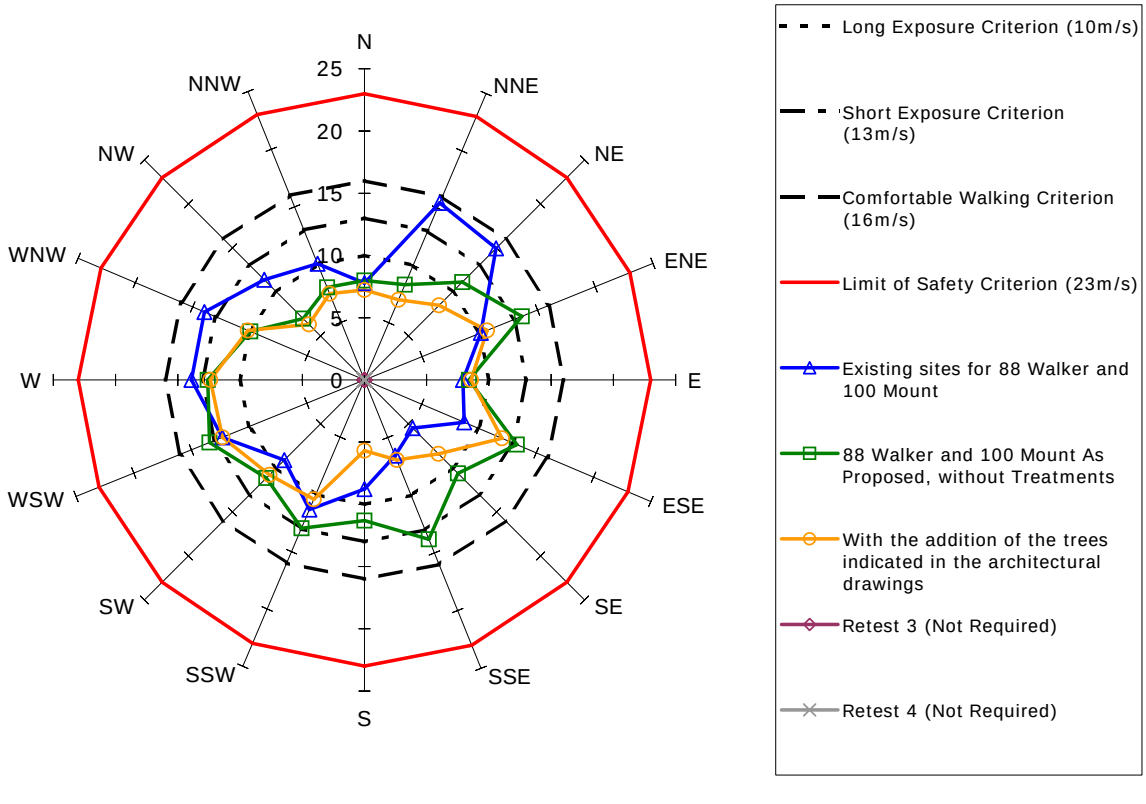


Measured Wind Speeds at Point 16

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

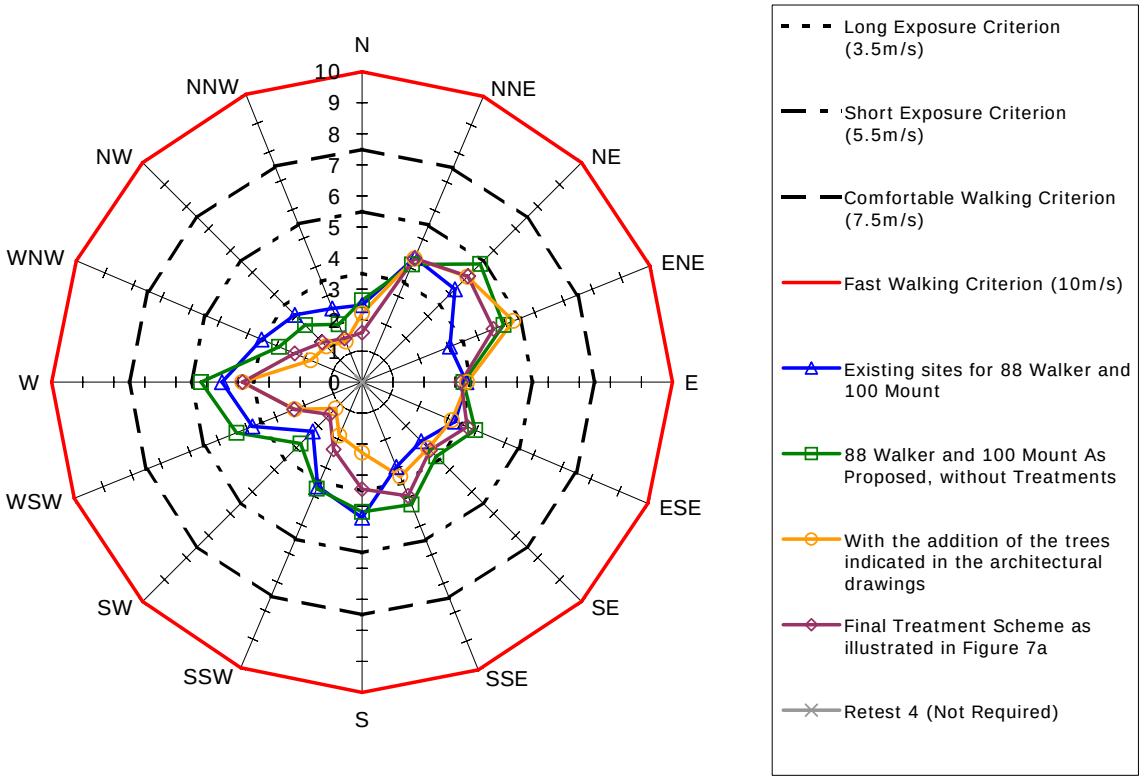


Annual Maximum Gust Wind Speeds (m/s)

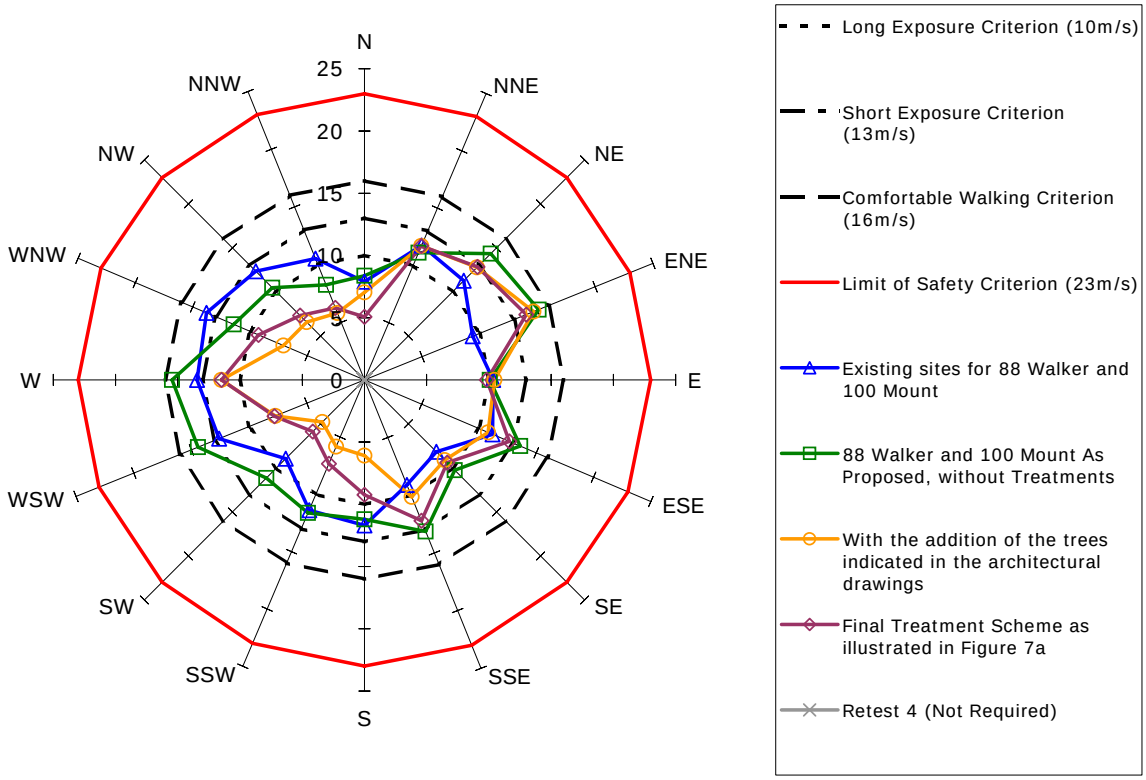


Measured Wind Speeds at Point 17

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

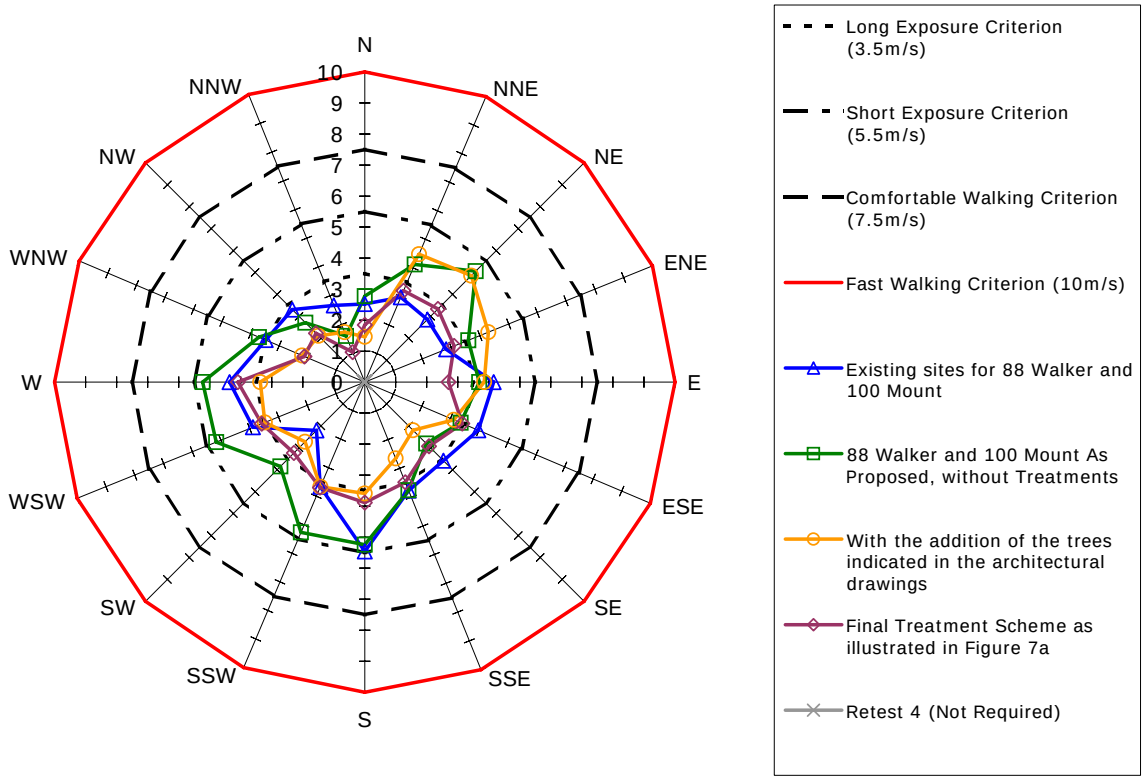


Annual Maximum Gust Wind Speeds (m/s)

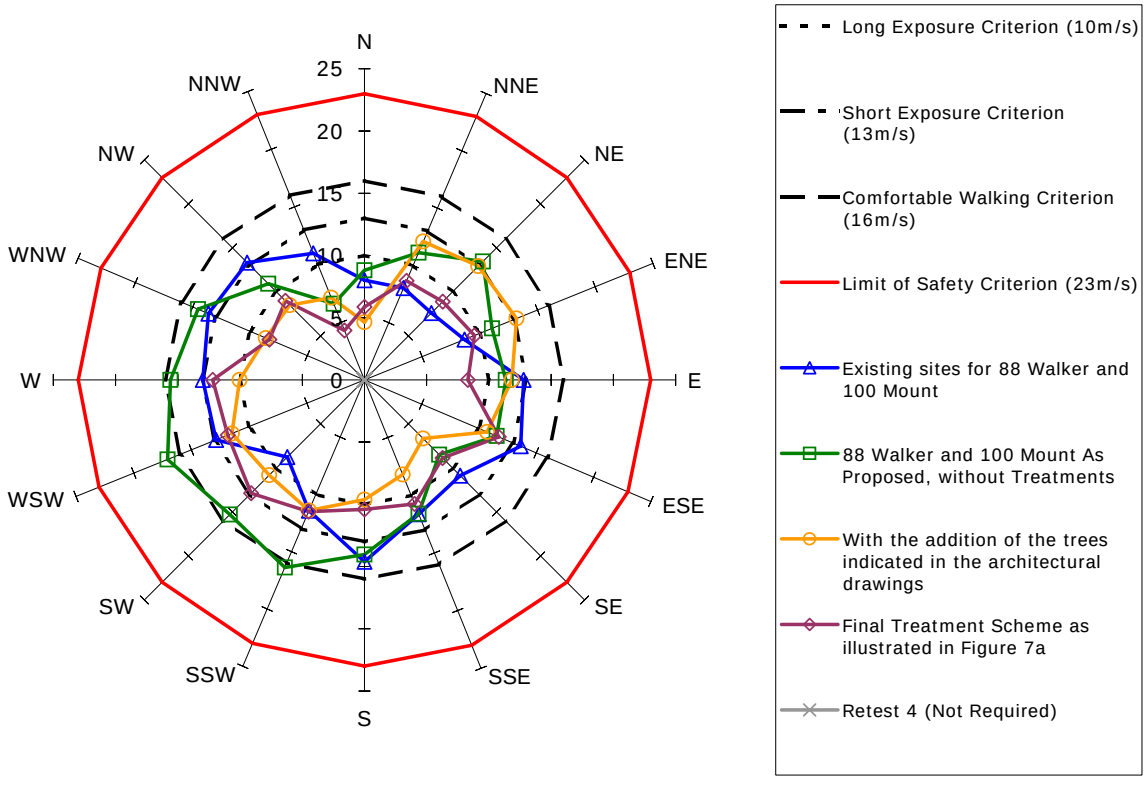


Measured Wind Speeds at Point 18

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

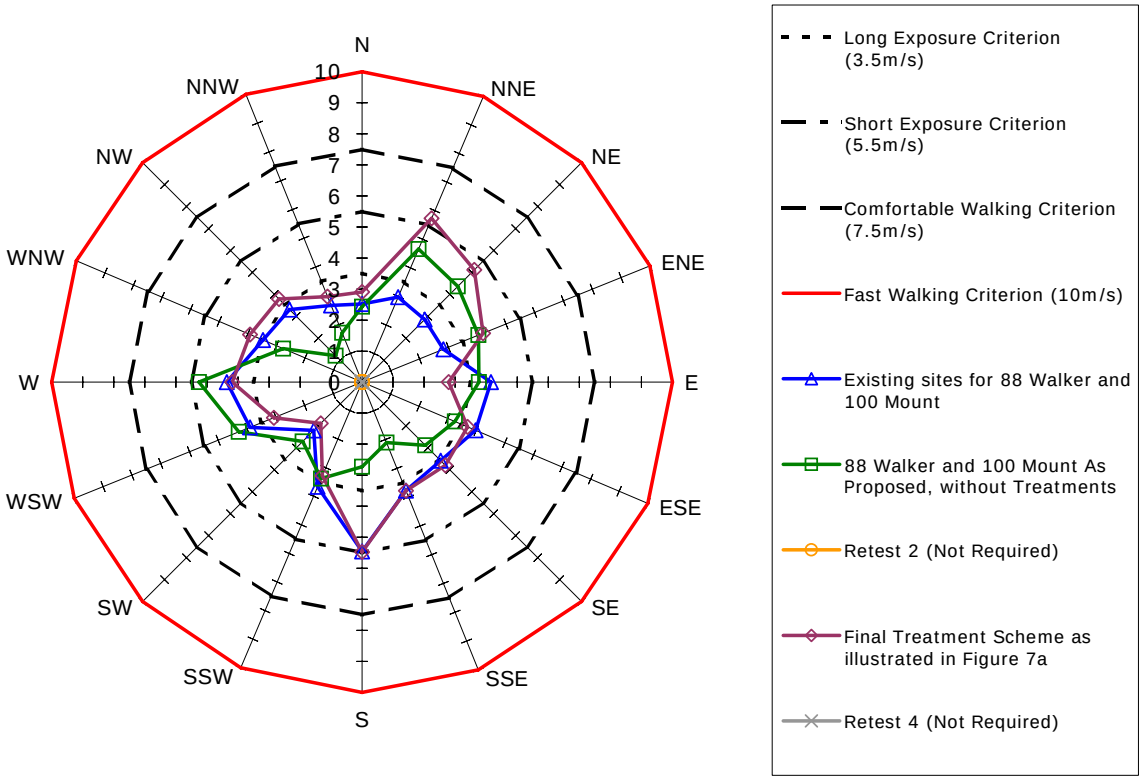


Annual Maximum Gust Wind Speeds (m/s)

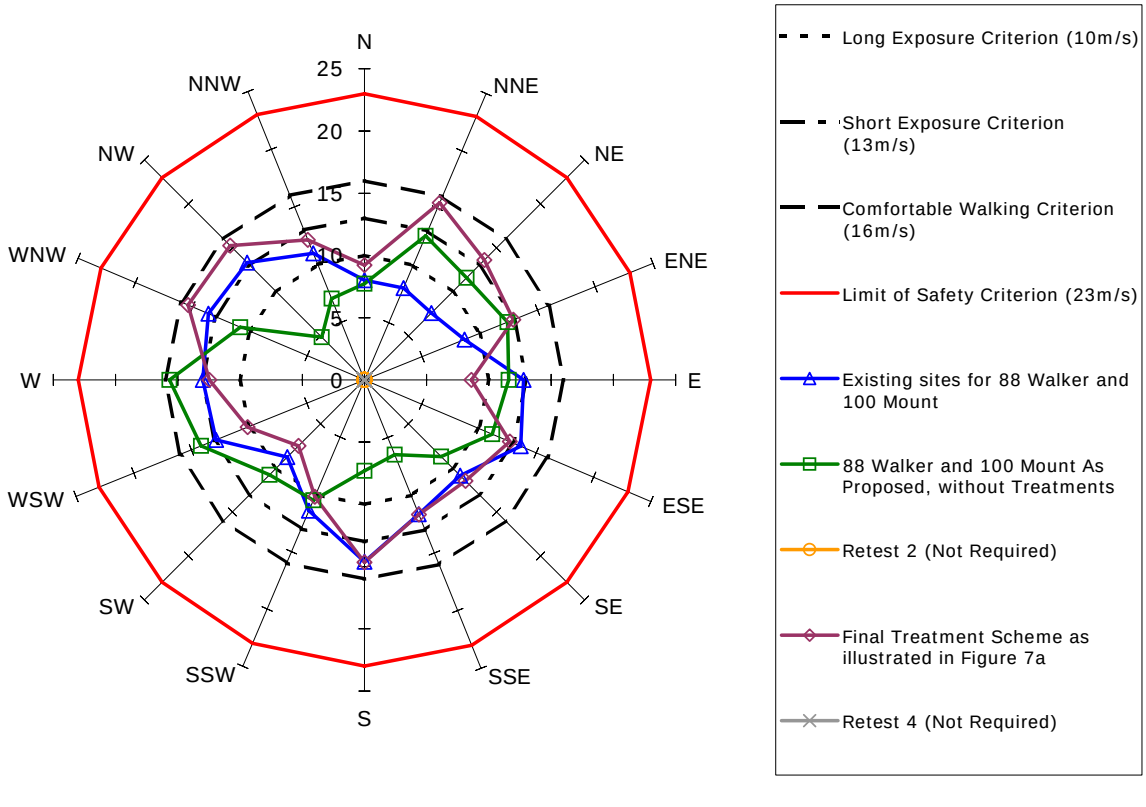


Measured Wind Speeds at Point 19

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

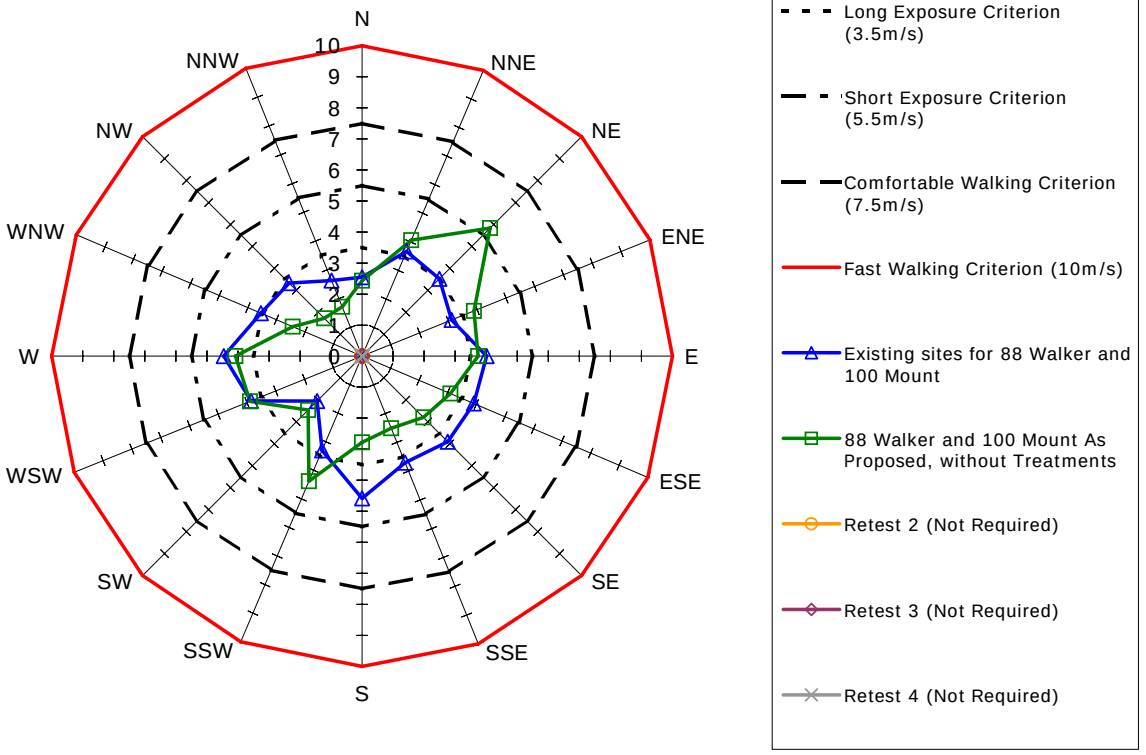


Annual Maximum Gust Wind Speeds (m/s)

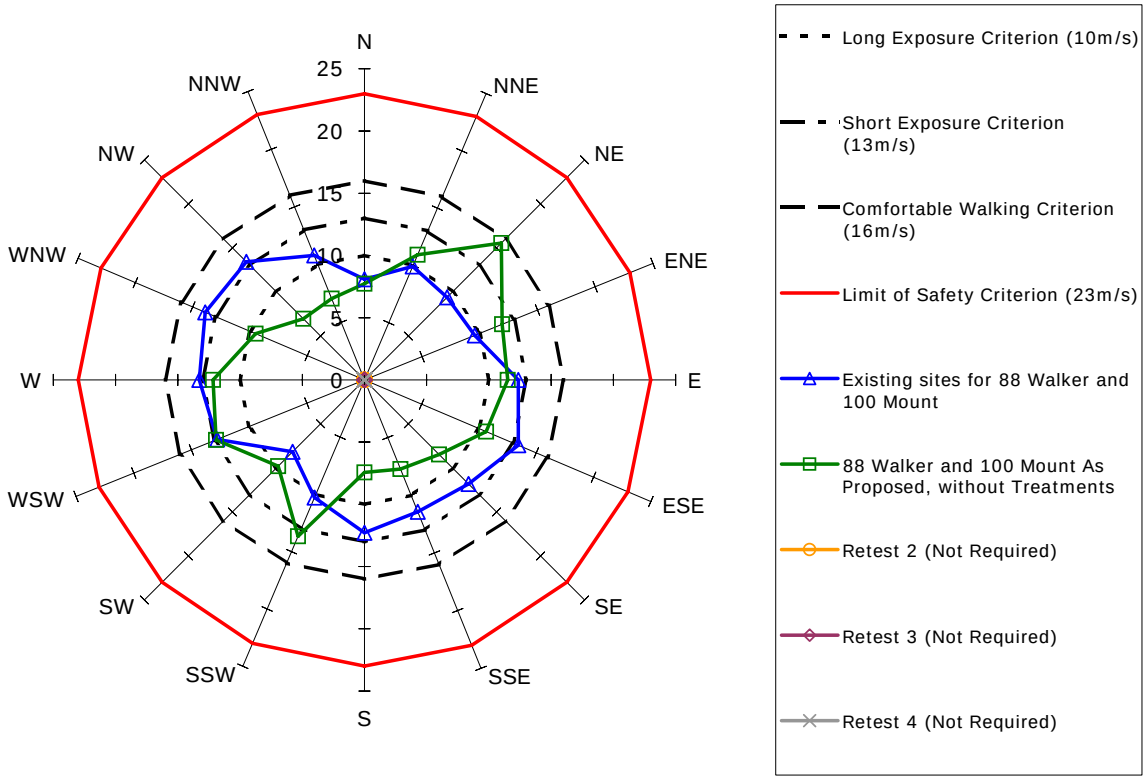


Measured Wind Speeds at Point 20

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

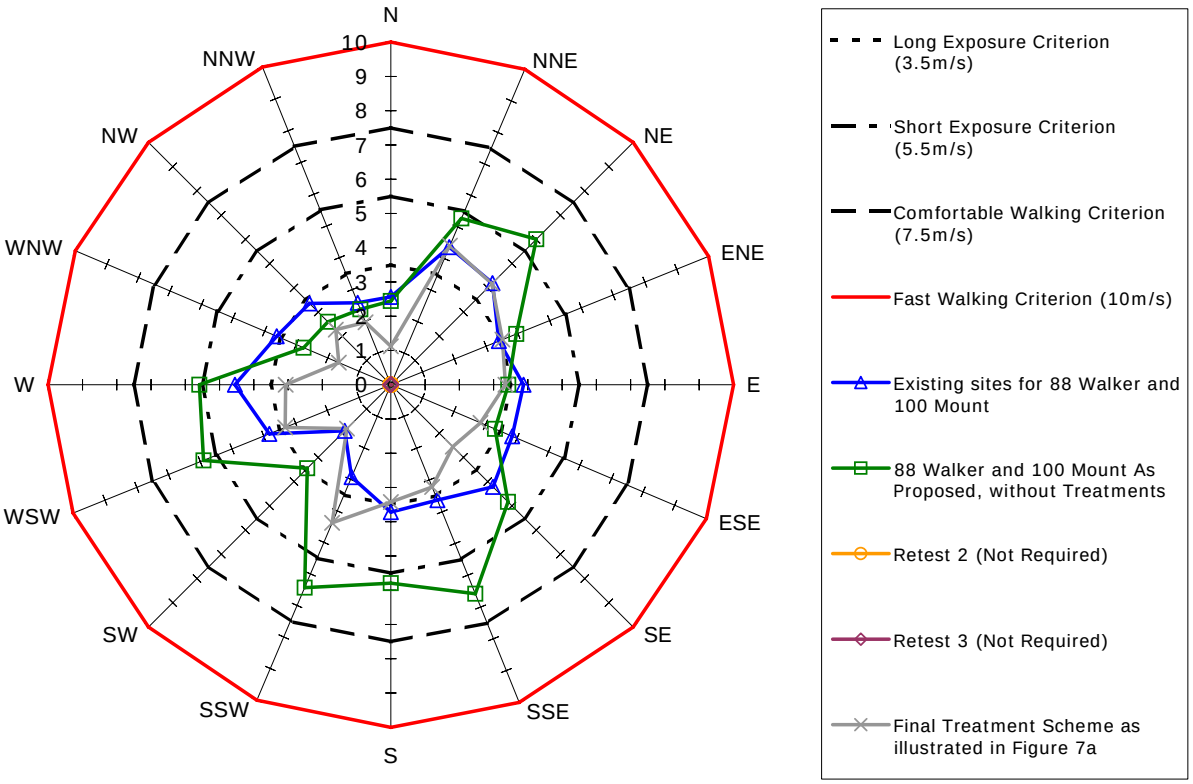


Annual Maximum Gust Wind Speeds (m/s)

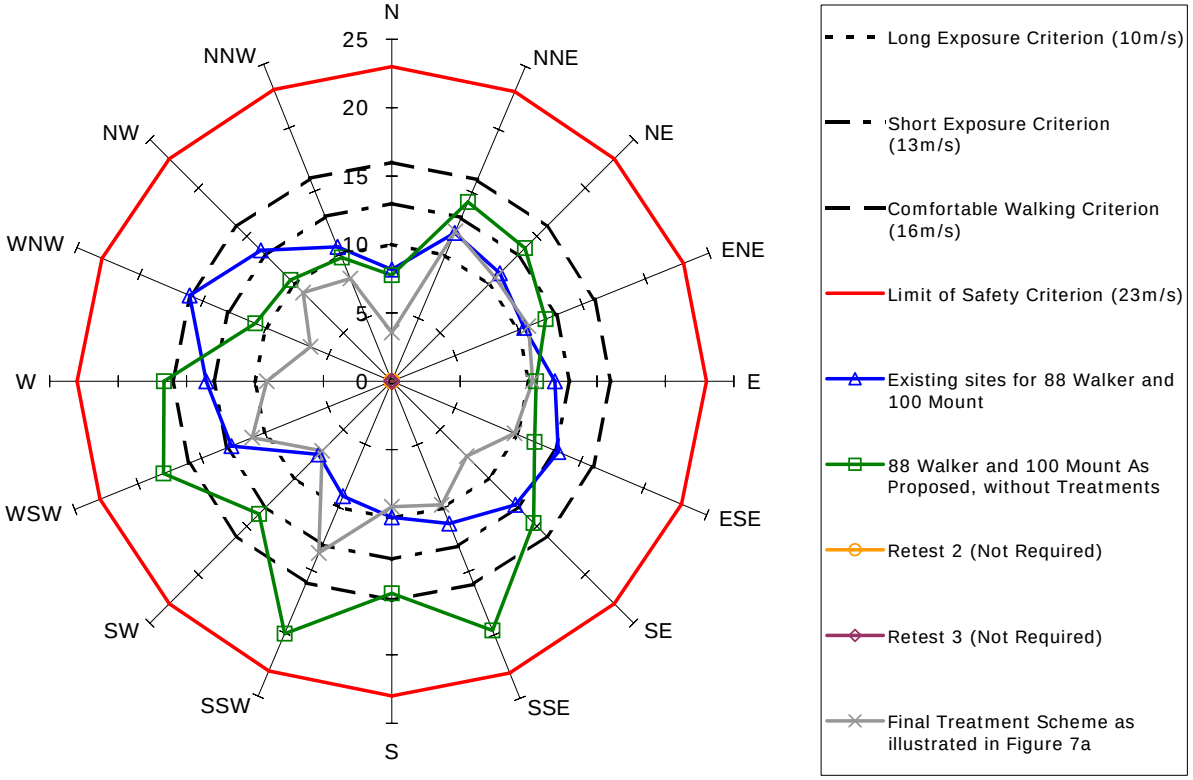


Measured Wind Speeds at Point 21

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

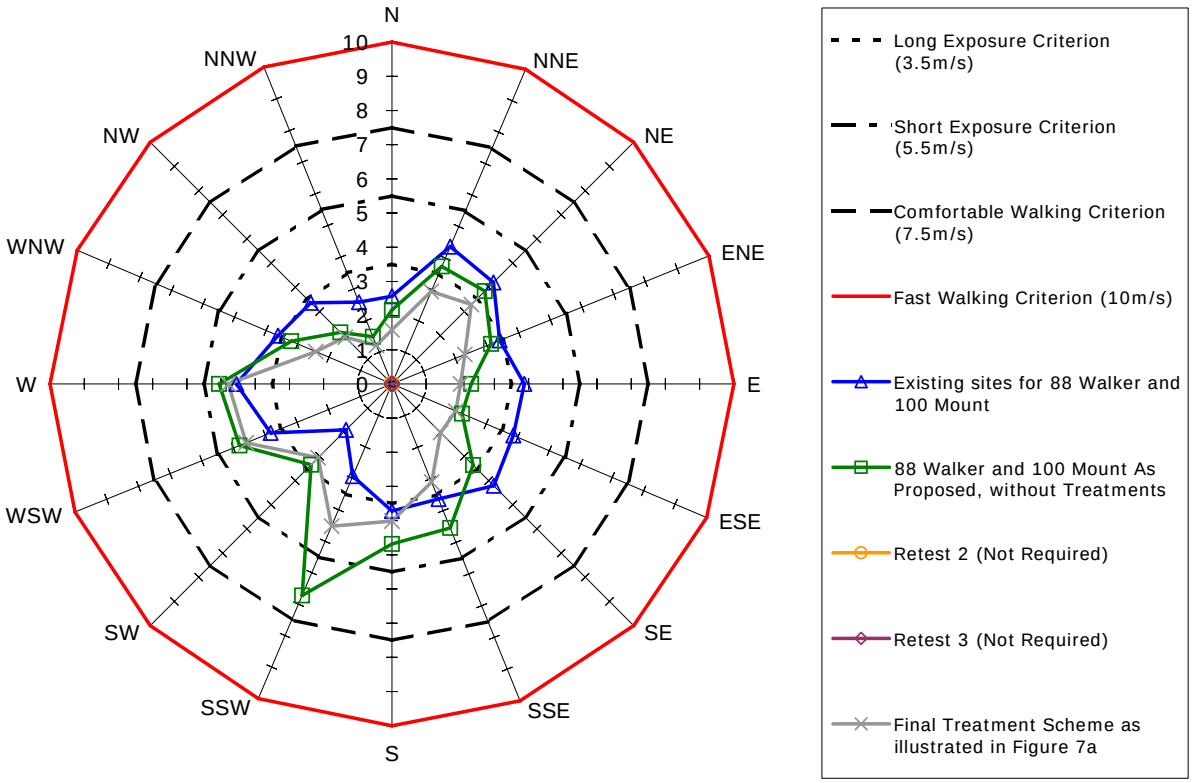


Annual Maximum Gust Wind Speeds (m/s)

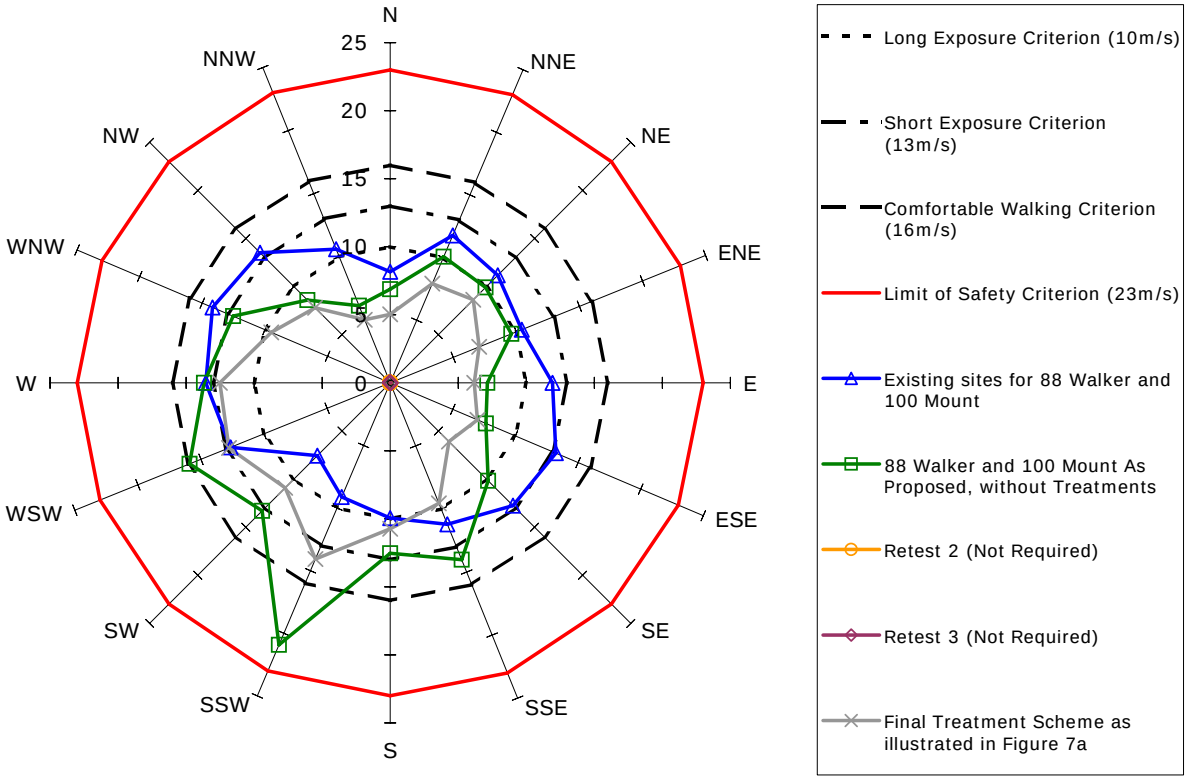


Measured Wind Speeds at Point 22

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

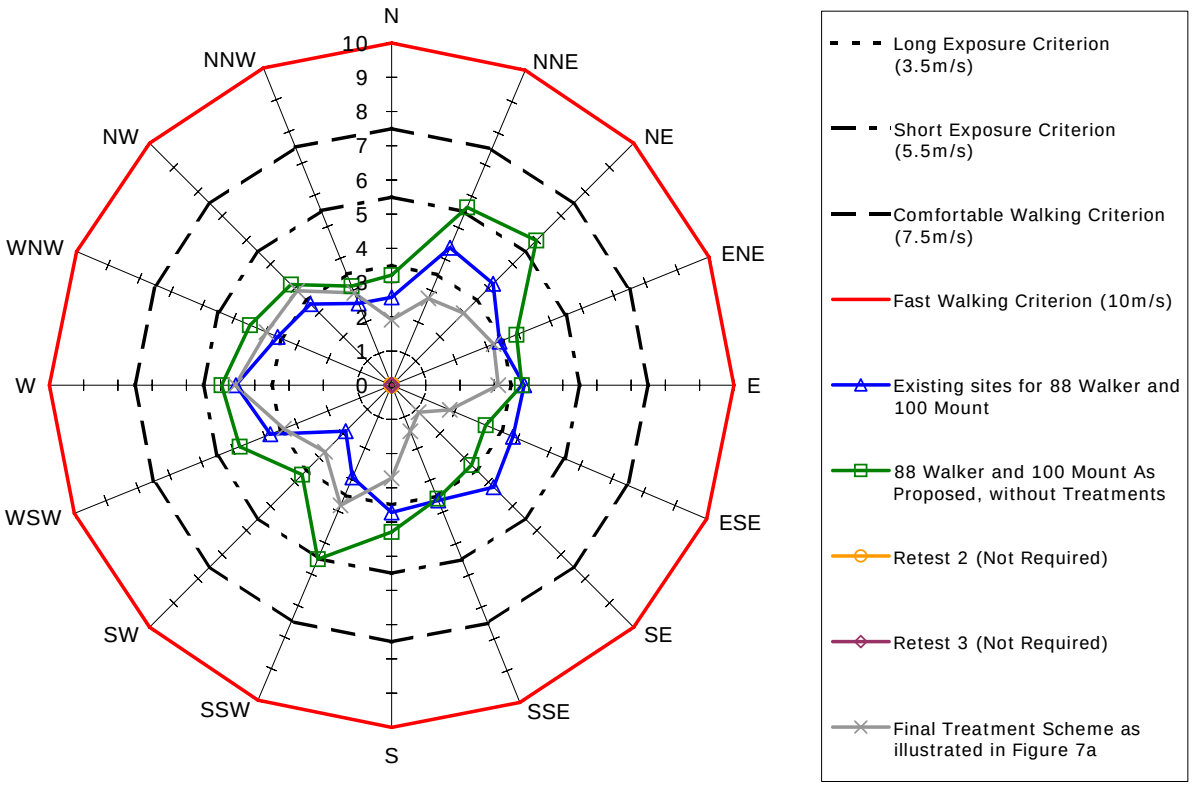


Annual Maximum Gust Wind Speeds (m/s)

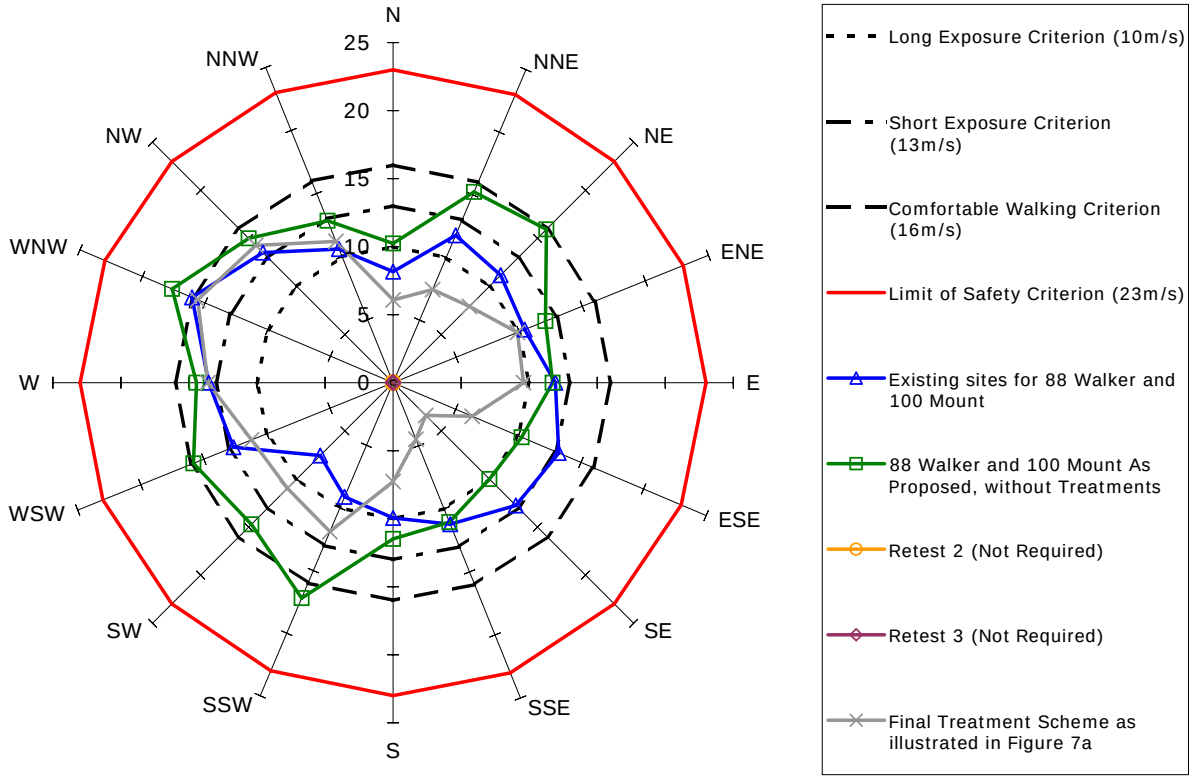


Measured Wind Speeds at Point 23

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

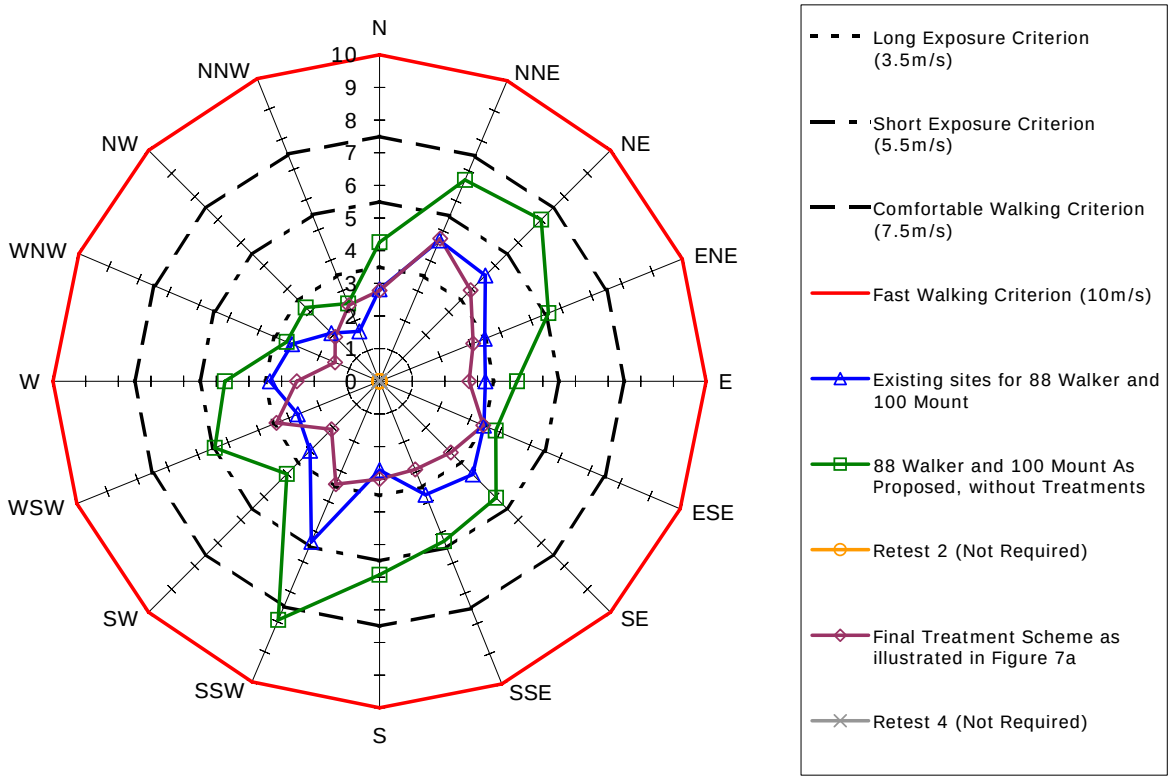


Annual Maximum Gust Wind Speeds (m/s)

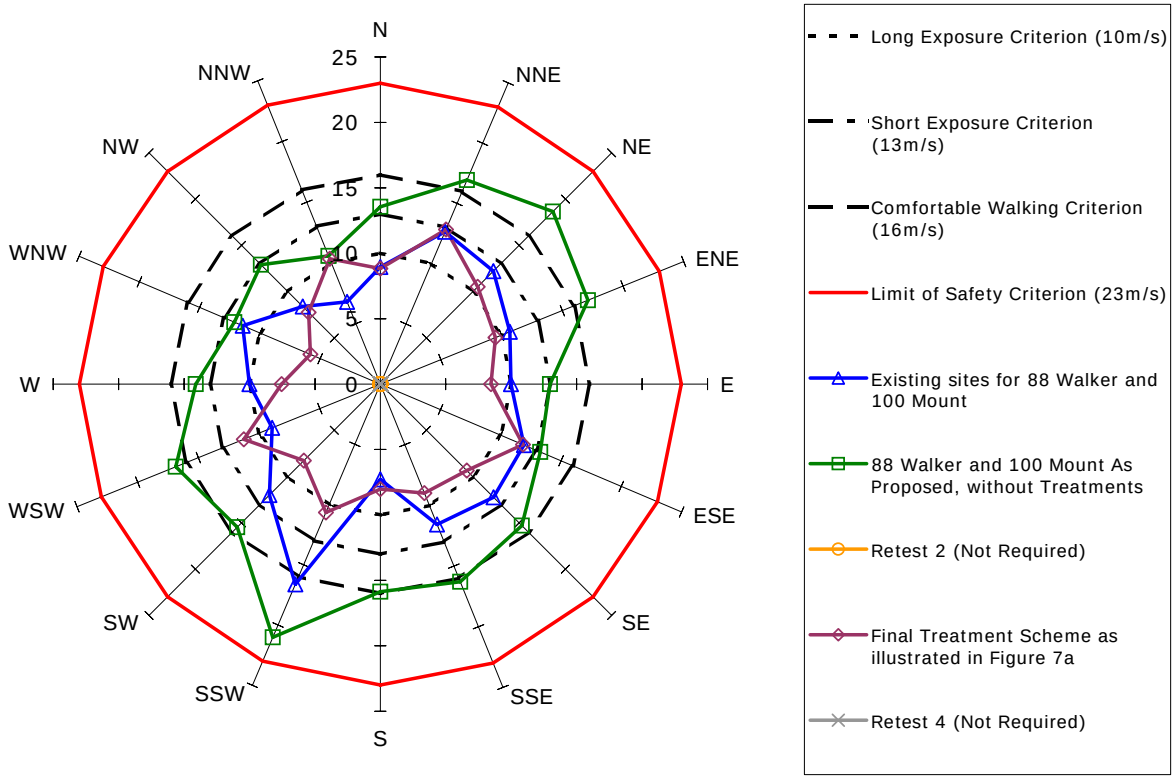


Measured Wind Speeds at Point 24

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

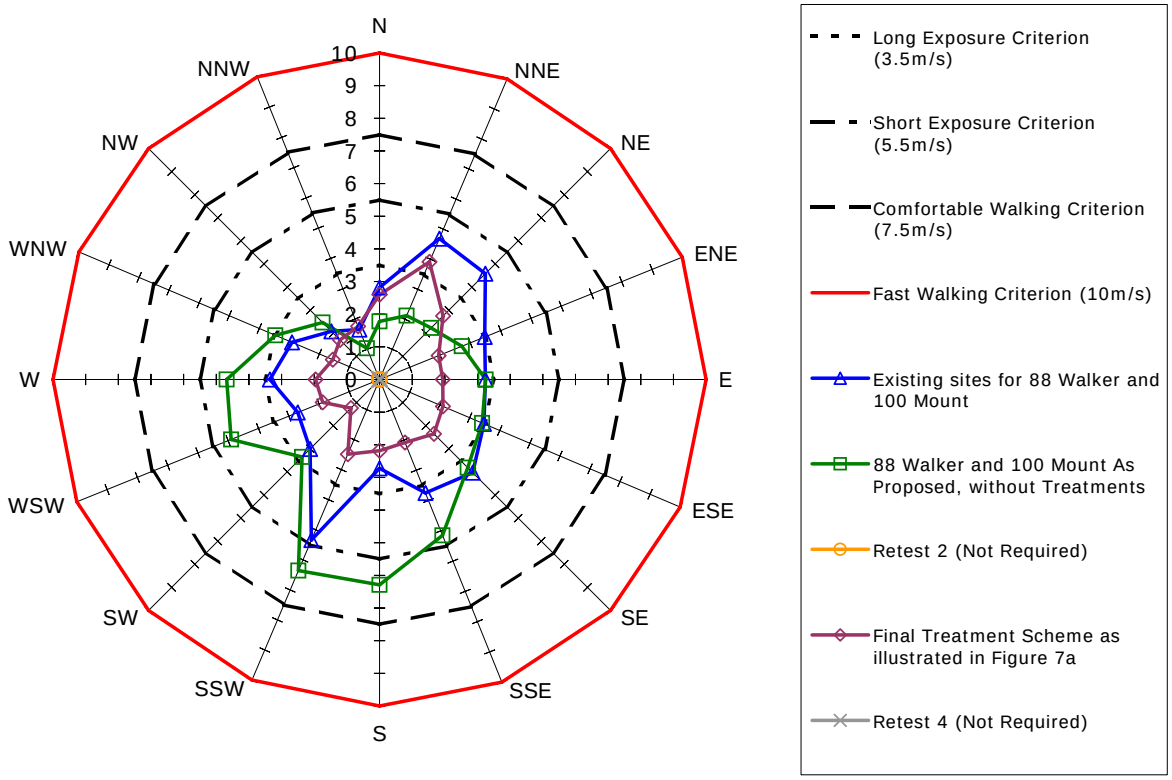


Annual Maximum Gust Wind Speeds (m/s)

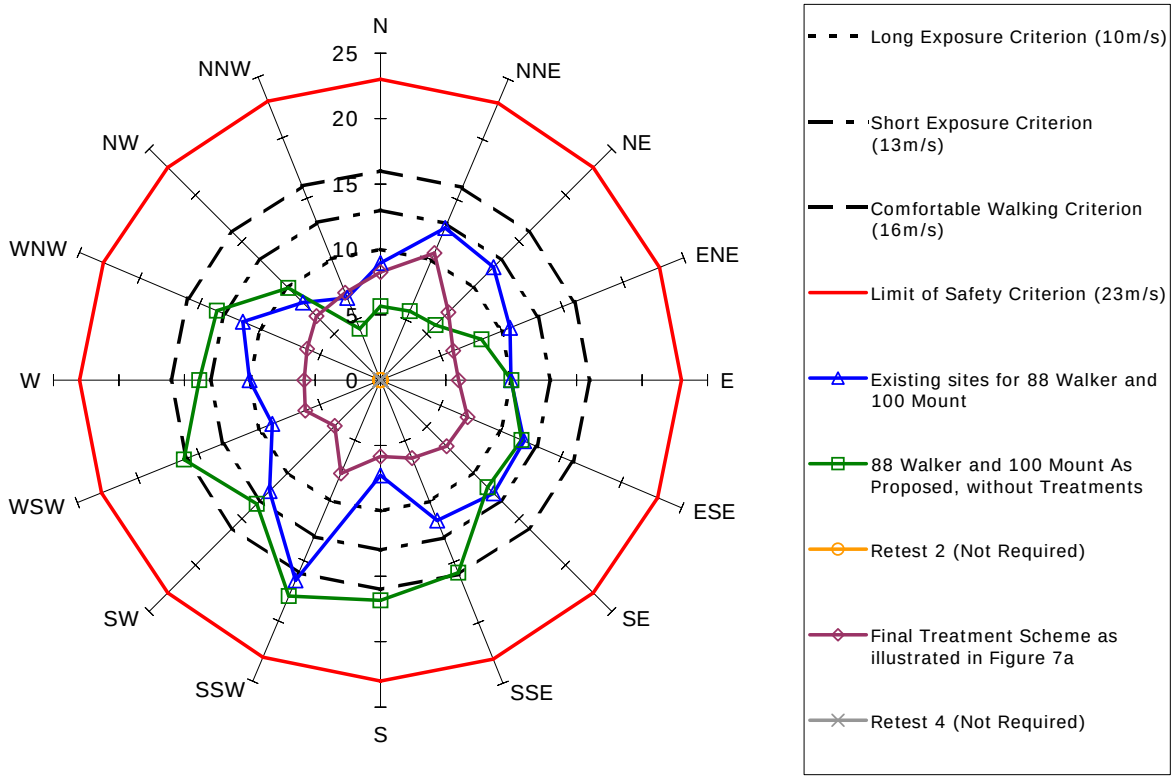


Measured Wind Speeds at Point 25

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

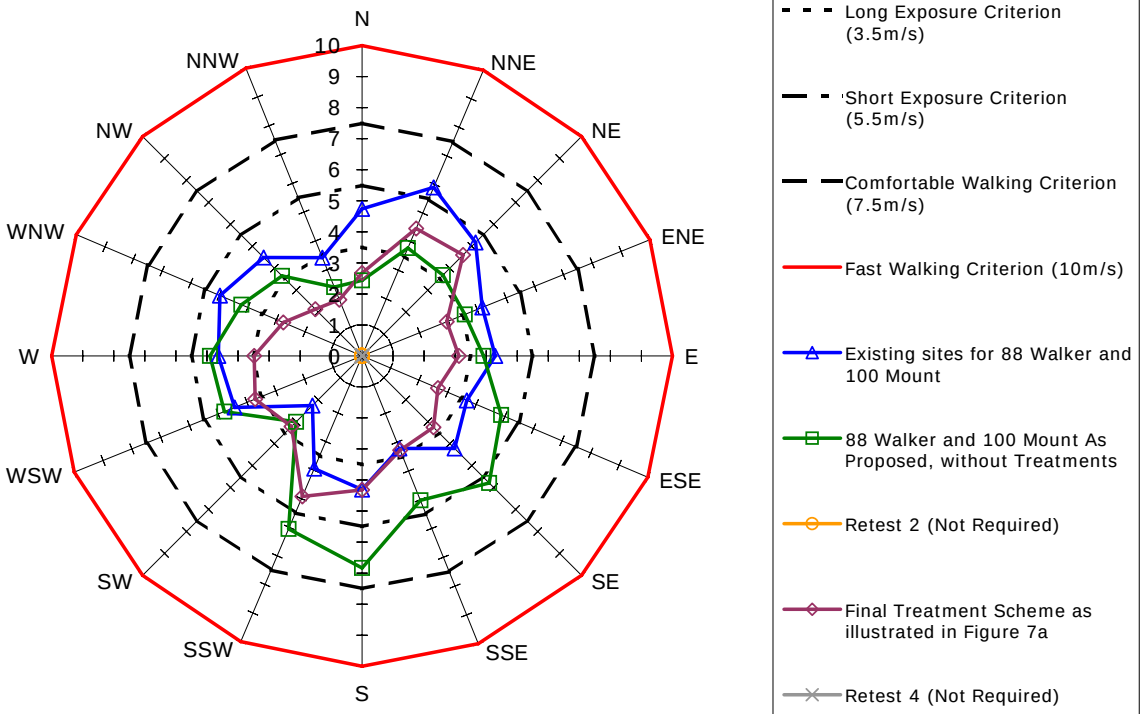


Annual Maximum Gust Wind Speeds (m/s)

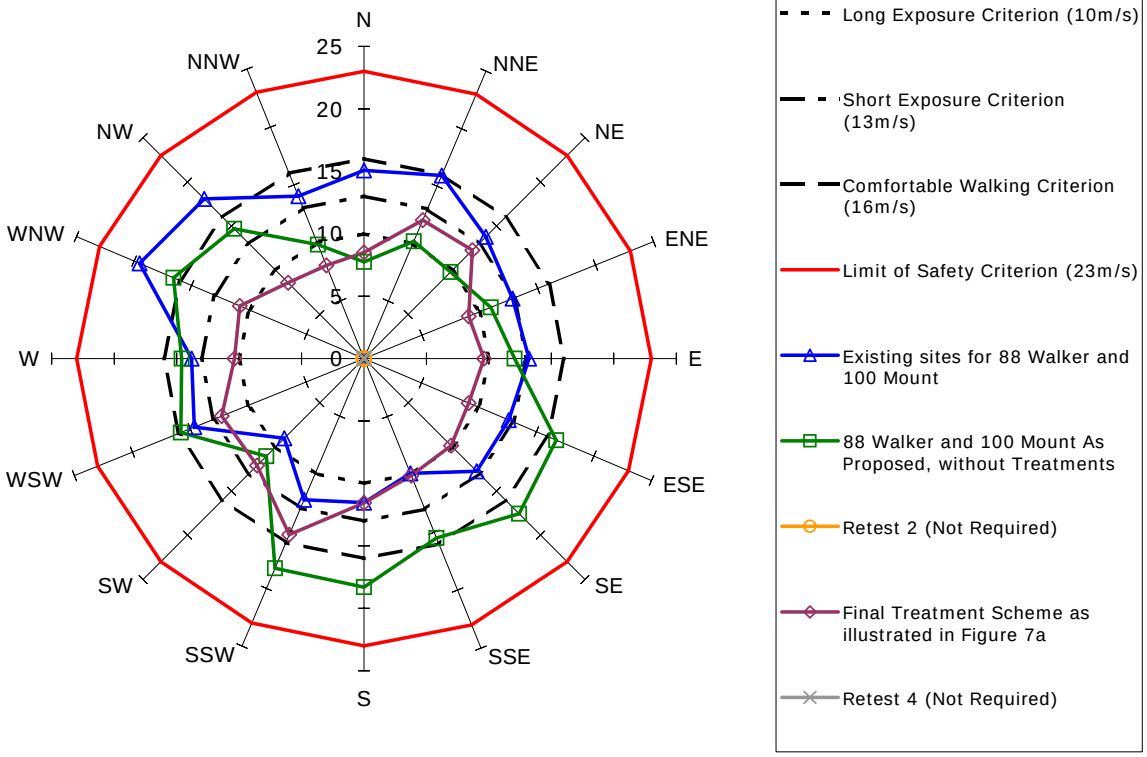


Measured Wind Speeds at Point 26

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

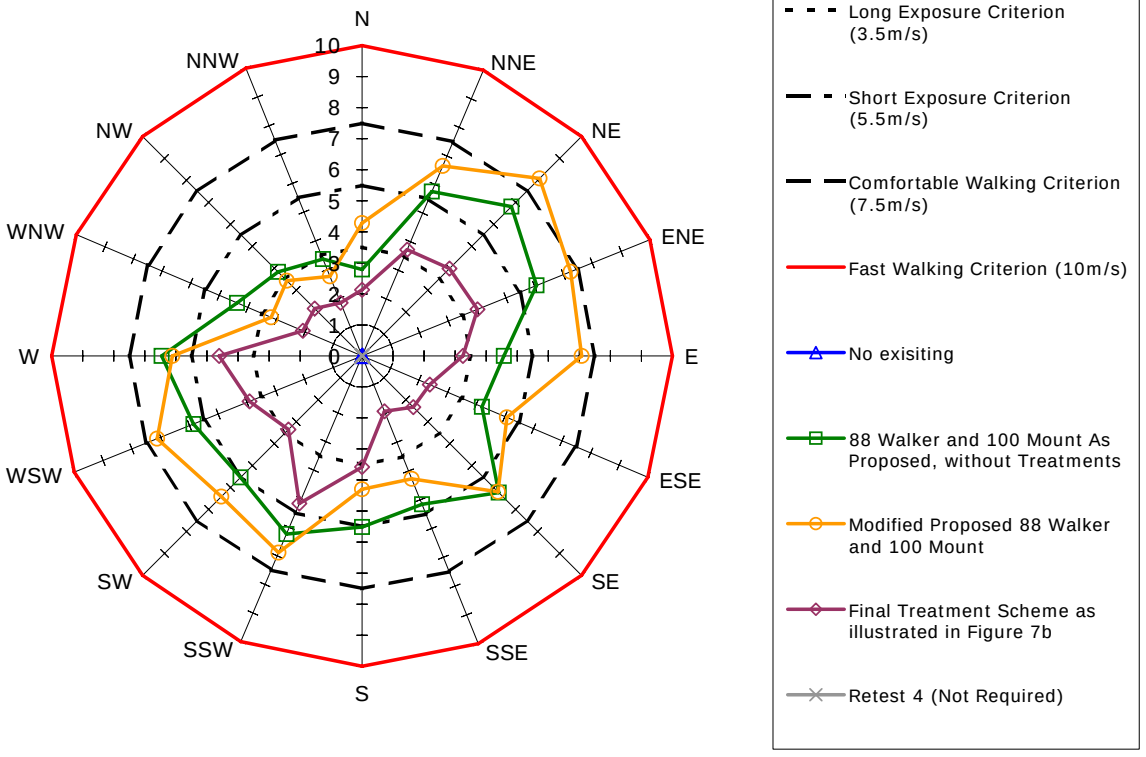


Annual Maximum Gust Wind Speeds (m/s)

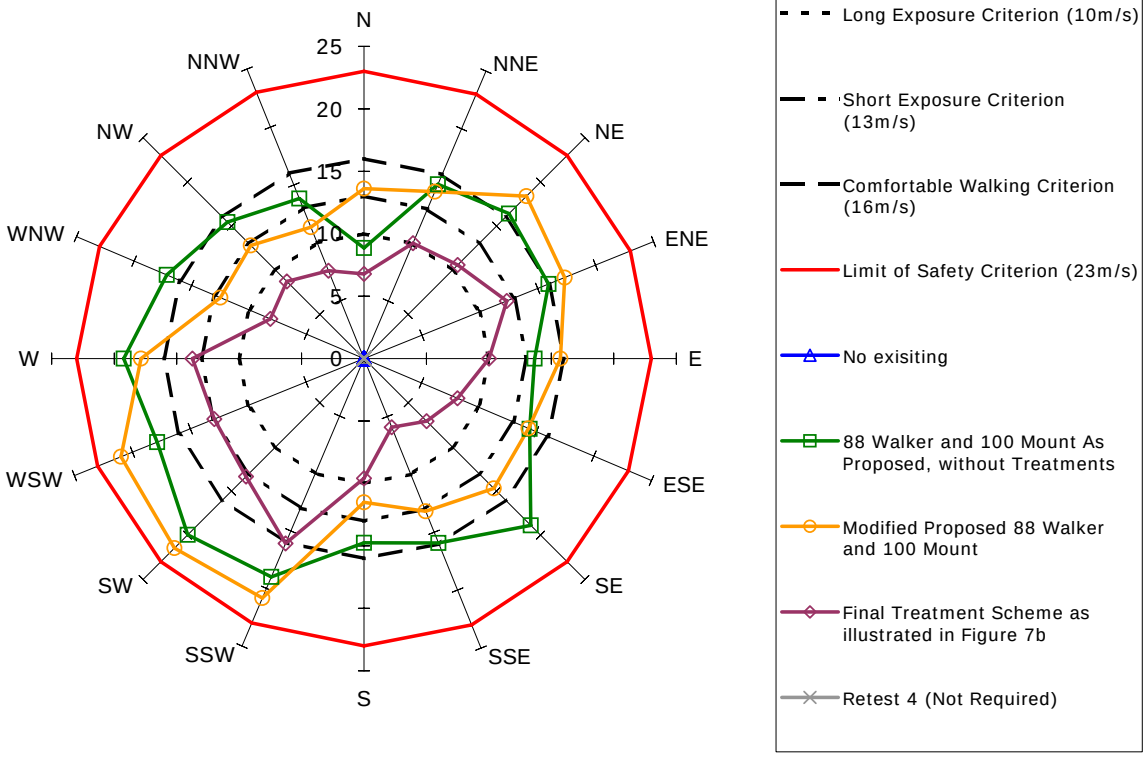


Measured Wind Speeds at Point 27

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

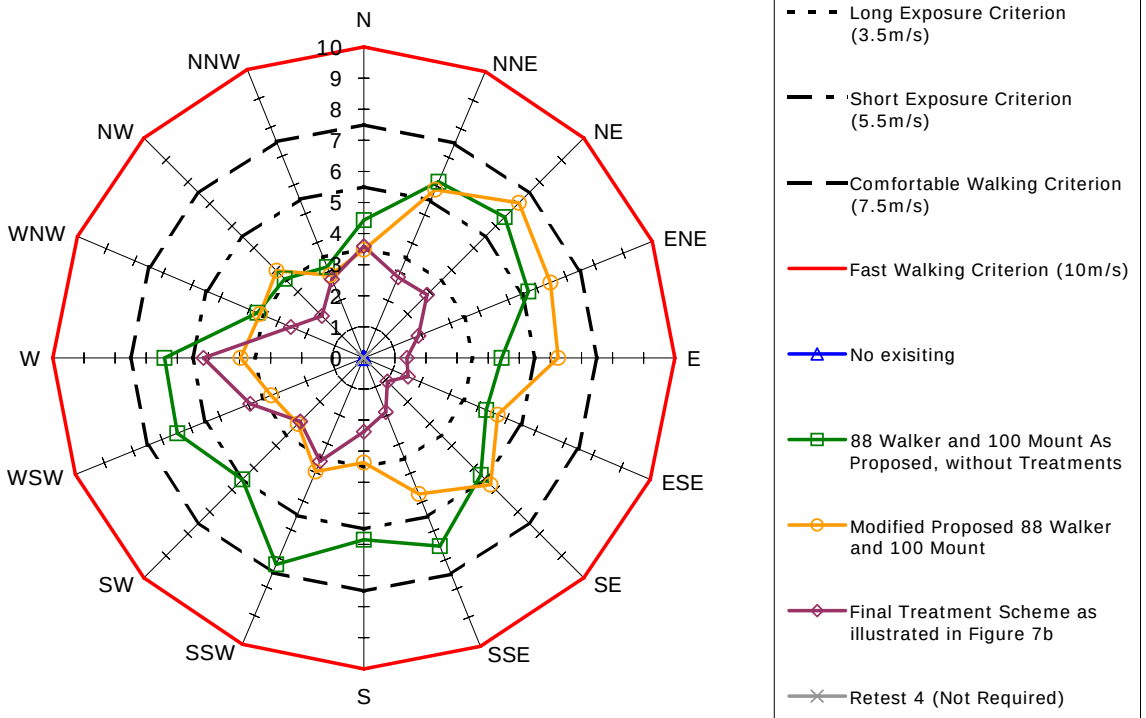


Annual Maximum Gust Wind Speeds (m/s)

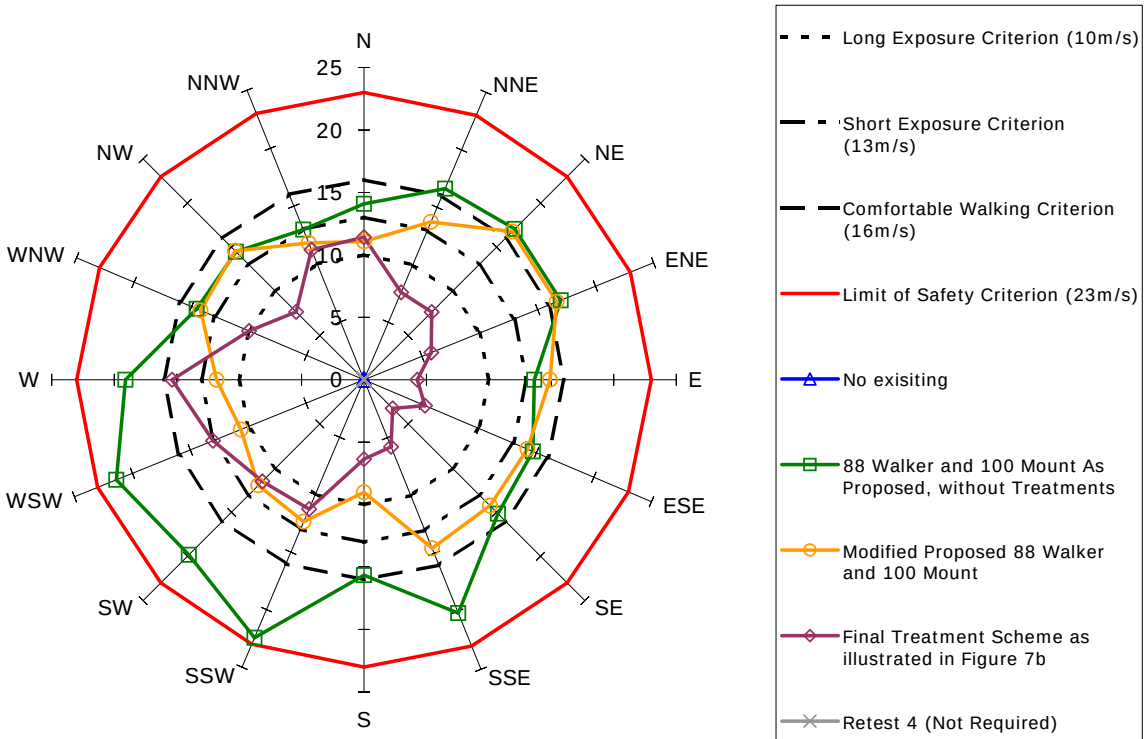


Measured Wind Speeds at Point 28

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

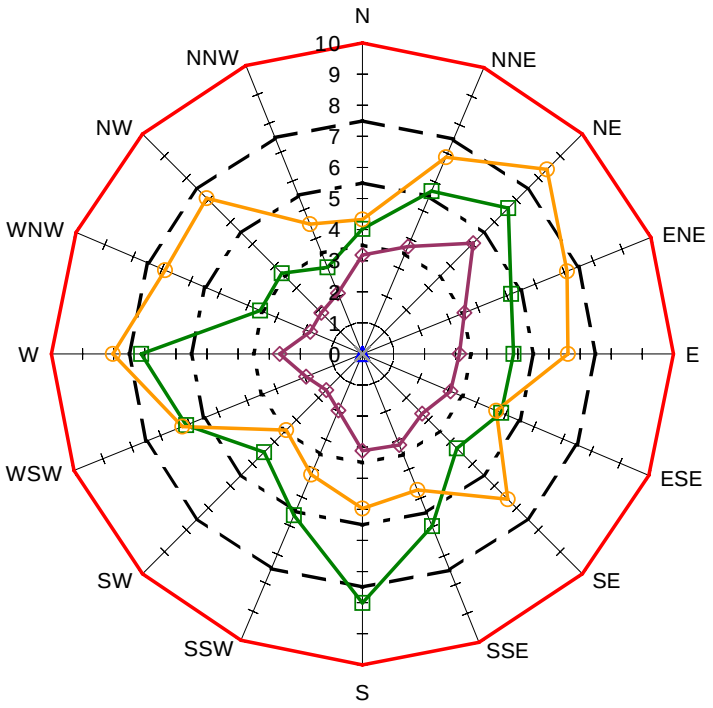


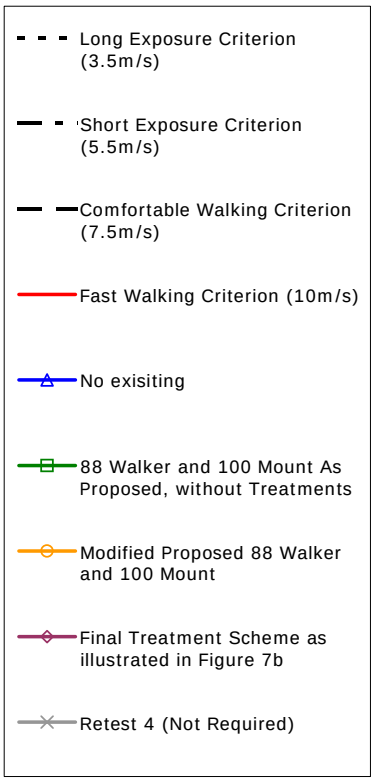
Annual Maximum Gust Wind Speeds (m/s)



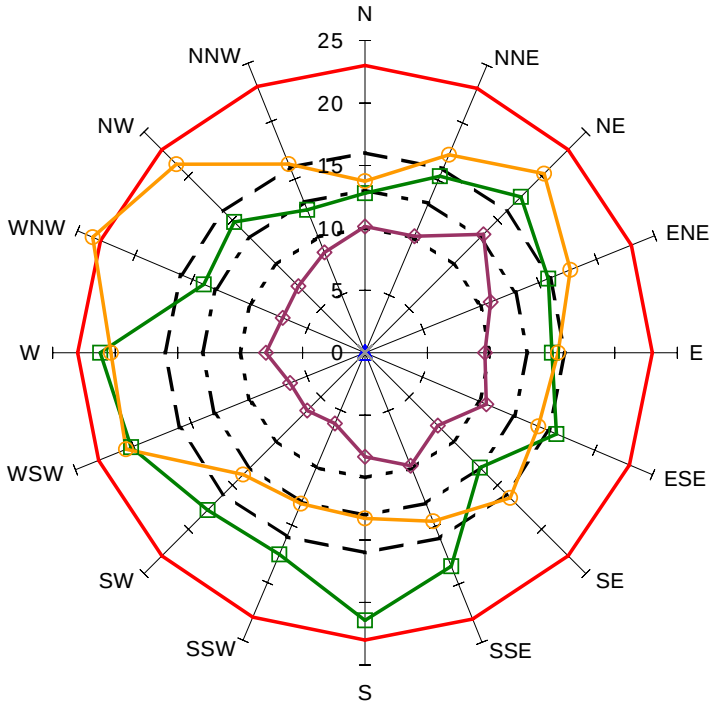
Measured Wind Speeds at Point 29

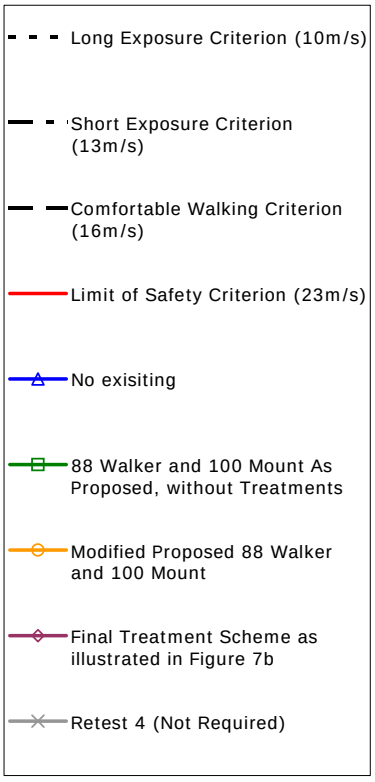
Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)





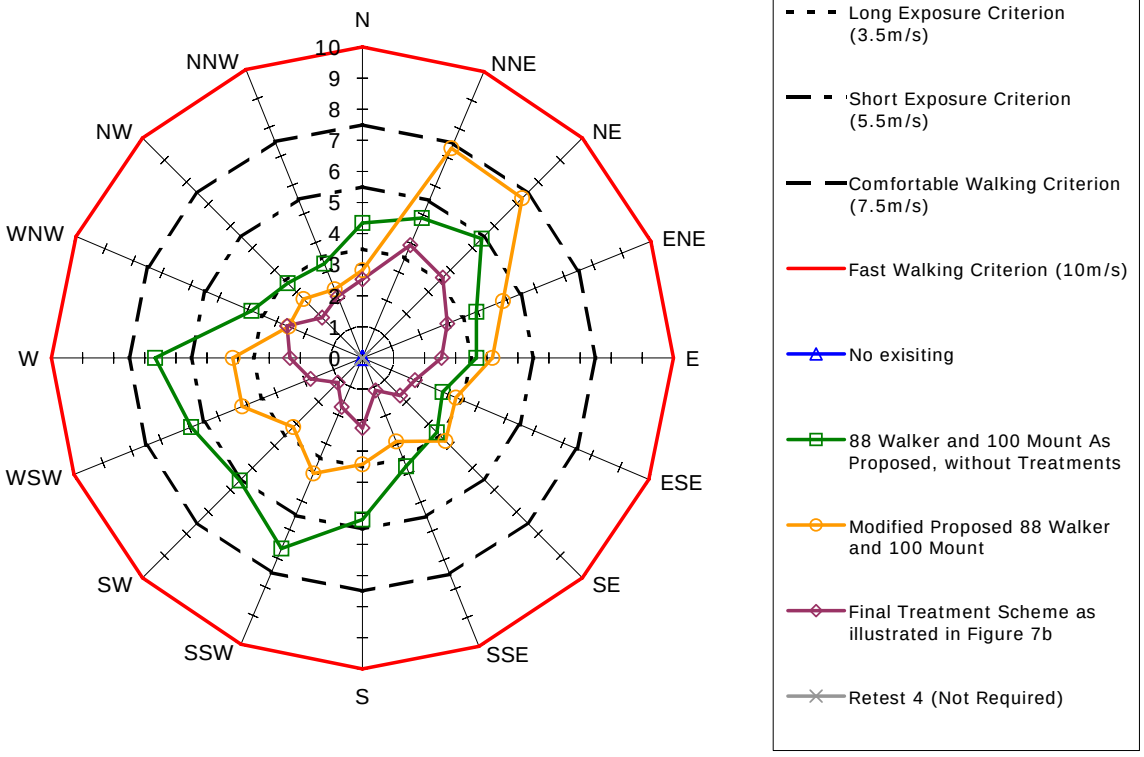
Annual Maximum Gust Wind Speeds (m/s)



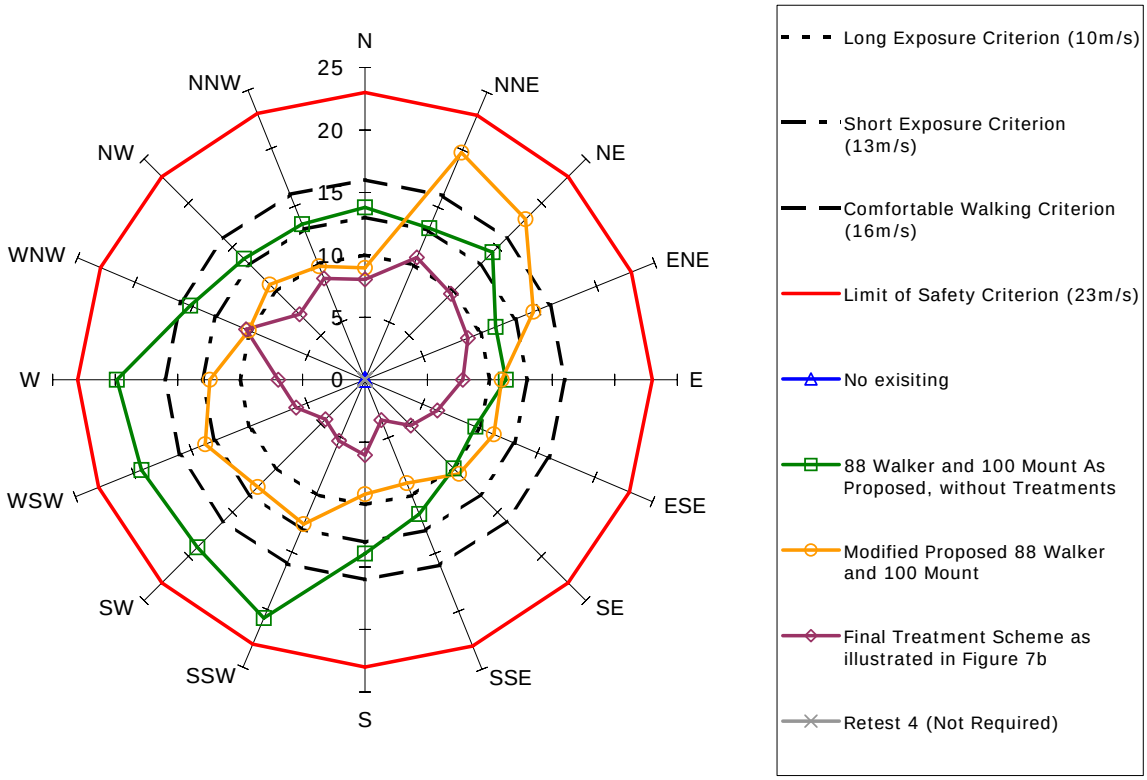


Measured Wind Speeds at Point 30

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

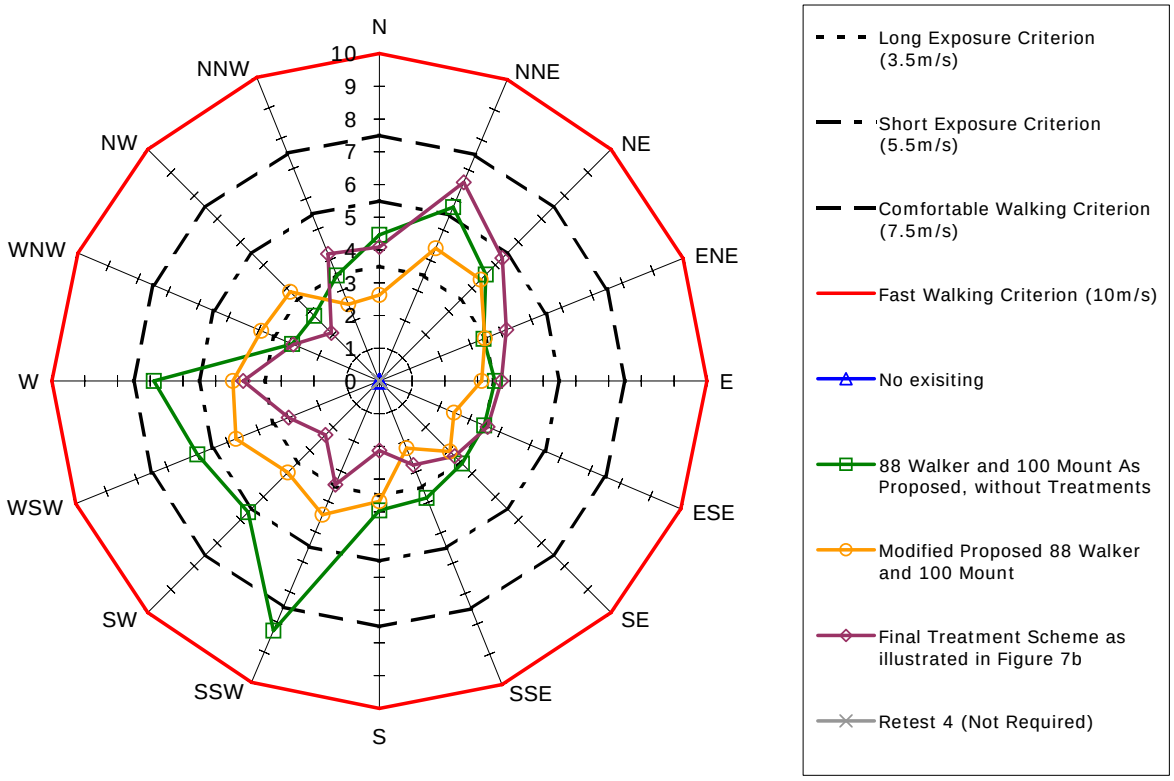


Annual Maximum Gust Wind Speeds (m/s)

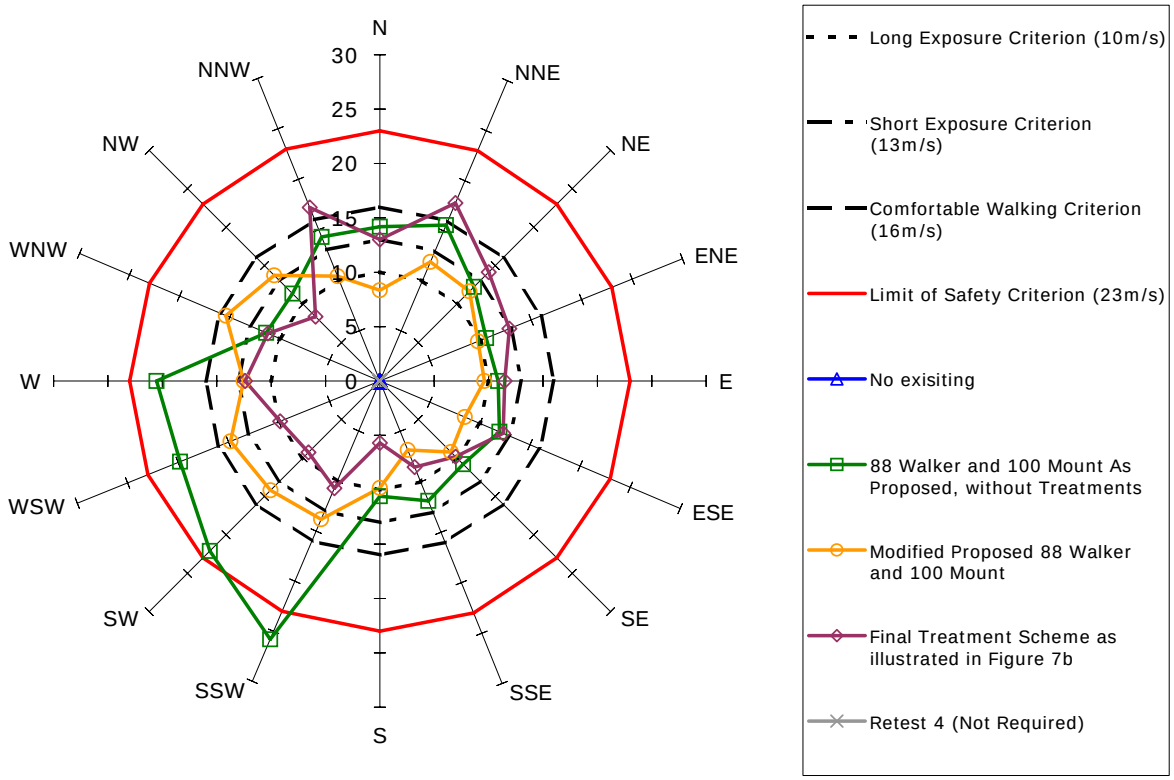


Measured Wind Speeds at Point 31

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

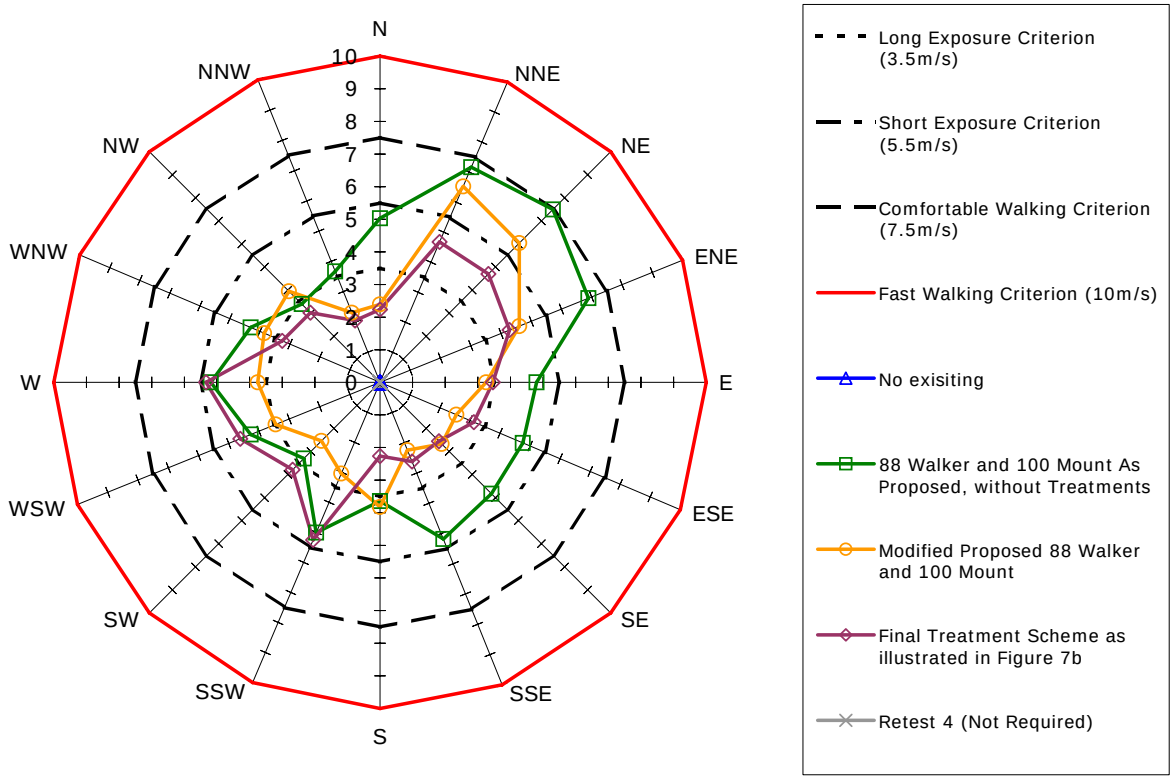


Annual Maximum Gust Wind Speeds (m/s)

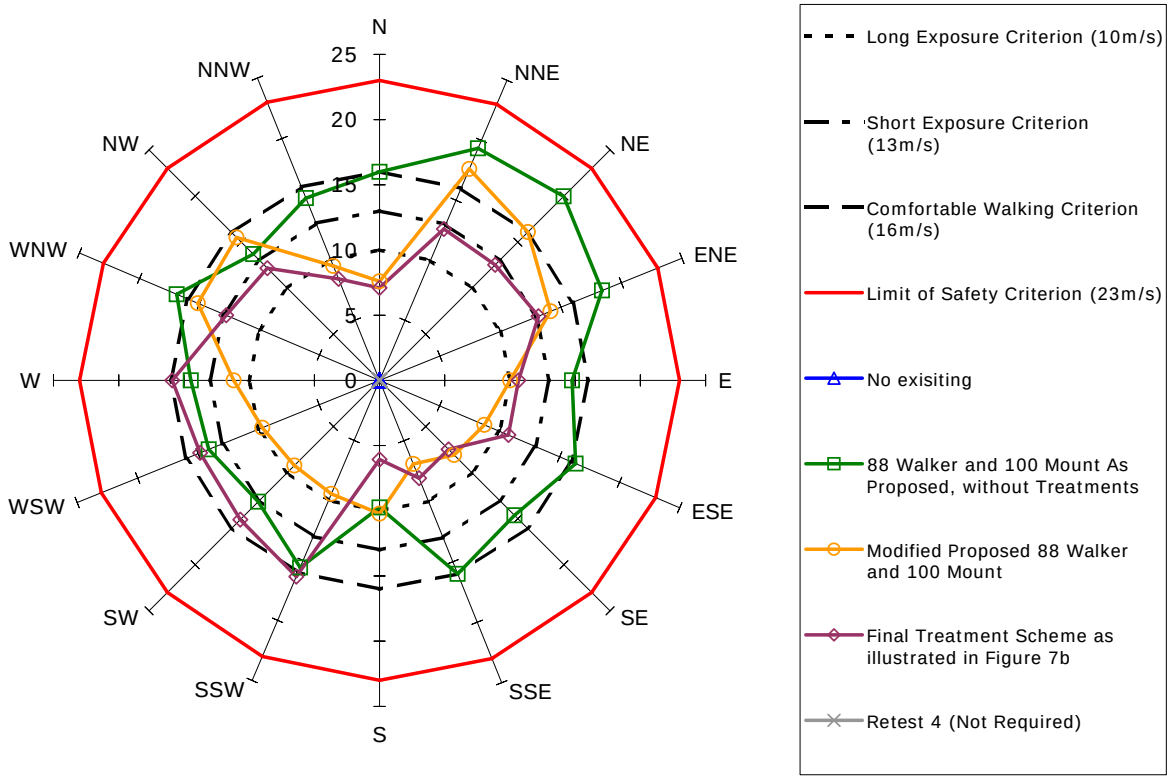


Measured Wind Speeds at Point 32

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

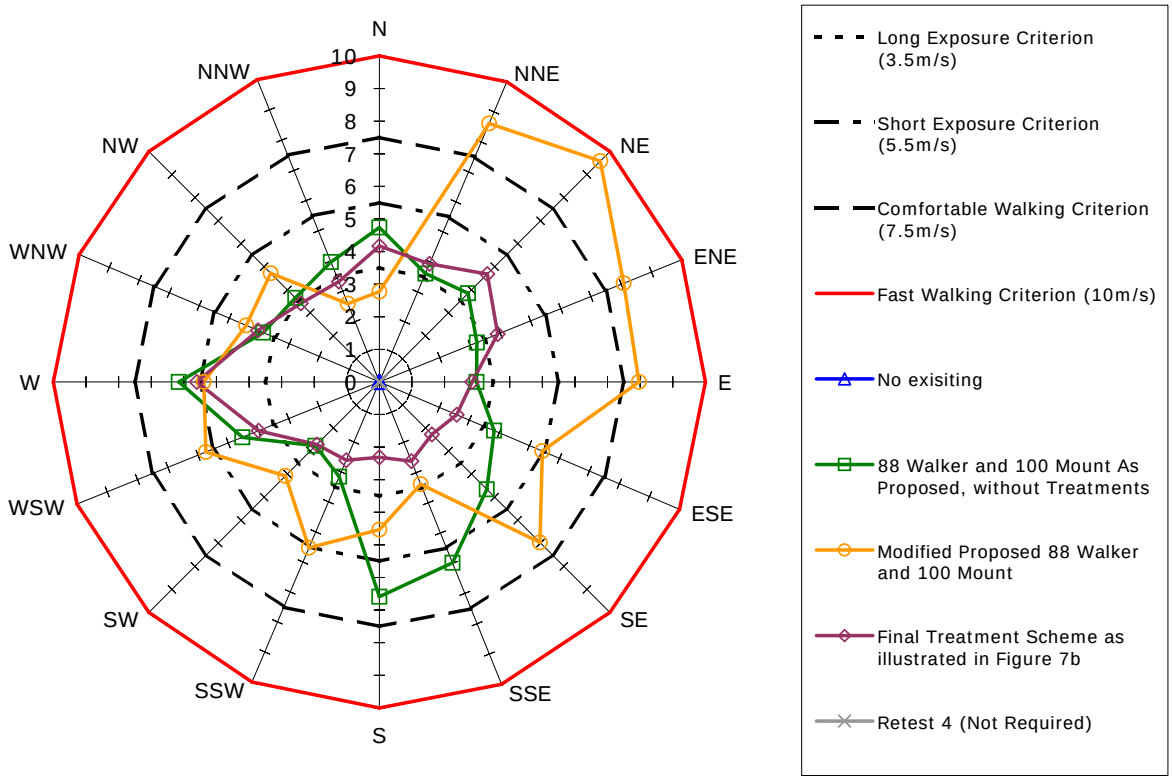


Annual Maximum Gust Wind Speeds (m/s)

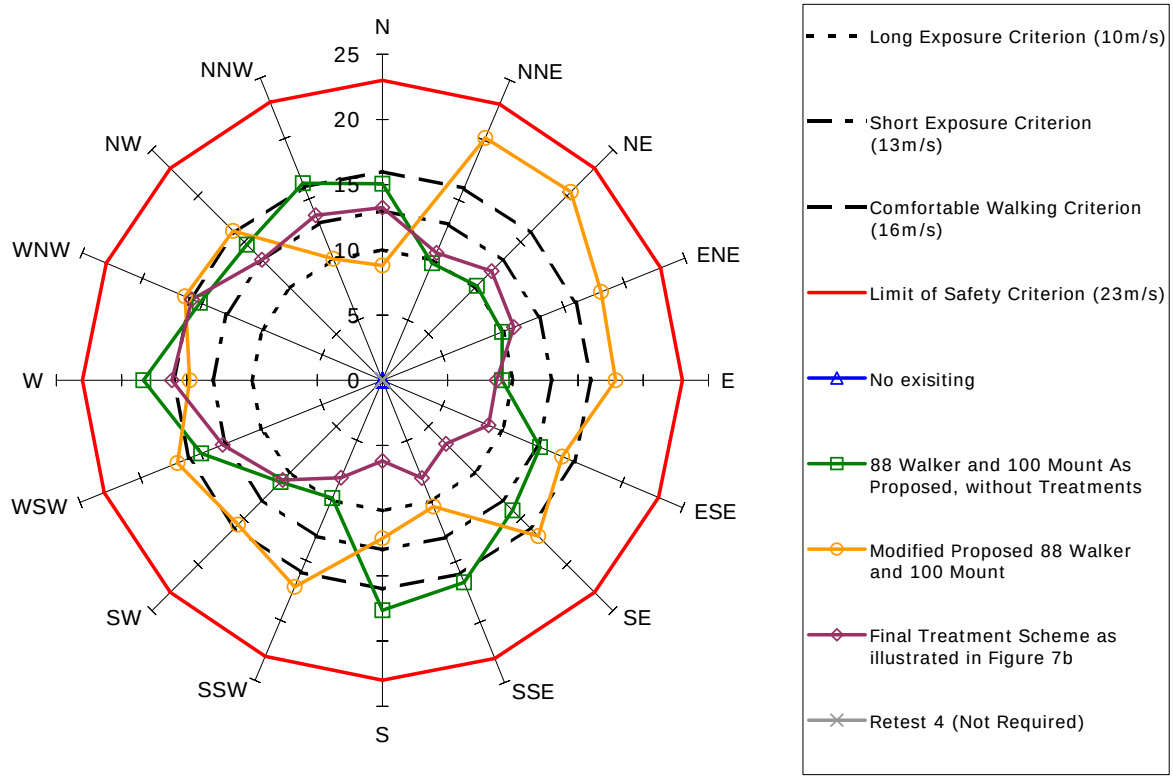


Measured Wind Speeds at Point 33

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

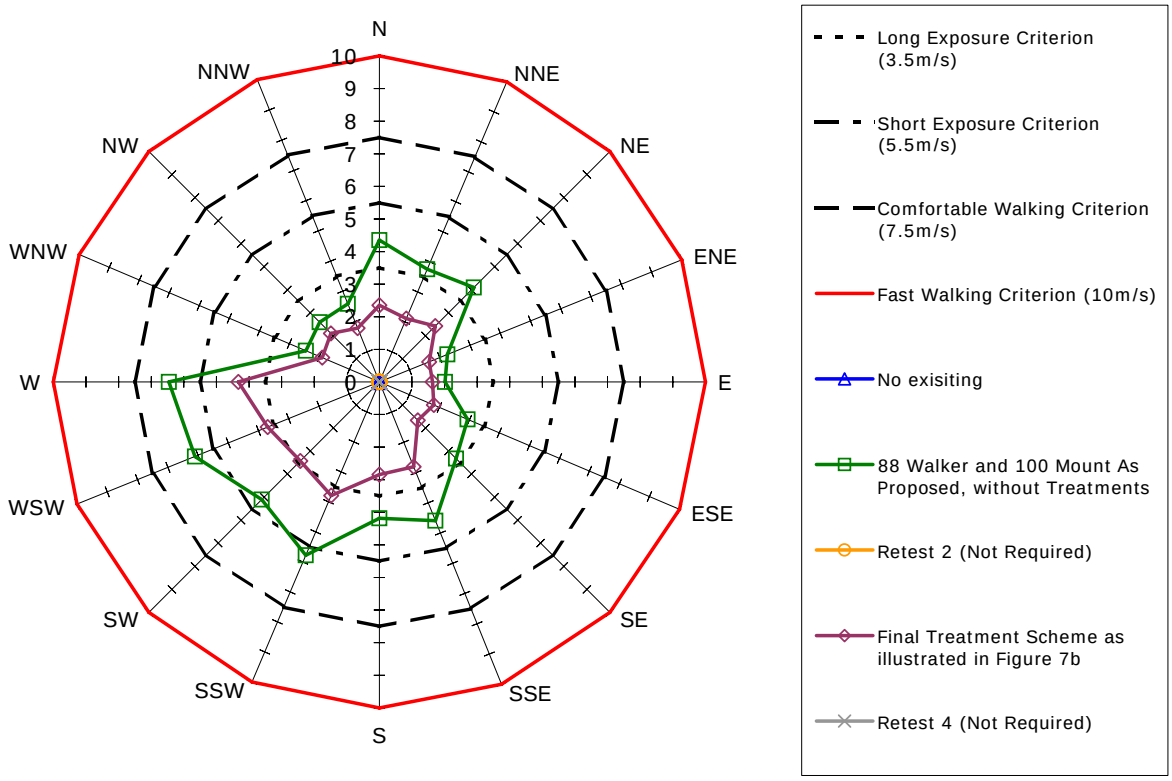


Annual Maximum Gust Wind Speeds (m/s)

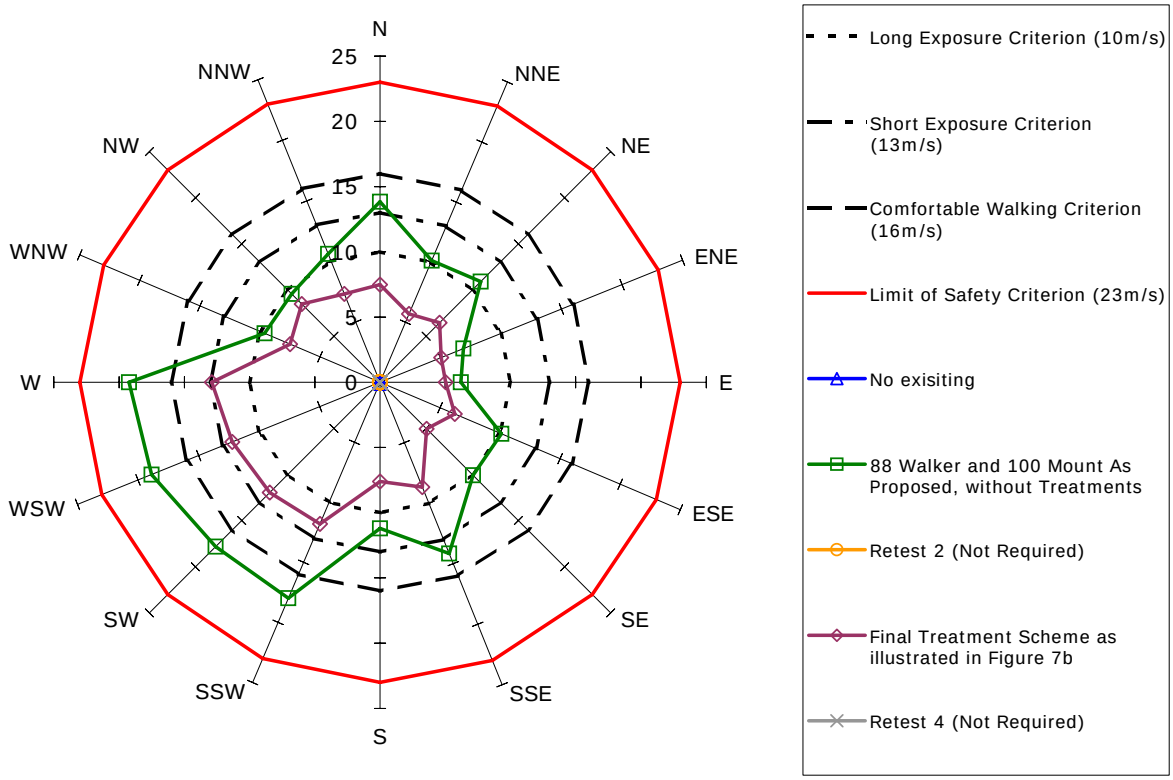


Measured Wind Speeds at Point 34

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

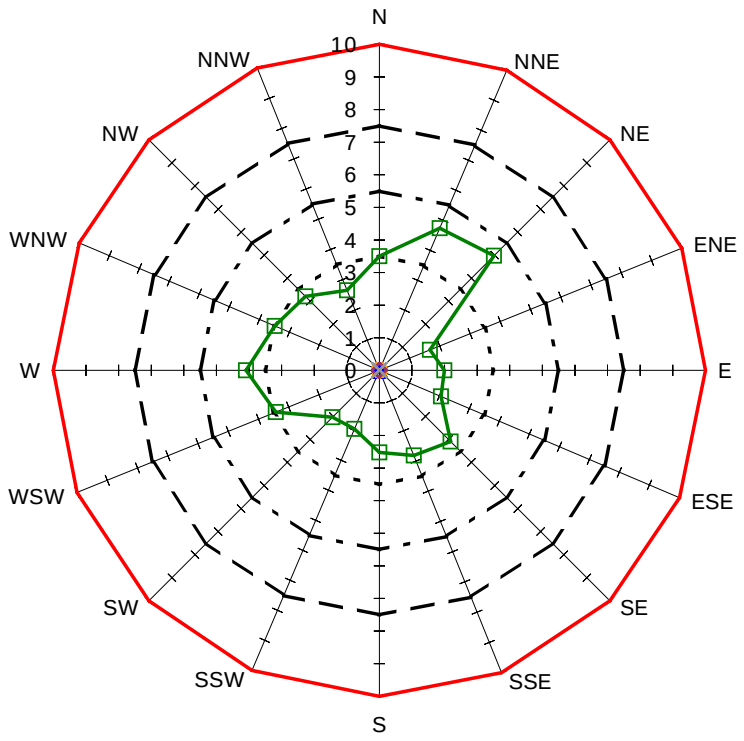


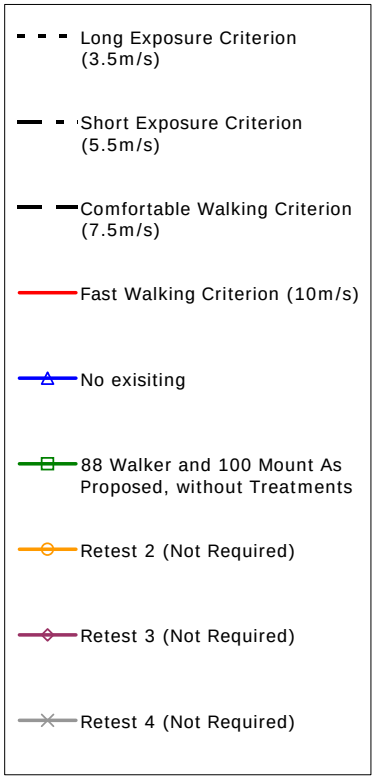
Annual Maximum Gust Wind Speeds (m/s)



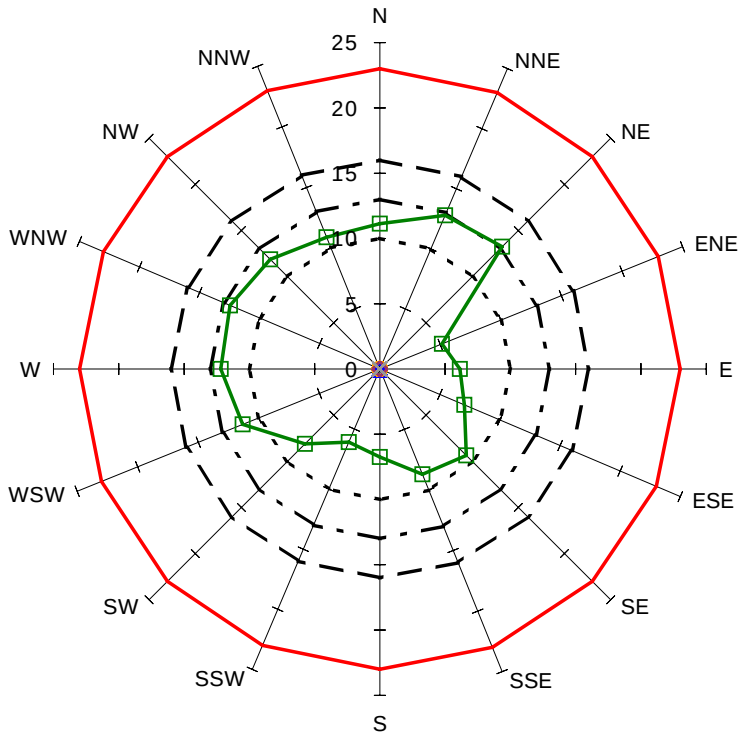
Measured Wind Speeds at Point 35

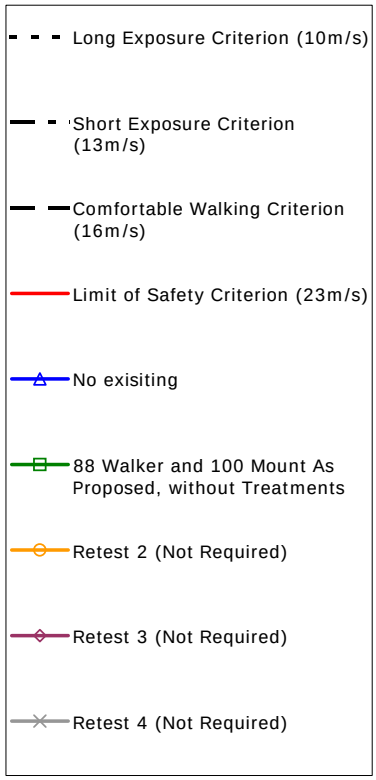
Weekly Maximum Gust Equivalent Mean Wind Speeds (m/s)





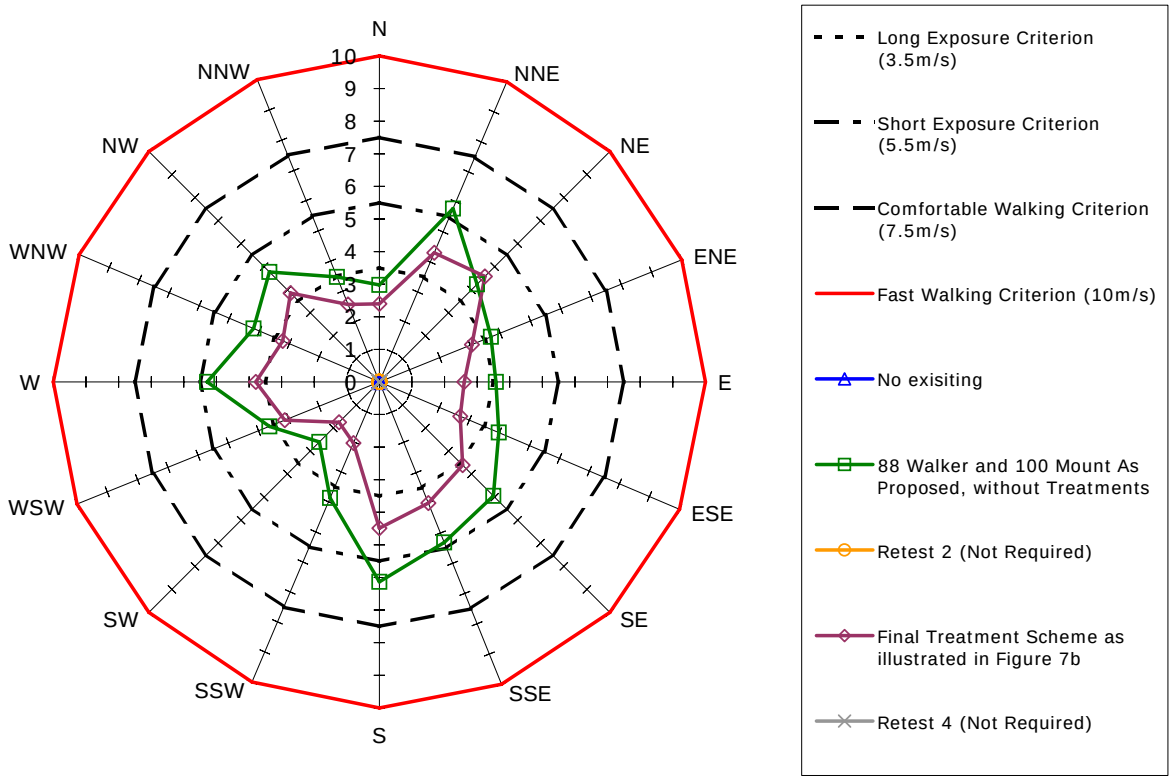
Annual Maximum Gust Wind Speeds (m/s)



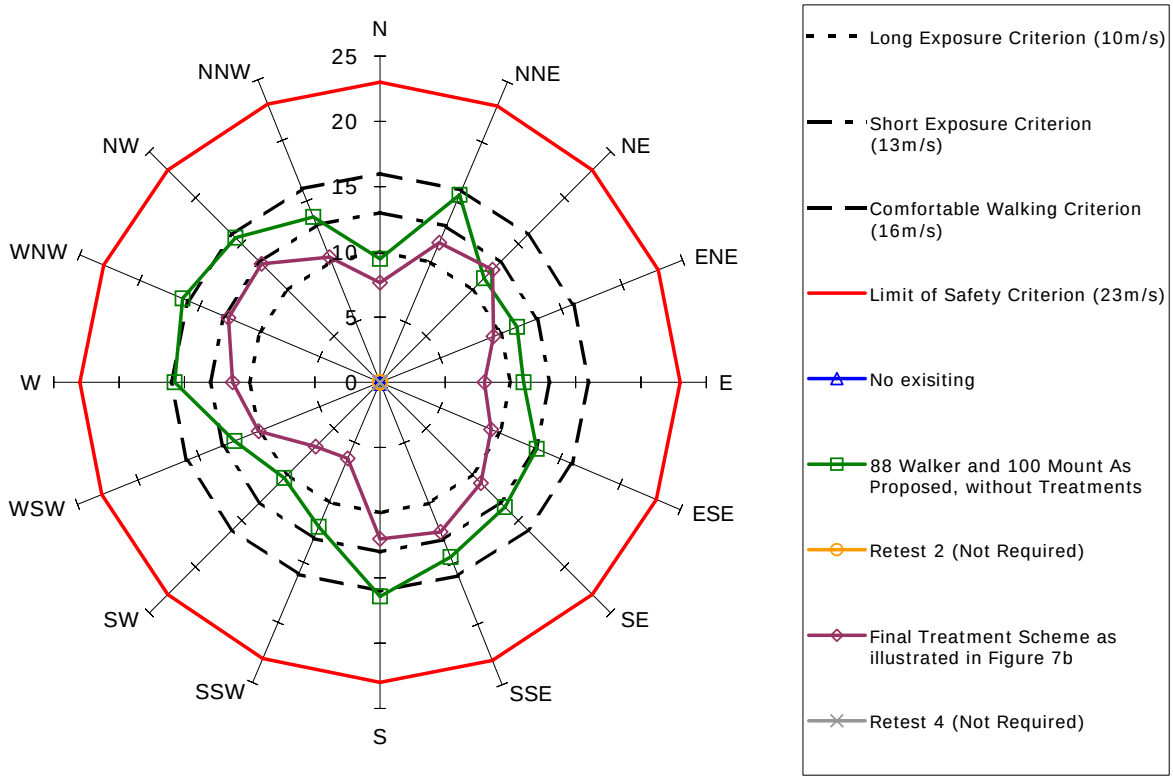


Measured Wind Speeds at Point 36

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

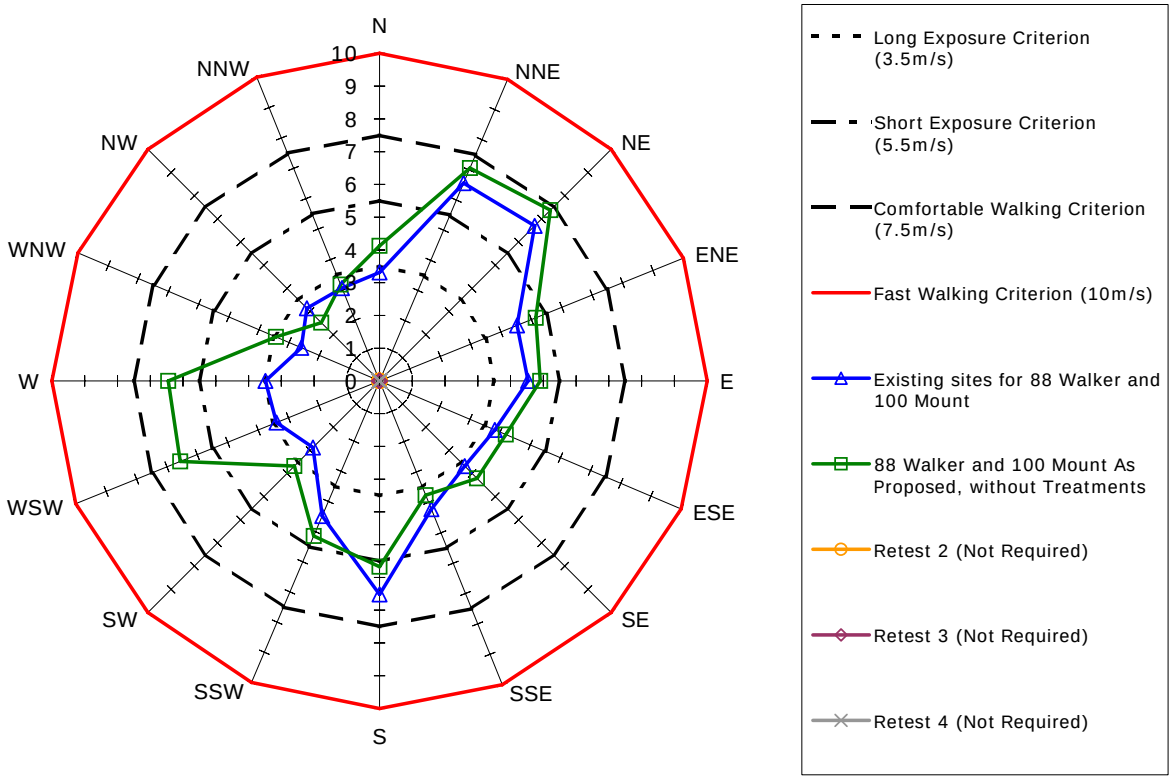


Annual Maximum Gust Wind Speeds (m/s)

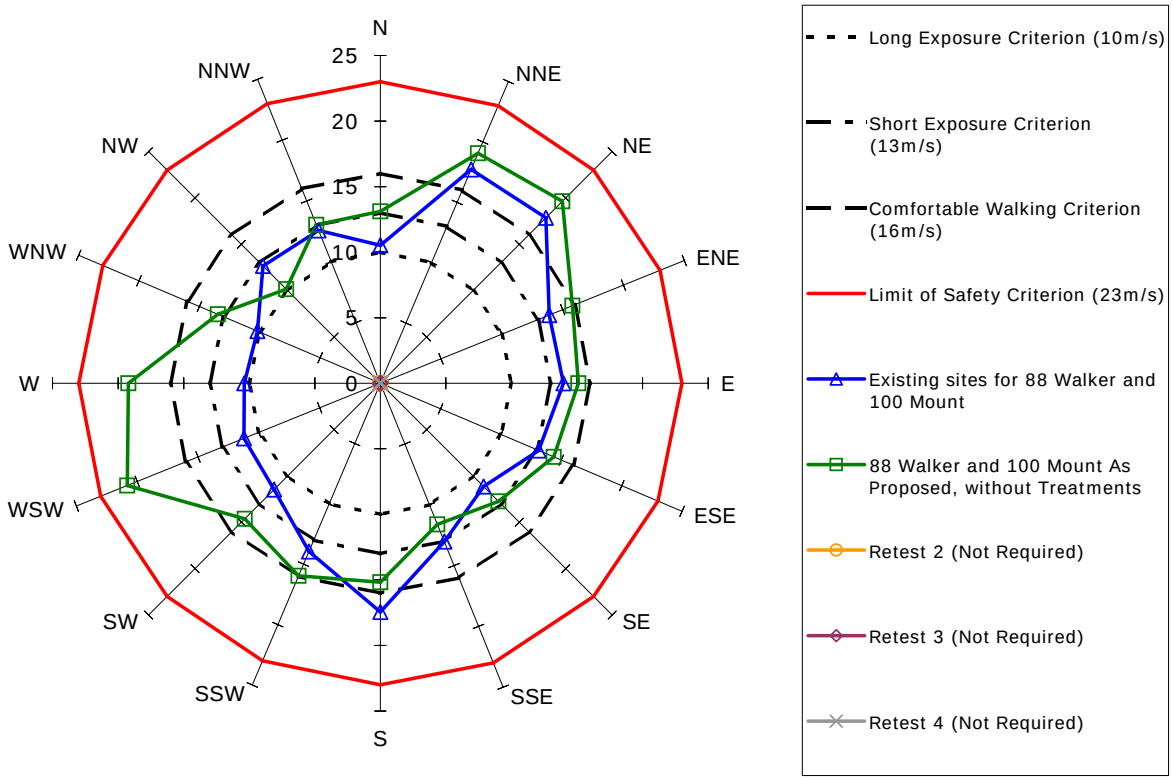


Measured Wind Speeds at Point 37

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

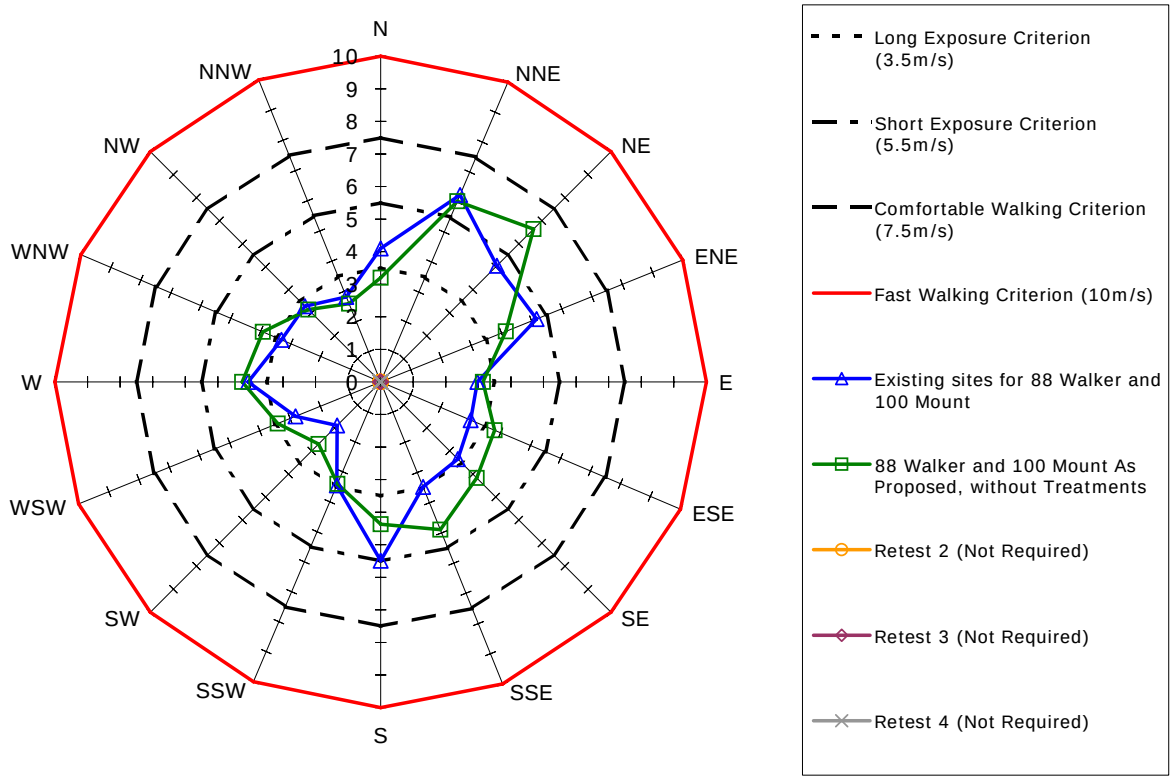


Annual Maximum Gust Wind Speeds (m/s)

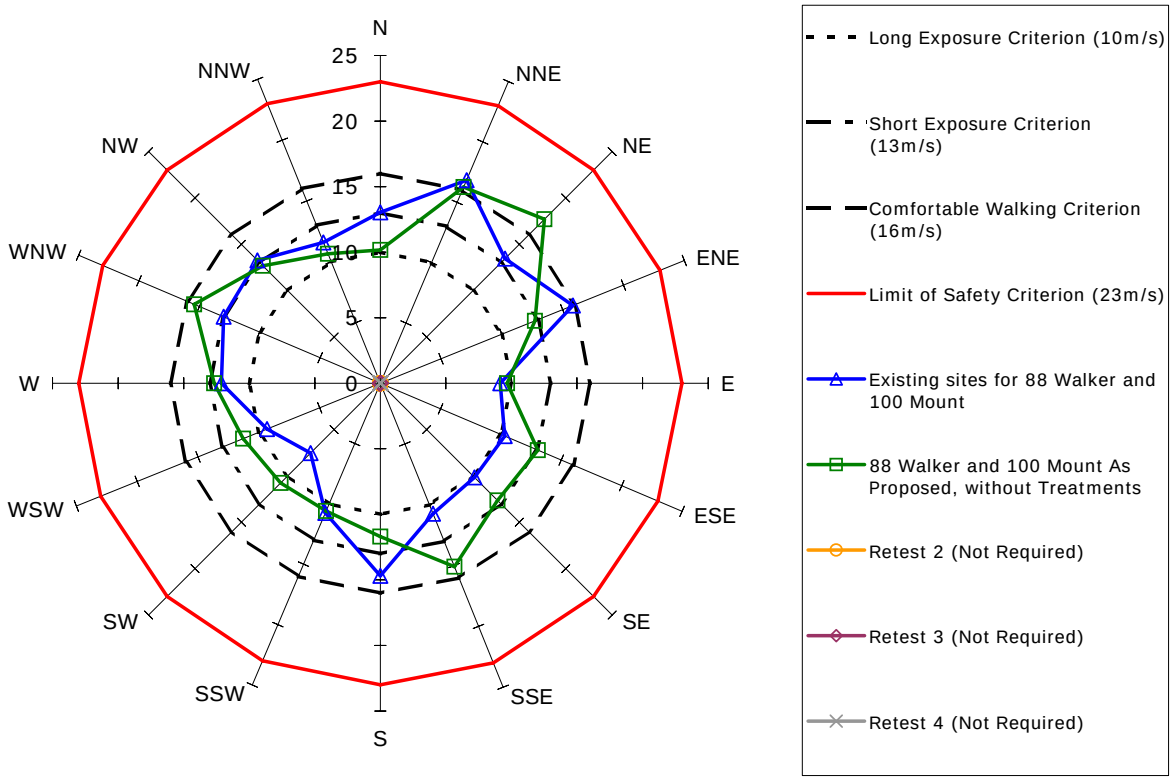


Measured Wind Speeds at Point 38

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

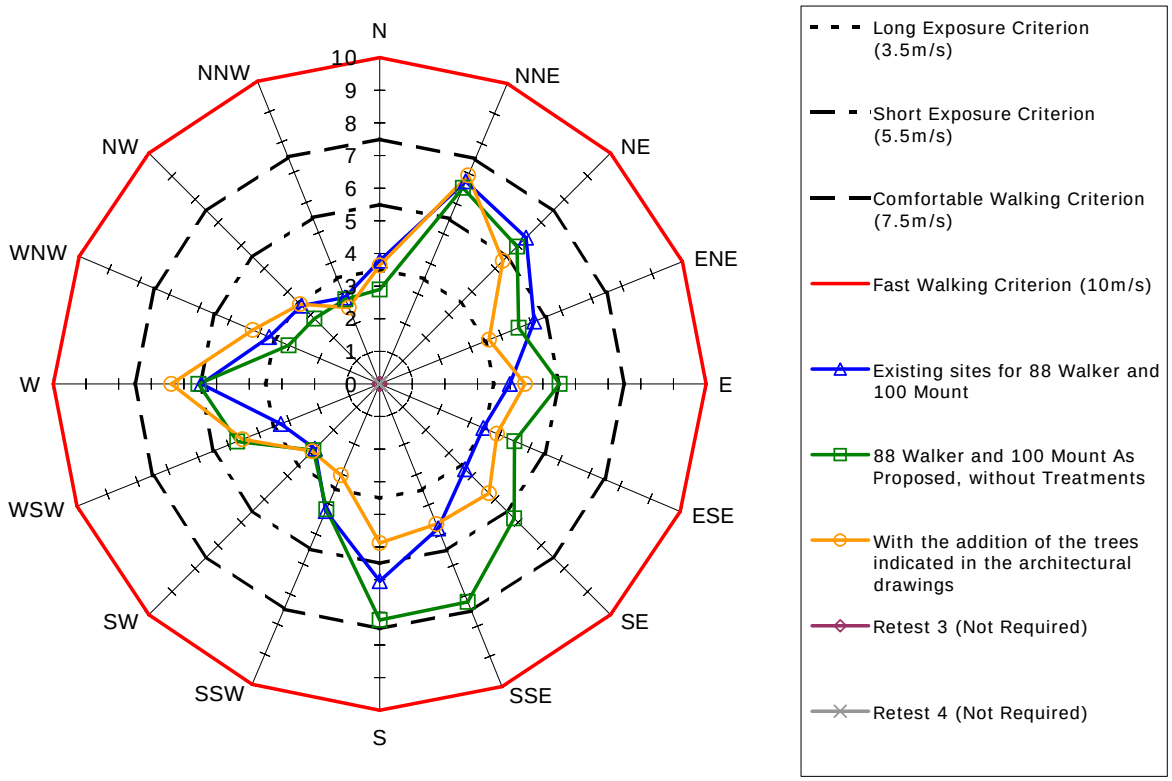


Annual Maximum Gust Wind Speeds (m/s)

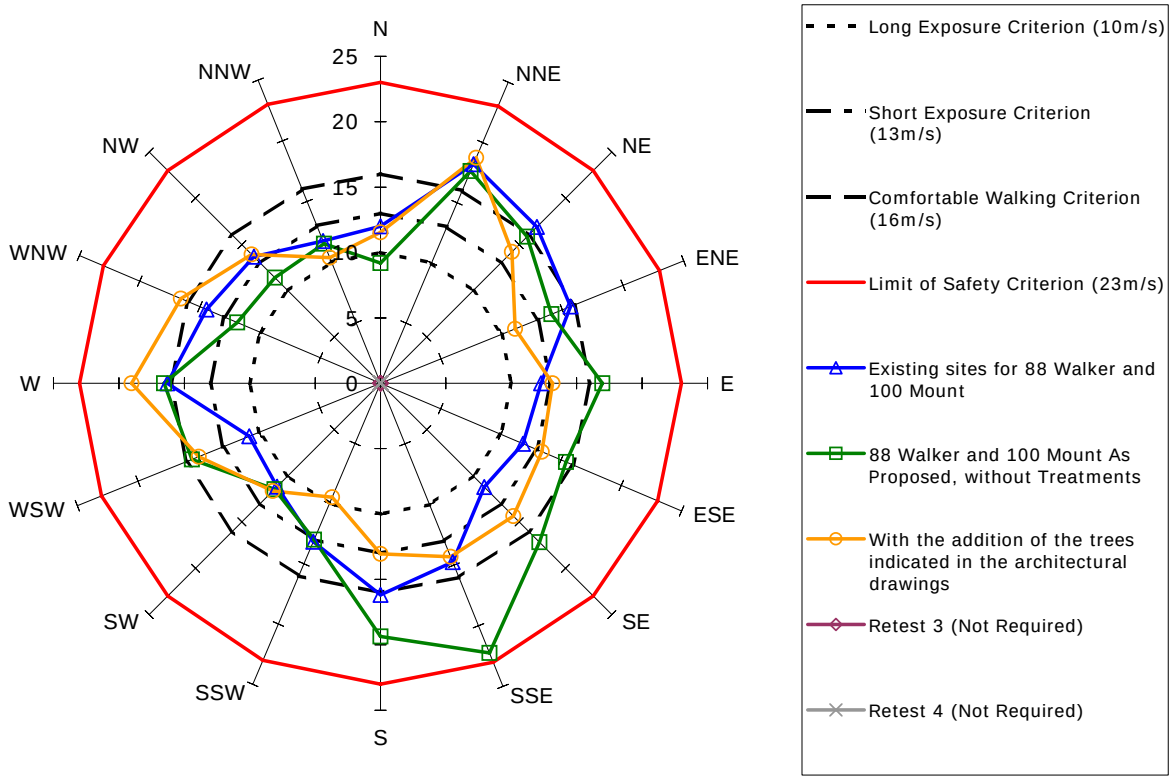


Measured Wind Speeds at Point 39

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

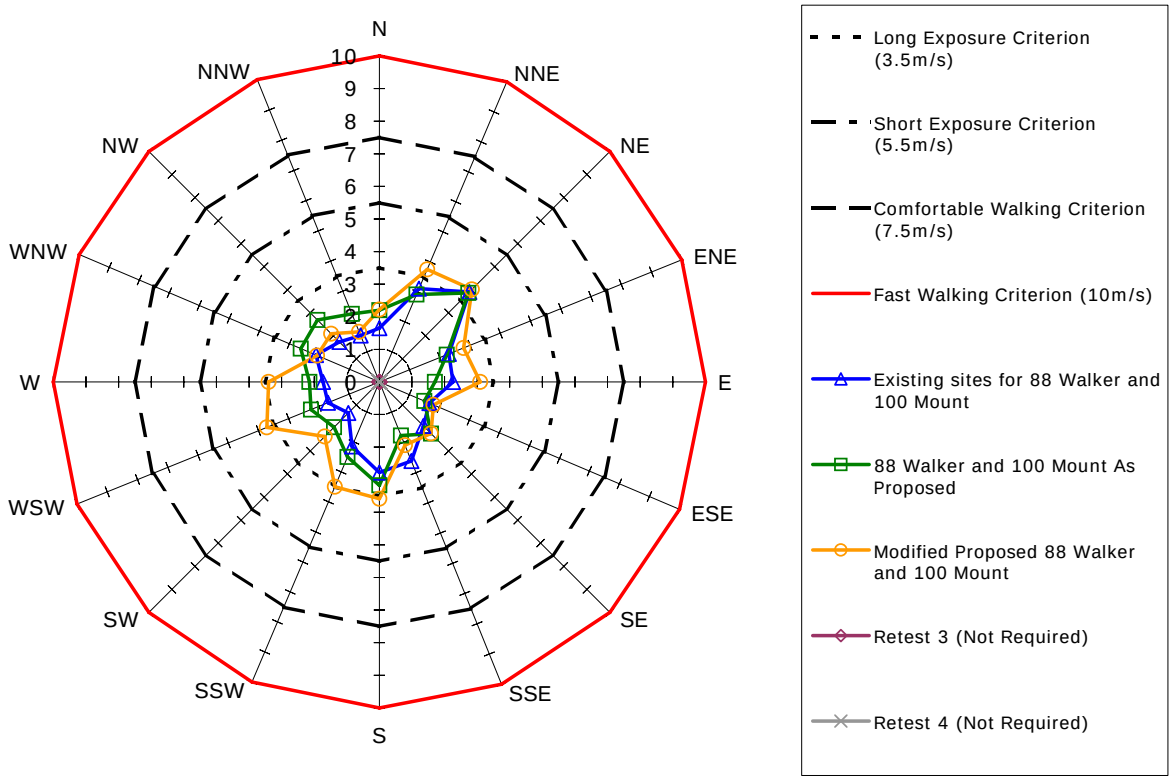


Annual Maximum Gust Wind Speeds (m/s)

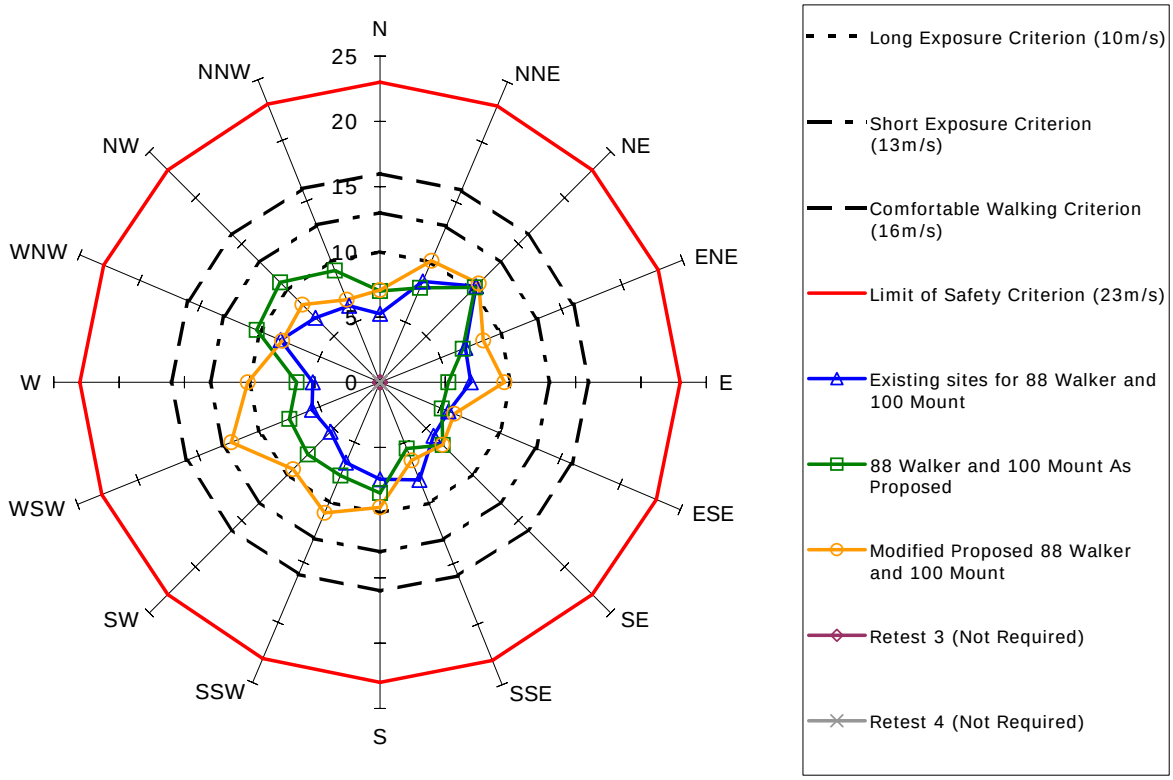


Measured Wind Speeds at Point 40

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

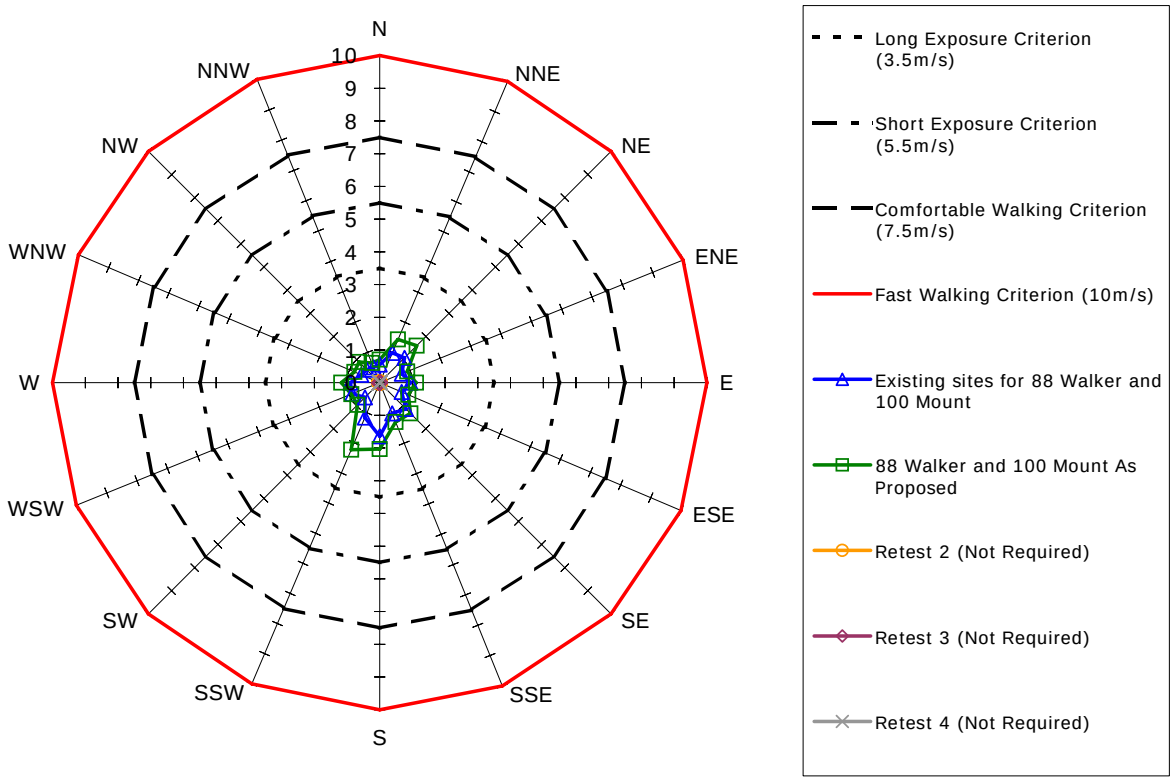


Annual Maximum Gust Wind Speeds (m/s)

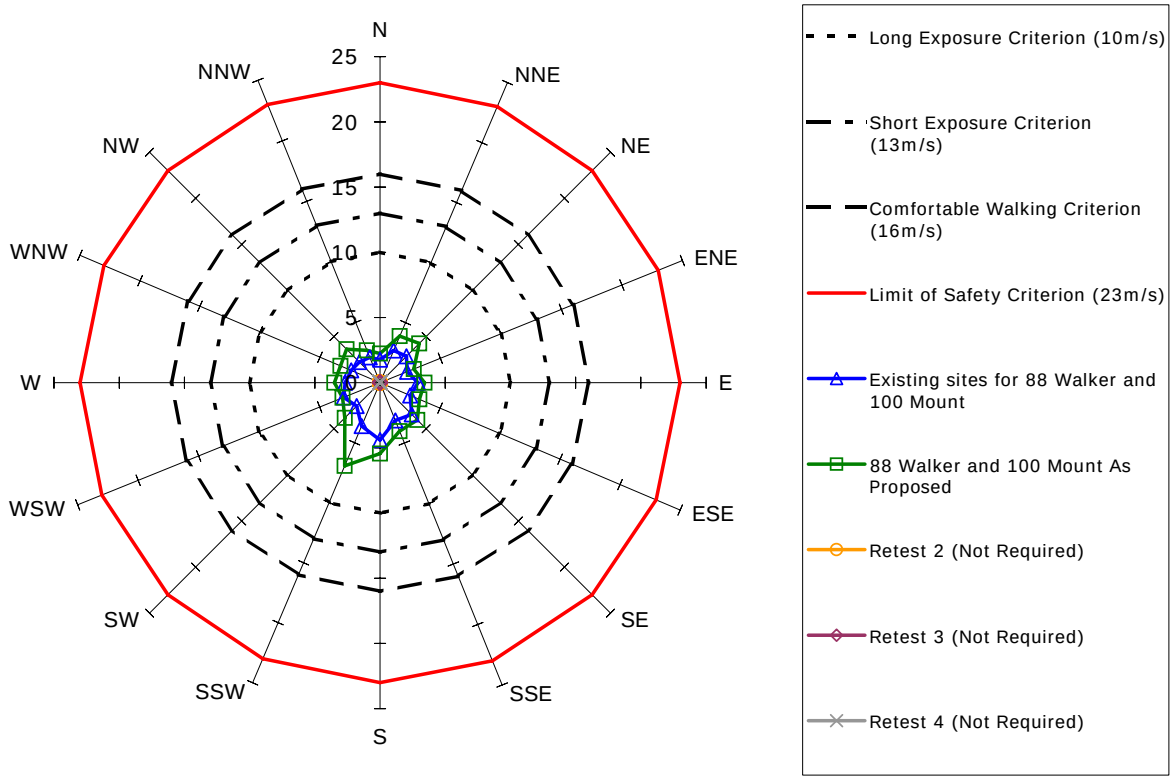


Measured Wind Speeds at Point 41

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

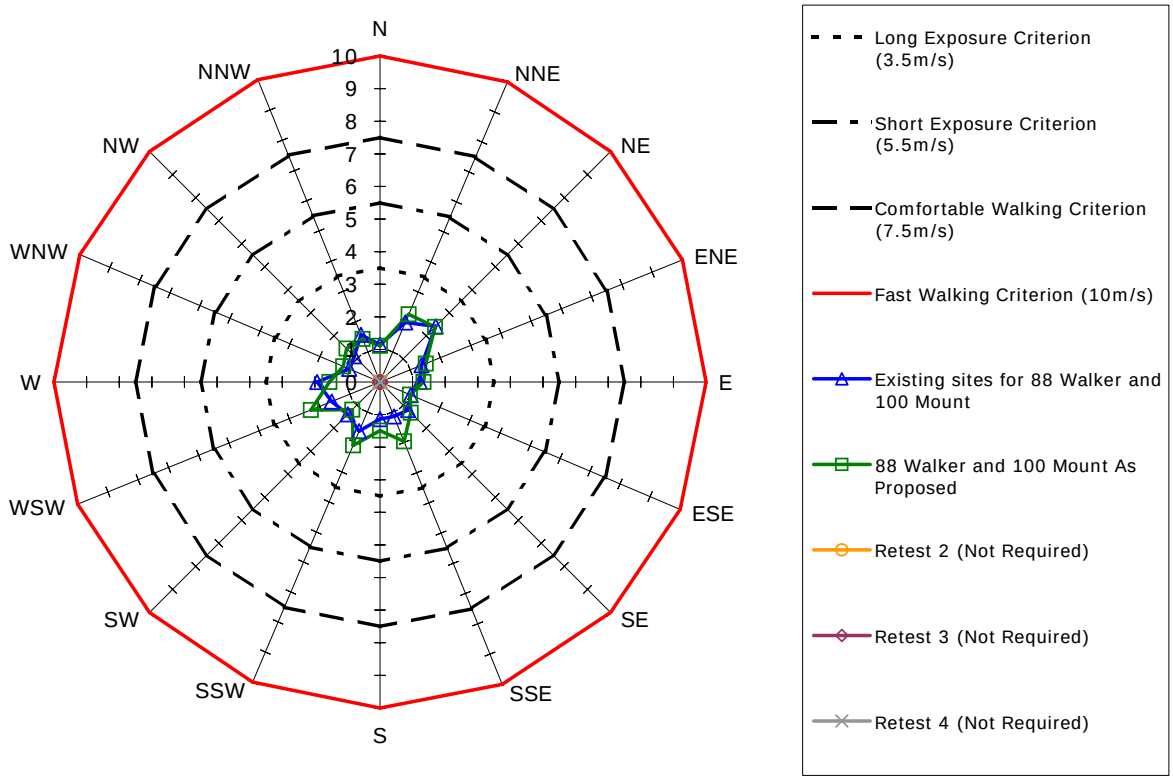


Annual Maximum Gust Wind Speeds (m/s)

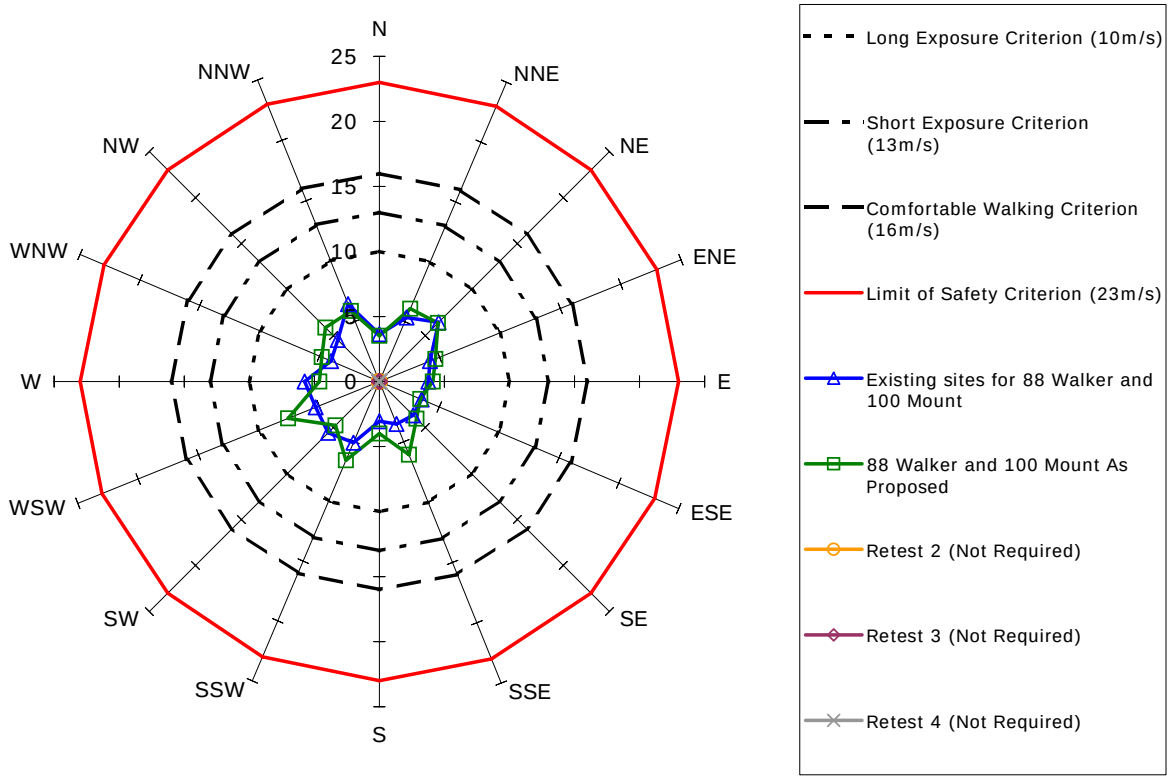


Measured Wind Speeds at Point 42

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

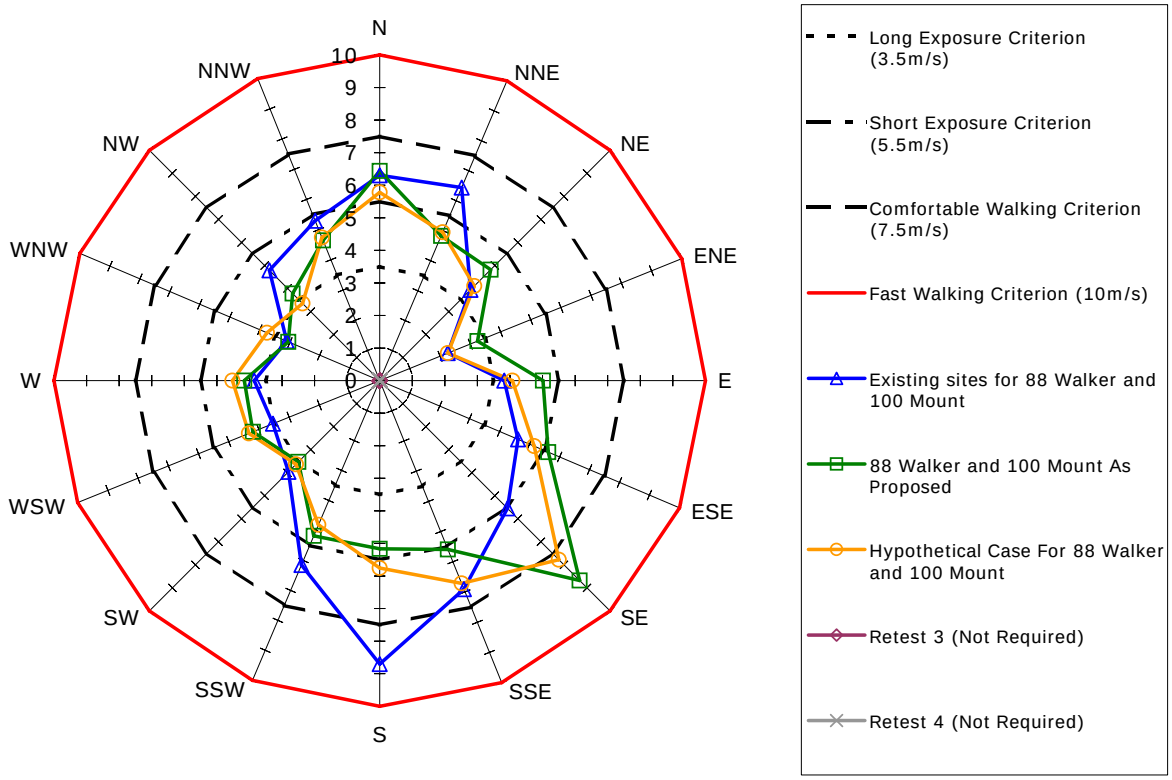


Annual Maximum Gust Wind Speeds (m/s)

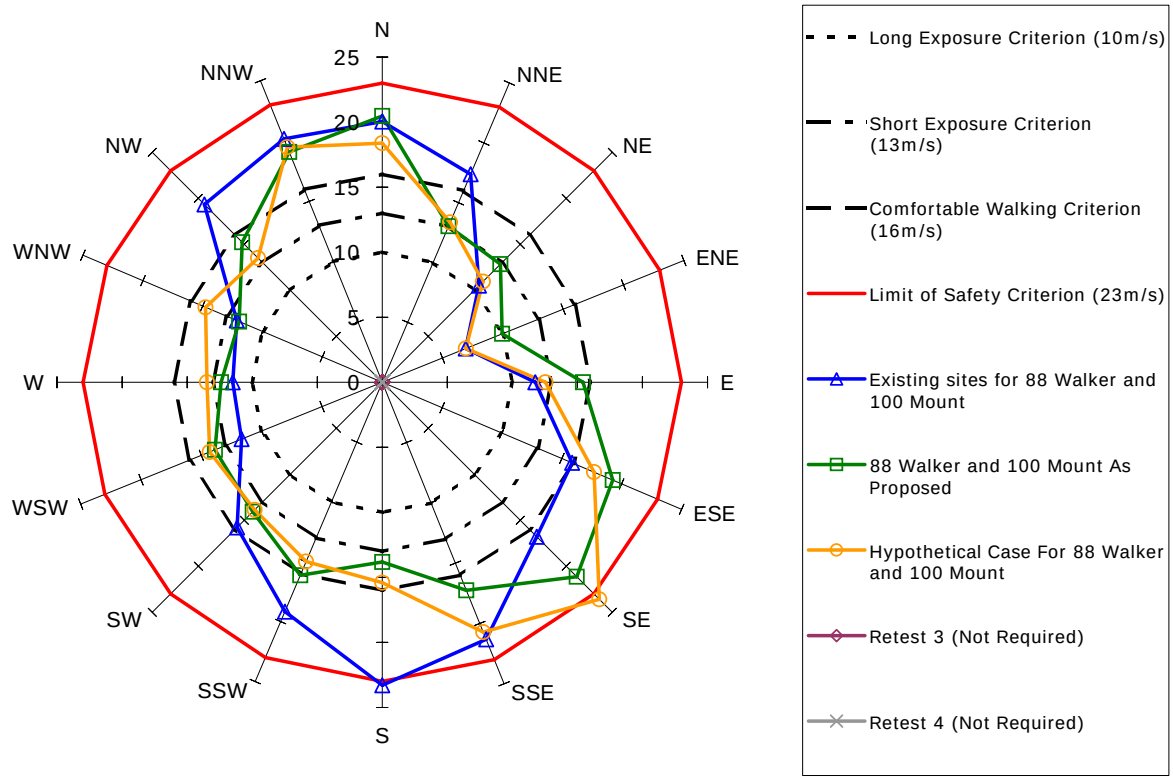


Measured Wind Speeds at Point 43

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

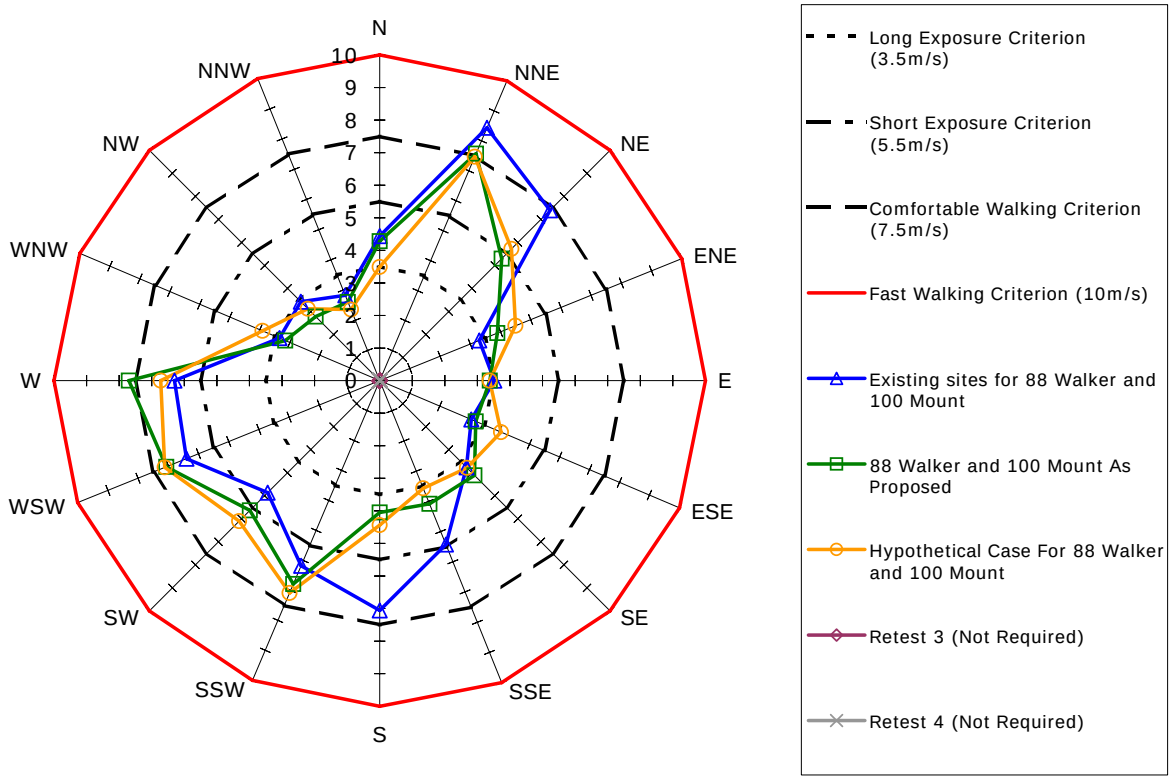


Annual Maximum Gust Wind Speeds (m/s)

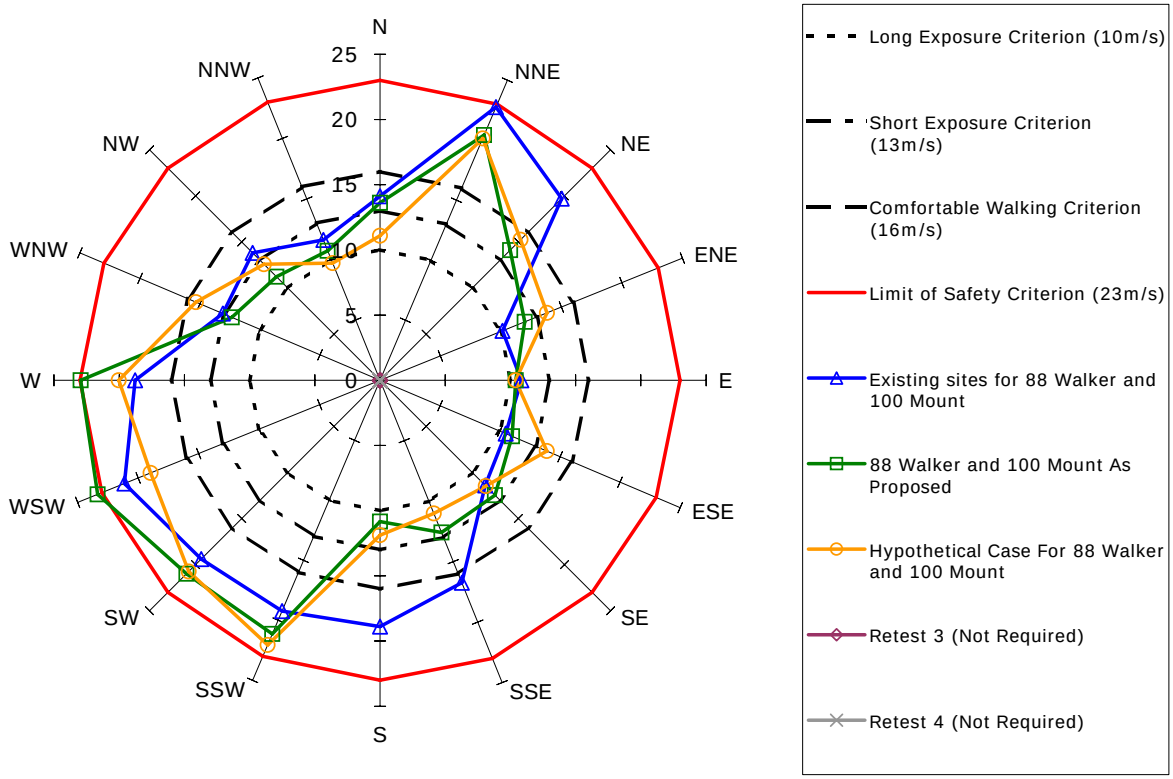


Measured Wind Speeds at Point 44

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

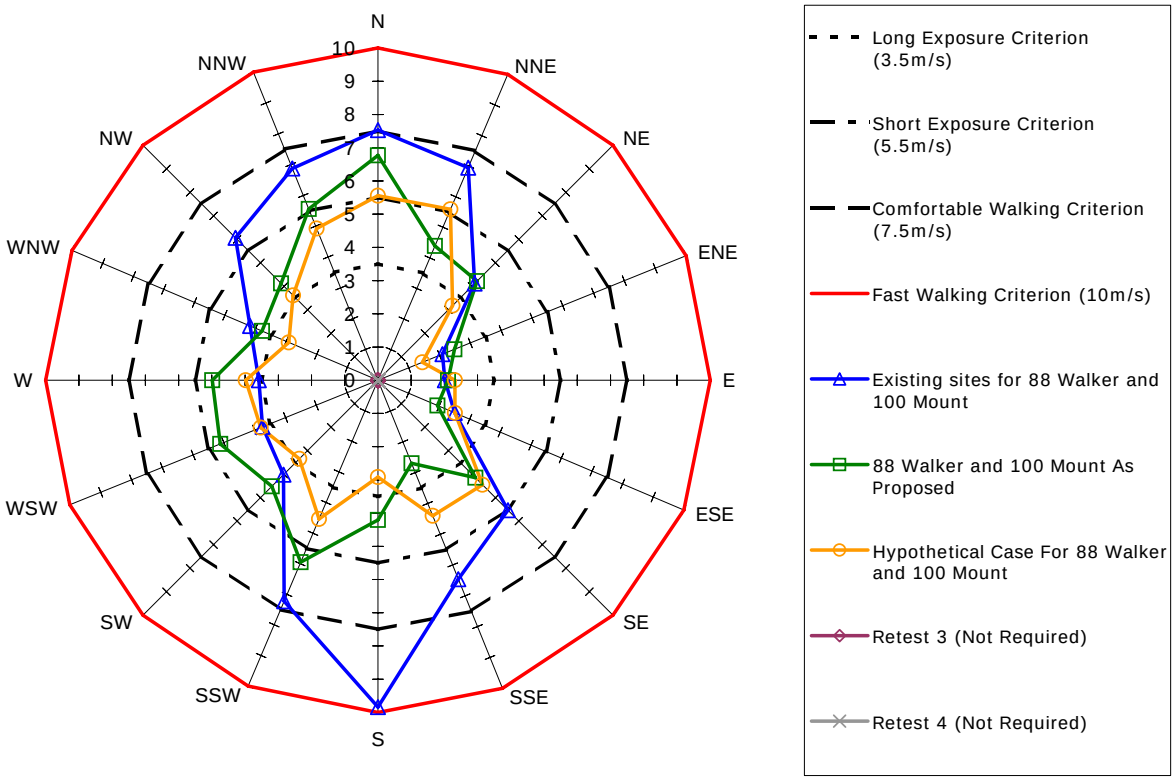


Annual Maximum Gust Wind Speeds (m/s)

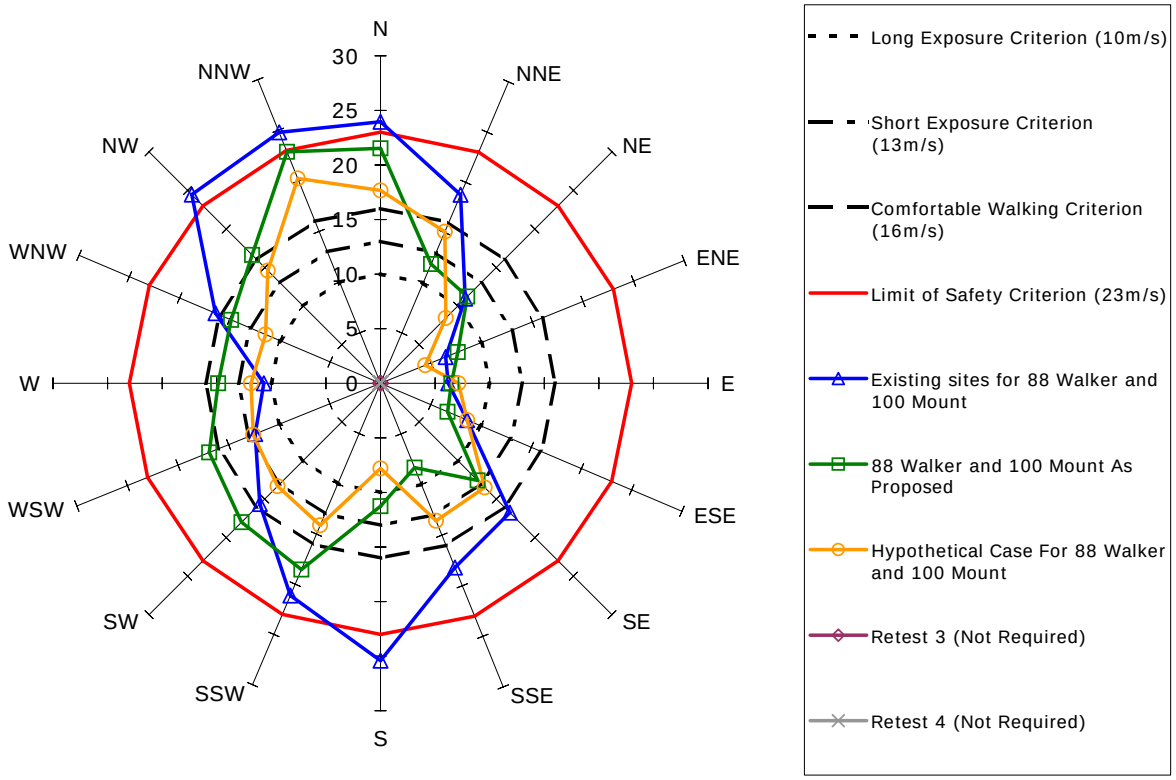


Measured Wind Speeds at Point 45

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

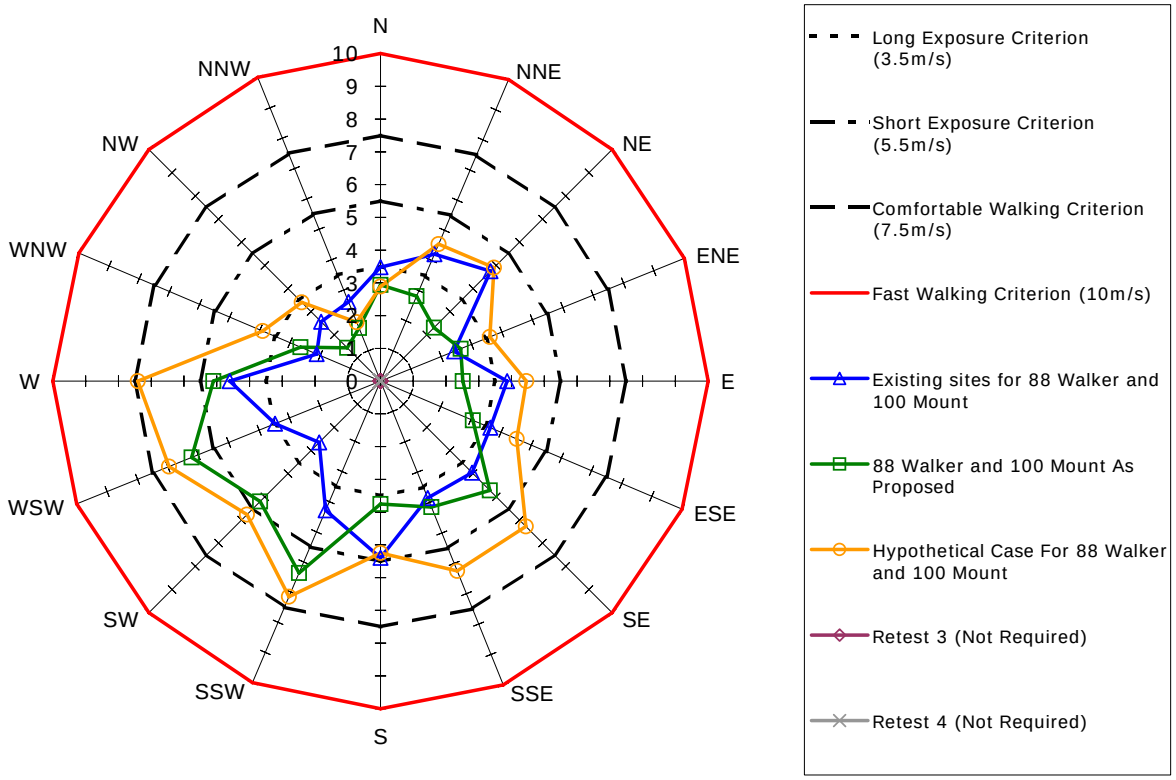


Annual Maximum Gust Wind Speeds (m/s)

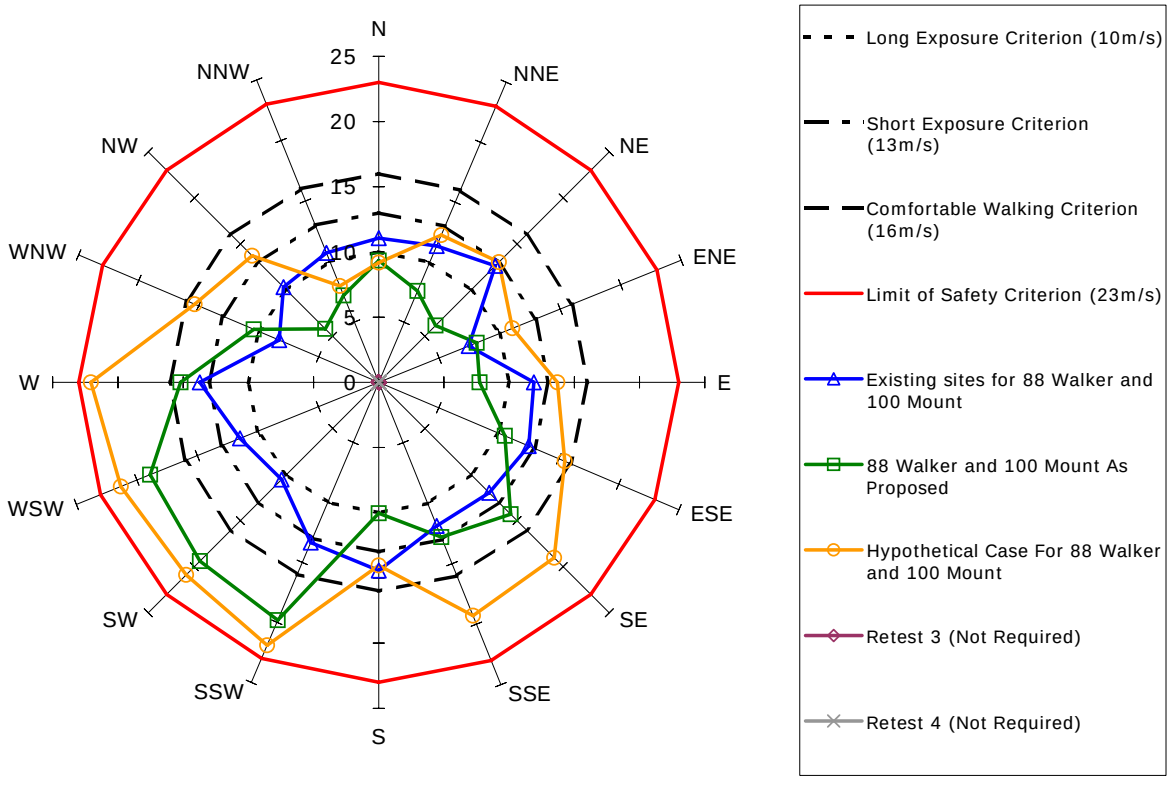


Measured Wind Speeds at Point 46

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

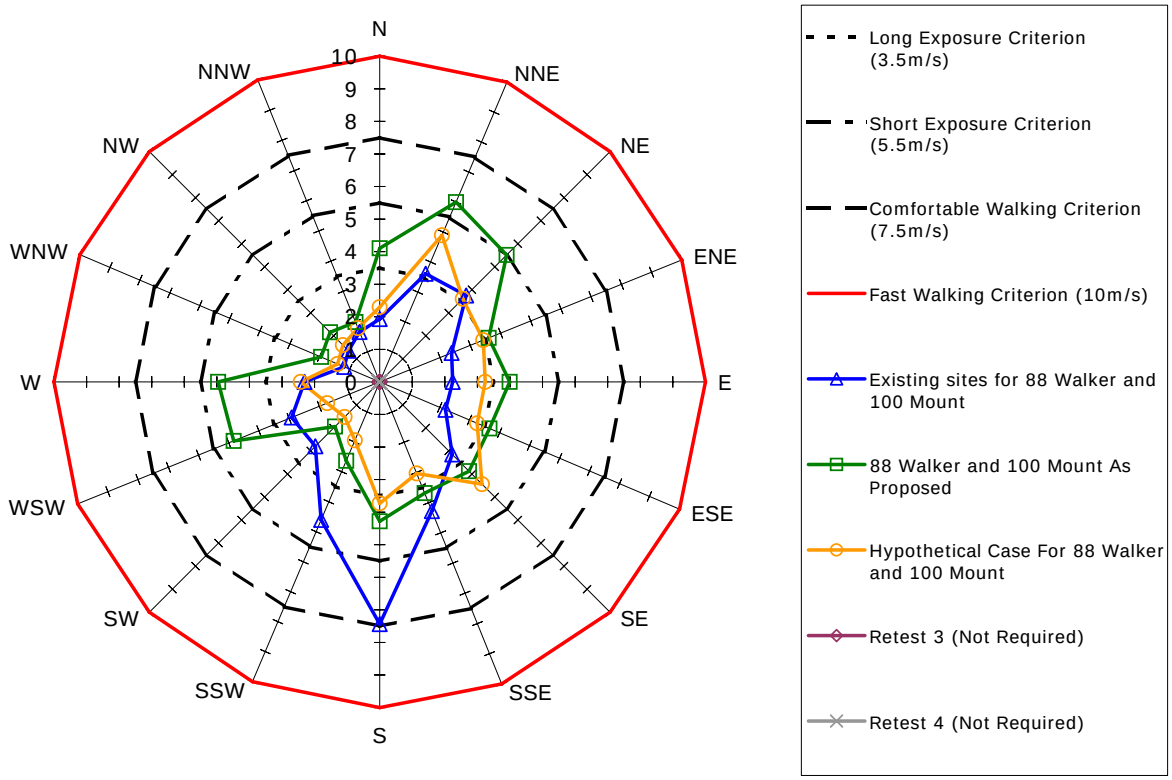


Annual Maximum Gust Wind Speeds (m/s)

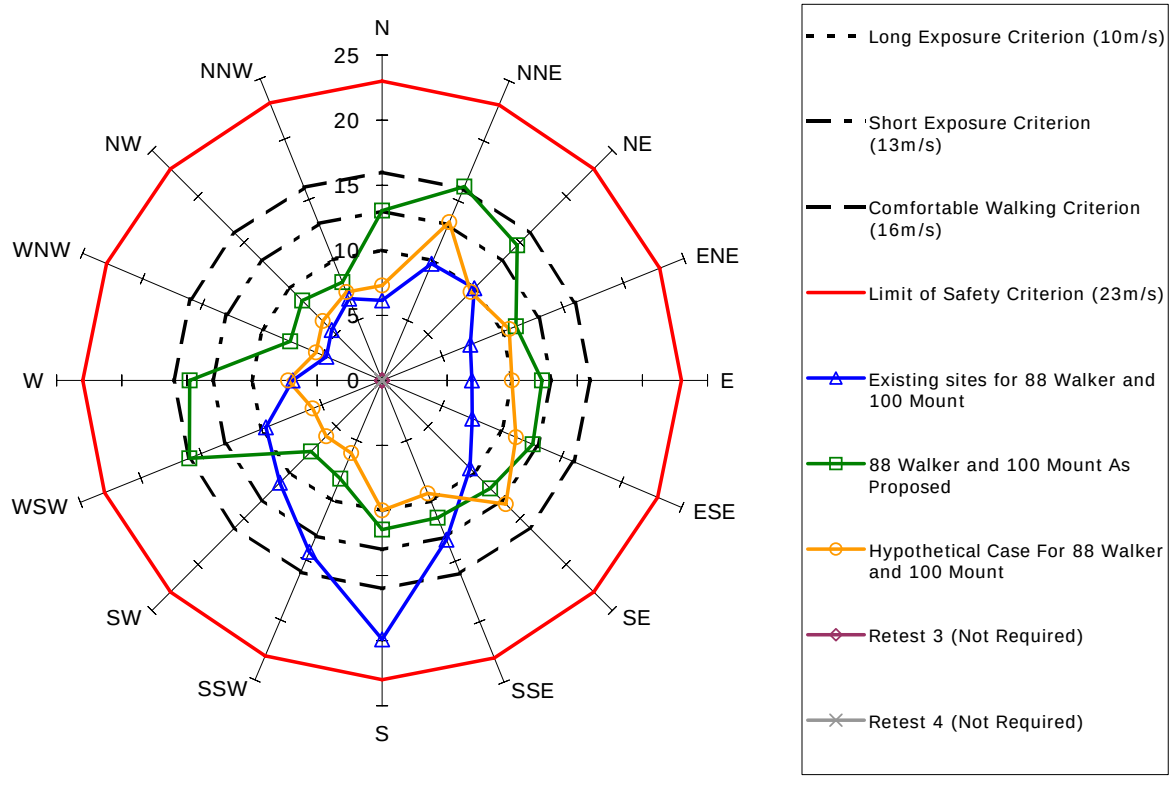


Measured Wind Speeds at Point 47

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

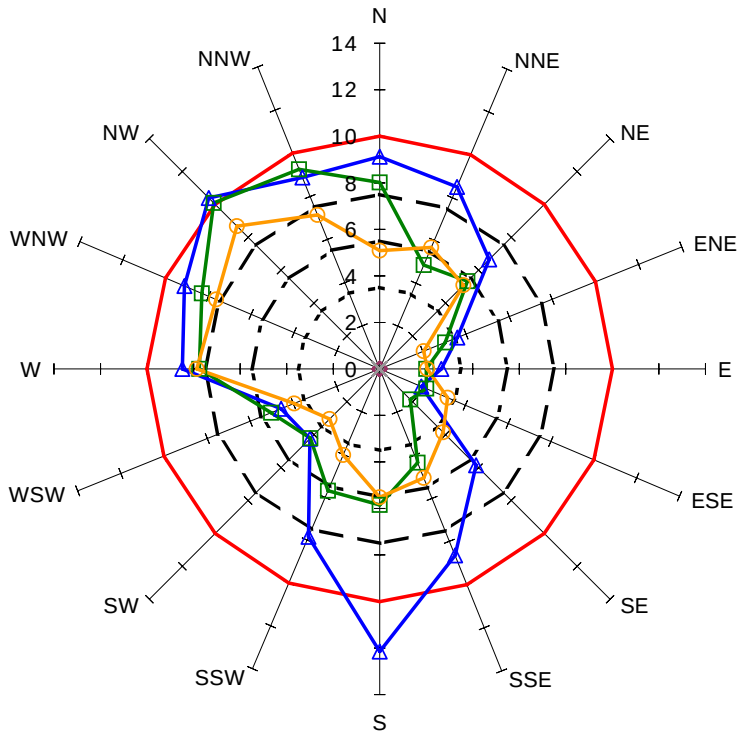


Annual Maximum Gust Wind Speeds (m/s)



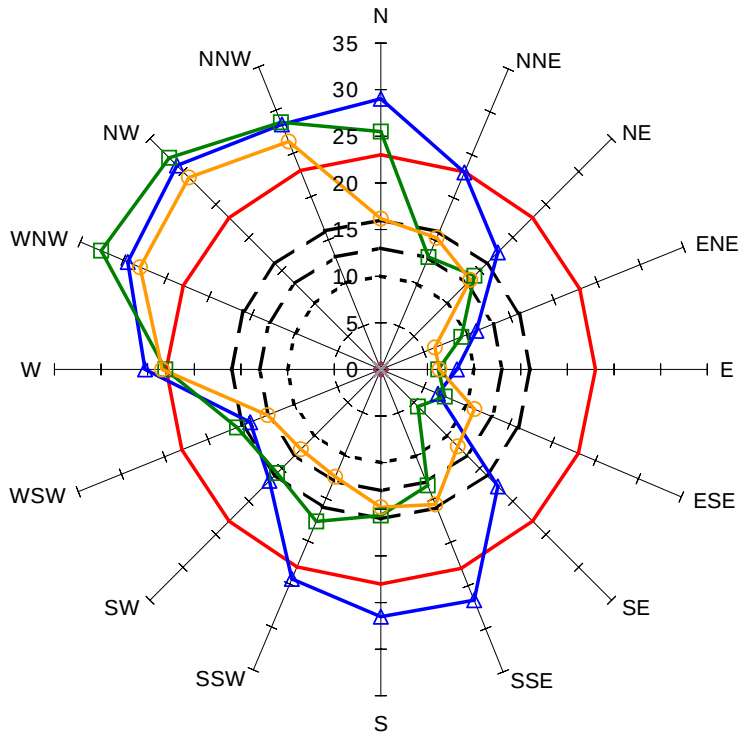
Measured Wind Speeds at Point 48

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- Hypothetical Case For 88 Walker and 100 Mount
- Retest 3 (Not Required)
- Retest 4 (Not Required)

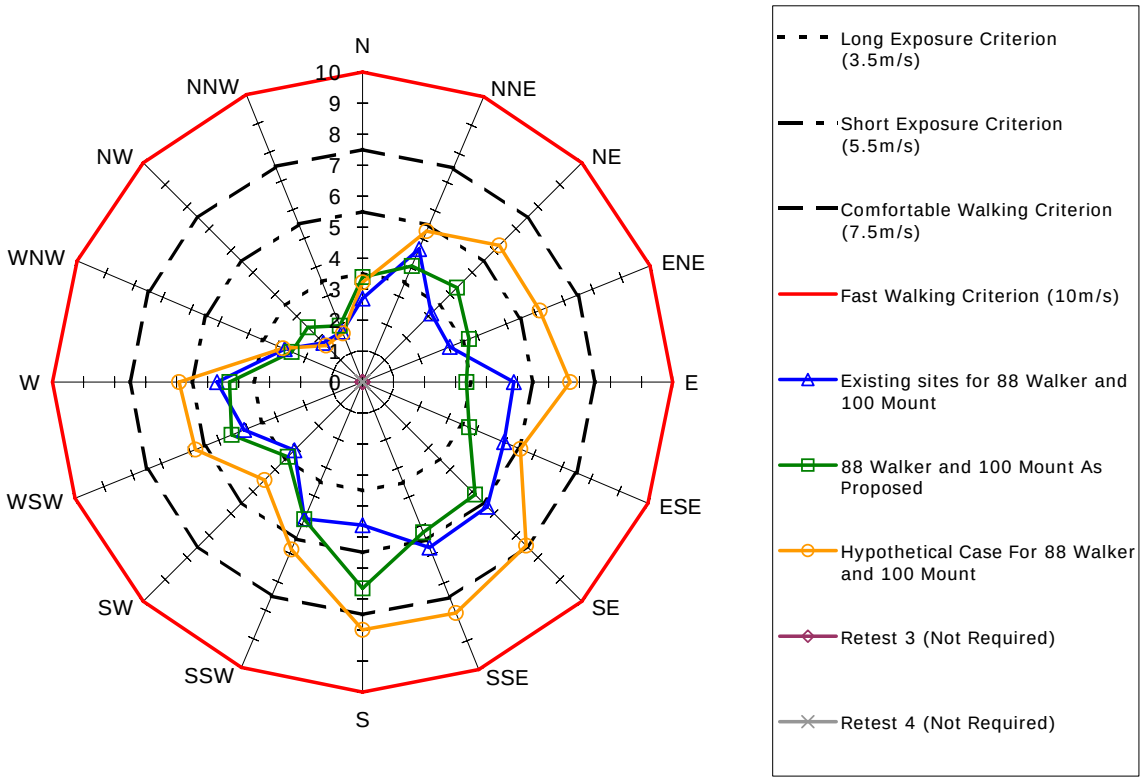
Annual Maximum Gust Wind Speeds (m/s)



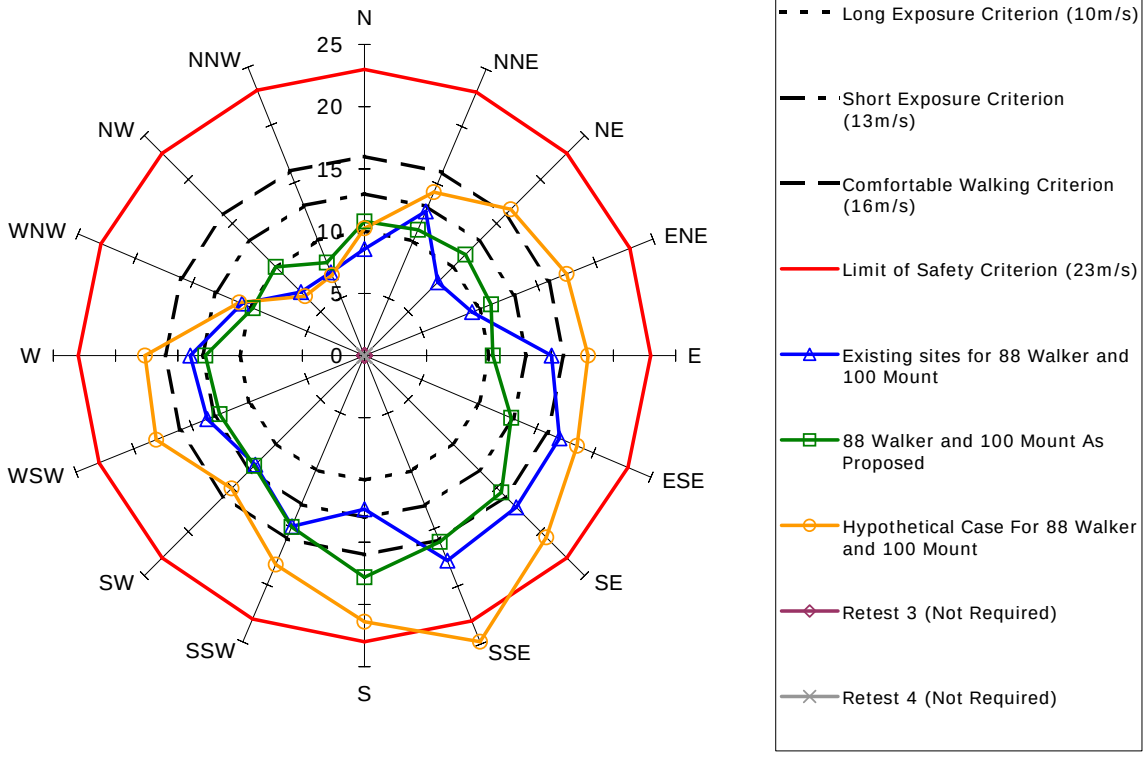
- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- Hypothetical Case For 88 Walker and 100 Mount
- Retest 3 (Not Required)
- Retest 4 (Not Required)

Measured Wind Speeds at Point 49

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

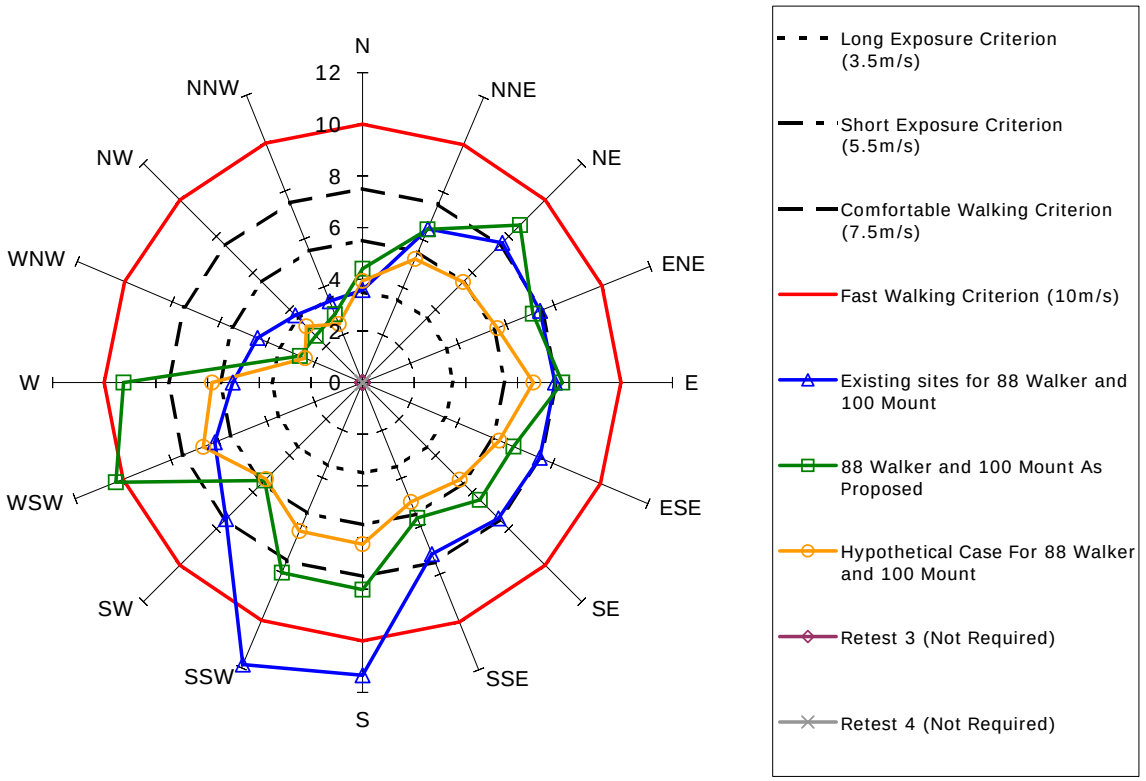


Annual Maximum Gust Wind Speeds (m/s)

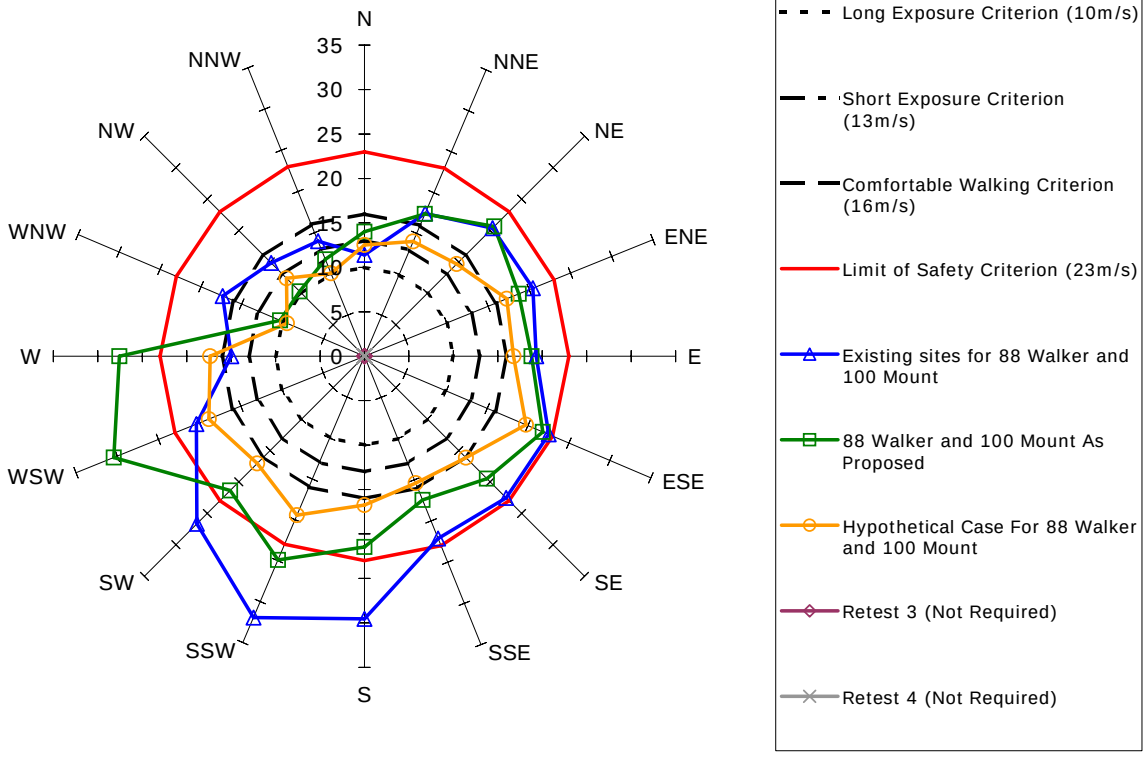


Measured Wind Speeds at Point 50

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

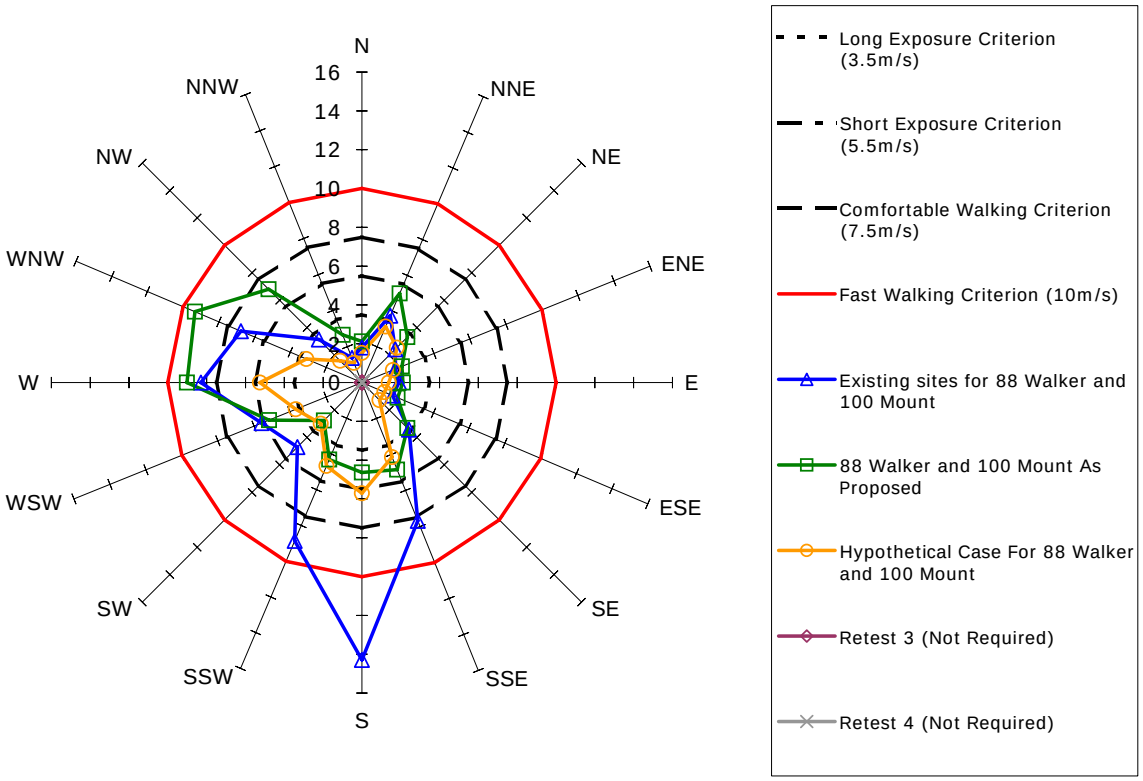


Annual Maximum Gust Wind Speeds (m/s)

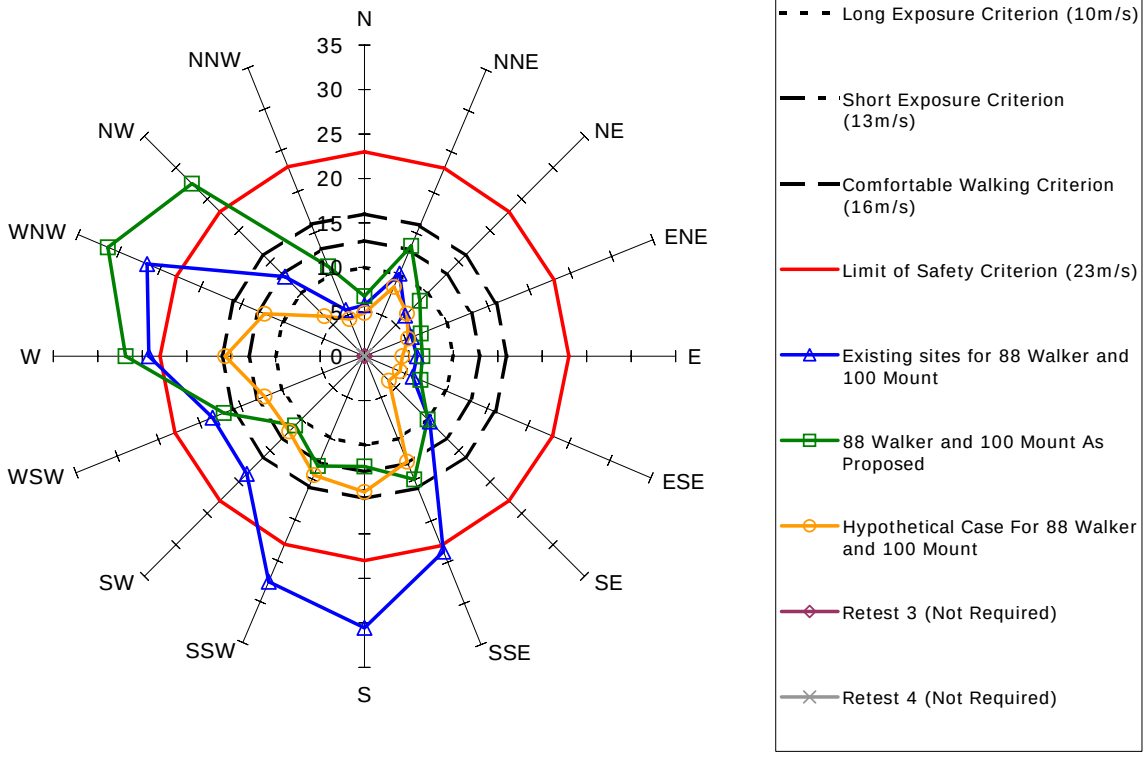


Measured Wind Speeds at Point 51

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

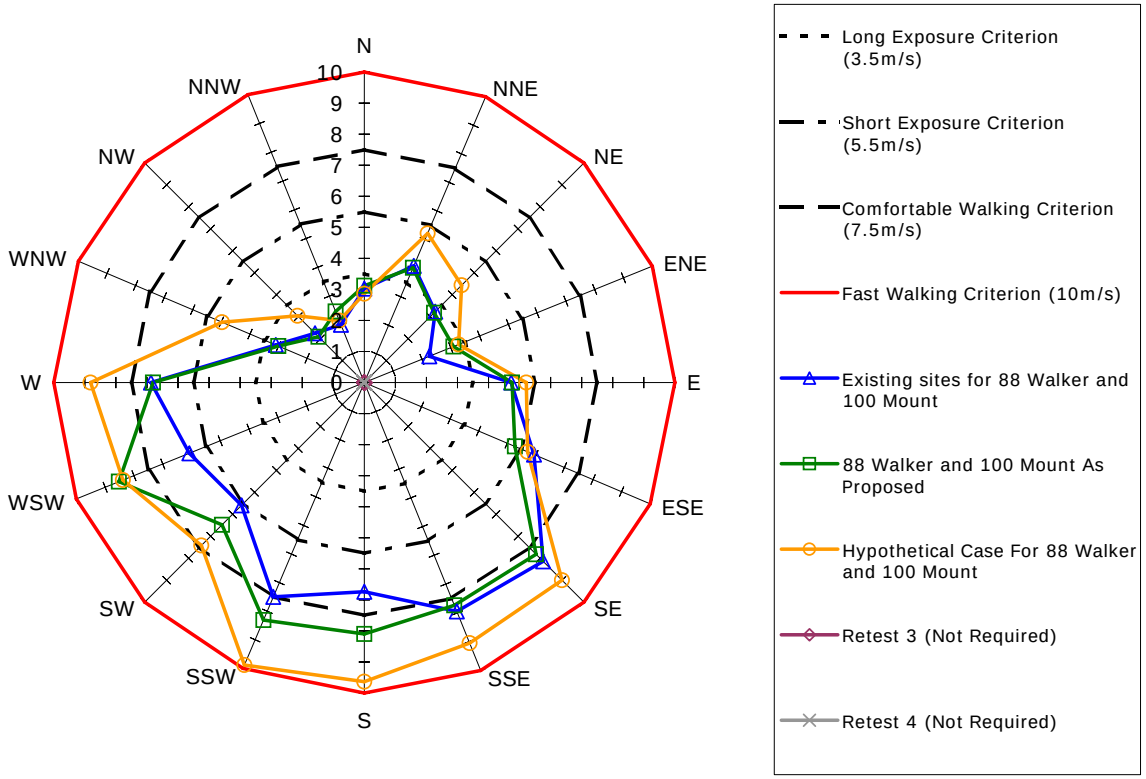


Annual Maximum Gust Wind Speeds (m/s)

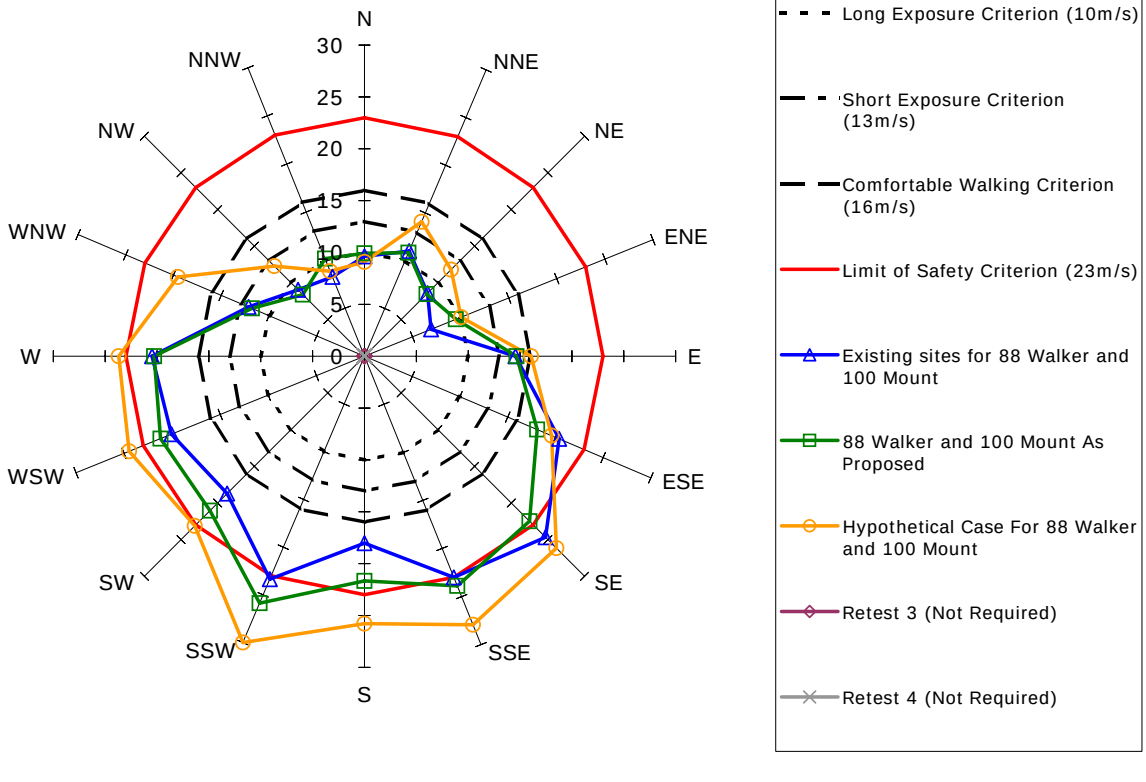


Measured Wind Speeds at Point 52

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

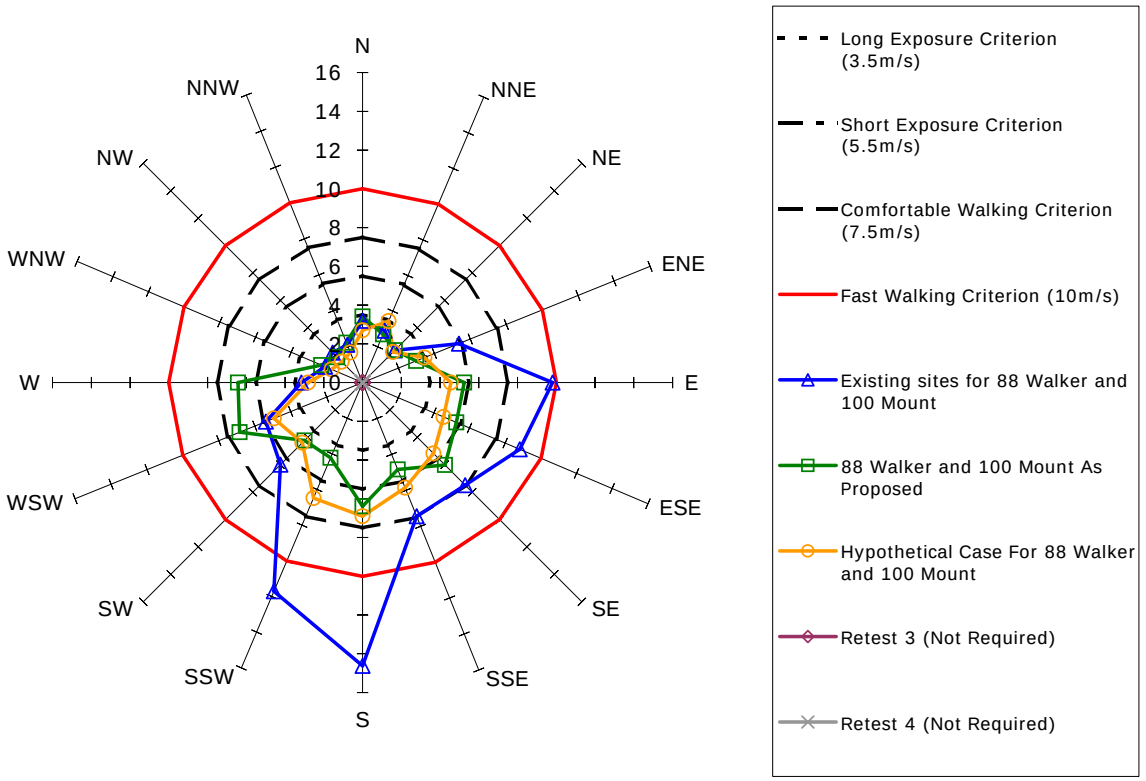


Annual Maximum Gust Wind Speeds (m/s)

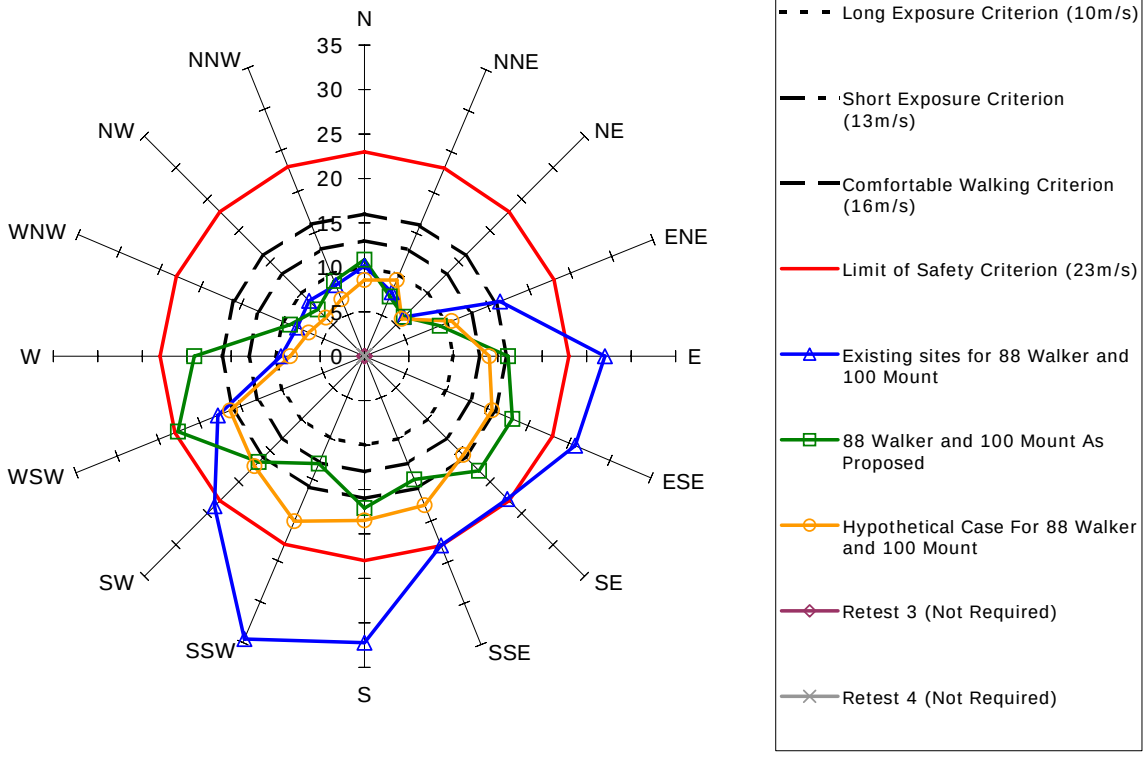


Measured Wind Speeds at Point 53

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

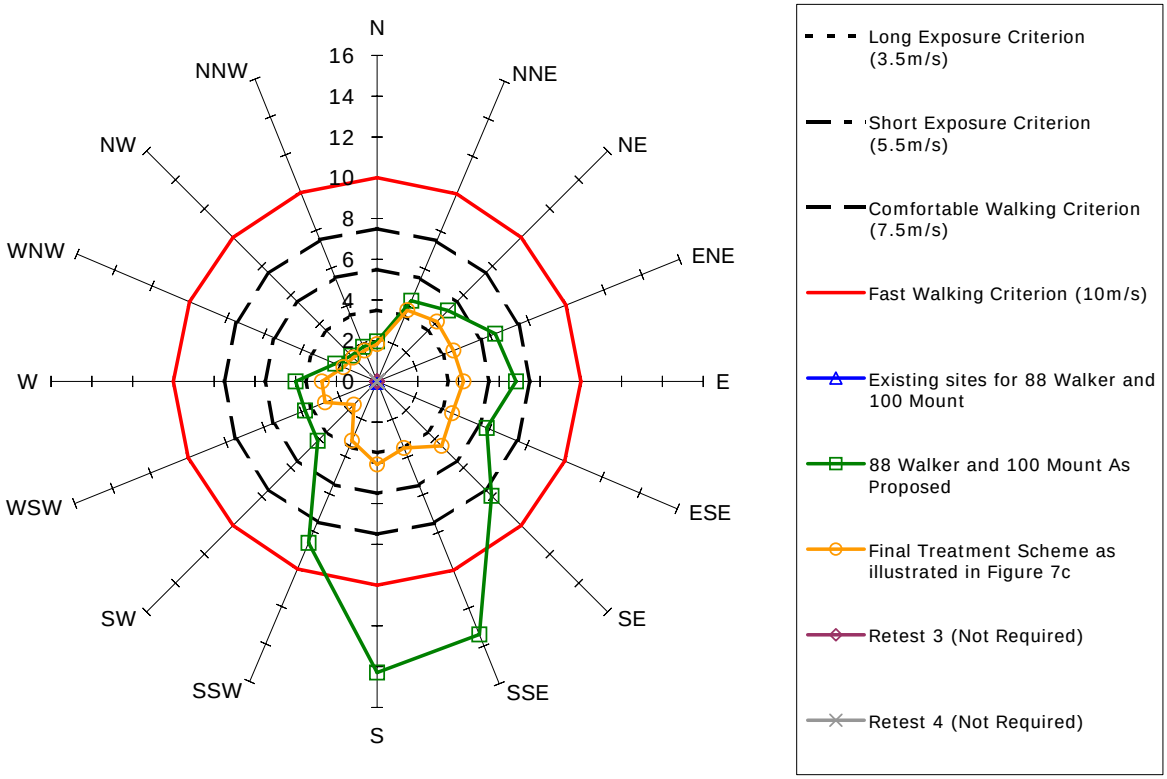


Annual Maximum Gust Wind Speeds (m/s)

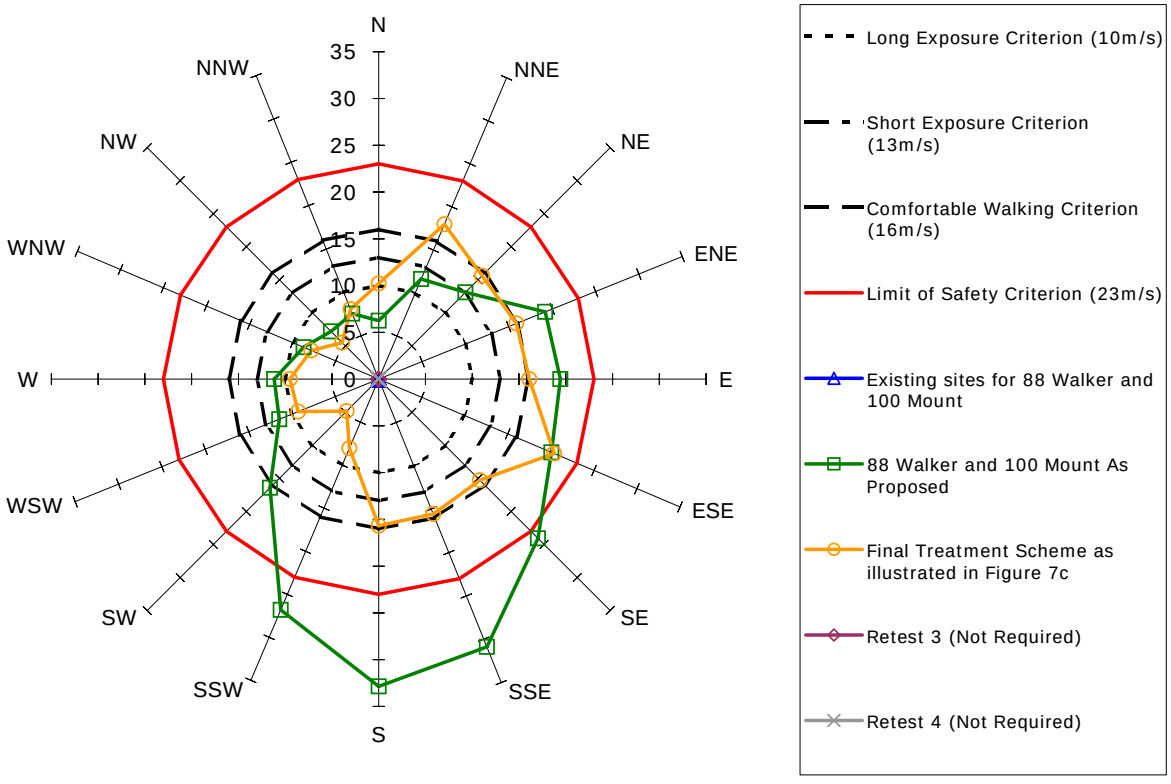


Measured Wind Speeds at Point 54

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

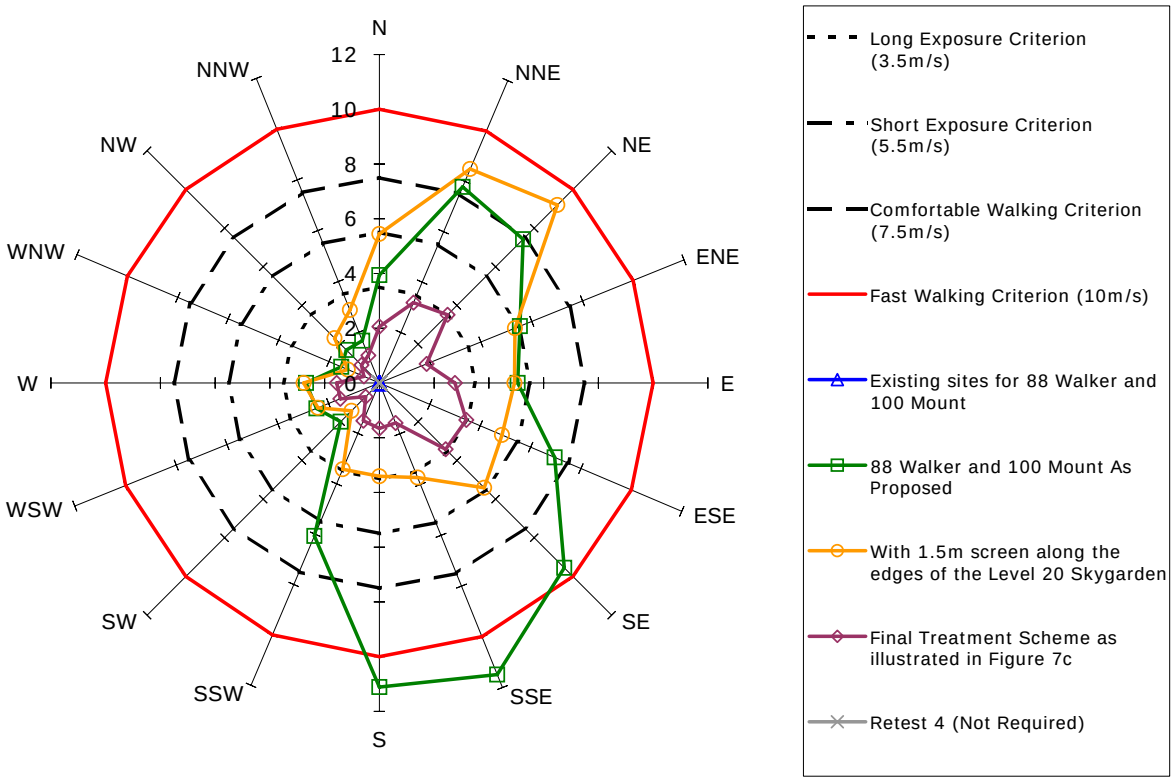


Annual Maximum Gust Wind Speeds (m/s)

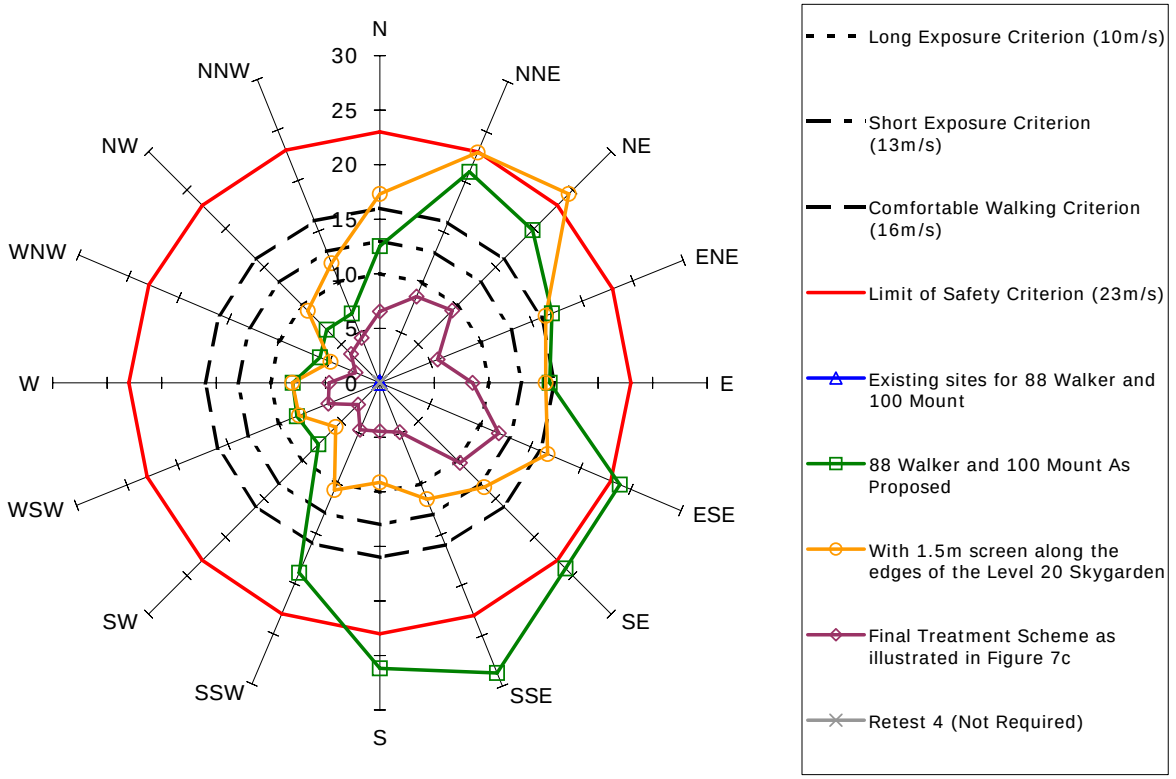


Measured Wind Speeds at Point 55

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

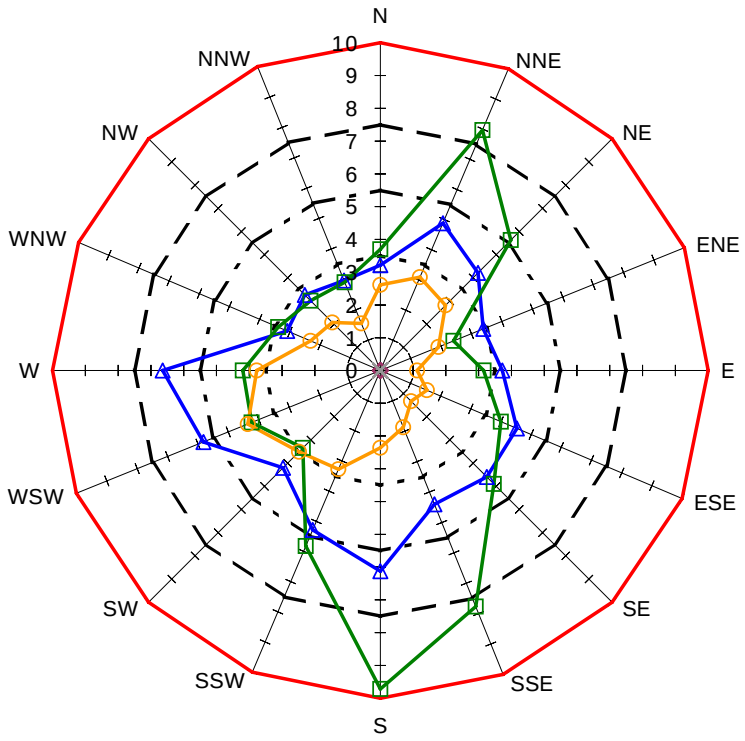


Annual Maximum Gust Wind Speeds (m/s)



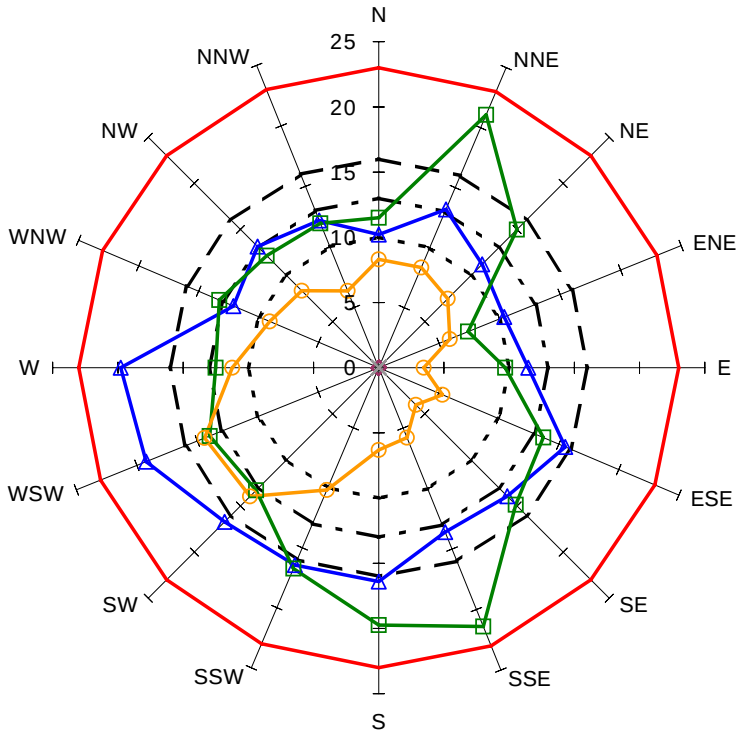
Measured Wind Speeds at Point 56

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- Final Treatment Scheme as illustrated in Figure 7a
- Retest 3 (Not Required)
- Retest 4 (Not Required)

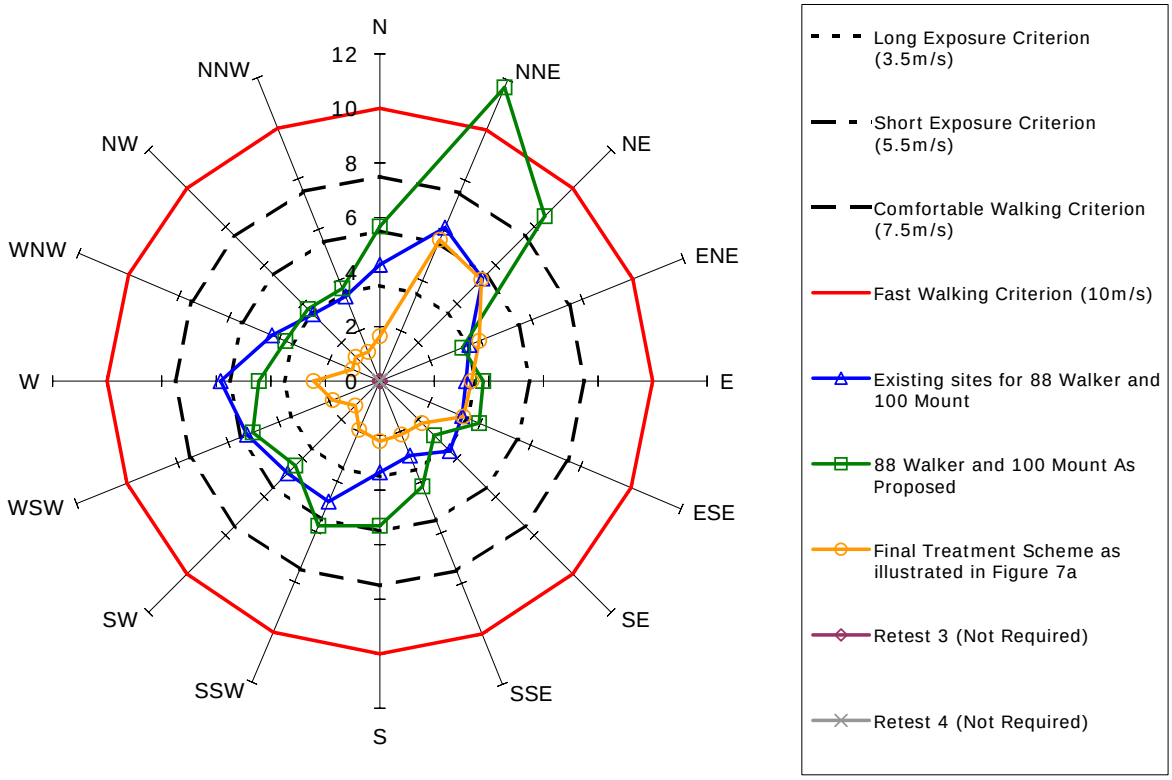
Annual Maximum Gust Wind Speeds (m/s)



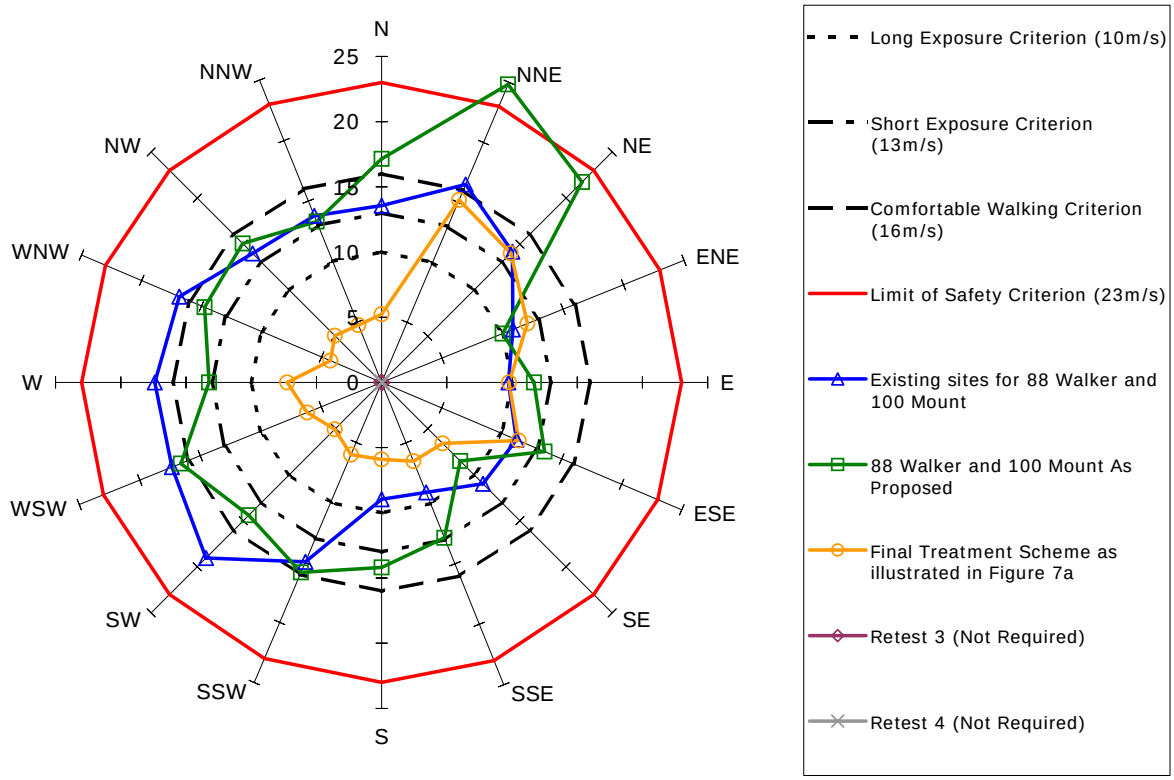
- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- Final Treatment Scheme as illustrated in Figure 7a
- Retest 3 (Not Required)
- Retest 4 (Not Required)

Measured Wind Speeds at Point 57

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

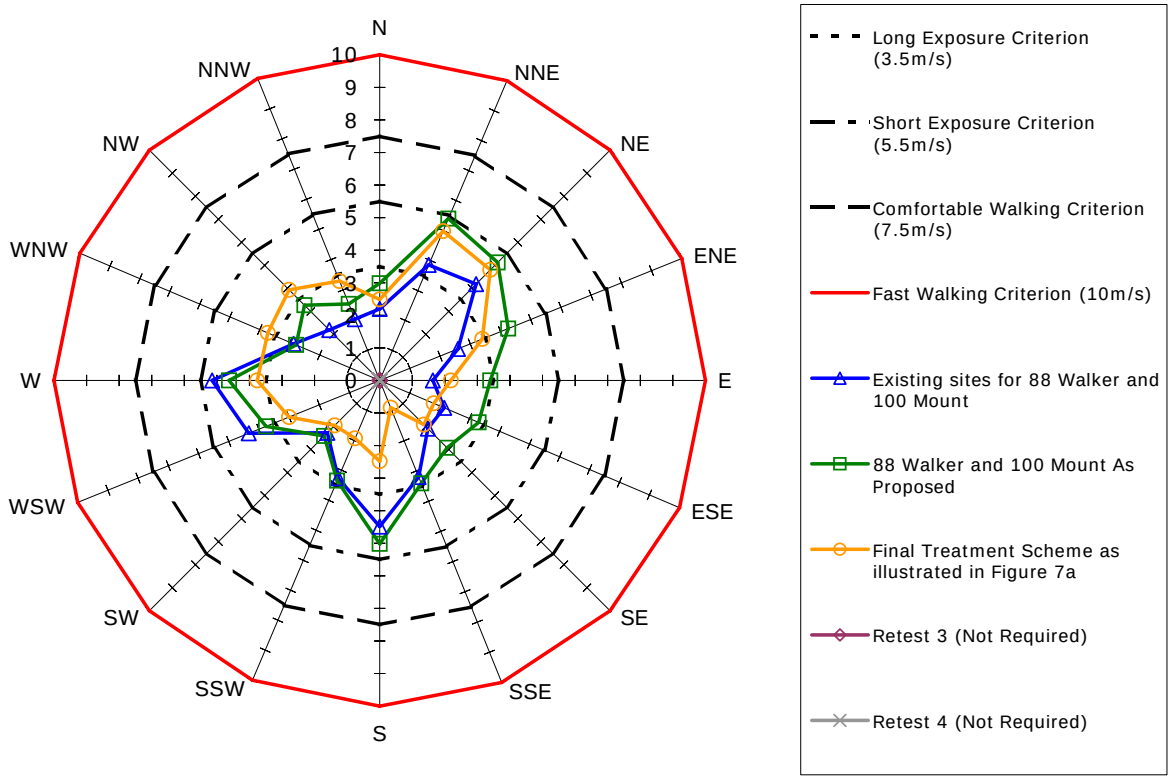


Annual Maximum Gust Wind Speeds (m/s)

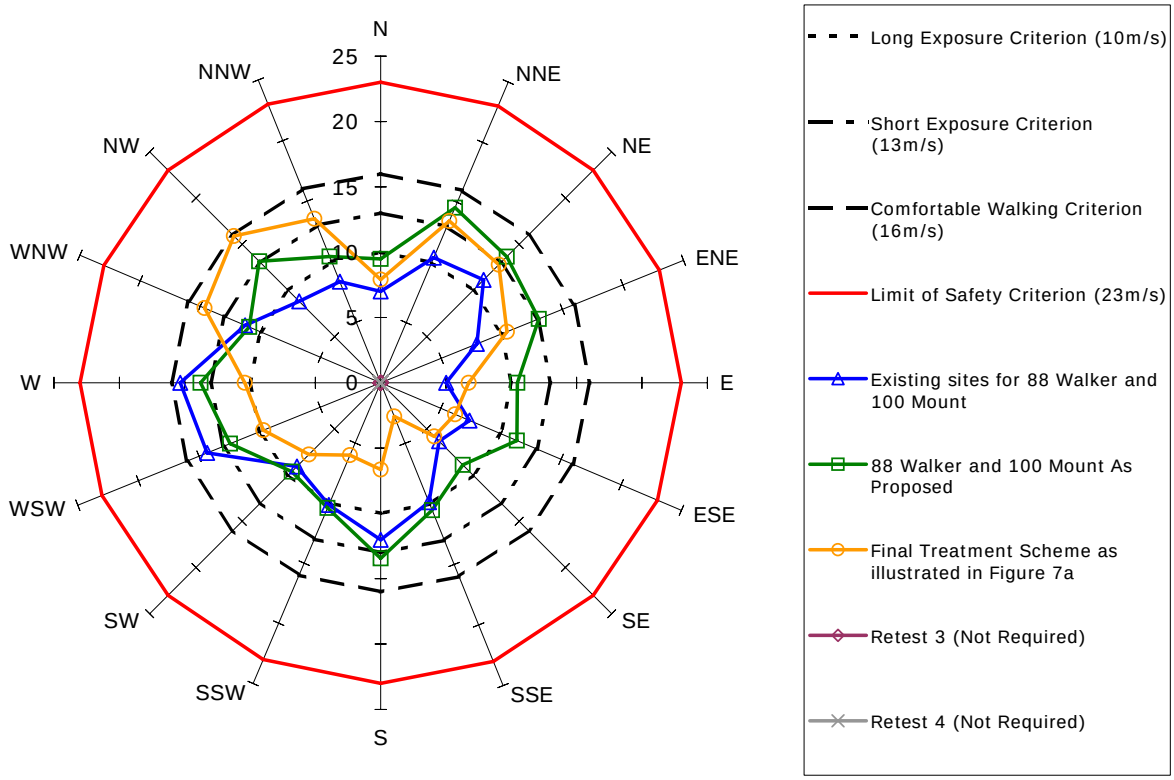


Measured Wind Speeds at Point 58

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

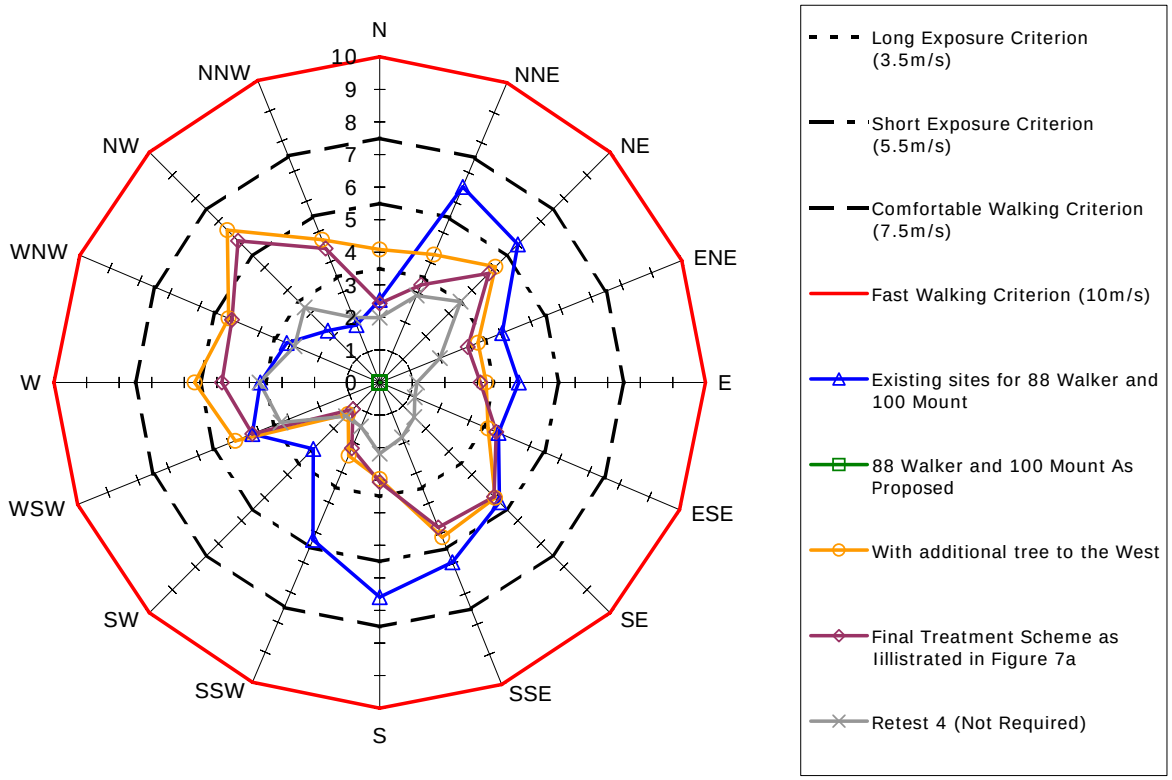


Annual Maximum Gust Wind Speeds (m/s)

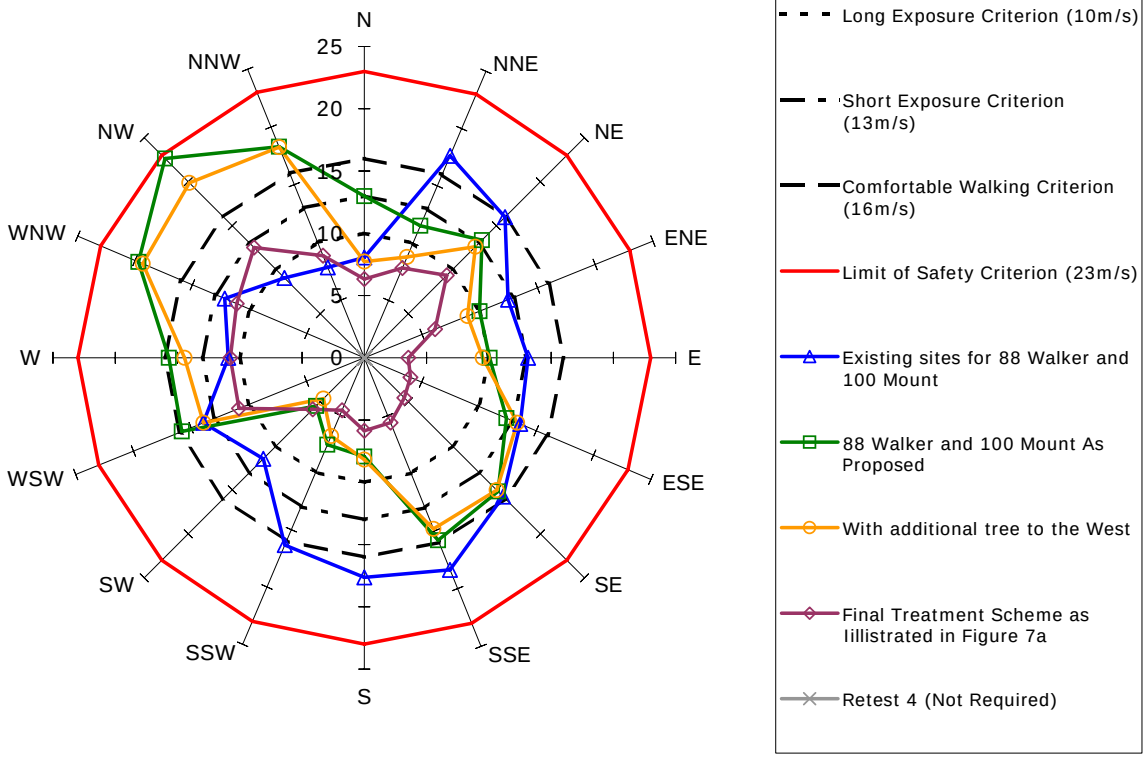


Measured Wind Speeds at Point 59

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

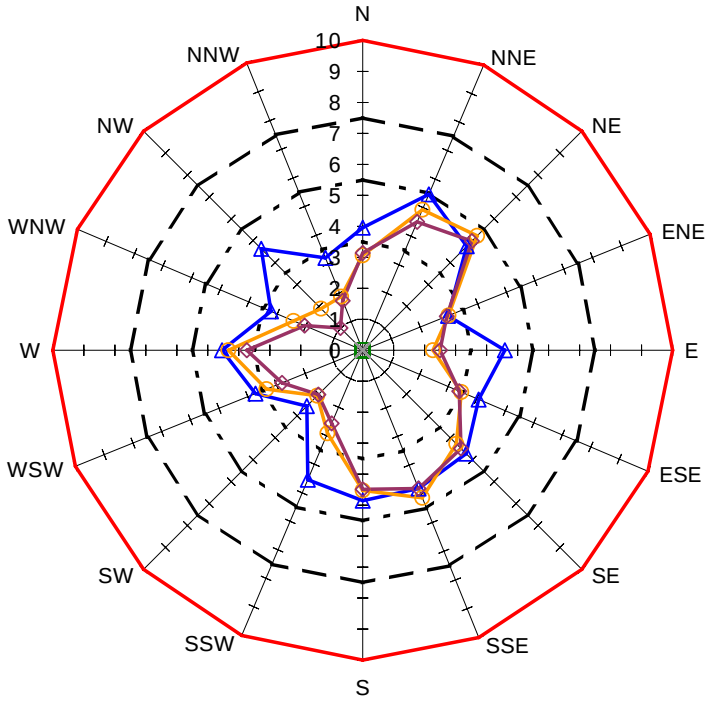


Annual Maximum Gust Wind Speeds (m/s)



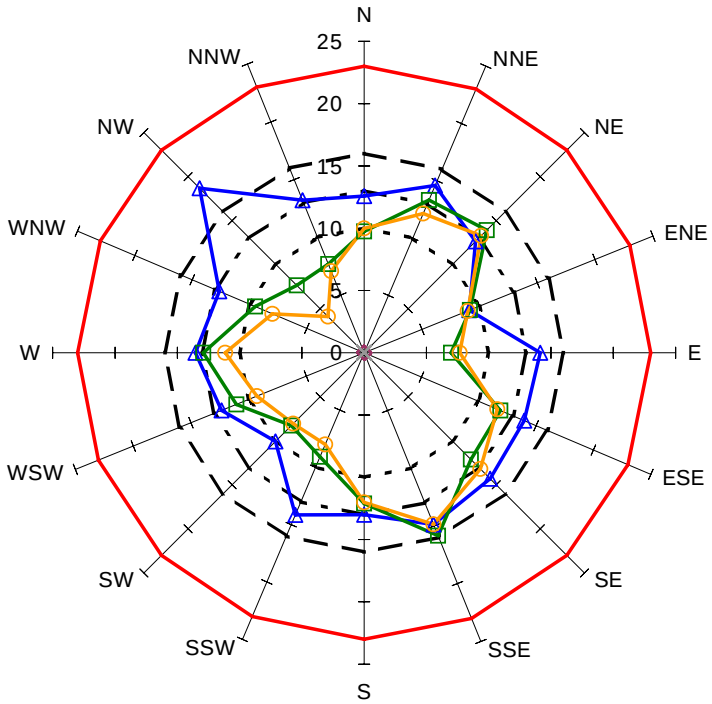
Measured Wind Speeds at Point 60

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- Final Treatment Scheme as Iillistrated in Figure 7a
- Retest 3 (Not Required)
- Retest 4 (Not Required)

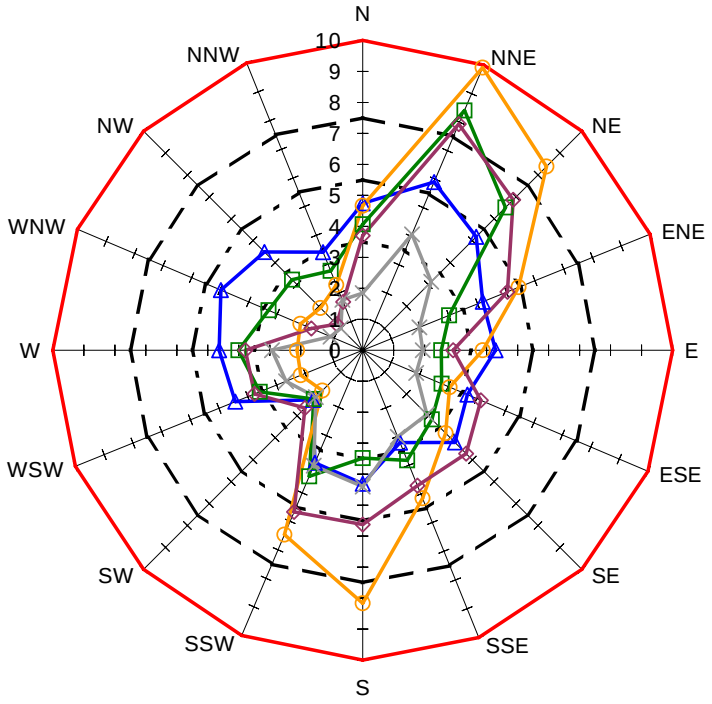
Annual Maximum Gust Wind Speeds (m/s)



- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- Final Treatment Scheme as Iillistrated in Figure 7a
- Retest 3 (Not Required)
- Retest 4 (Not Required)

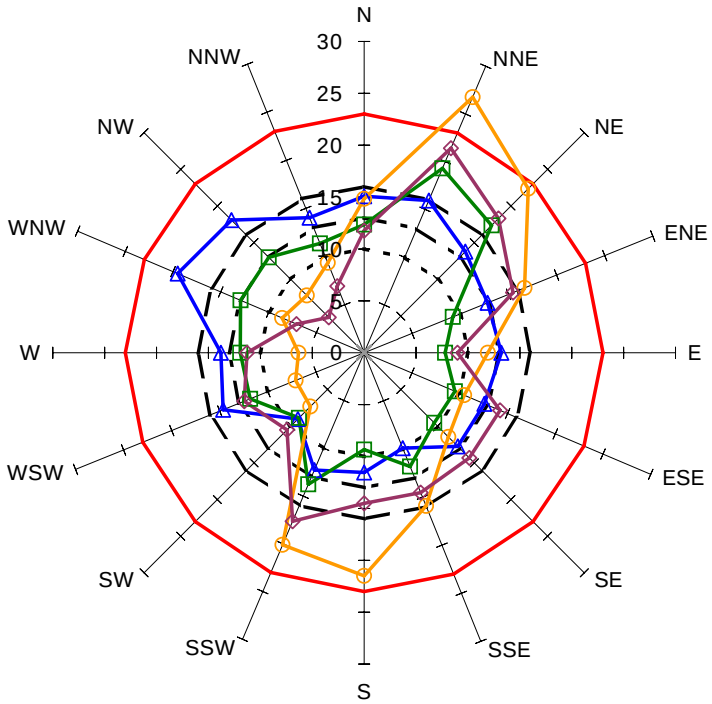
Measured Wind Speeds at Point 61

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- With inclusion of awning along Walker Street
- With Trees and awning along Walker Street
- Final Treatment Scheme as lillistrated in Figure 7a

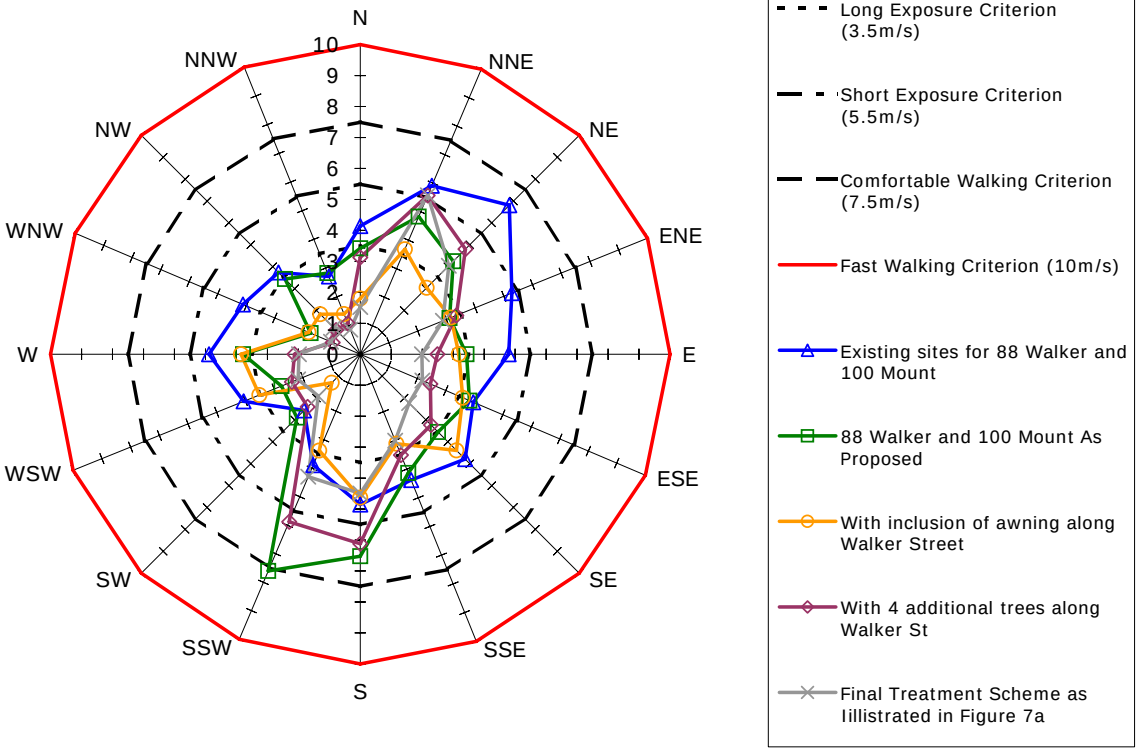
Annual Maximum Gust Wind Speeds (m/s)



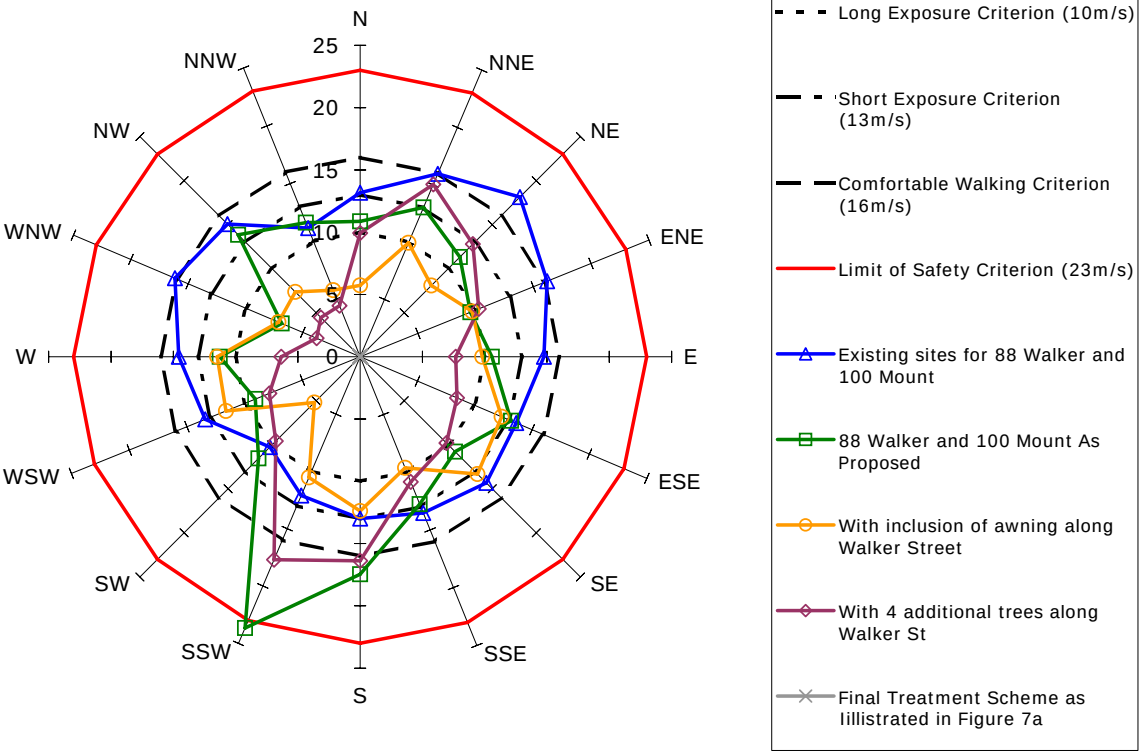
- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- With inclusion of awning along Walker Street
- With Trees and awning along Walker Street
- Final Treatment Scheme as lillistrated in Figure 7a

Measured Wind Speeds at Point 62

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

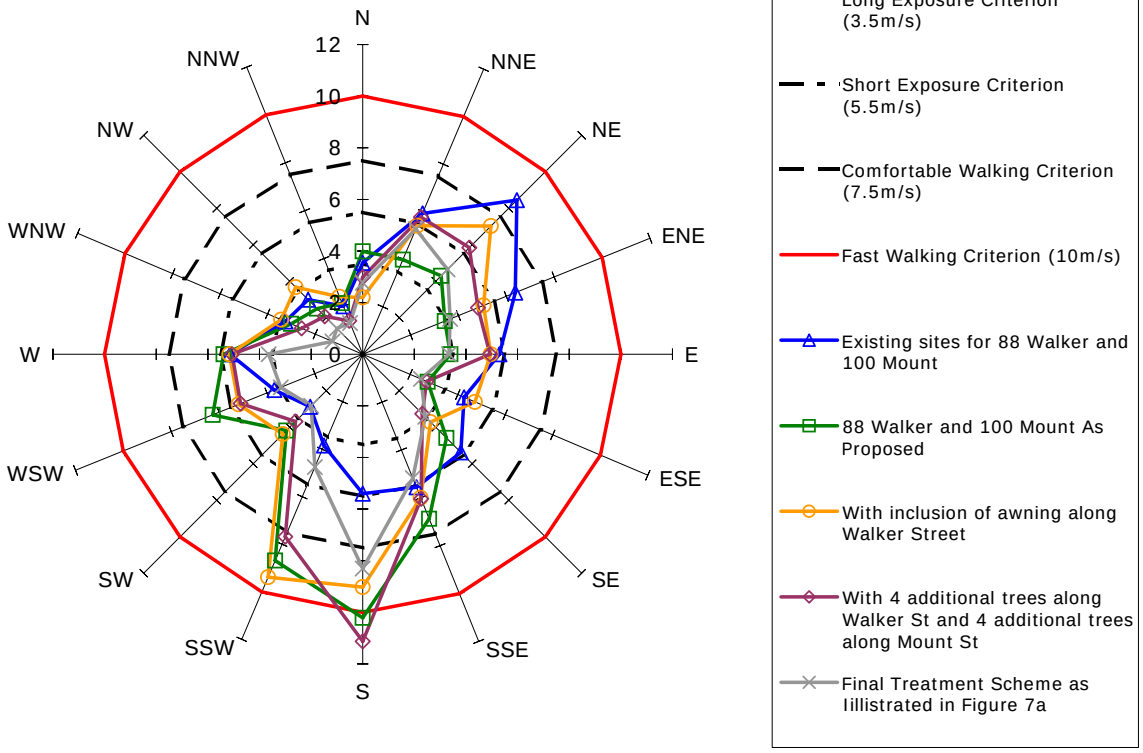


Annual Maximum Gust Wind Speeds (m/s)

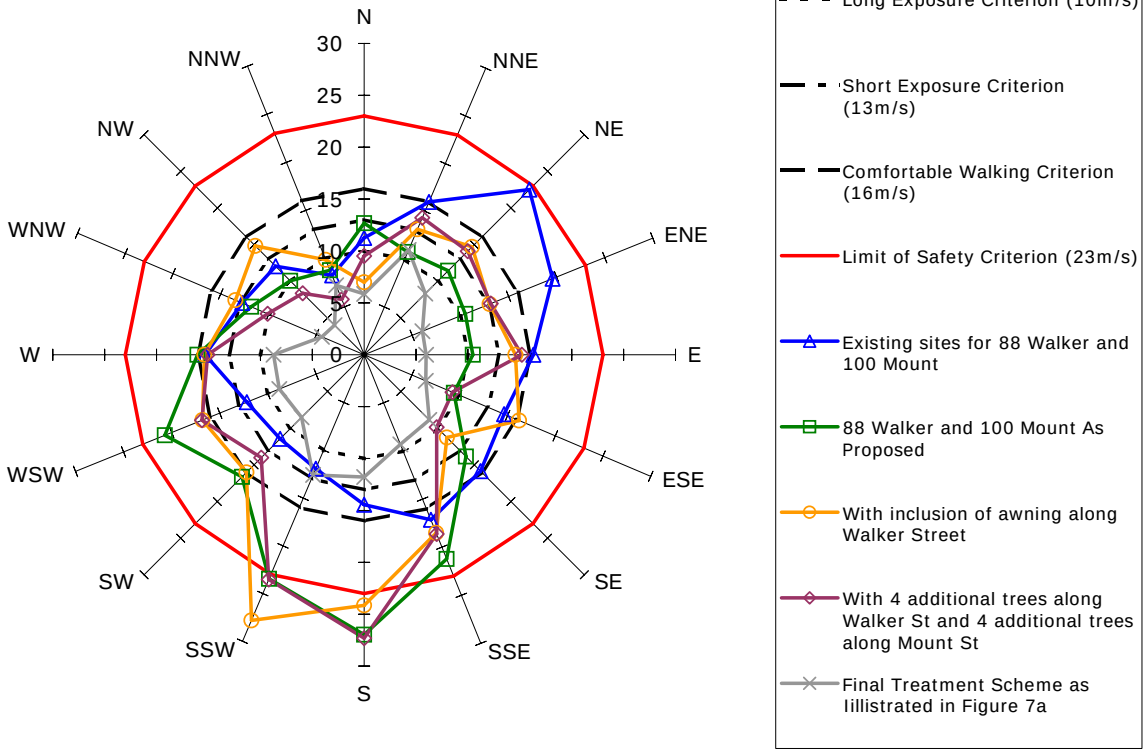


Measured Wind Speeds at Point 63

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

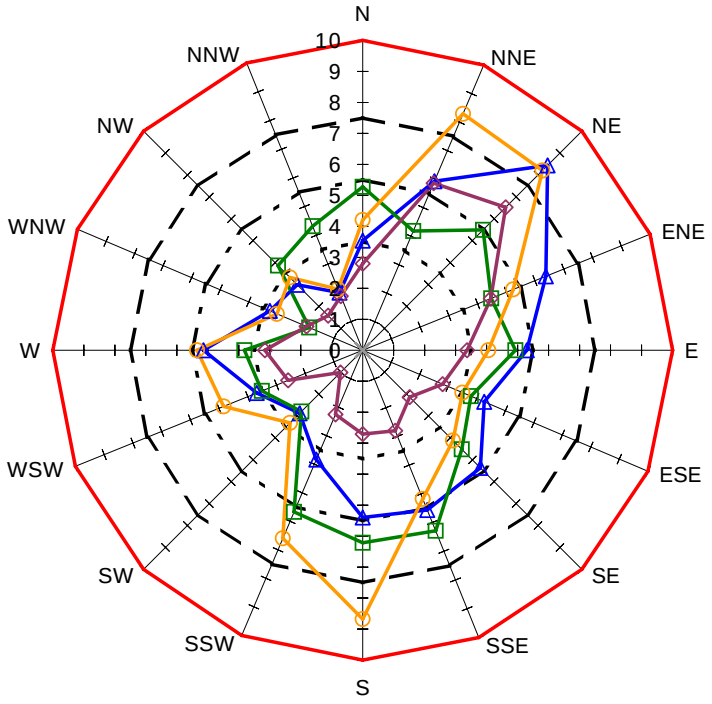


Annual Maximum Gust Wind Speeds (m/s)



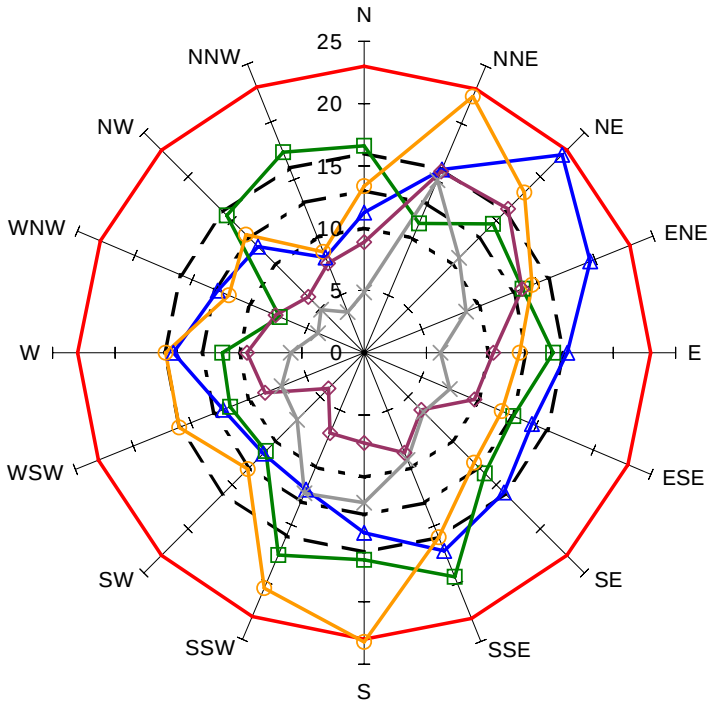
Measured Wind Speeds at Point 64

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- With 4 additional trees along Mount St
- Final Treatment Scheme as Iillistrated in Figure 7a
- Retest 4 (Not Required)

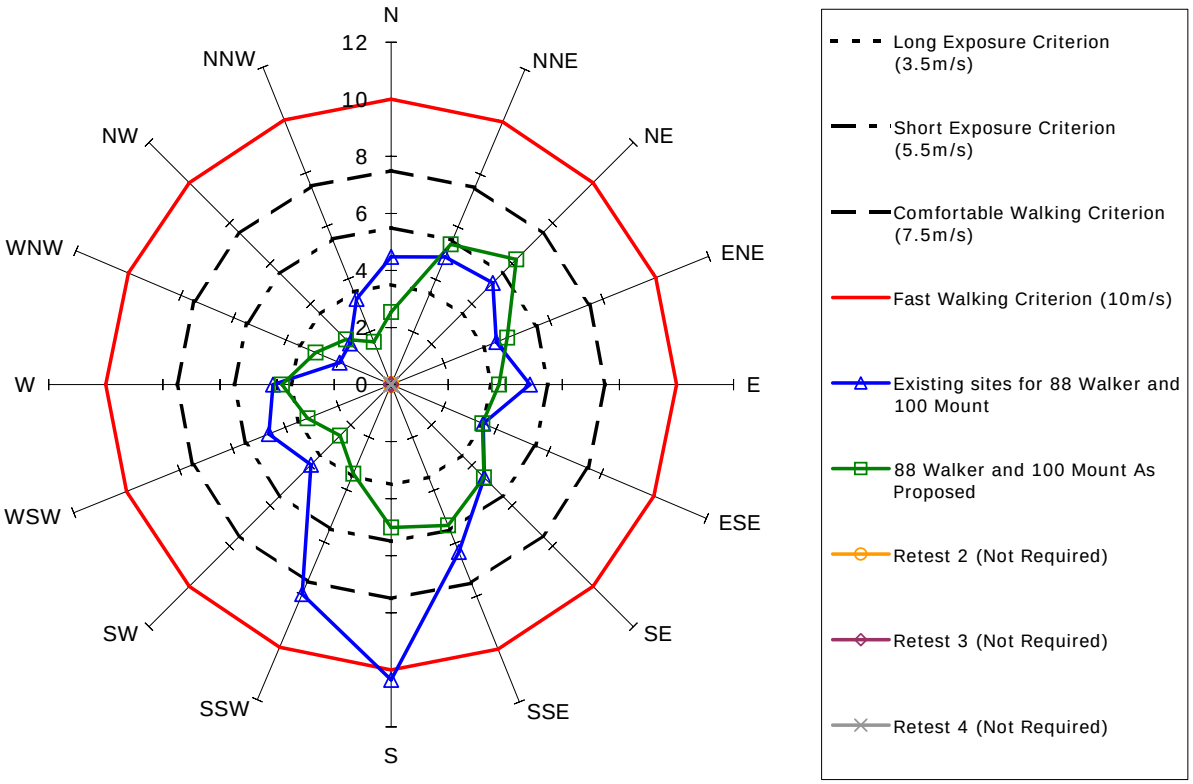
Annual Maximum Gust Wind Speeds (m/s)



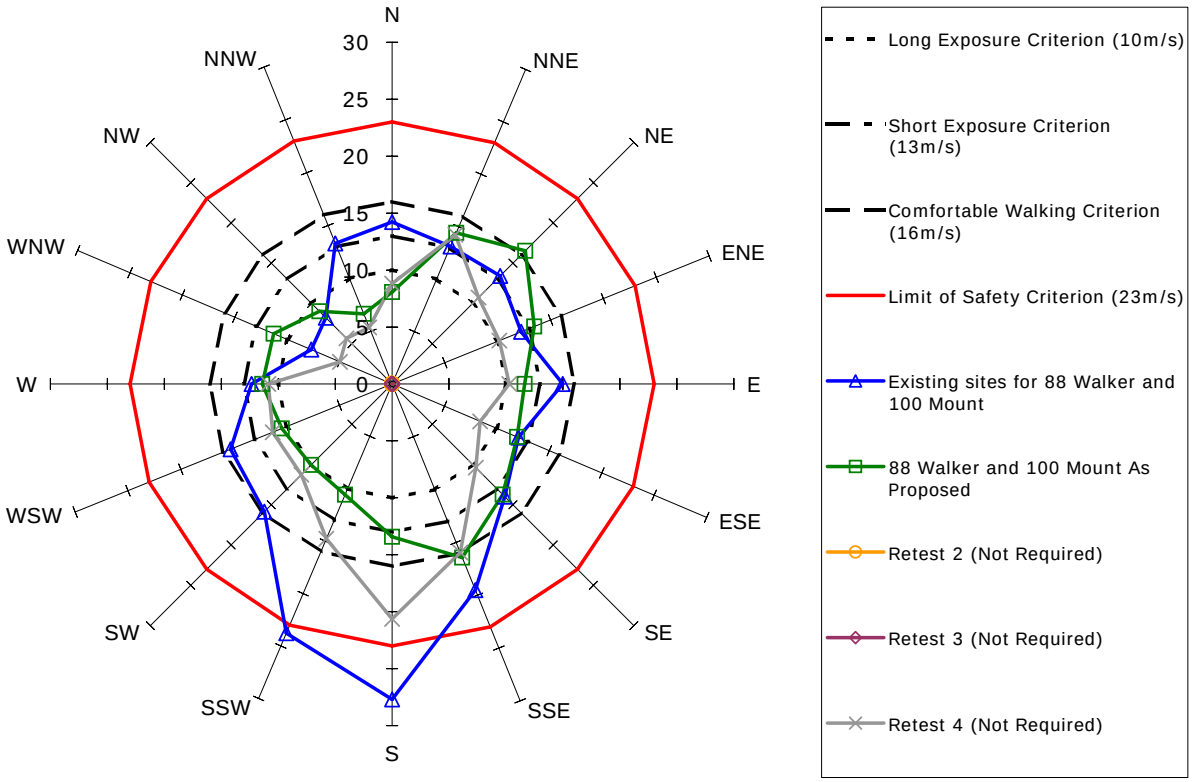
- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- With 4 additional trees along Mount St
- Final Treatment Scheme as Iillistrated in Figure 7a
- Retest 4 (Not Required)

Measured Wind Speeds at Point 65

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

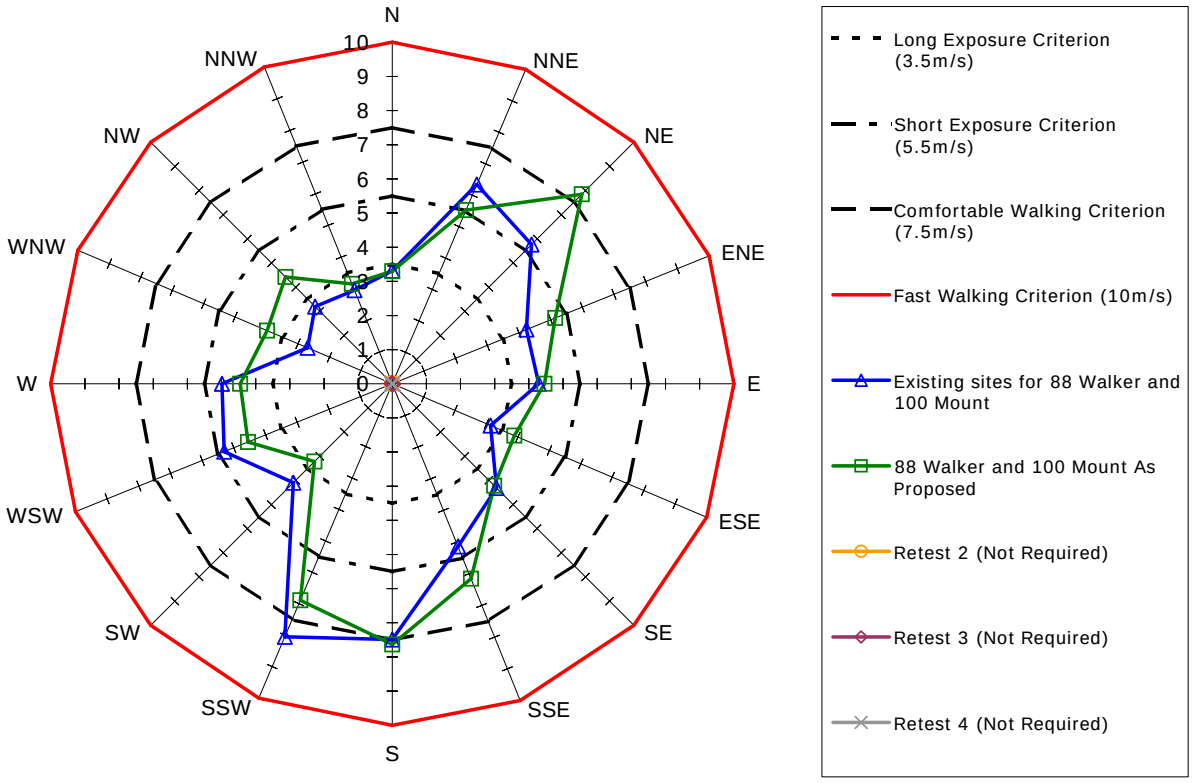


Annual Maximum Gust Wind Speeds (m/s)

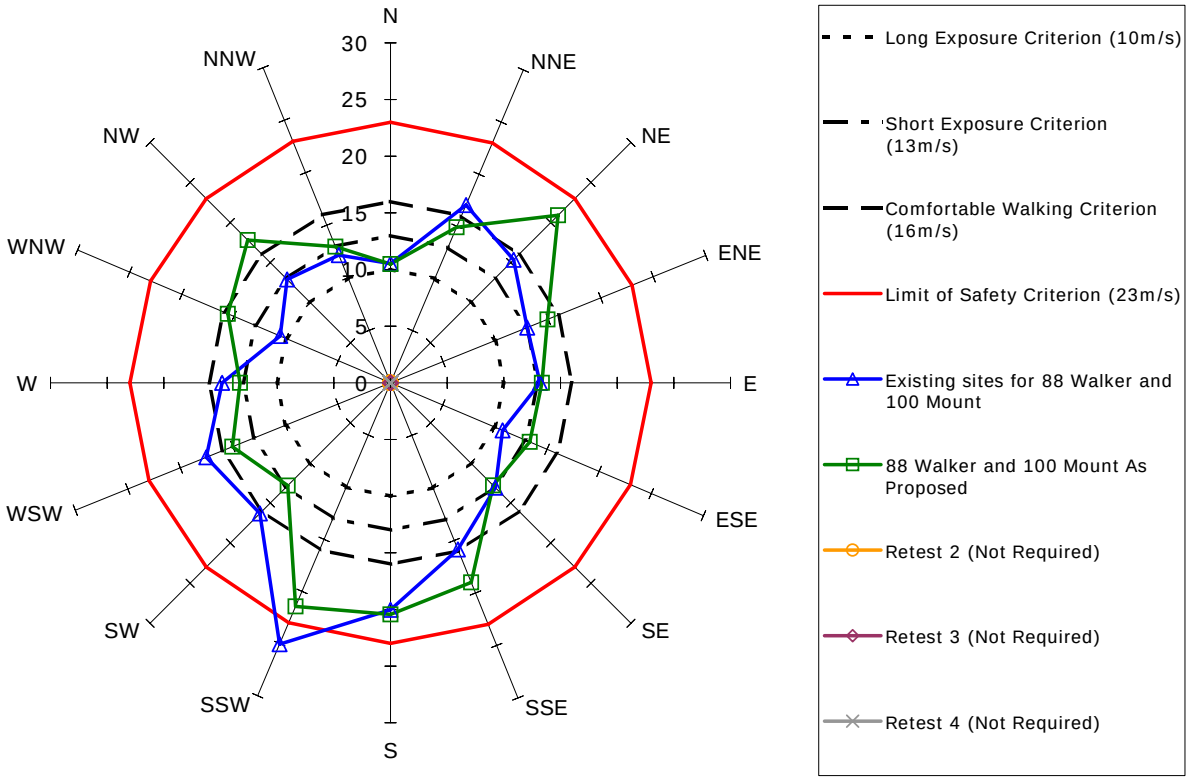


Measured Wind Speeds at Point 66

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

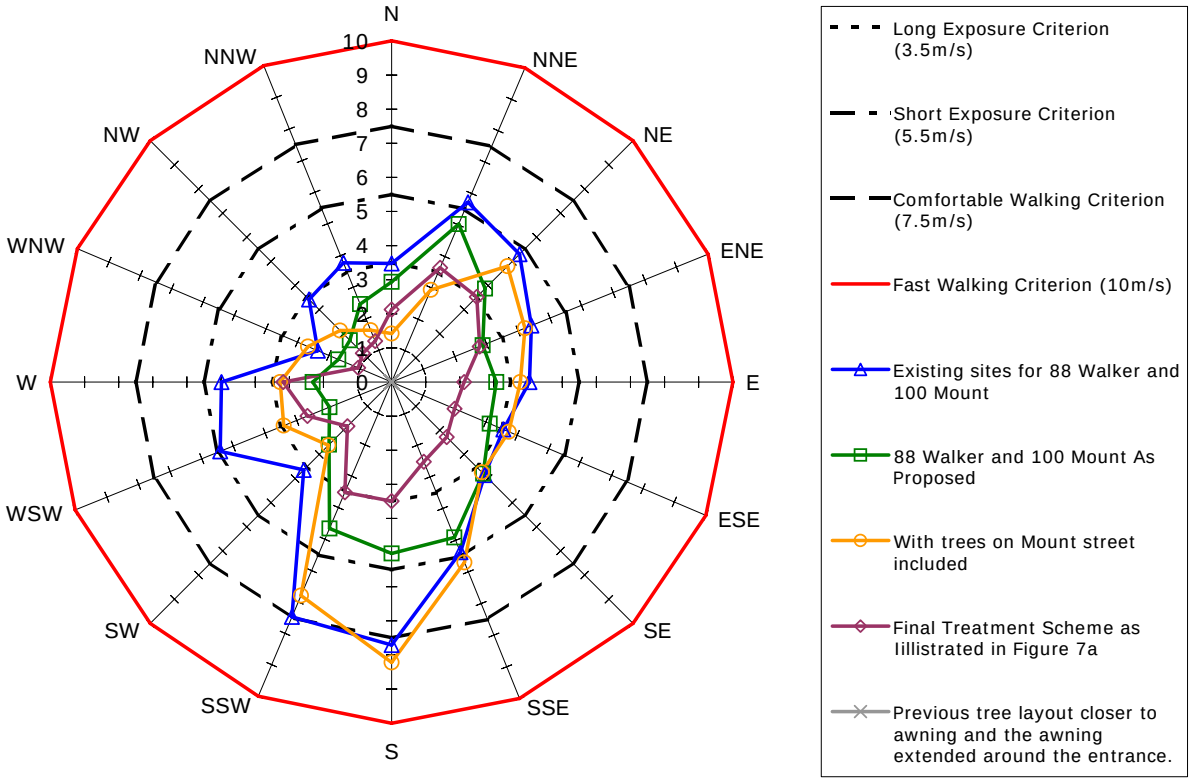


Annual Maximum Gust Wind Speeds (m/s)

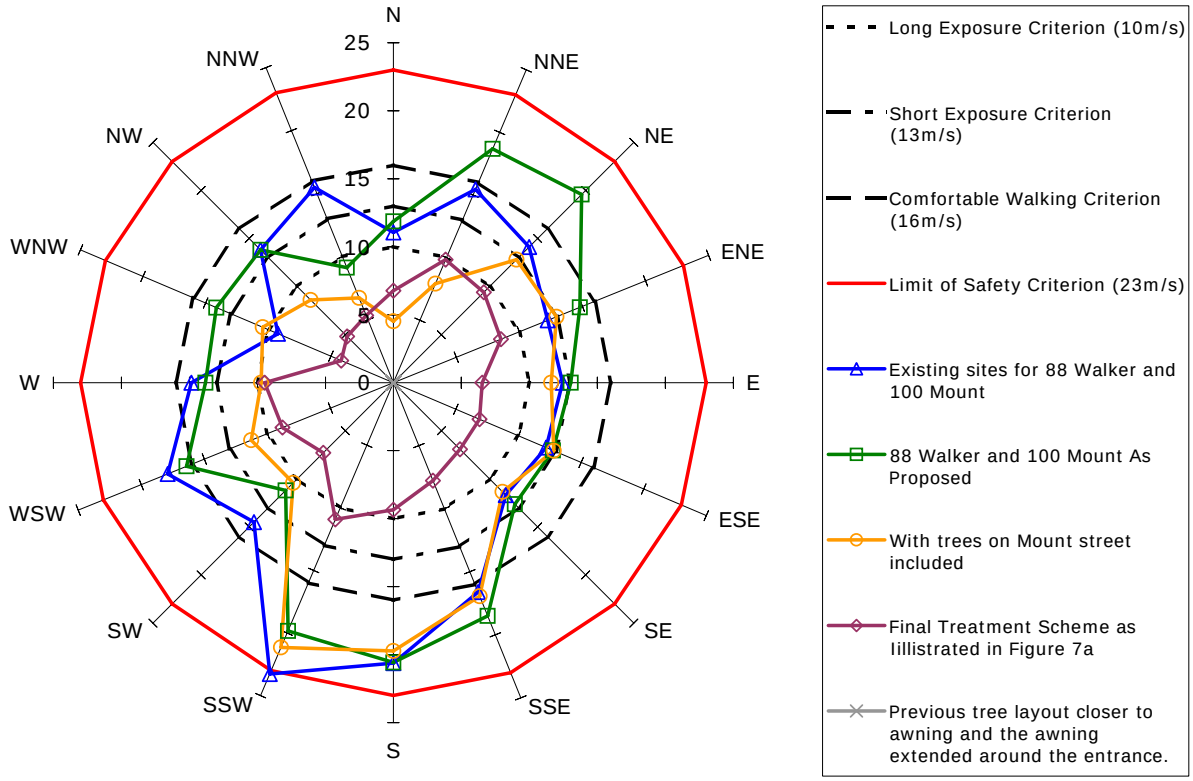


Measured Wind Speeds at Point 67

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

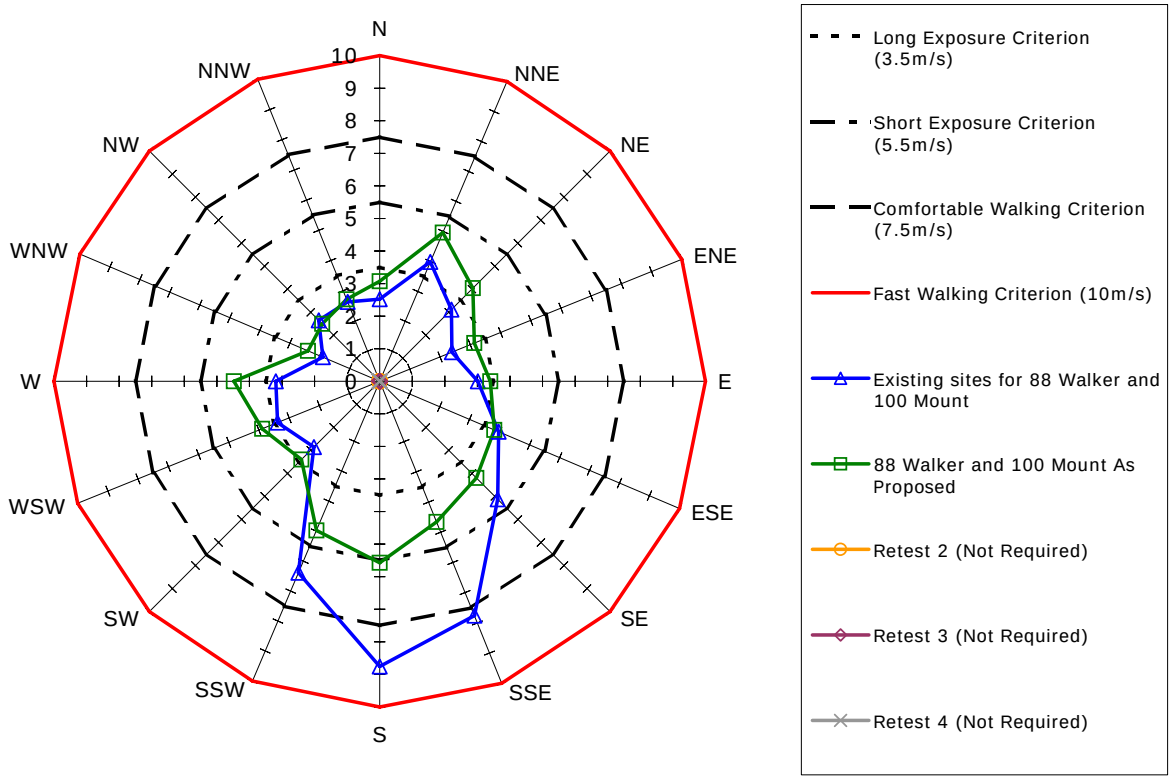


Annual Maximum Gust Wind Speeds (m/s)

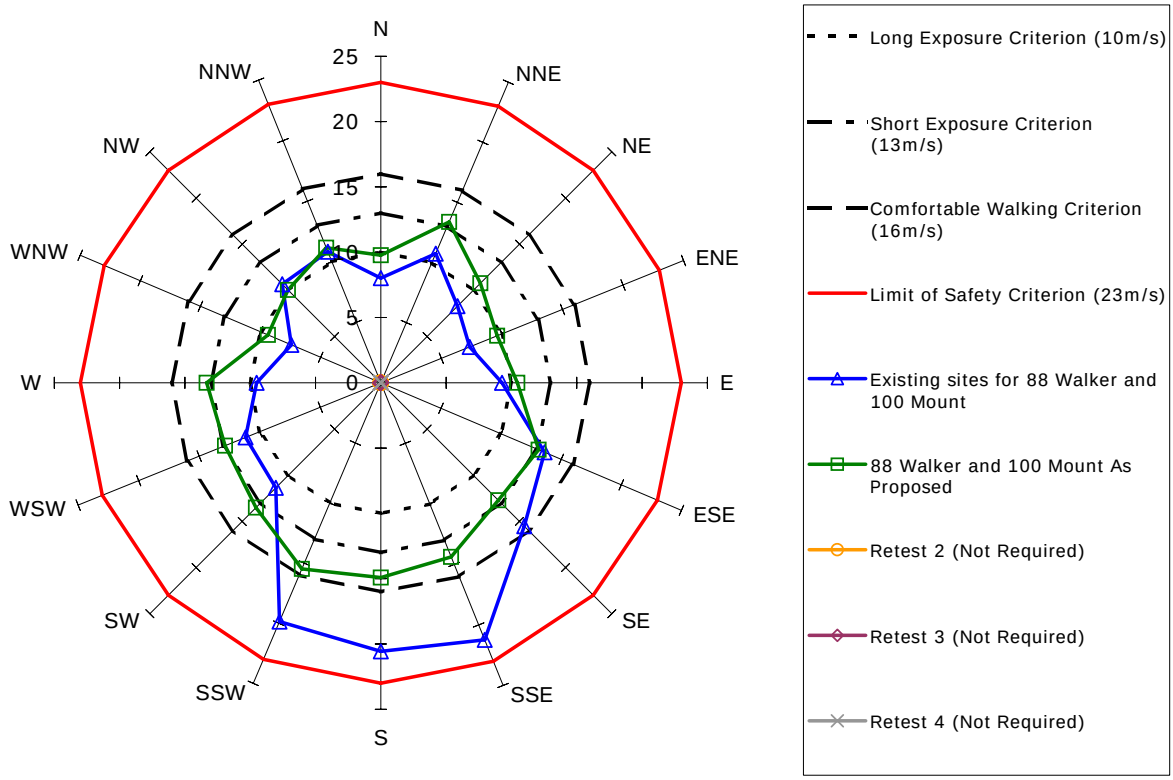


Measured Wind Speeds at Point 68

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

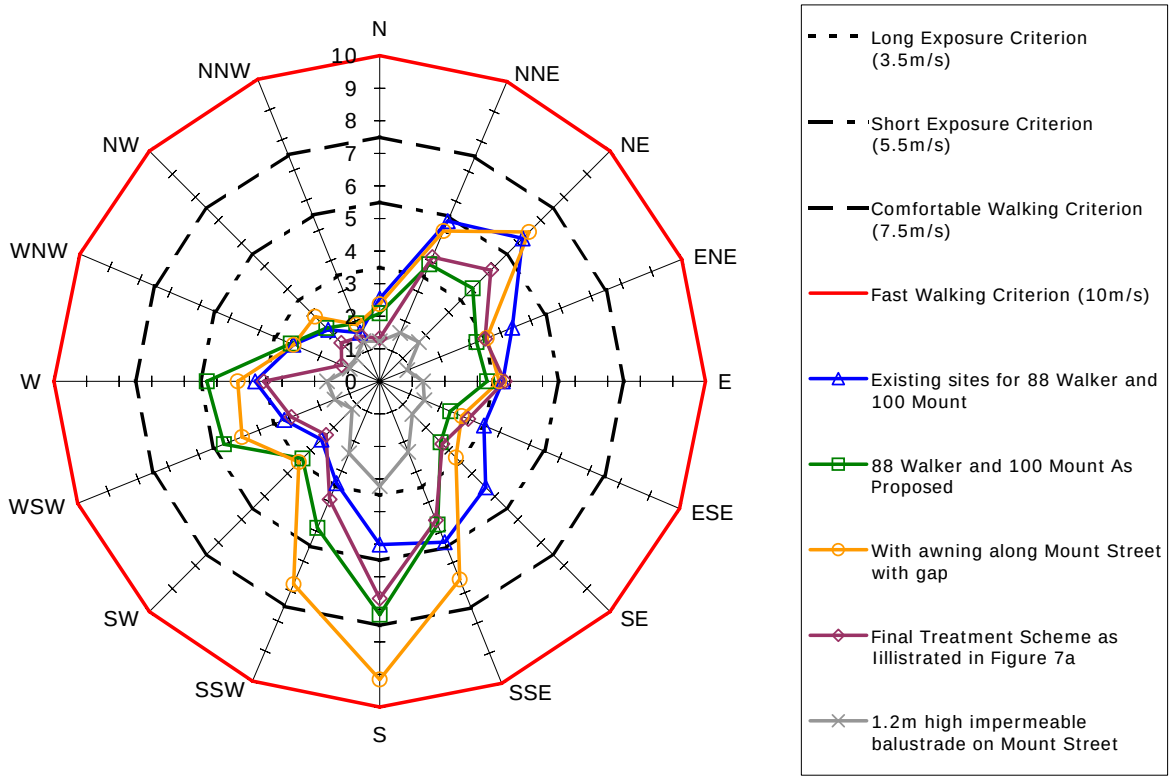


Annual Maximum Gust Wind Speeds (m/s)

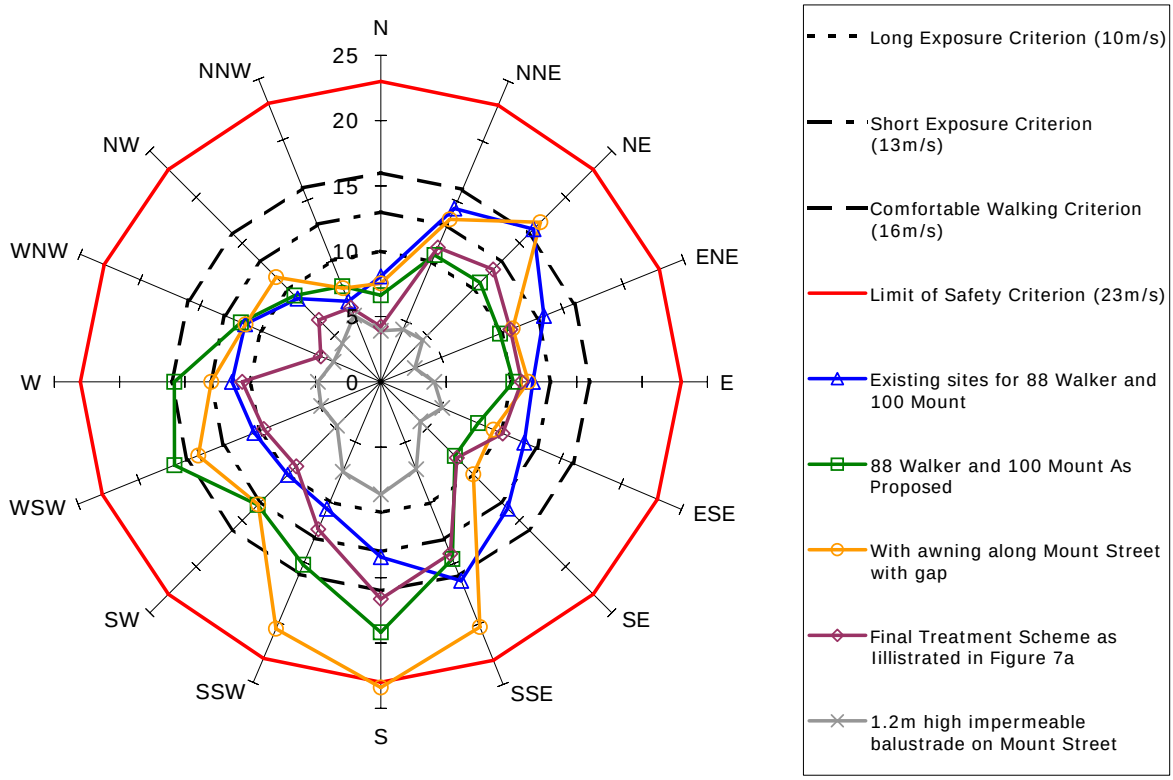


Measured Wind Speeds at Point 69

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

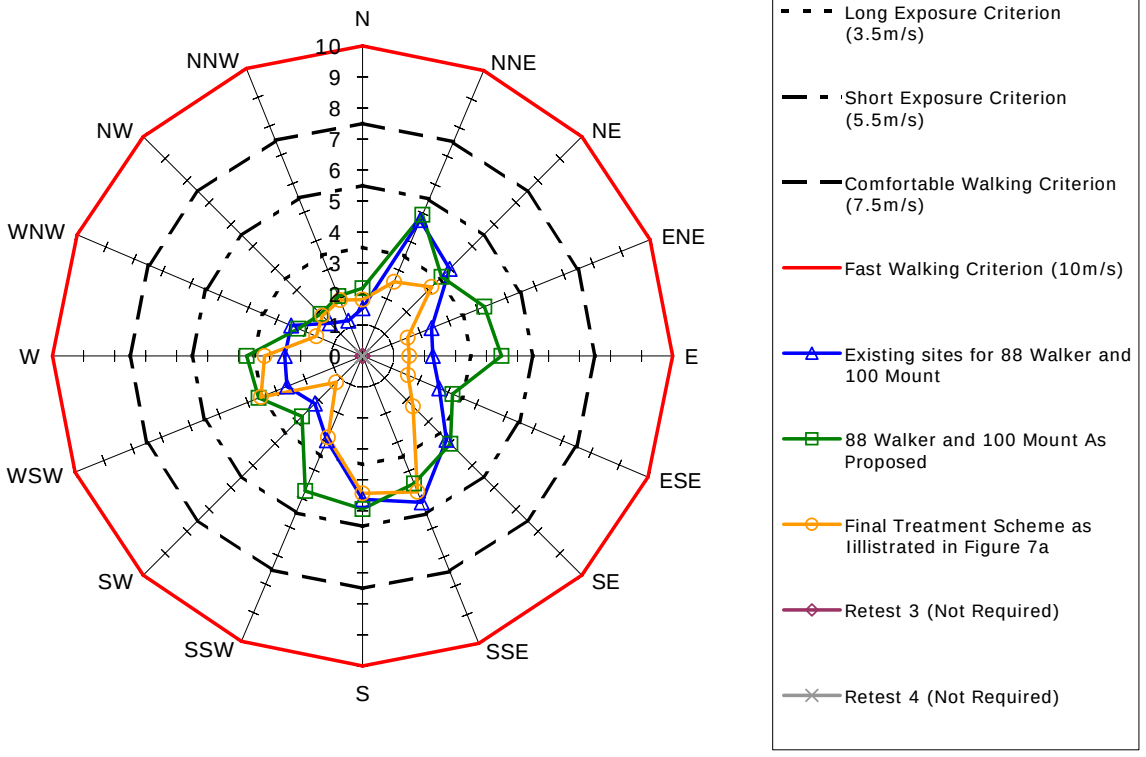


Annual Maximum Gust Wind Speeds (m/s)

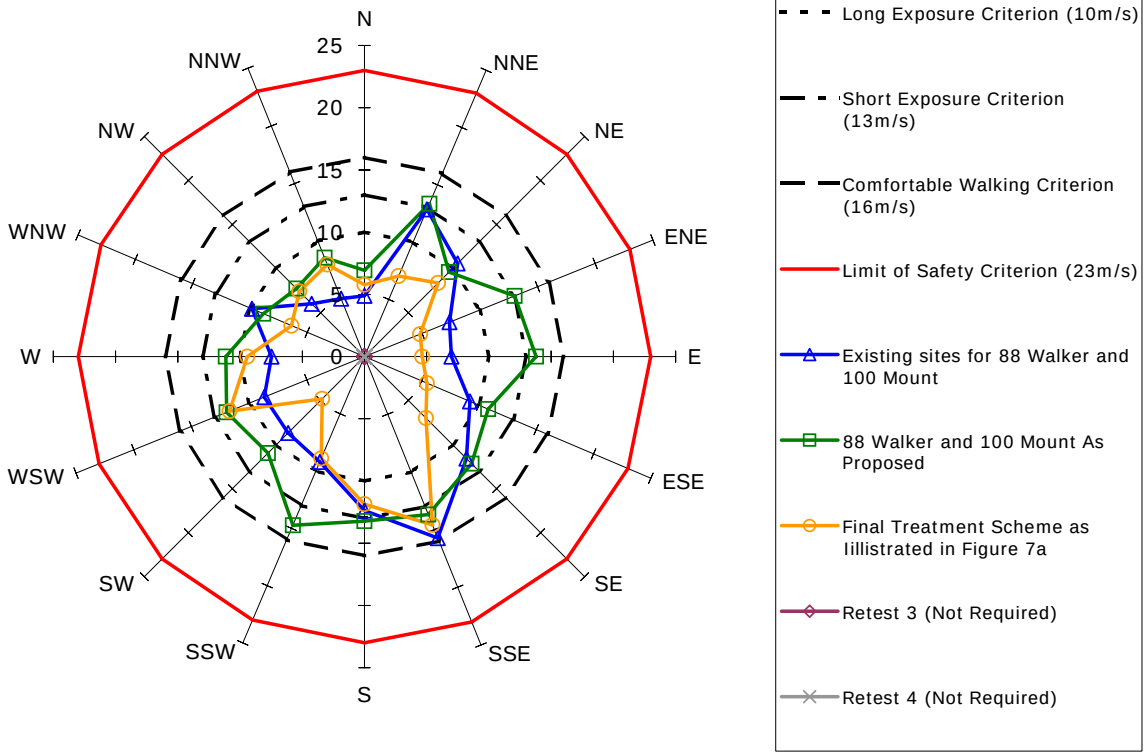


Measured Wind Speeds at Point 70

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

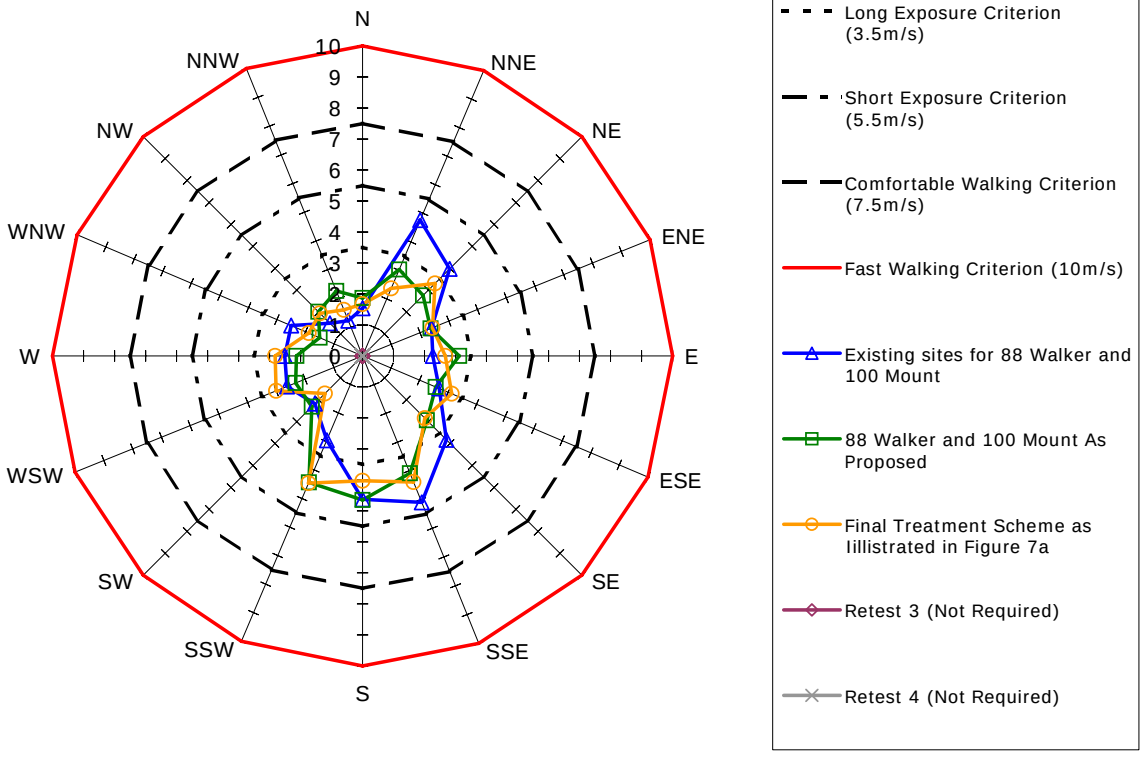


Annual Maximum Gust Wind Speeds (m/s)

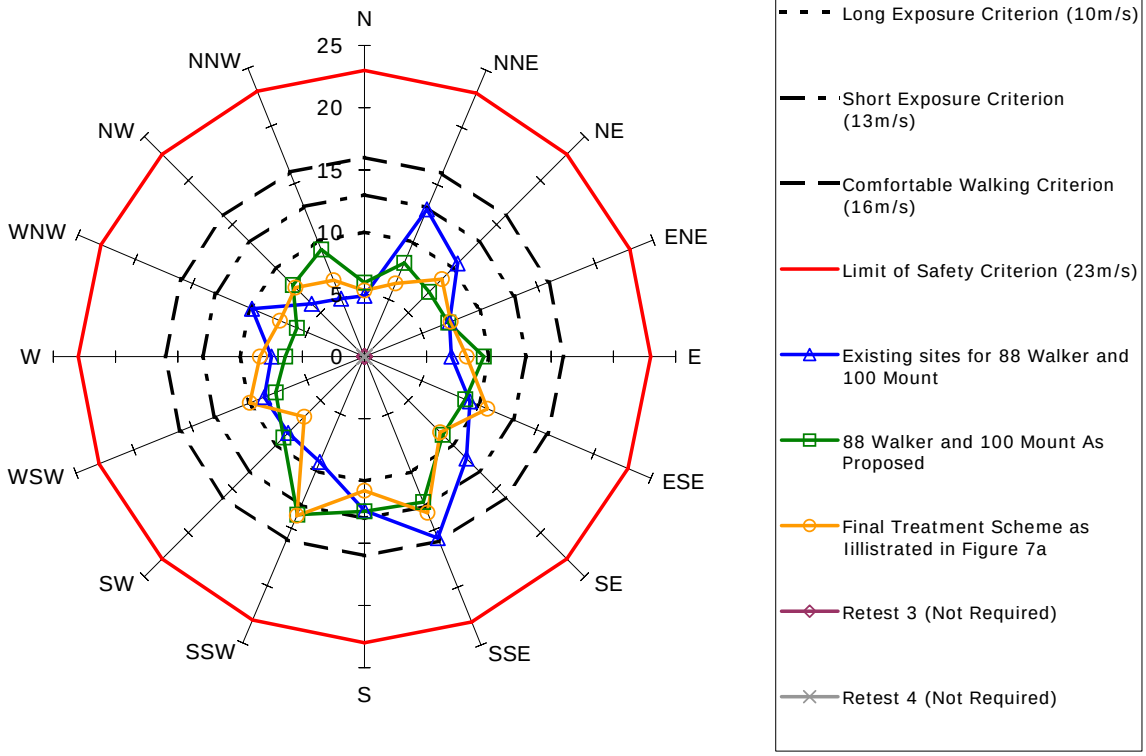


Measured Wind Speeds at Point 71

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

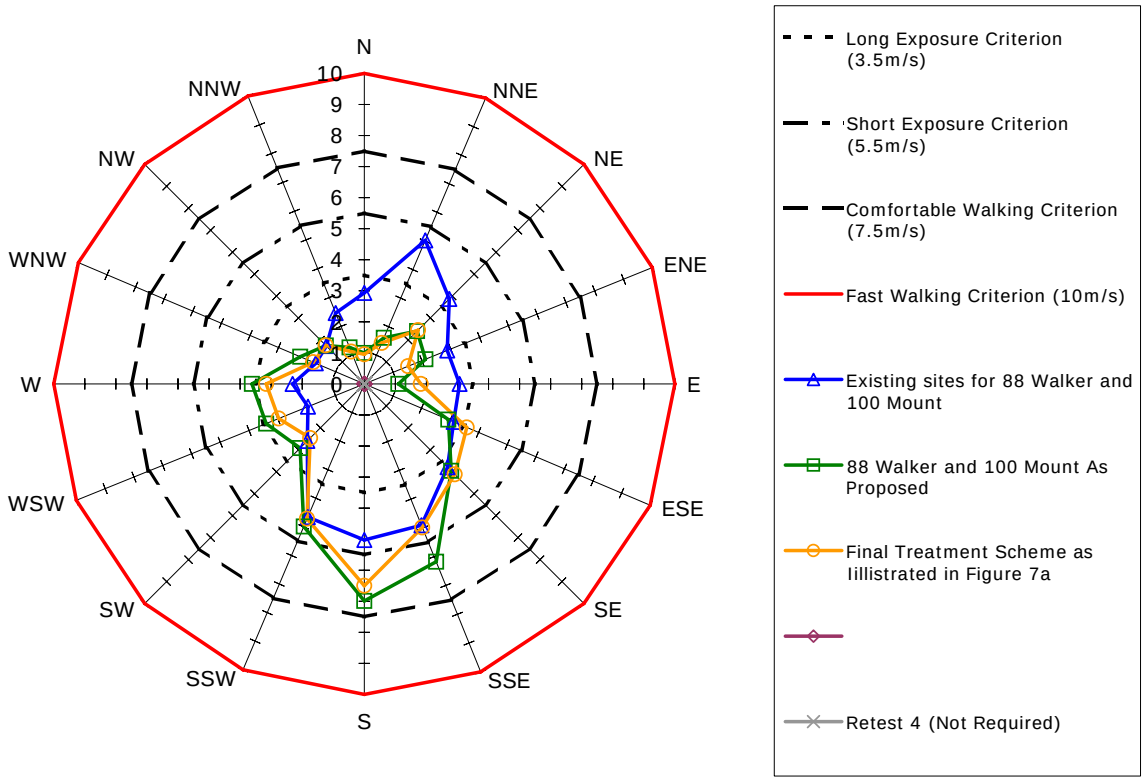


Annual Maximum Gust Wind Speeds (m/s)

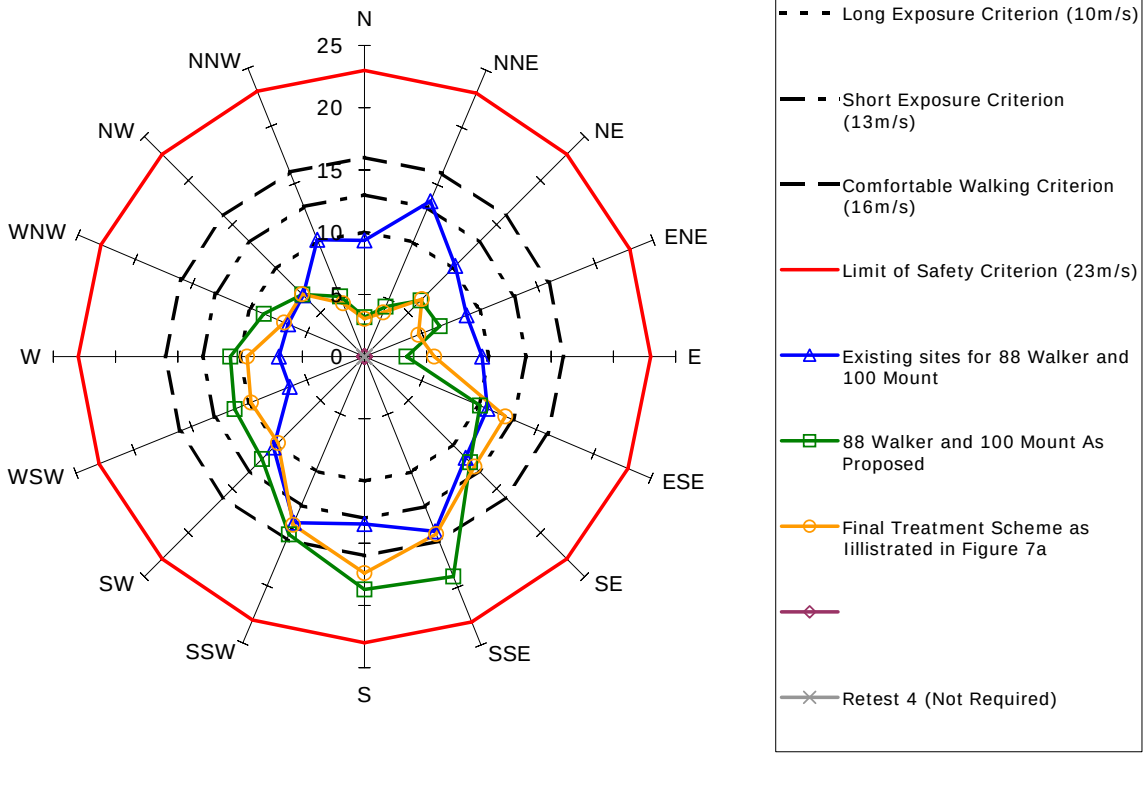


Measured Wind Speeds at Point 72

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

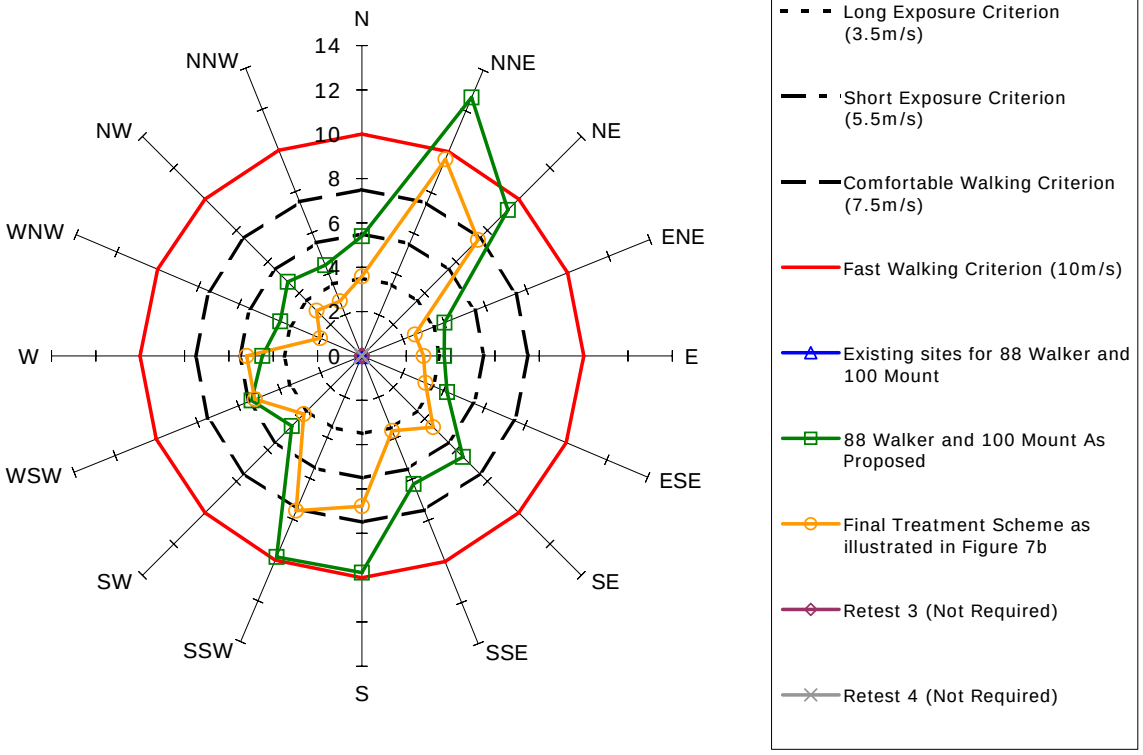


Annual Maximum Gust Wind Speeds (m/s)

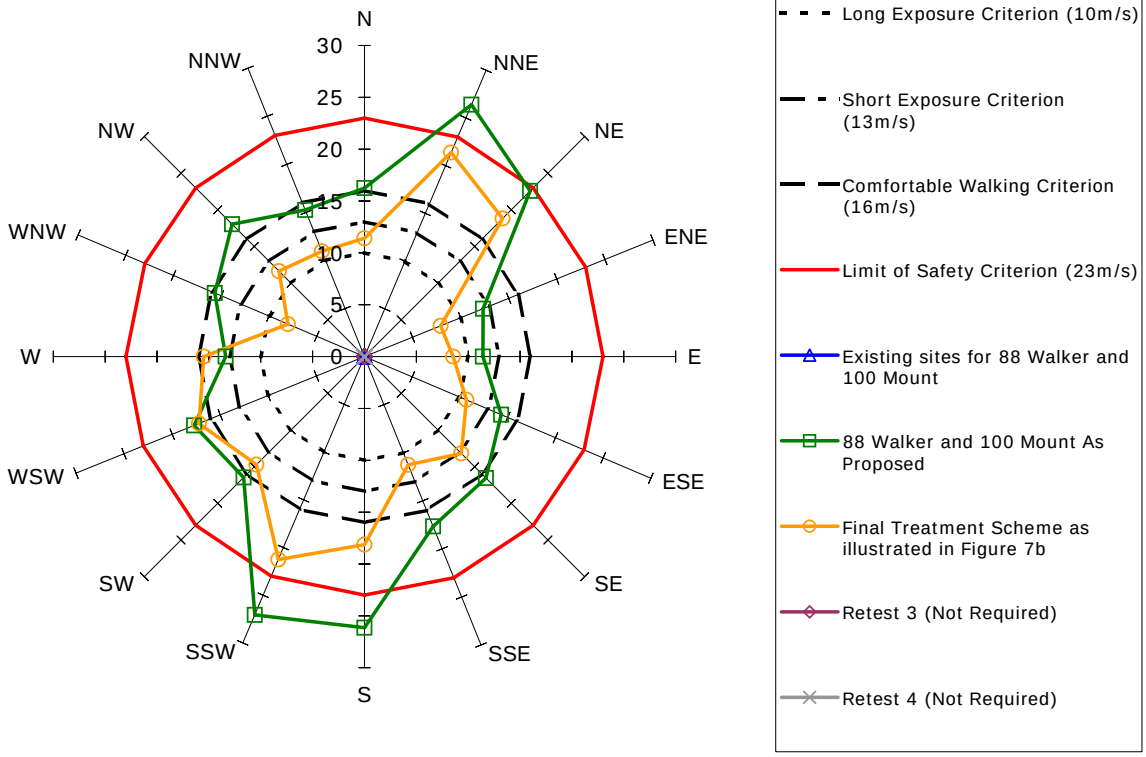


Measured Wind Speeds at Point 73

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

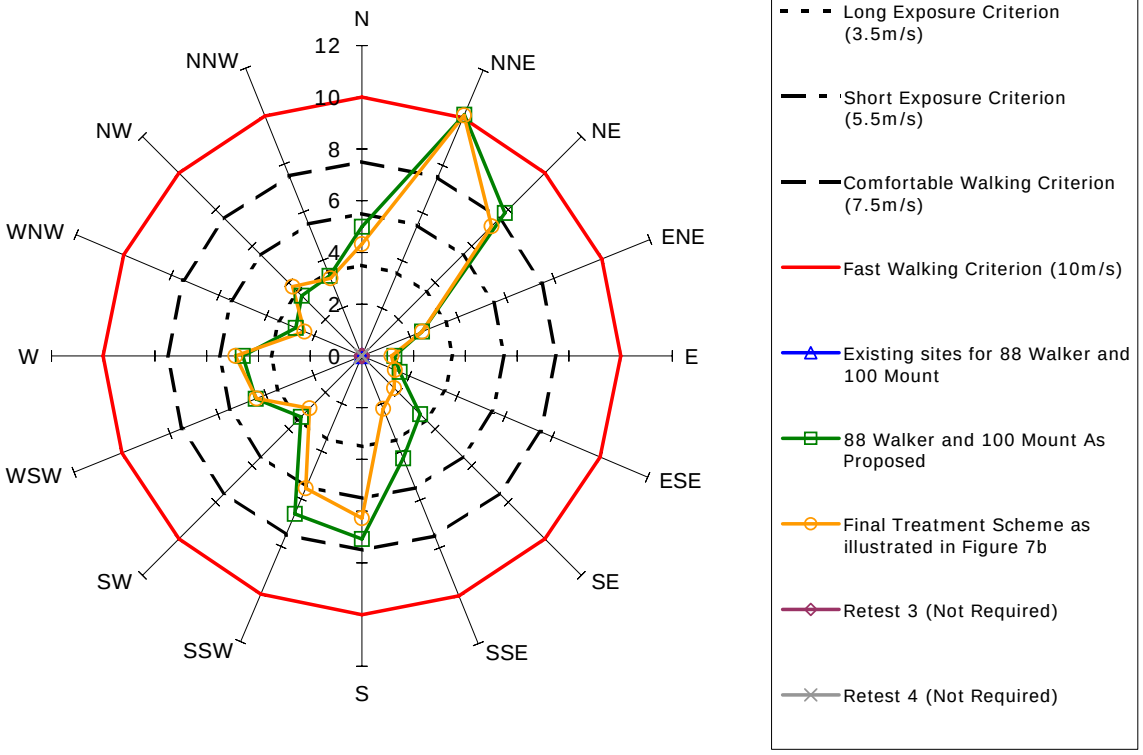


Annual Maximum Gust Wind Speeds (m/s)

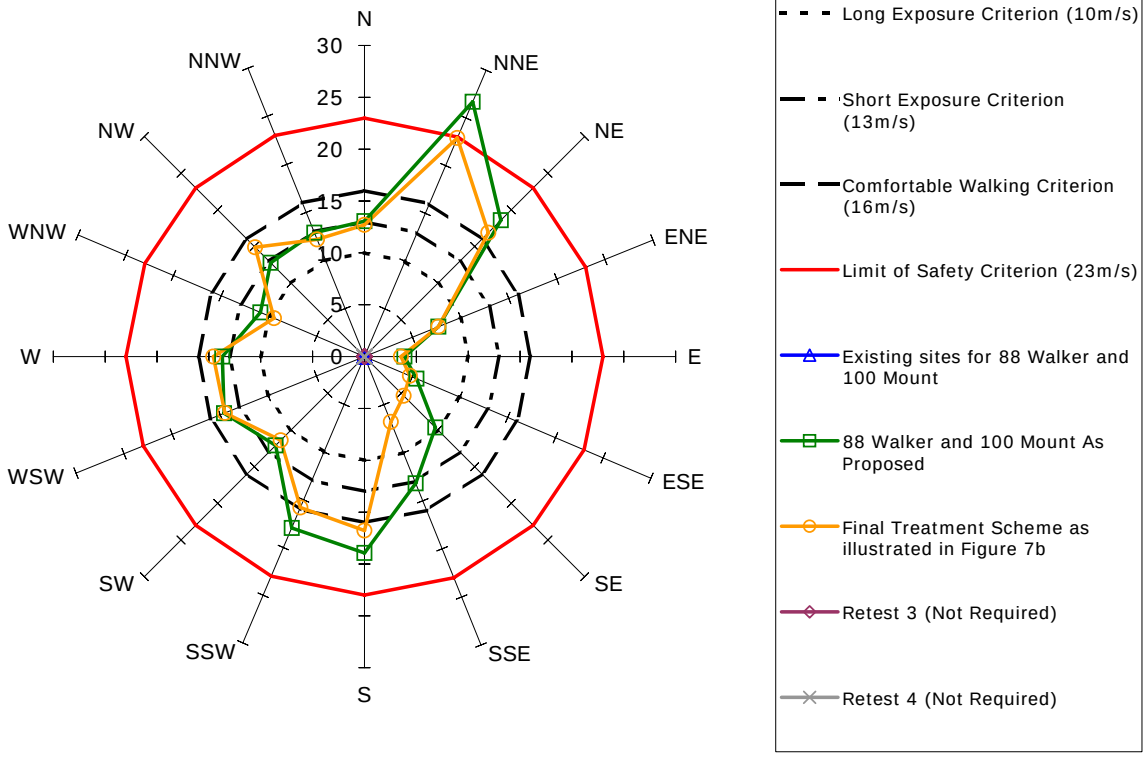


Measured Wind Speeds at Point 74

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

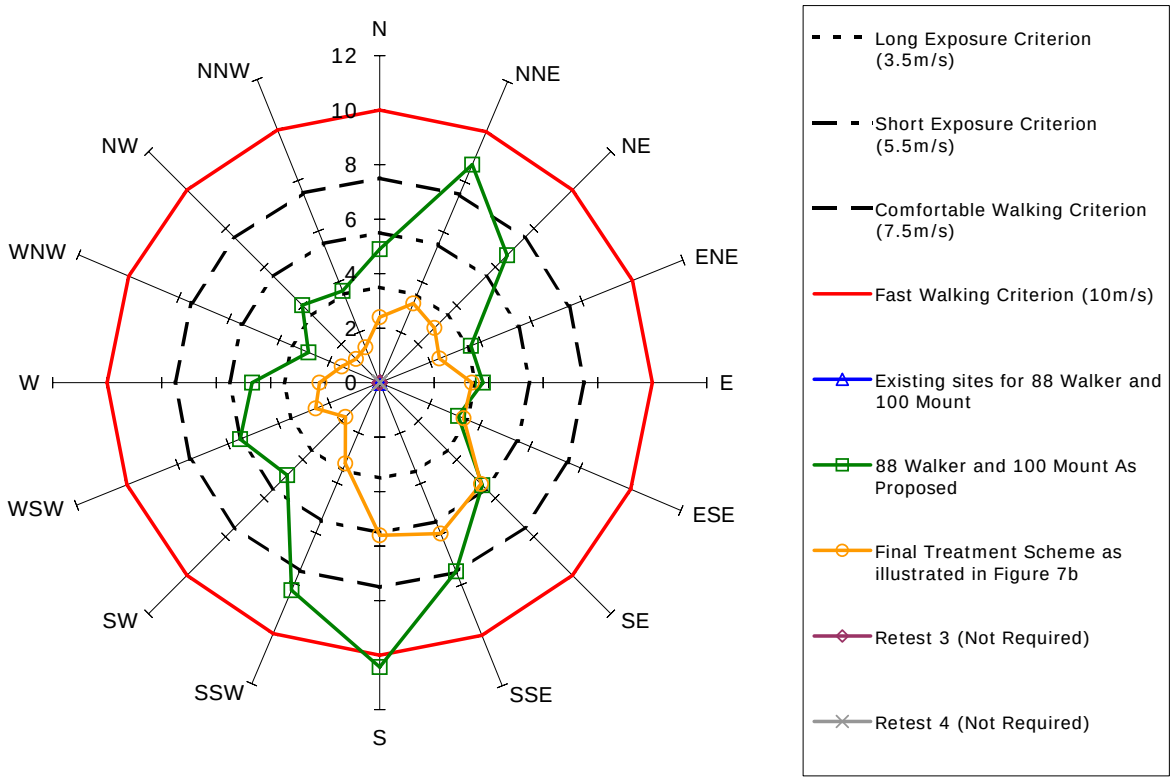


Annual Maximum Gust Wind Speeds (m/s)

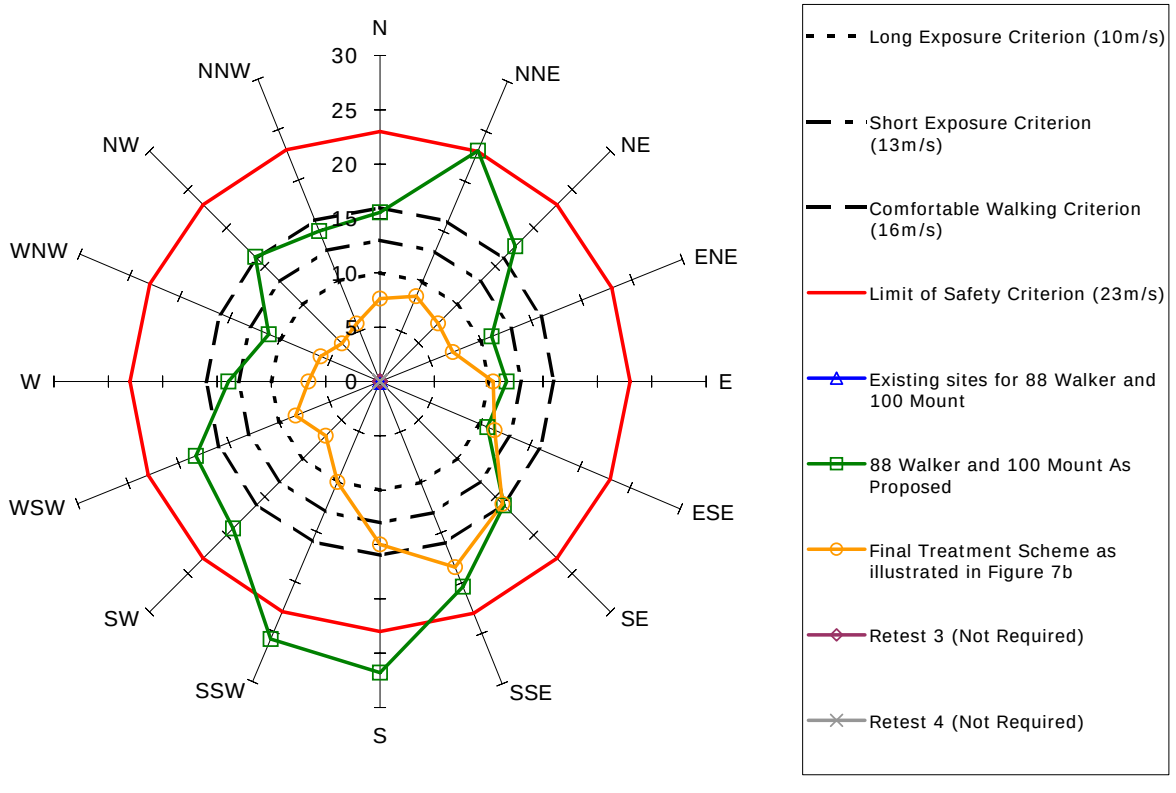


Measured Wind Speeds at Point 75

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

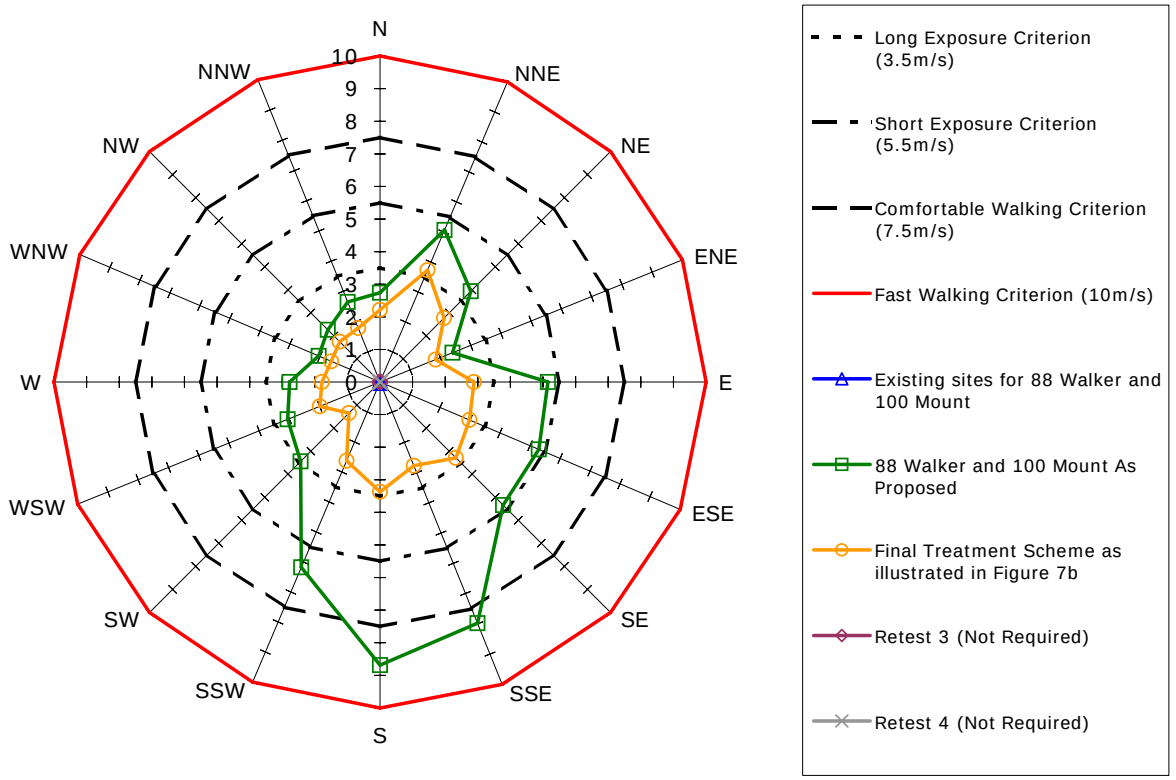


Annual Maximum Gust Wind Speeds (m/s)

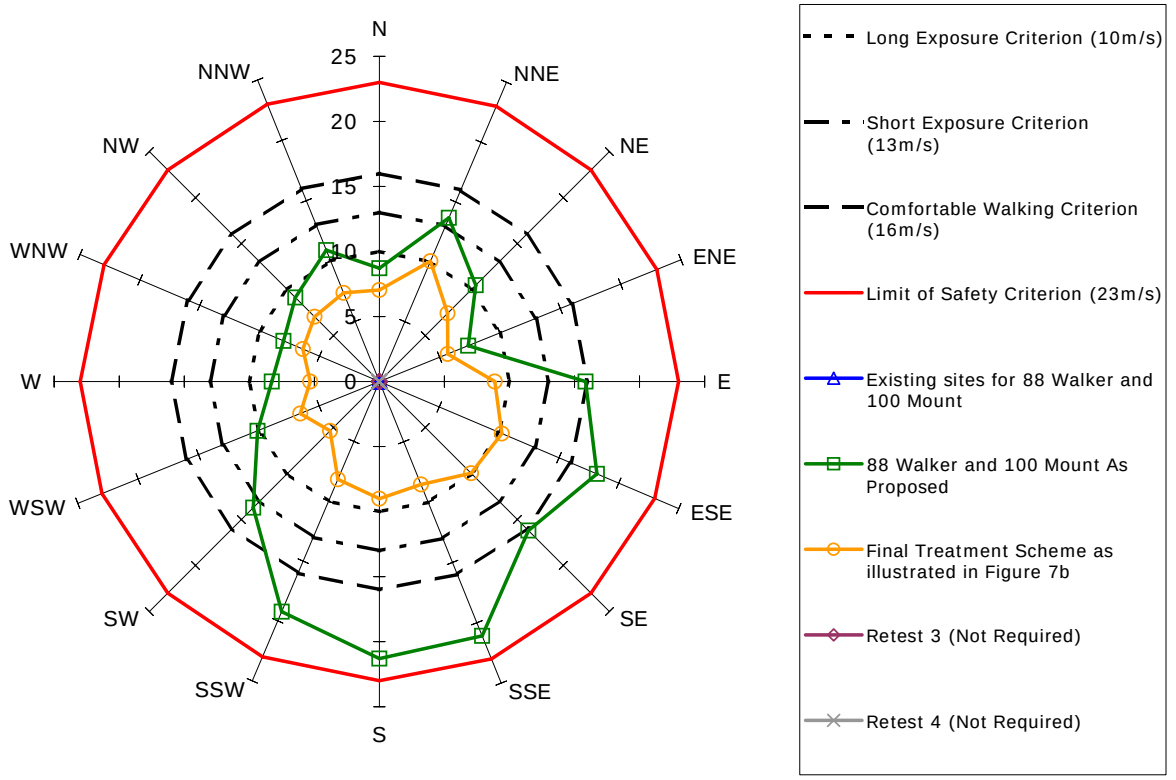


Measured Wind Speeds at Point 76

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

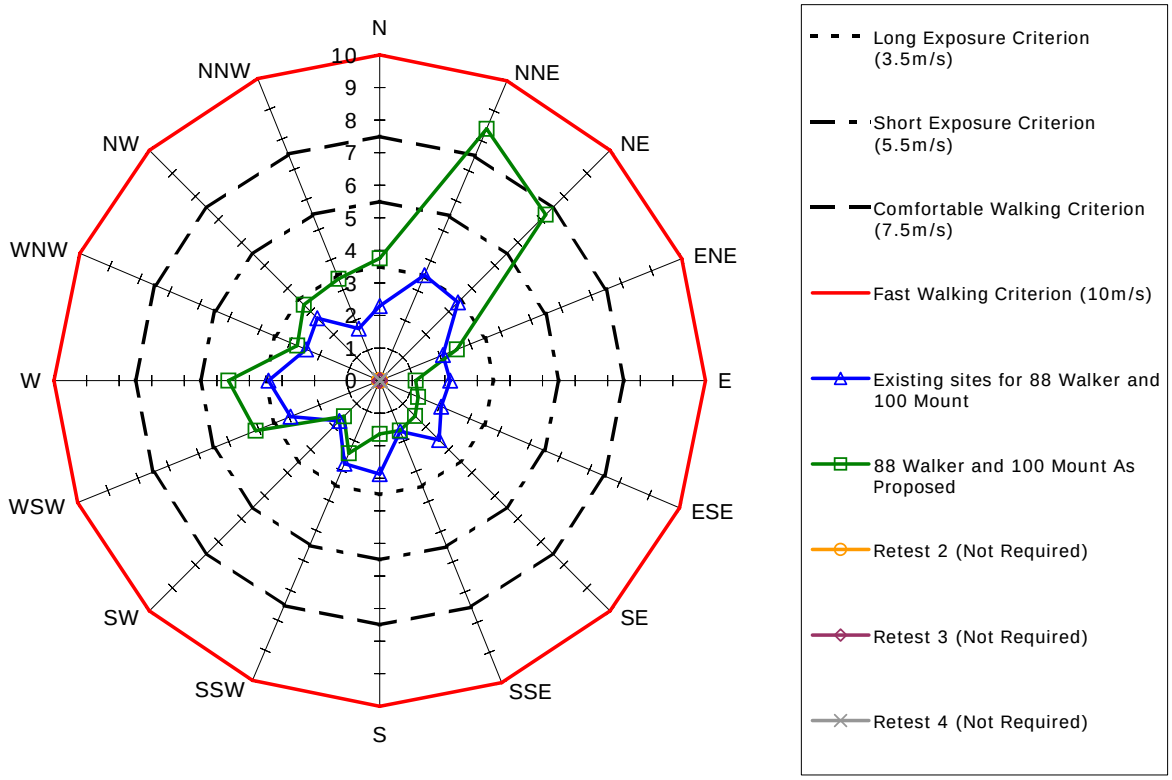


Annual Maximum Gust Wind Speeds (m/s)

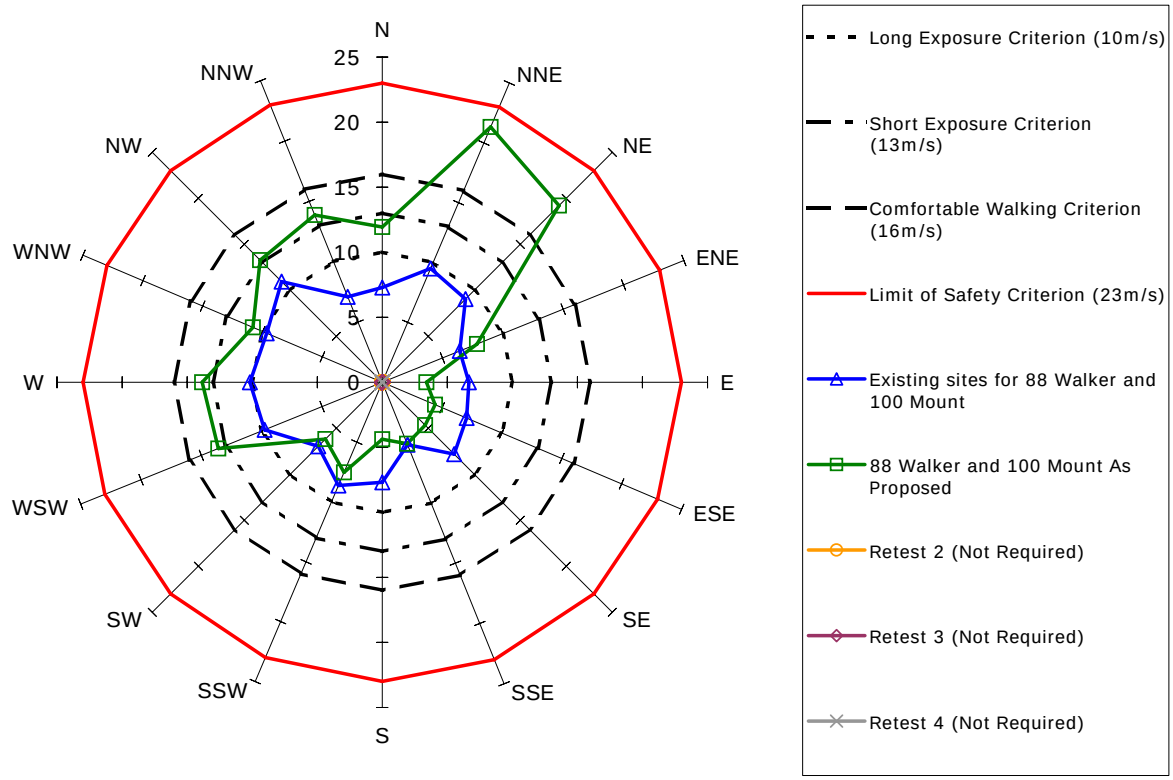


Measured Wind Speeds at Point 77

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

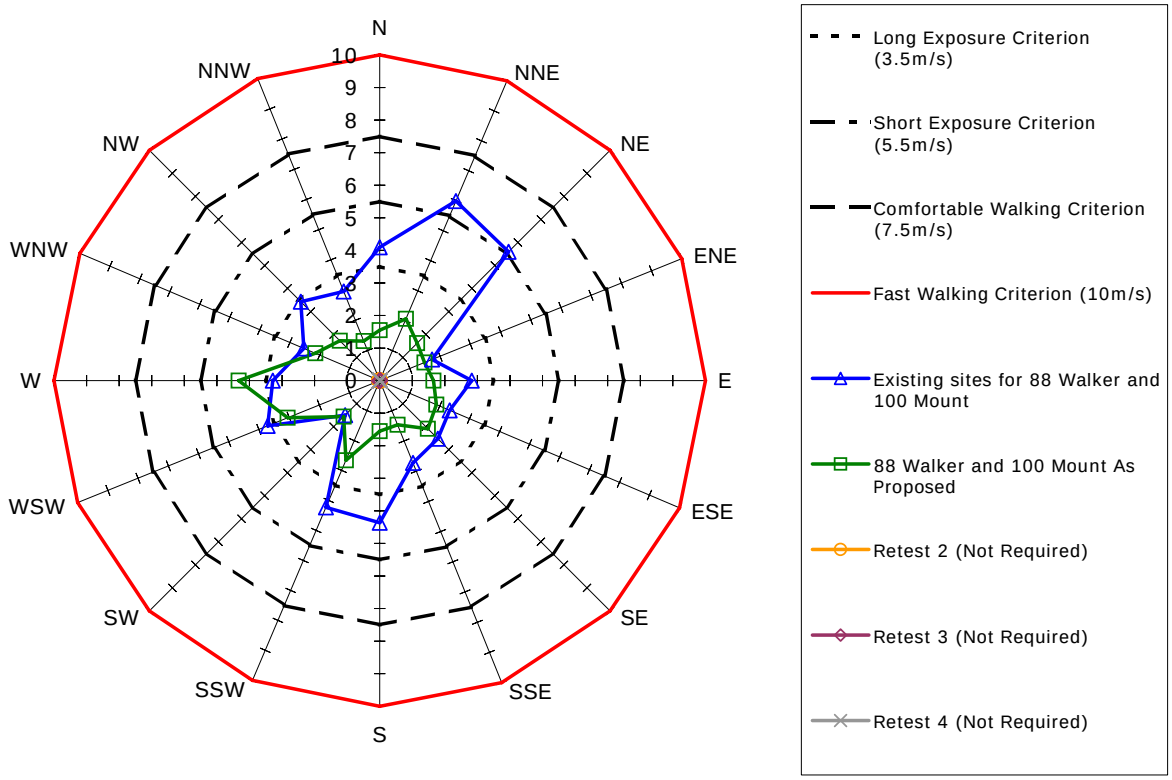


Annual Maximum Gust Wind Speeds (m/s)

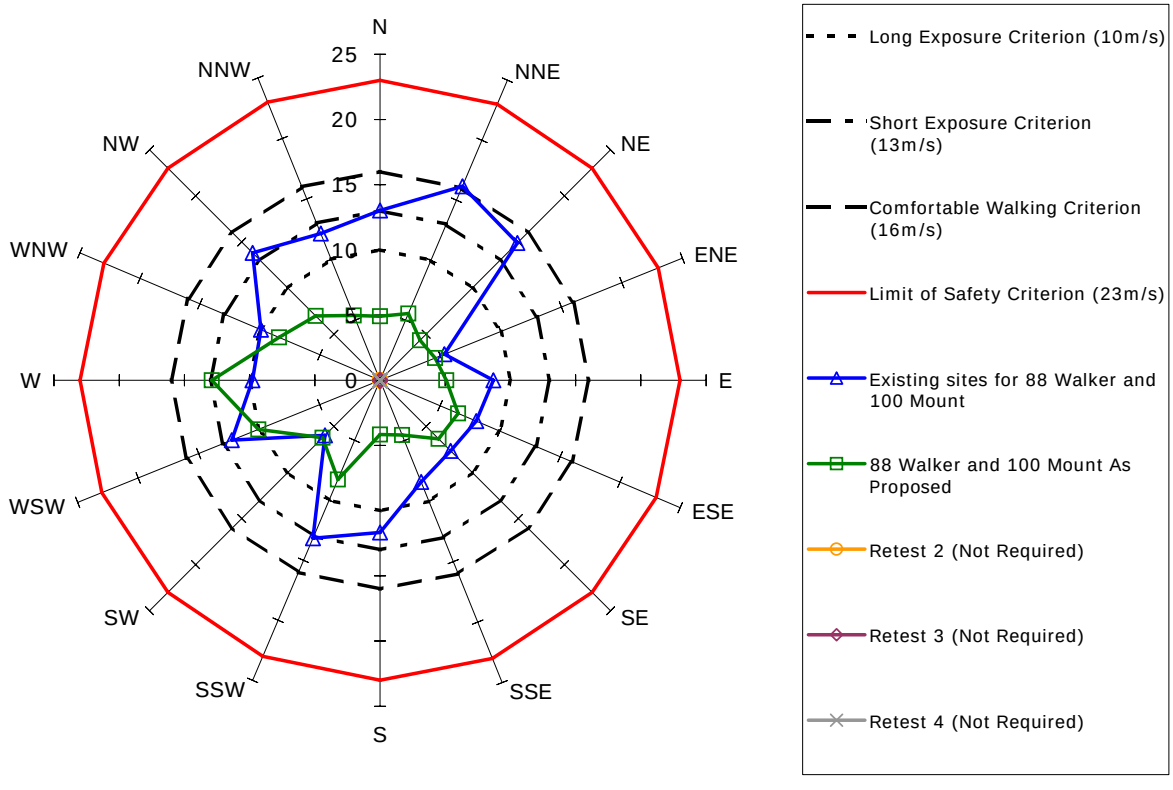


Measured Wind Speeds at Point 78

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

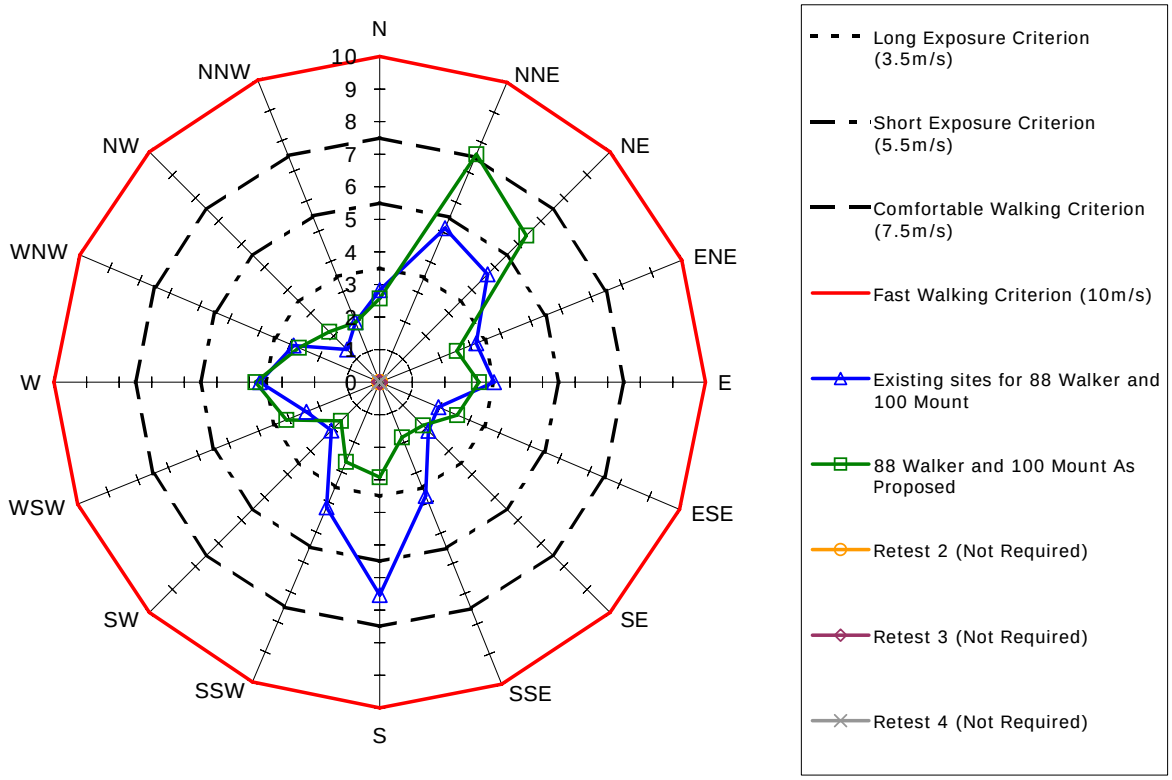


Annual Maximum Gust Wind Speeds (m/s)

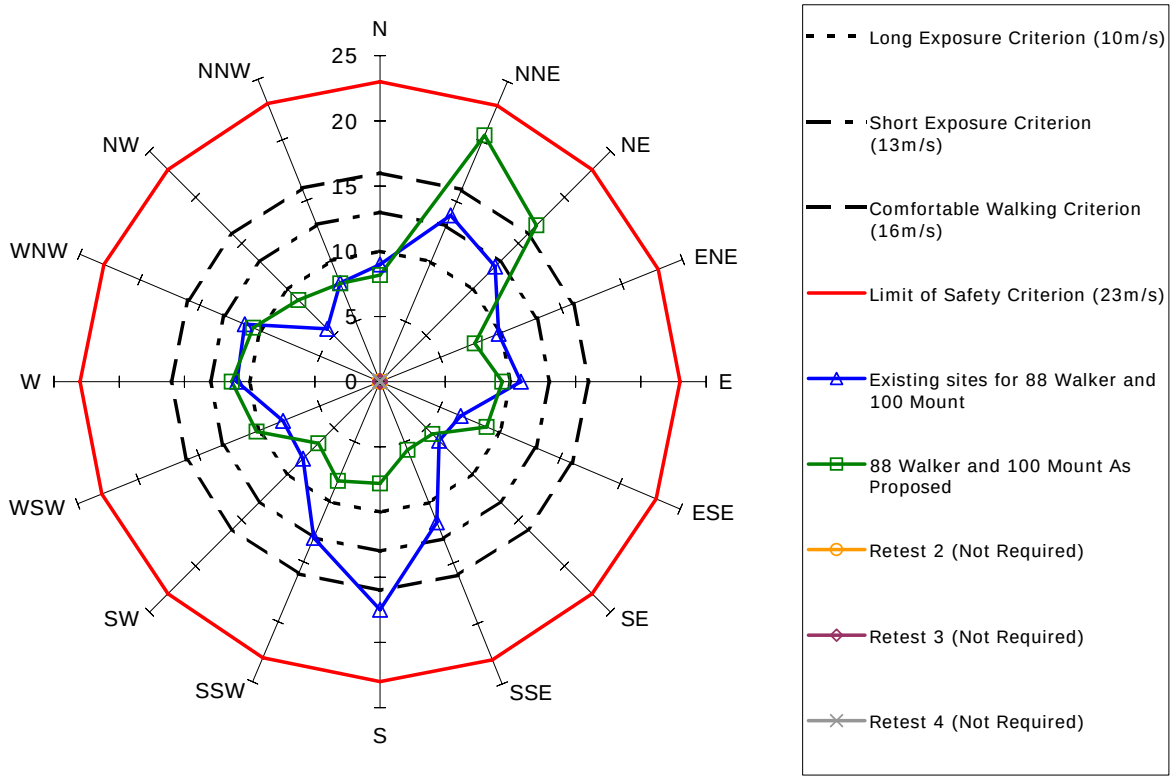


Measured Wind Speeds at Point 79

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

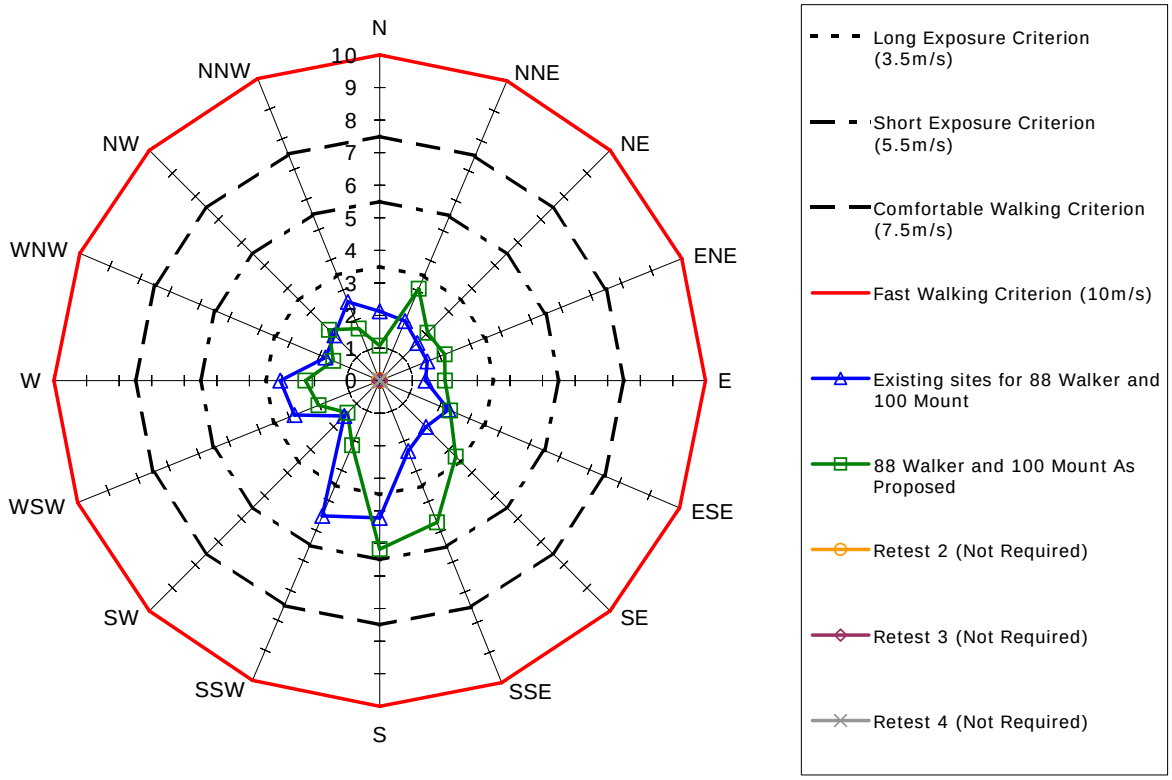


Annual Maximum Gust Wind Speeds (m/s)

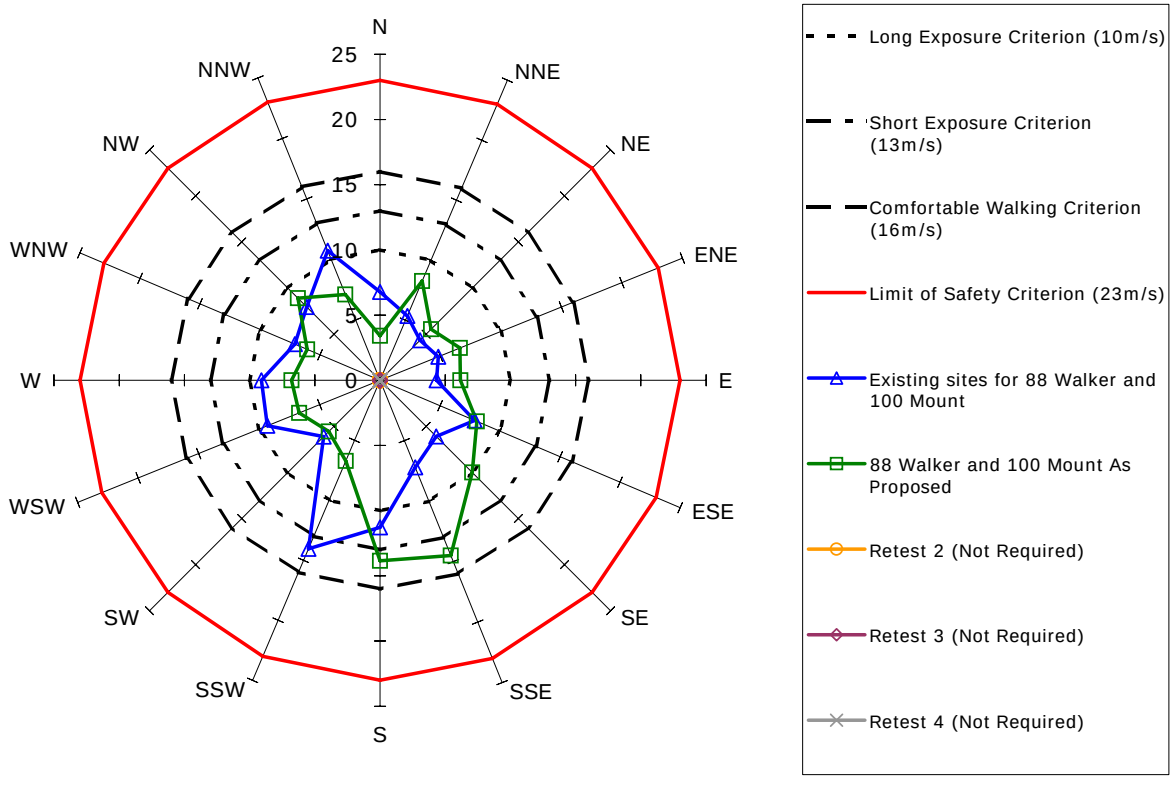


Measured Wind Speeds at Point 80

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

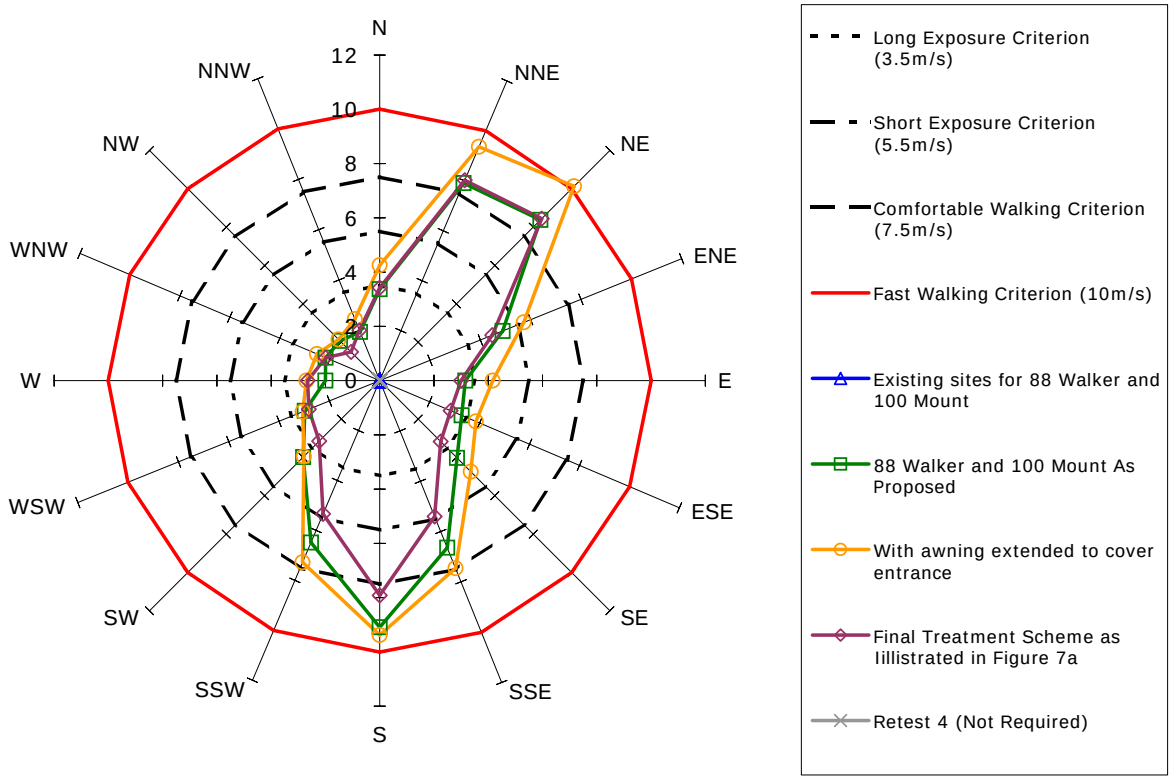


Annual Maximum Gust Wind Speeds (m/s)

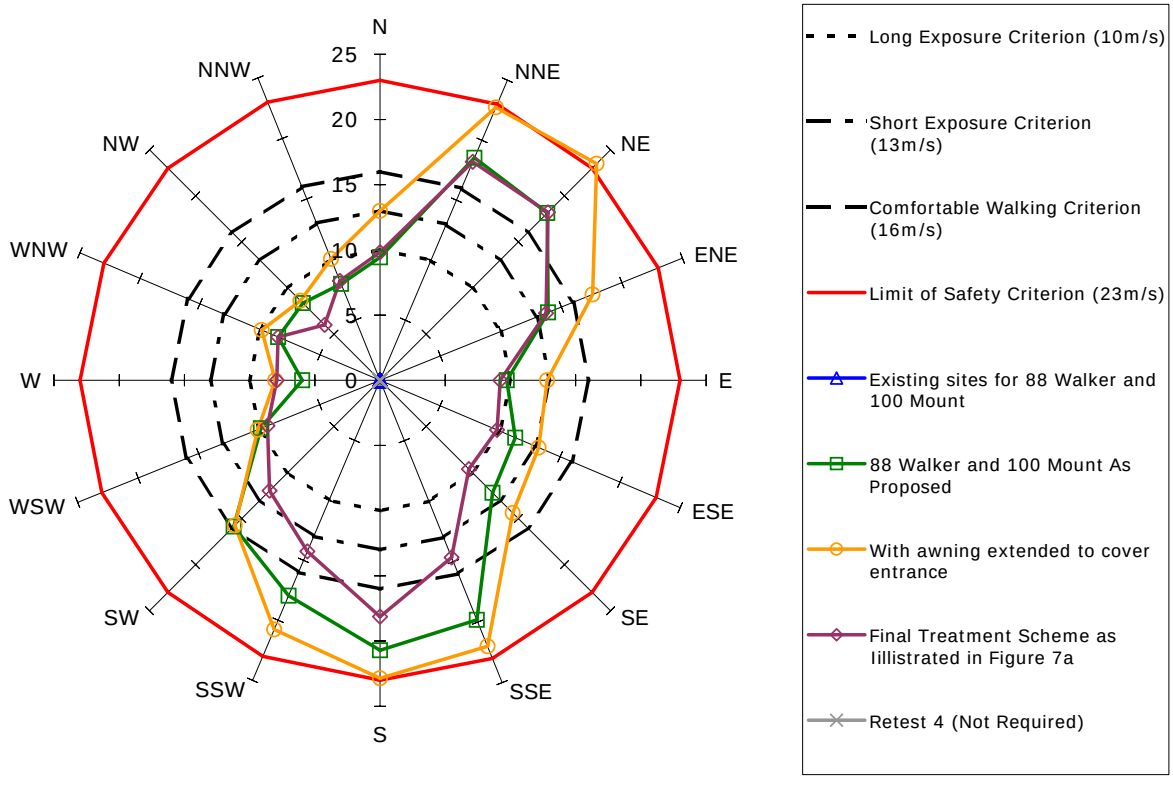


Measured Wind Speeds at Point 81

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

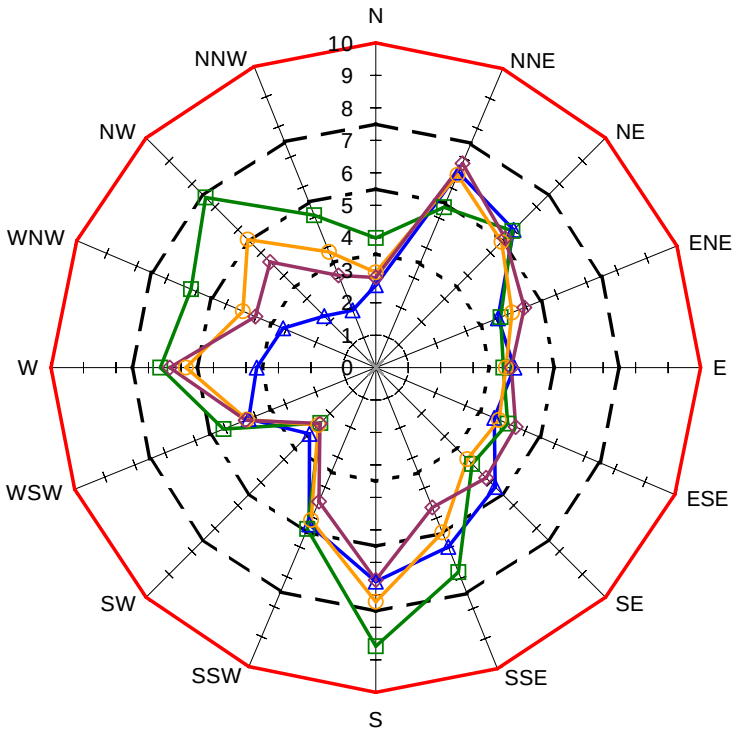


Annual Maximum Gust Wind Speeds (m/s)



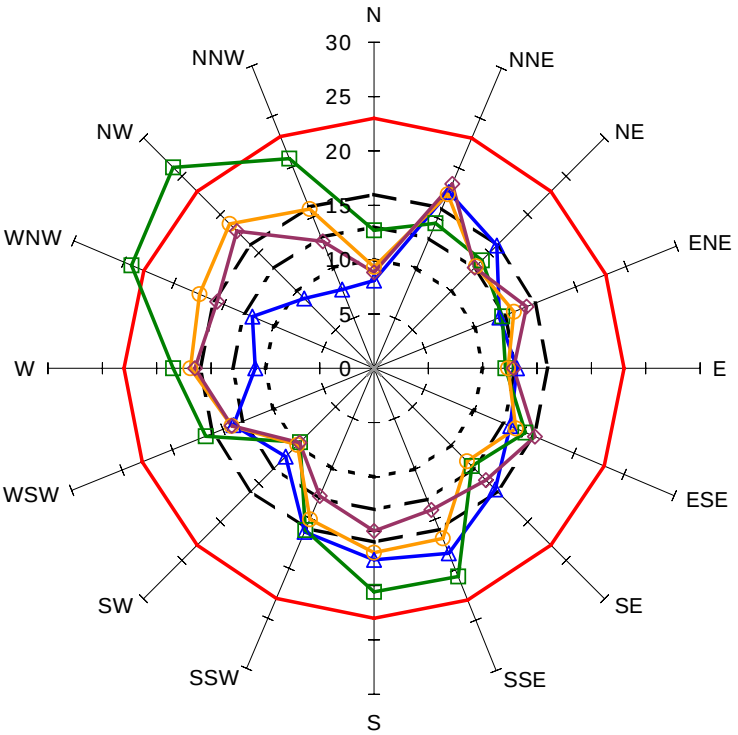
Measured Wind Speeds at Point 82

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



- Long Exposure Criterion (3.5m/s)
- Short Exposure Criterion (5.5m/s)
- Comfortable Walking Criterion (7.5m/s)
- Fast Walking Criterion (10m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- With additional tree to the immediate NW
- Final Treatment Scheme as Iillistrated in Figure 7a
- Retest 4 (Not Required)

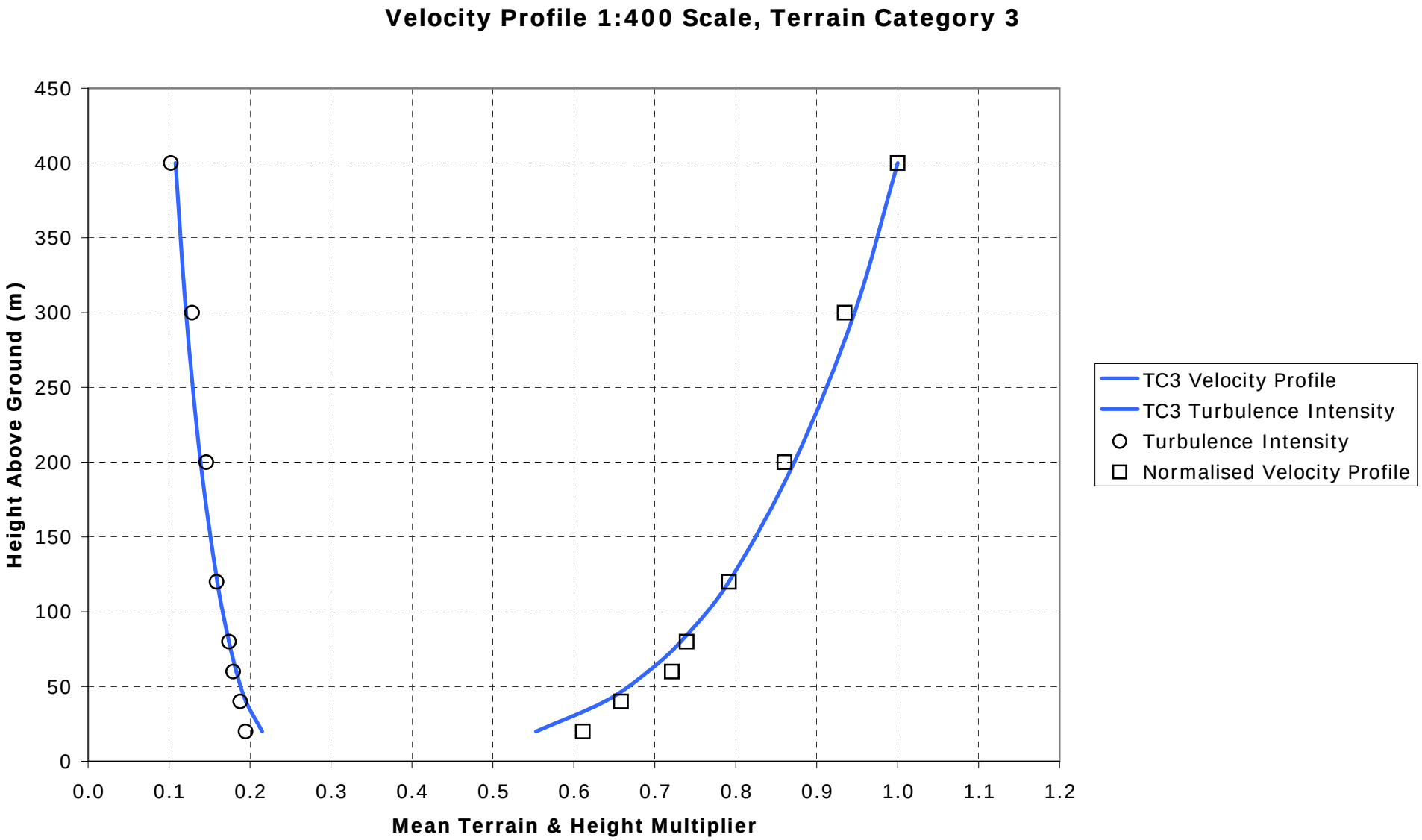
Annual Maximum Gust Wind Speeds (m/s)

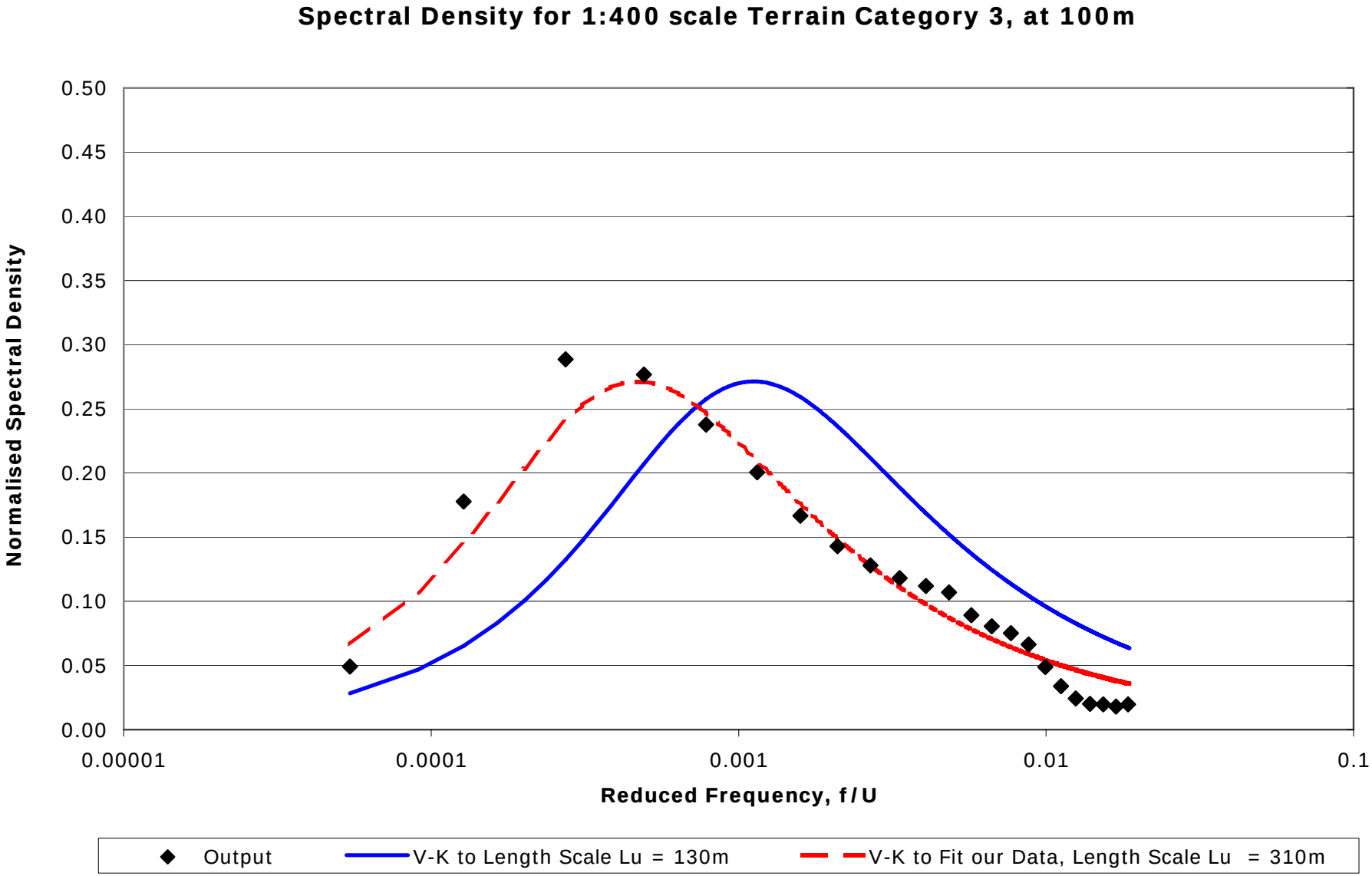


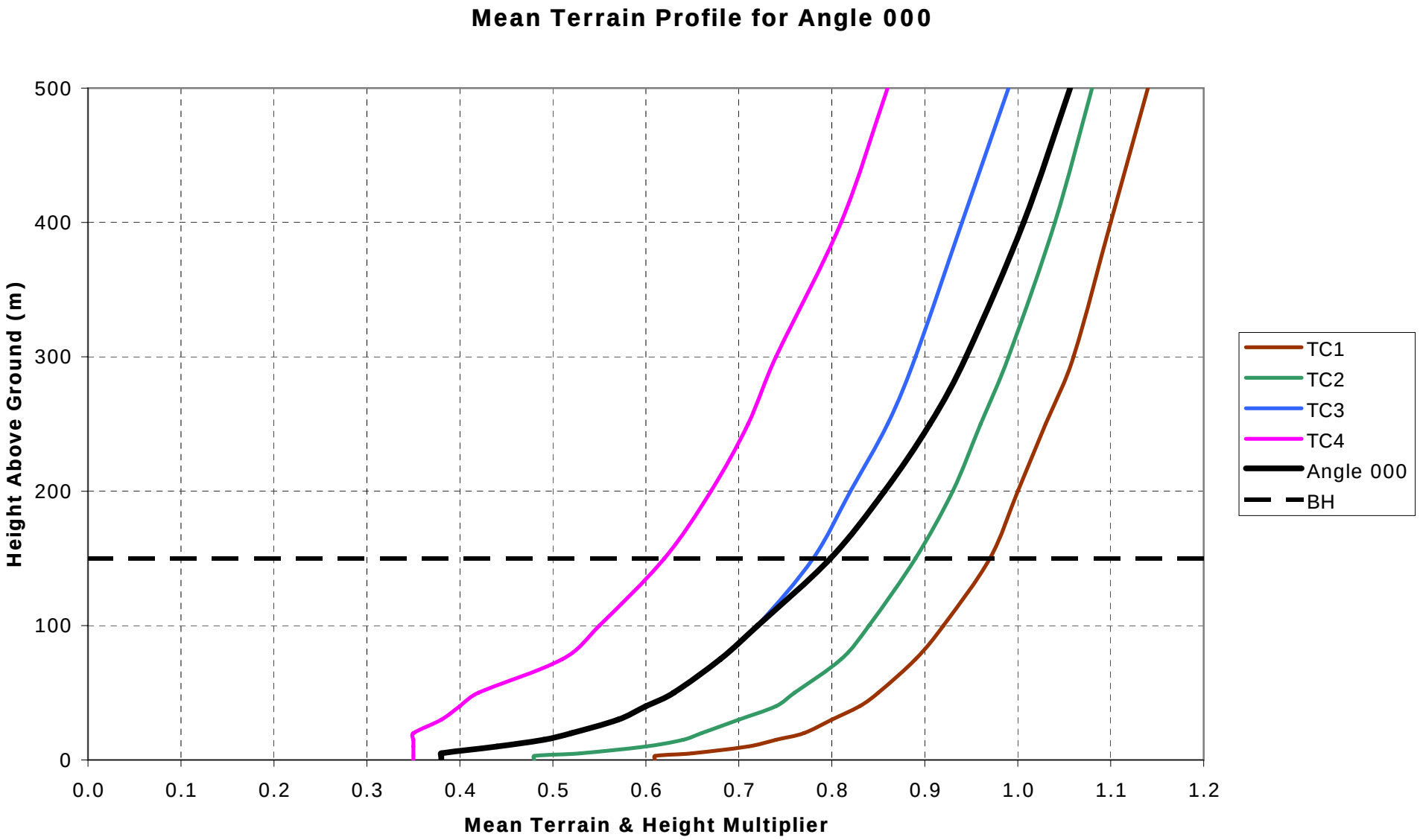
- Long Exposure Criterion (10m/s)
- Short Exposure Criterion (13m/s)
- Comfortable Walking Criterion (16m/s)
- Limit of Safety Criterion (23m/s)
- Existing sites for 88 Walker and 100 Mount
- 88 Walker and 100 Mount As Proposed
- With additional tree to the immediate NW
- Final Treatment Scheme as Iillistrated in Figure 7a
- Retest 4 (Not Required)

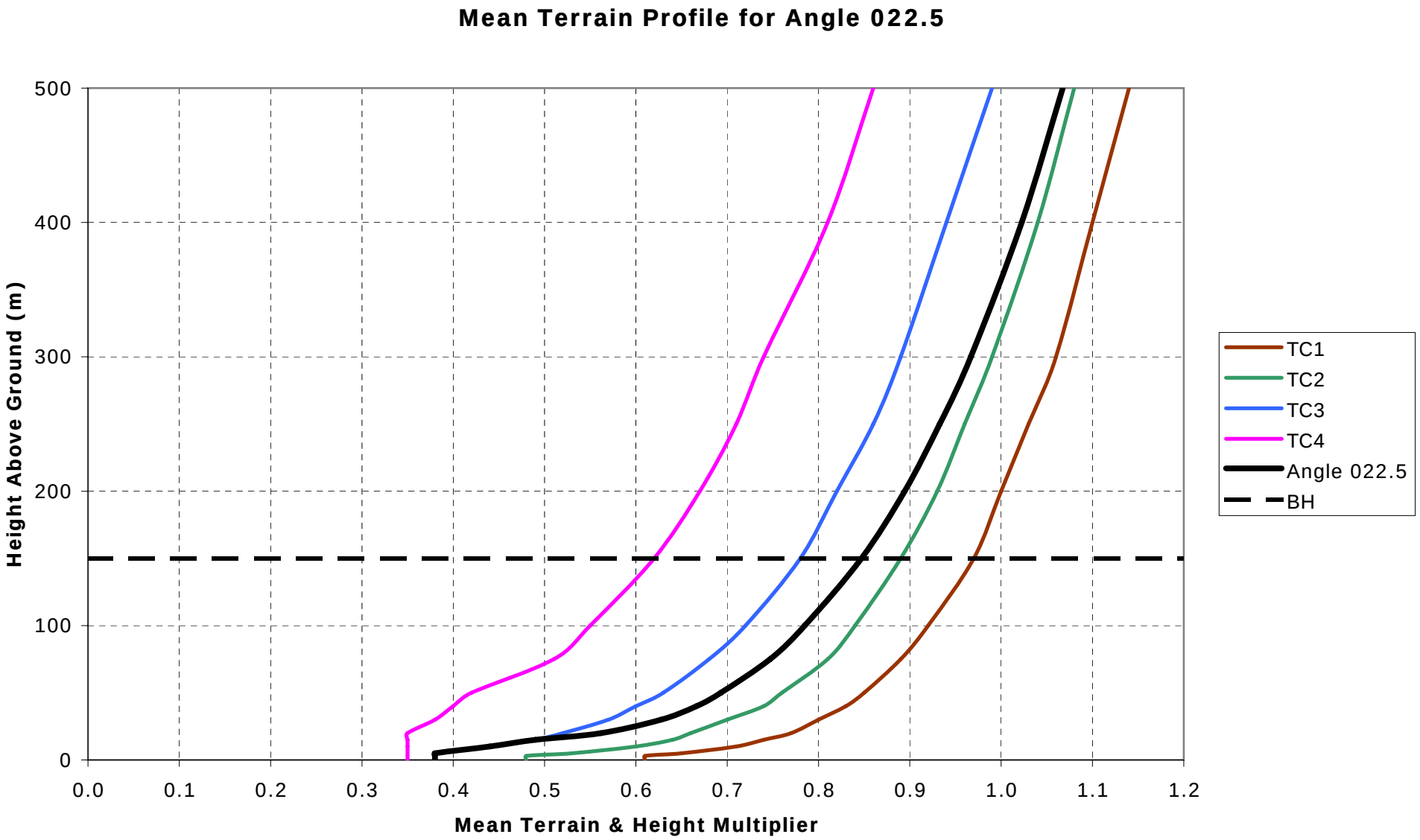
Appendix B

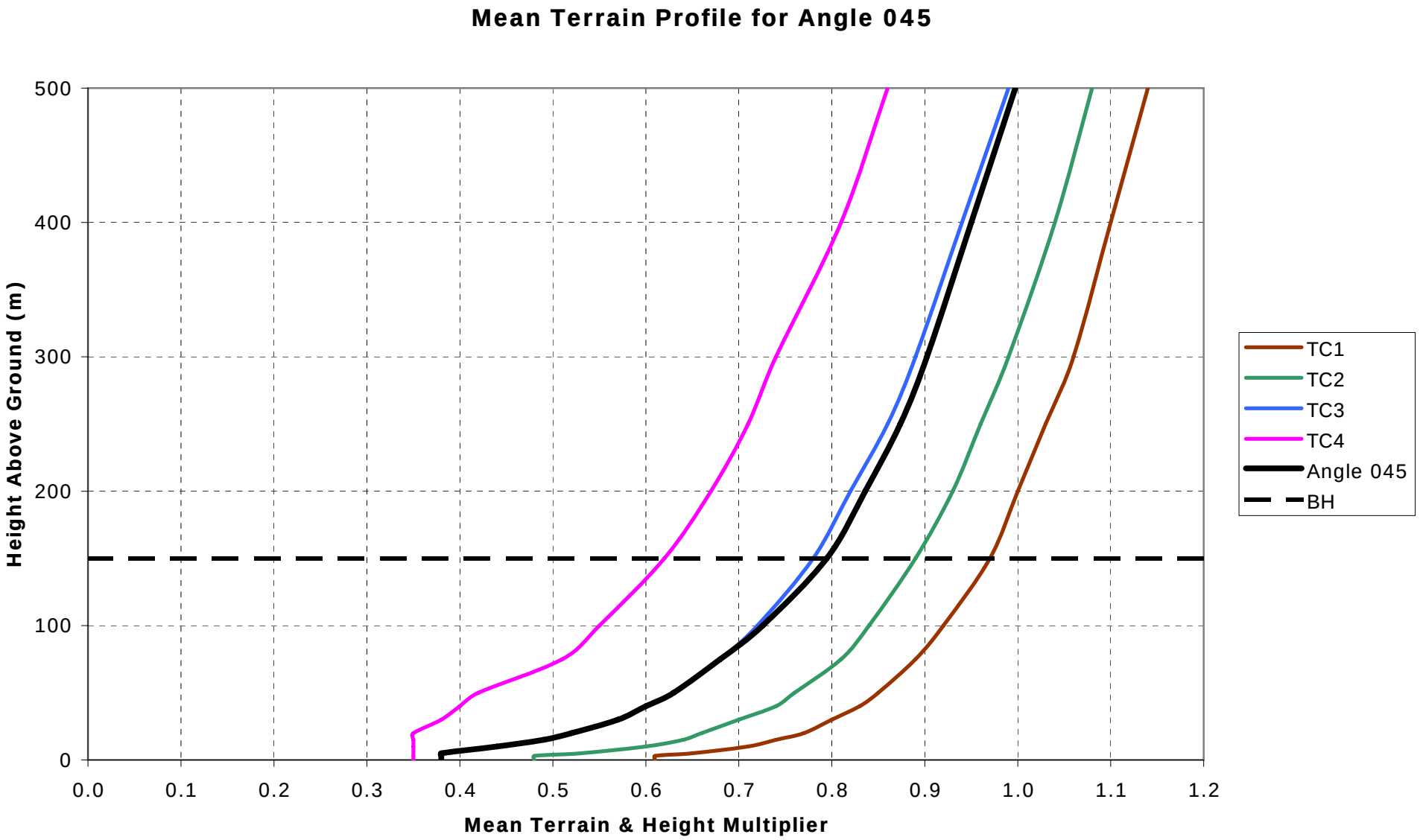
Wind Tunnel Boundary Layer Profile

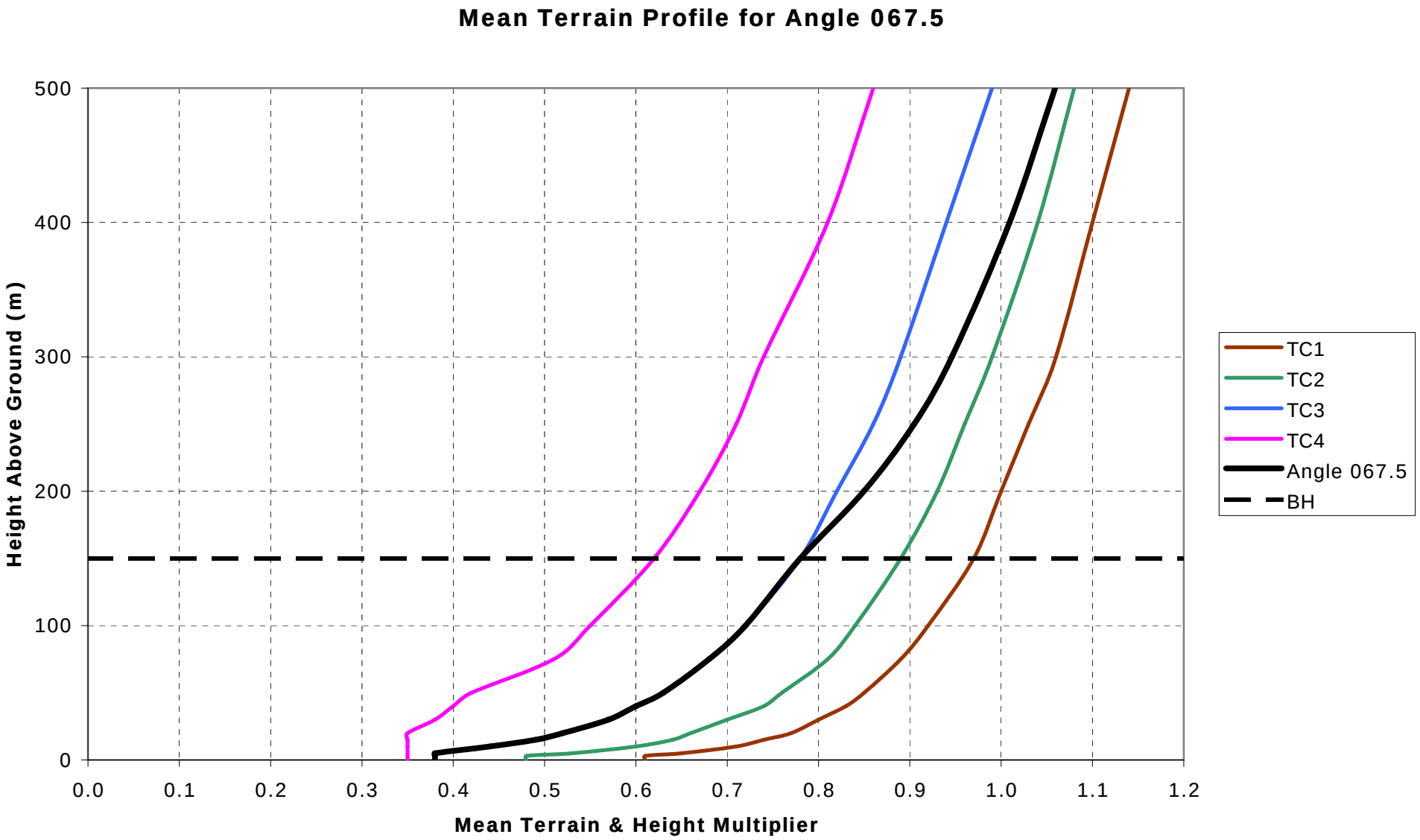

Velocity Profile 1:400 Scale, Terrain Category 3
Height Above Ground (m)
450
400
350
300
250
200
150
100
50
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC3 Velocity Profile
TC3 Turbulence Intensity
Turbulence Intensity
Normalised Velocity Profile

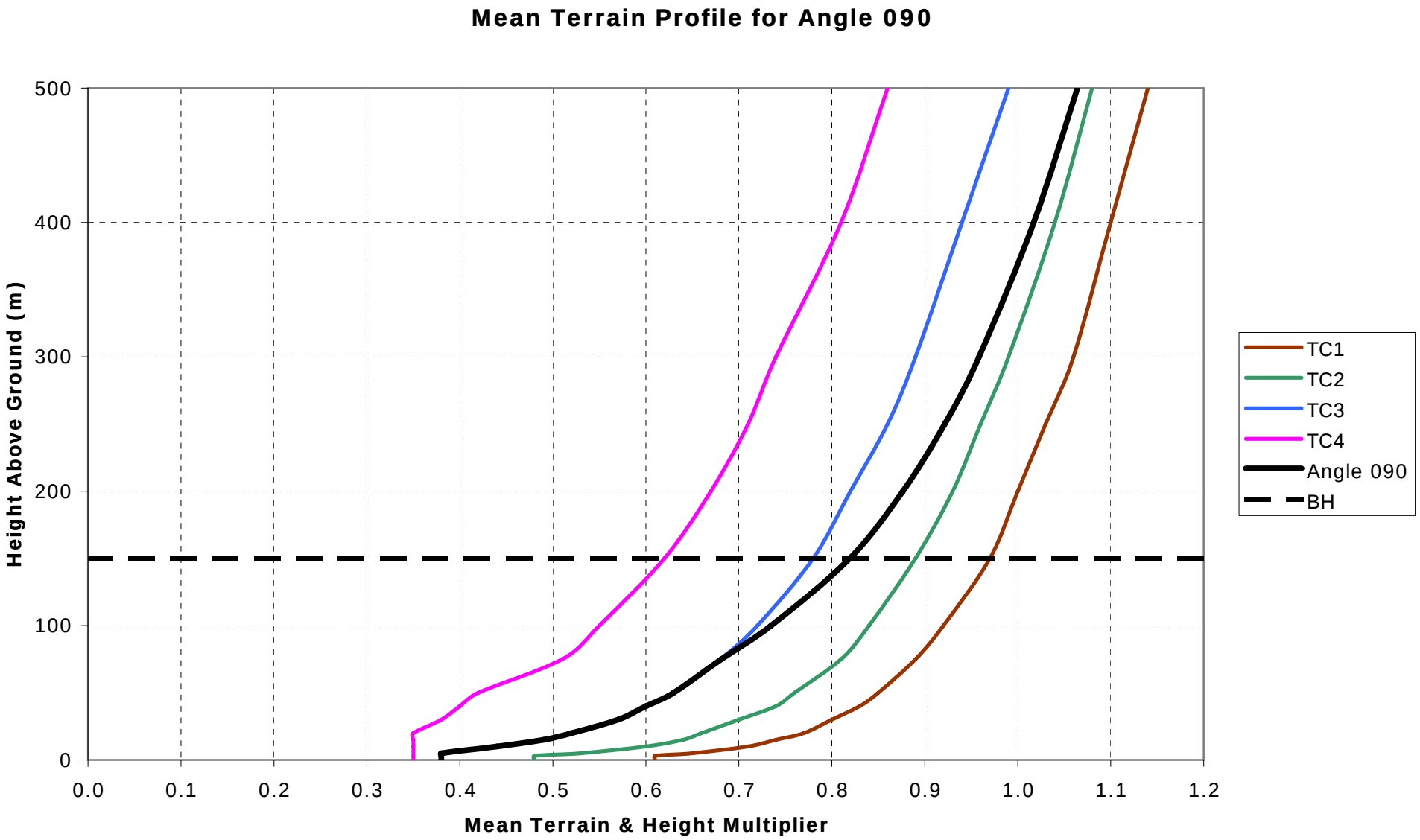

Spectral Density for 1:400 scale Terrain Category 3, at 100m
Normalised Spectral Density
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.00001
0.0001
0.001
0.01
0.1
Reduced Frequency, f/U
Output
V-K to Length Scale Lu = 130m
V-K to Fit our Data, Length Scale Lu = 310m

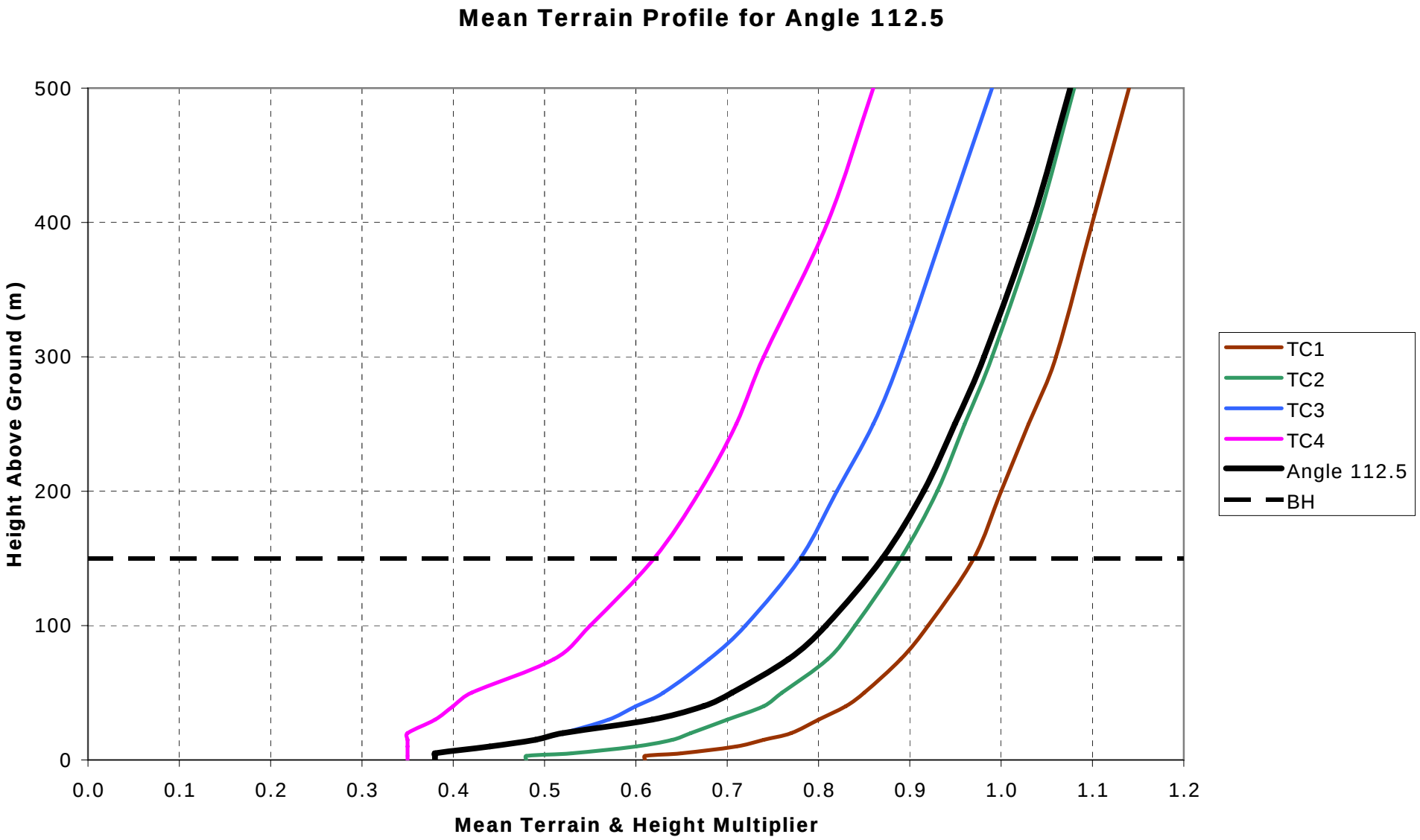

Mean Terrain Profile for Angle 000
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 000
BH

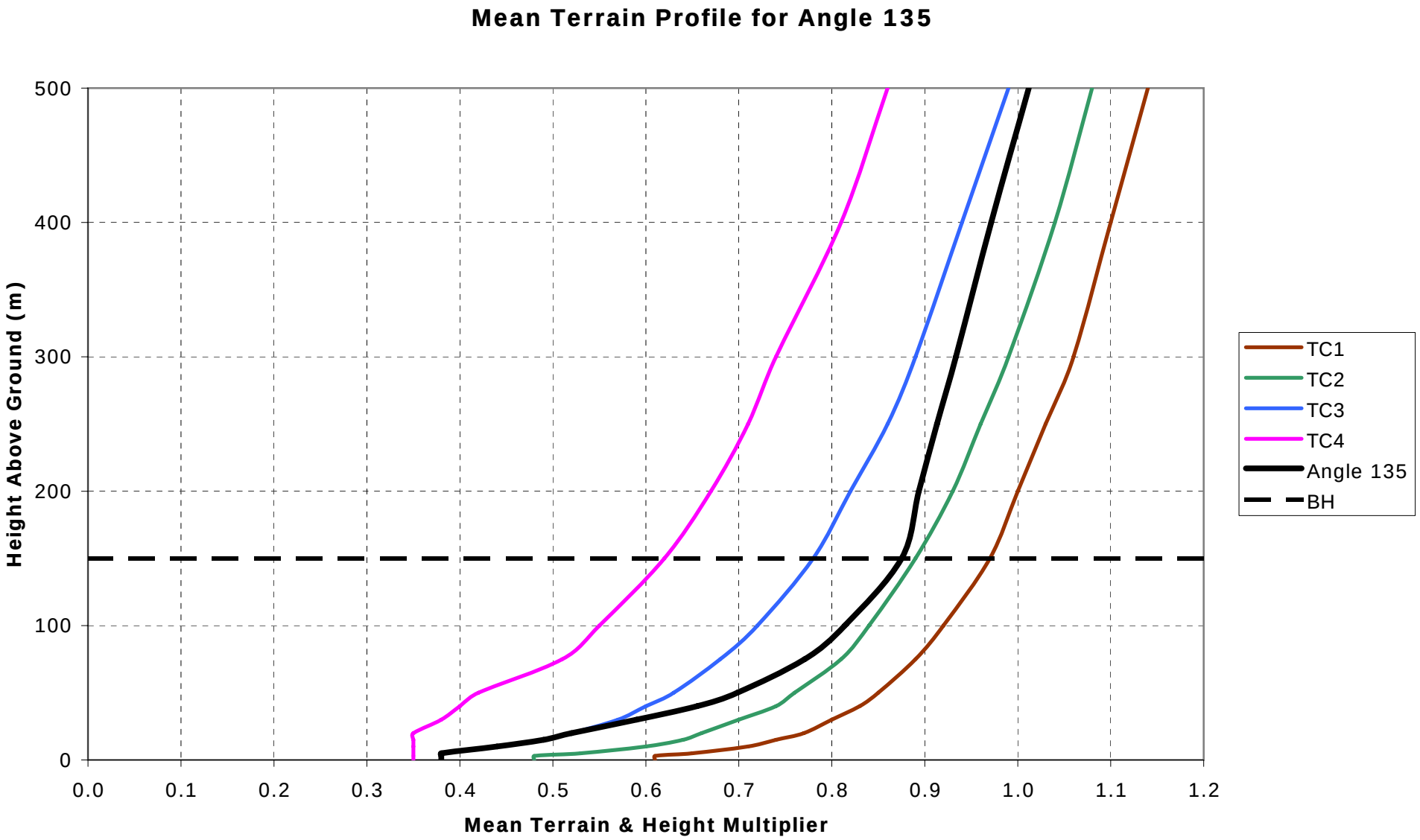

Mean Terrain Profile for Angle 022.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 022.5
BH

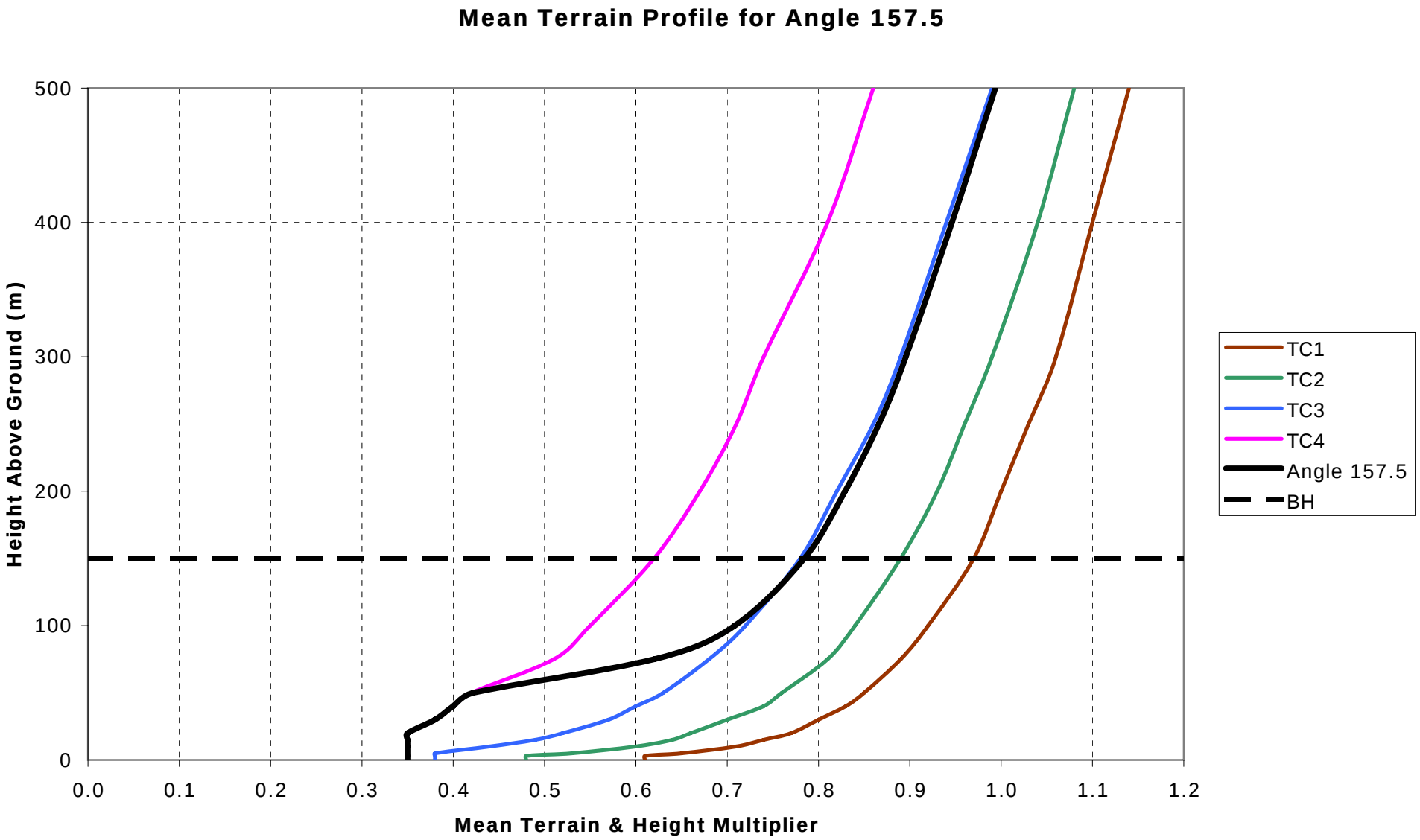

Mean Terrain Profile for Angle 045
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 045
BH

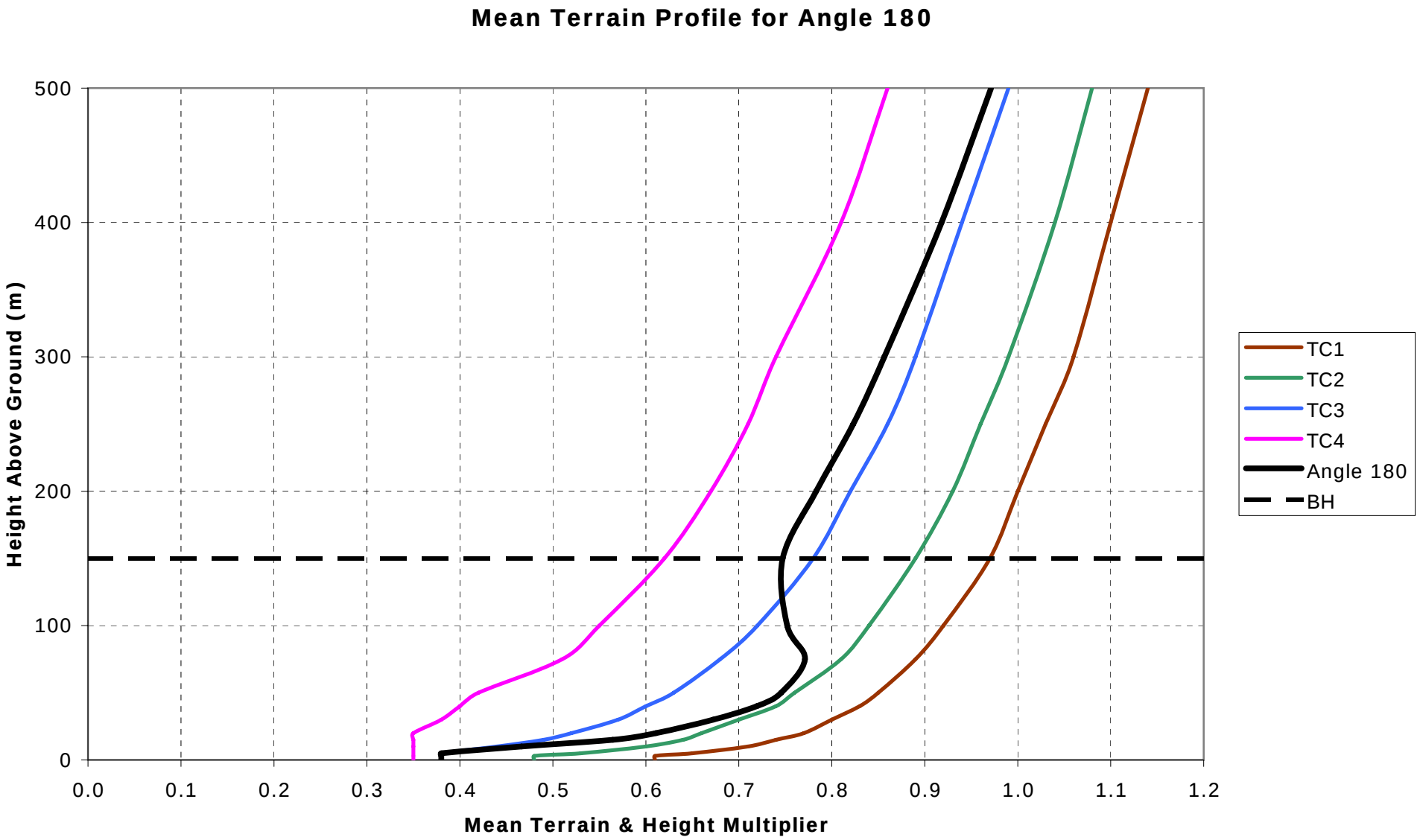

Mean Terrain Profile for Angle 067.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 067.5
BH

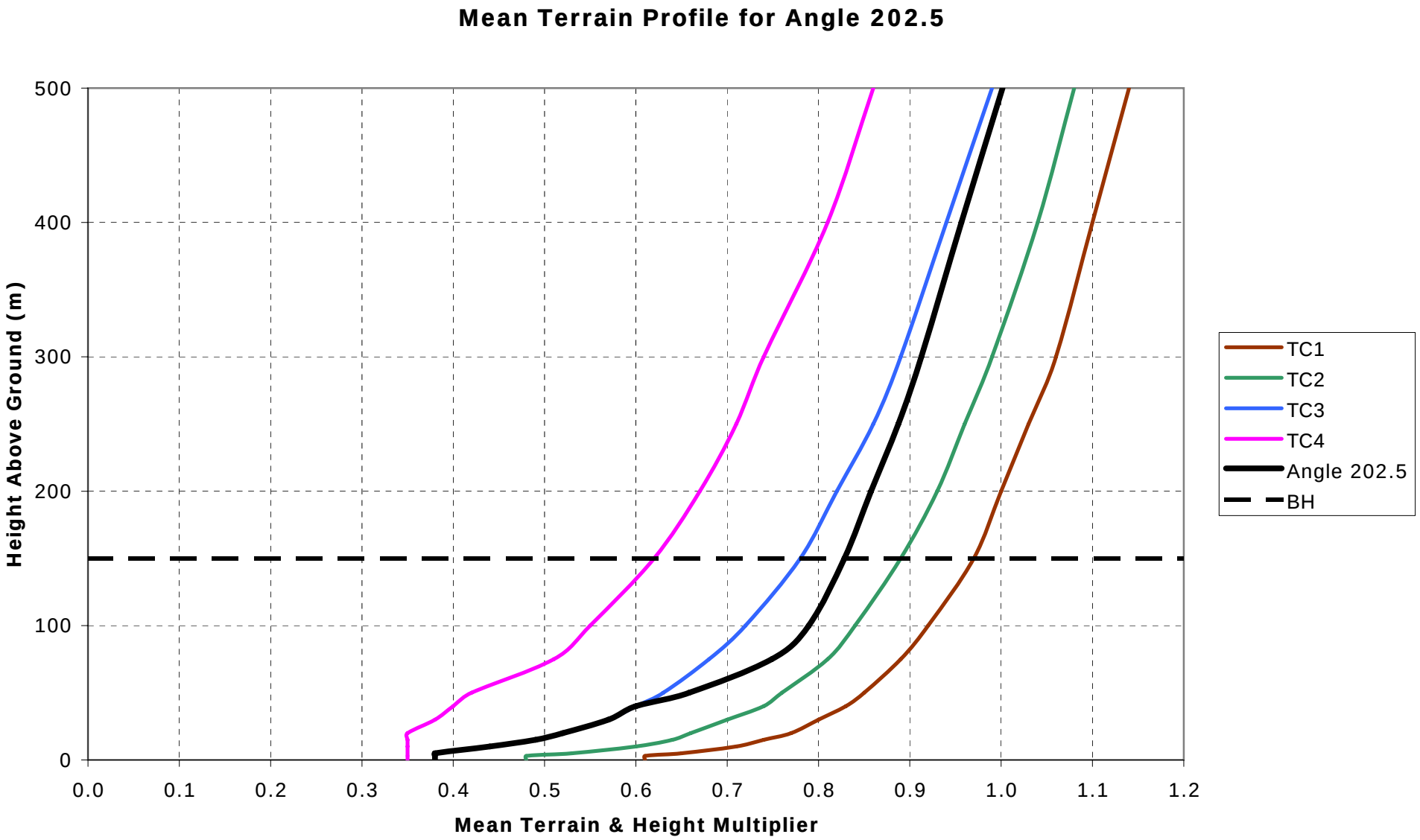

Mean Terrain Profile for Angle 090
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 090
BH

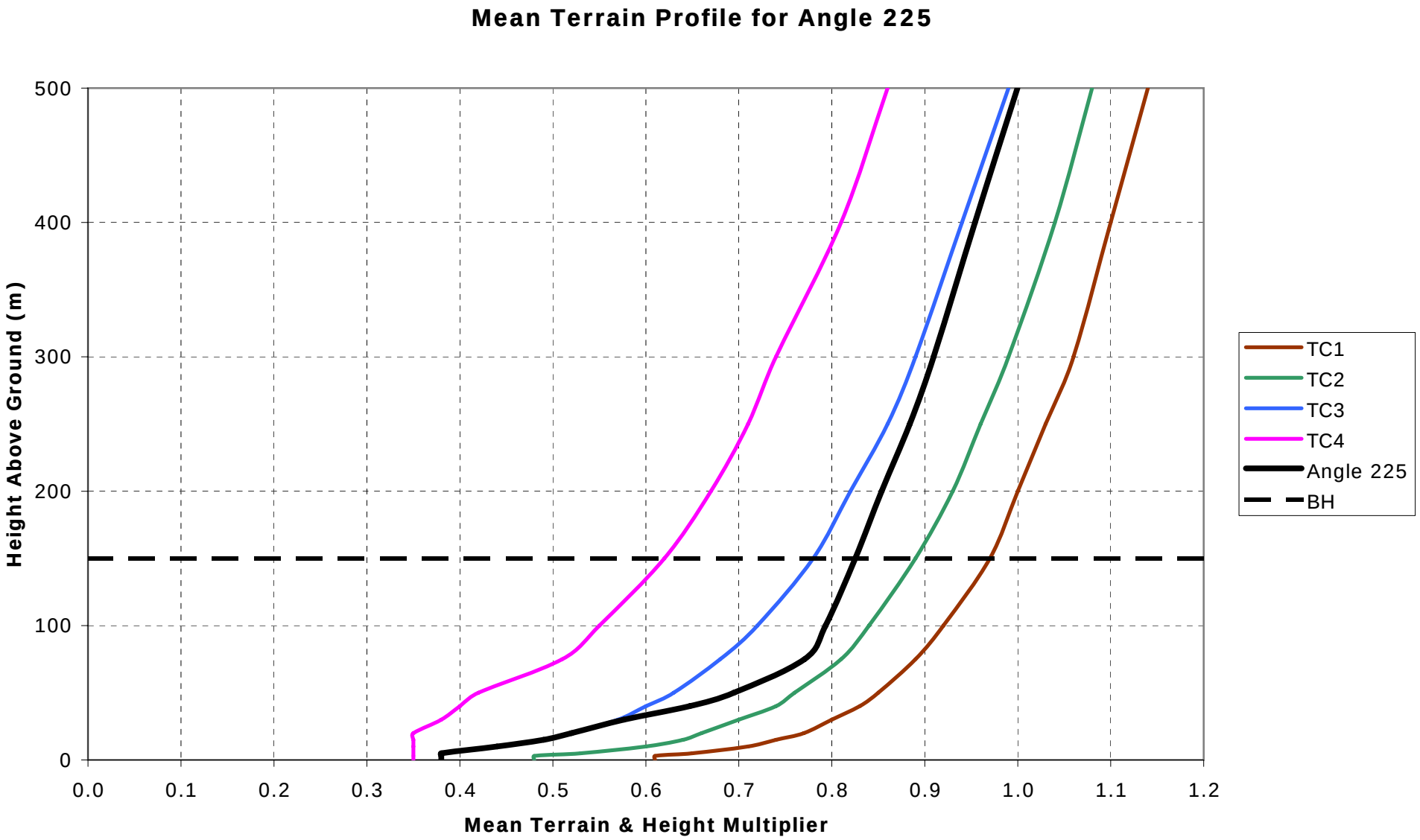

Mean Terrain Profile for Angle 112.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 112.5
BH

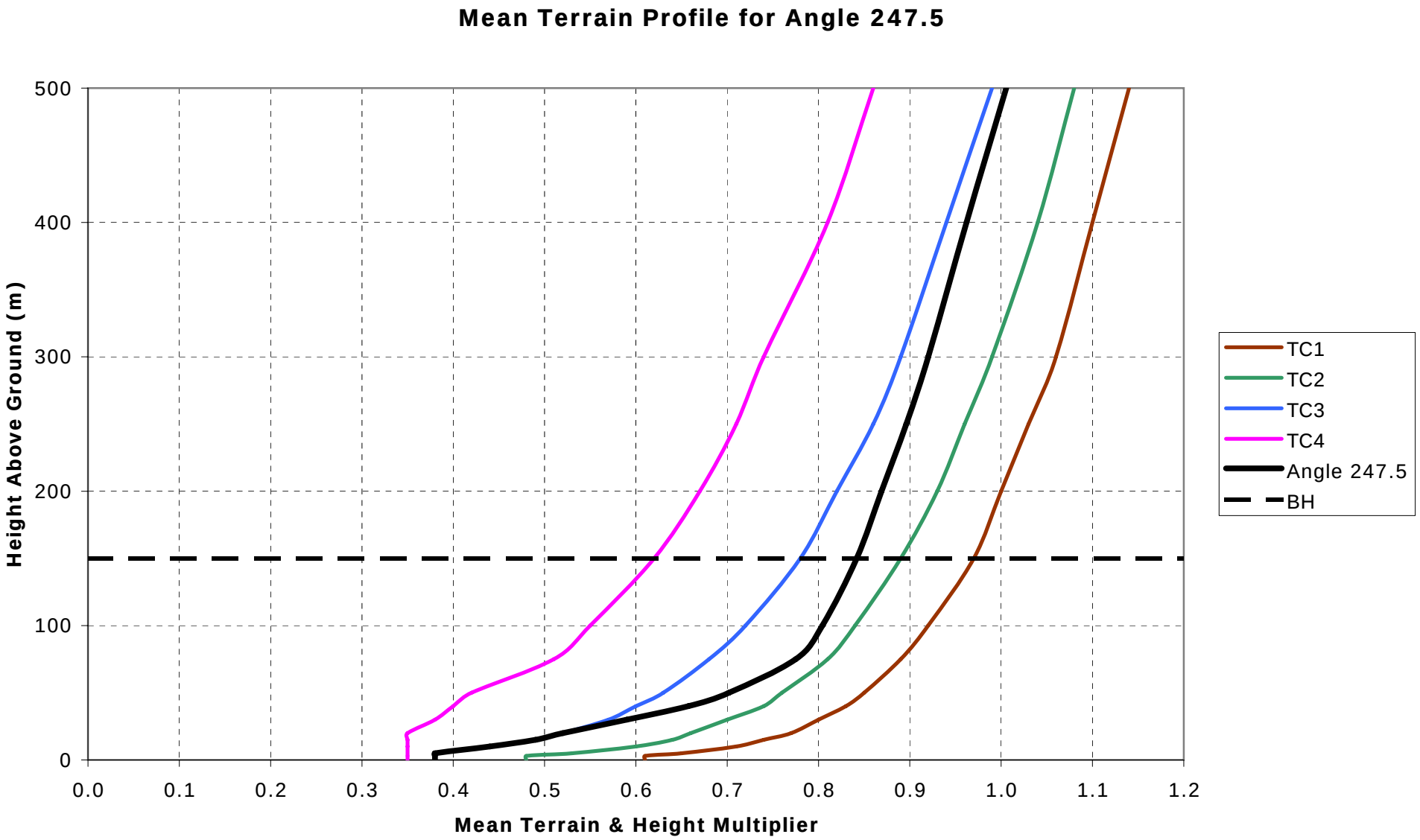

Mean Terrain Profile for Angle 135
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 135
BH

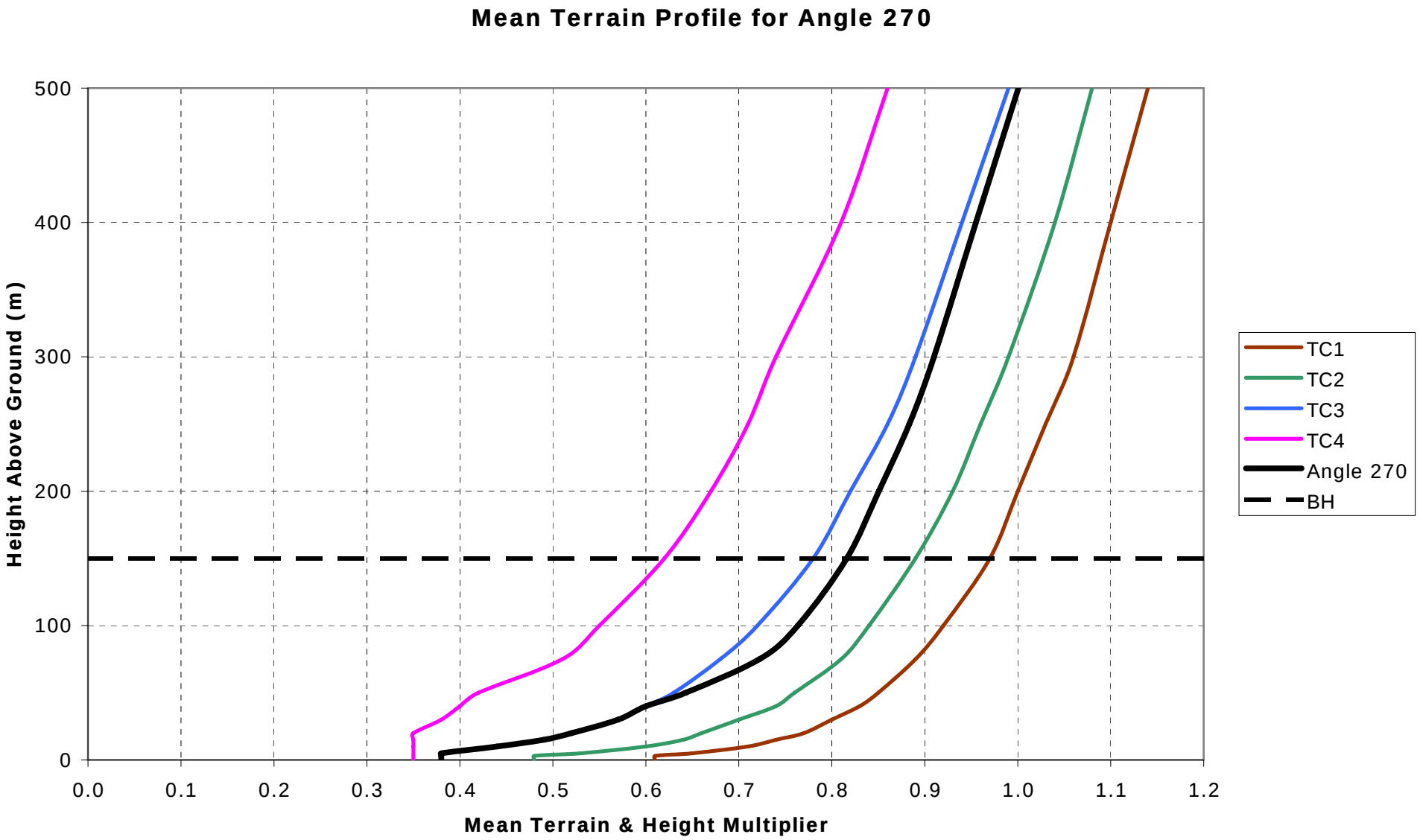

Mean Terrain Profile for Angle 157.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 157.5
BH

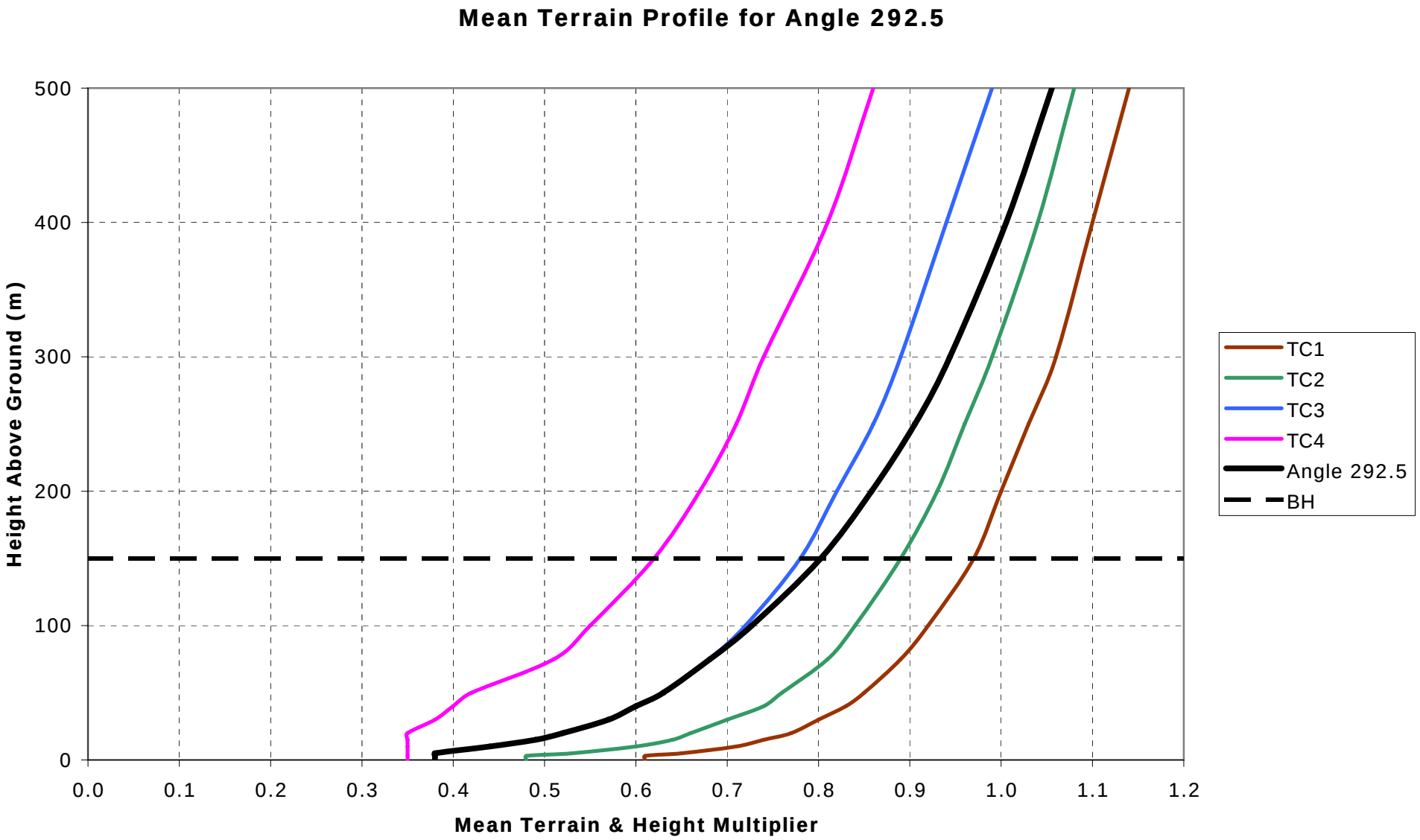

Mean Terrain Profile for Angle 180
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 180
BH

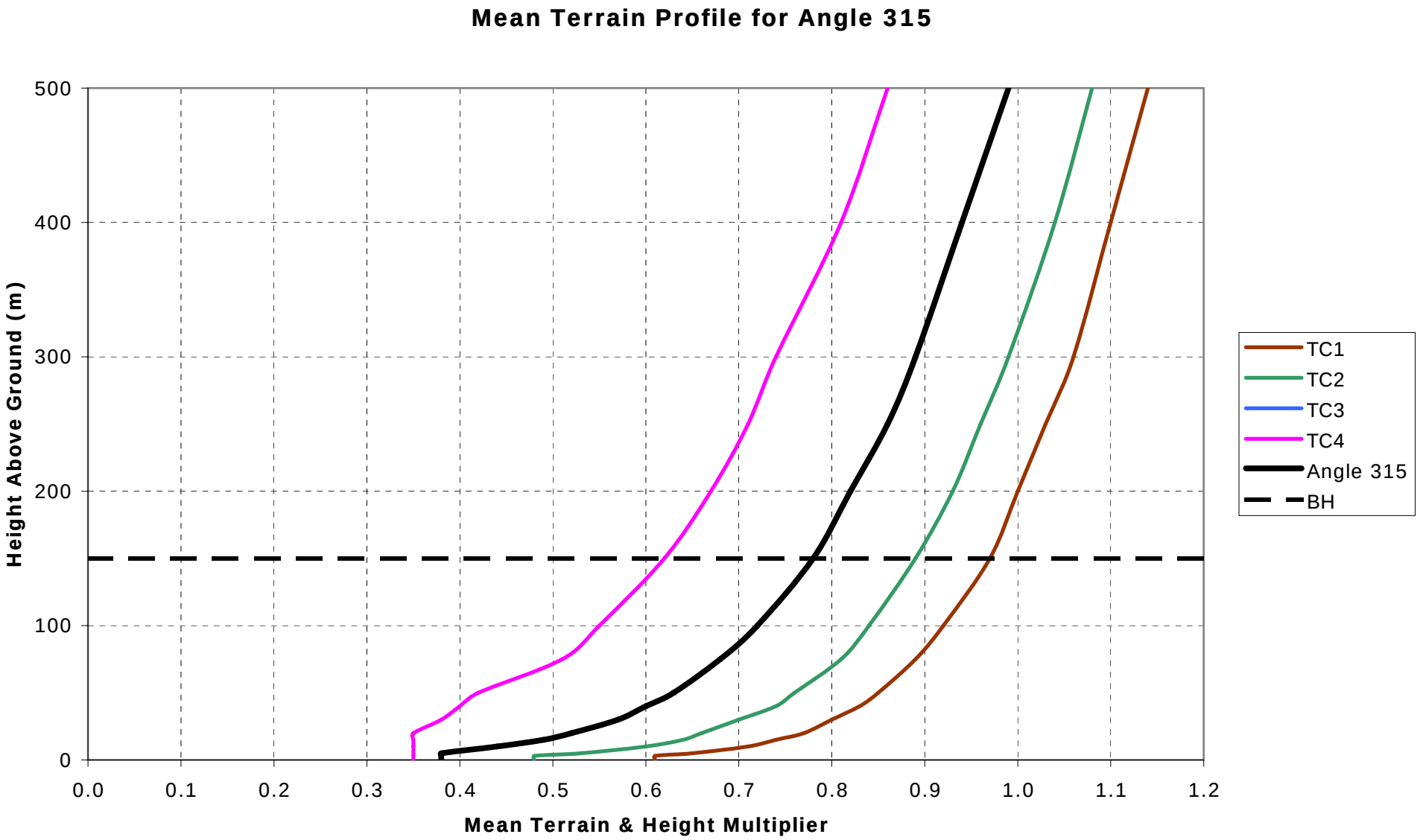

Mean Terrain Profile for Angle 202.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 202.5
BH

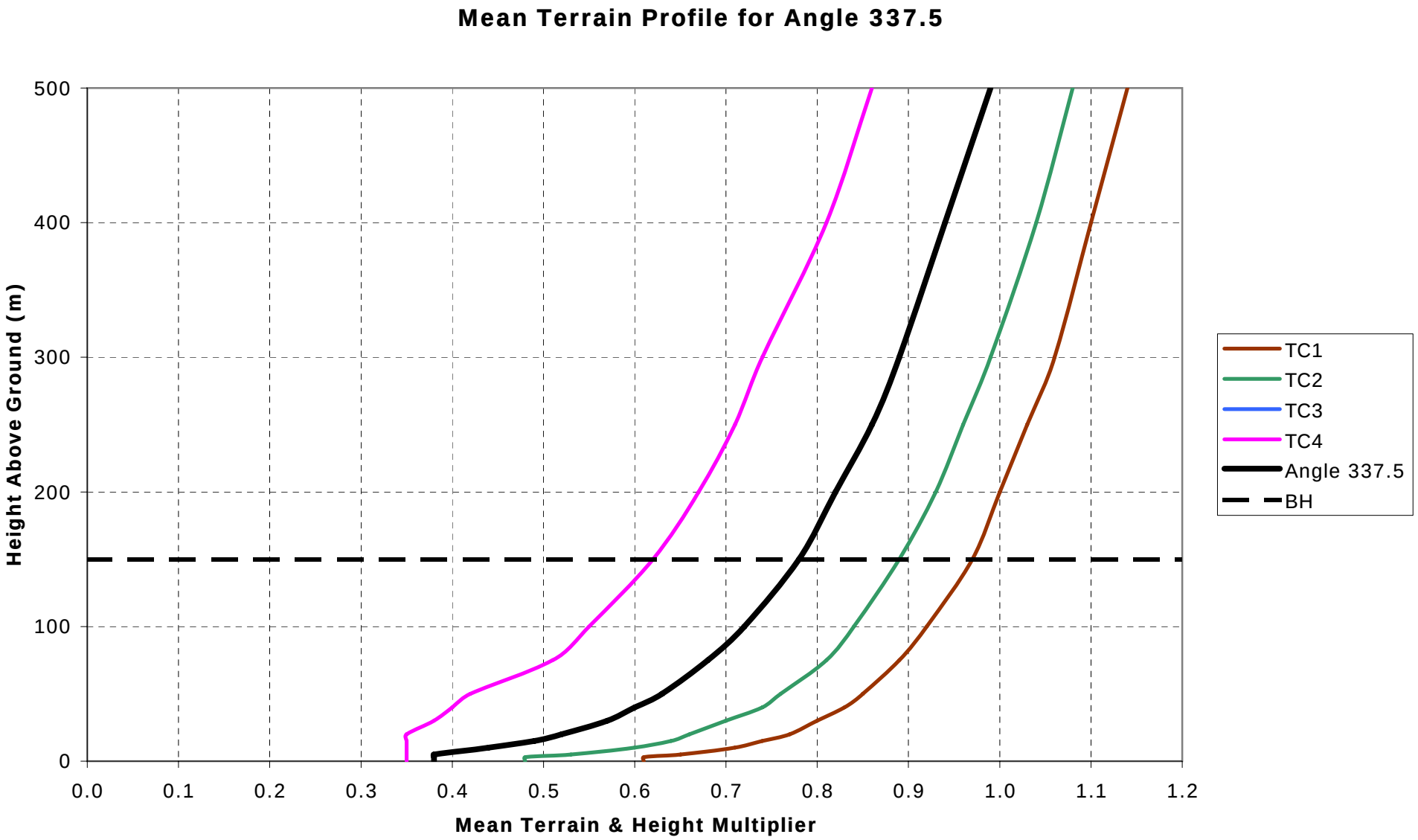

Mean Terrain Profile for Angle 225
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 225
BH


Mean Terrain Profile for Angle 247.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 247.5
BH


Mean Terrain Profile for Angle 270
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 270
BH


Mean Terrain Profile for Angle 292.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 292.5
BH


Mean Terrain Profile for Angle 315
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 315
BH


Mean Terrain Profile for Angle 337.5
Height Above Ground (m)
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Mean Terrain & Height Multiplier
TC1
TC2
TC3
TC4
Angle 337.5
BH

Appendix C

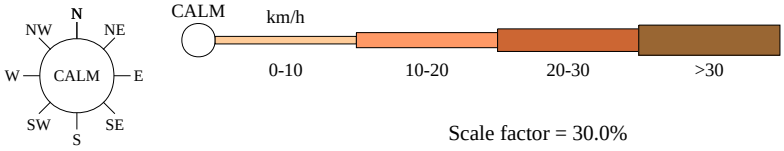
Wind Roses for the Sydney Region

Sydney Airport, 1939-2000

WIND FREQUENCY ANALYSIS (in km/h)

SYDNEY AIRPORT AMO STATION NUMBER 066037

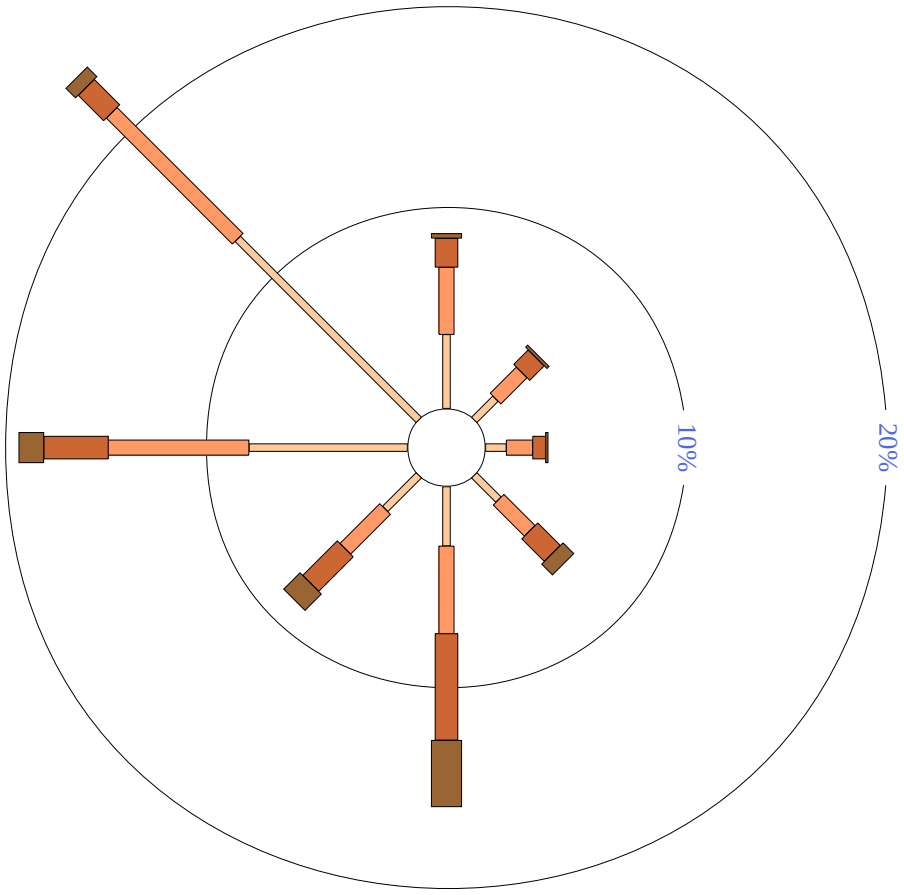
Latitude: -33.94 ° Longitude: 151.17 °



Scale factor = 30.0%

9 am
23333 Total Observations (1939 to 2004)

Calm 10%

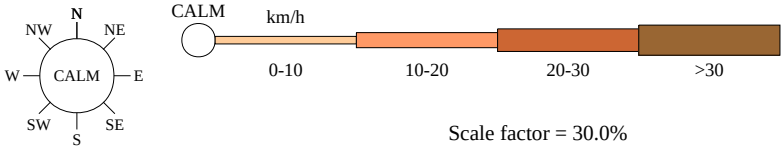


Wind directions are divided into eight compass directions. Calm has no direction.
An asterisk (*) indicates that calm is less than 1% .
An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.

WIND FREQUENCY ANALYSIS (in km/h)

SYDNEY AIRPORT AMO STATION NUMBER 066037

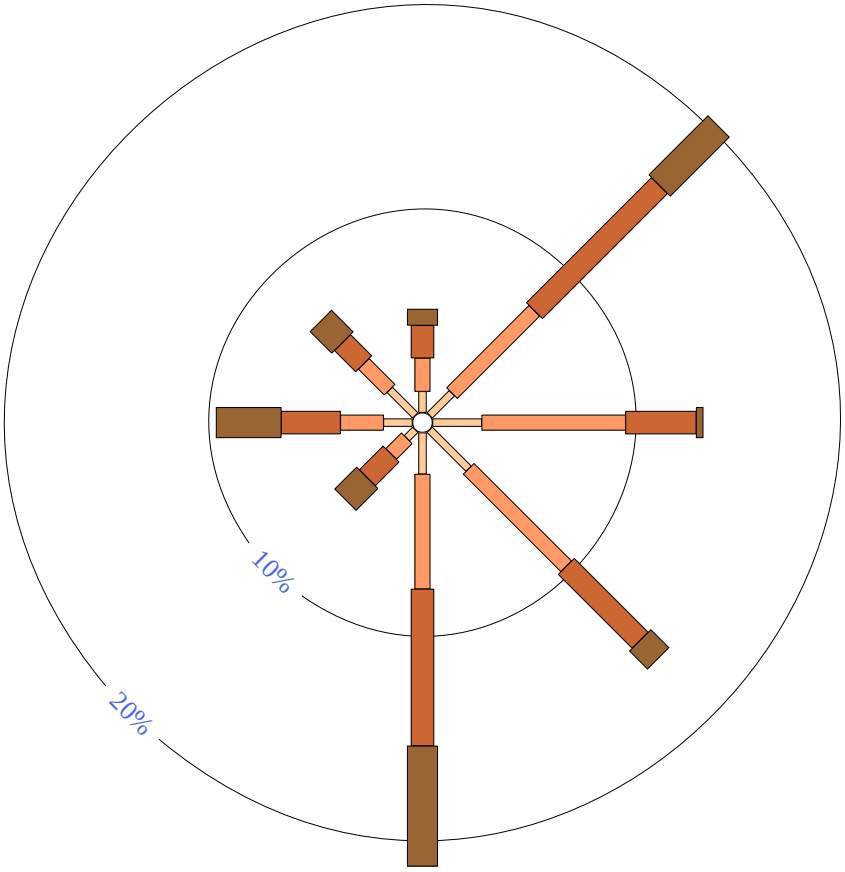
Latitude: -33.94 ° Longitude: 151.17 °



Scale factor = 30.0%

3 pm
23407 Total Observations (1939 to 2004)

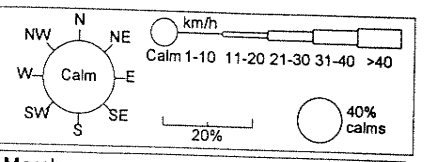
Calm 2%



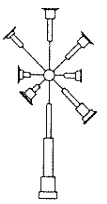
Wind directions are divided into eight compass directions. Calm has no direction.
An asterisk (*) indicates that calm is less than 1% .
An observed wind speed which falls precisely on the boundary between two divisions (eg 10km/h) will be included in the lower range (eg 1-10 km/h). Only quality controlled data have been used.

Wind Roses using available data between 1939 and 2000 for SYDNEY AIRPORT AMO

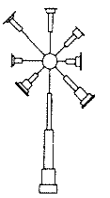
Site Number 066037 • Locality: SYDNEY AIRPORT • Opened Jan 1929 • Still Open
Latitude 33°56'28"S • Longitude 151°10'21"E • Elevation 6m



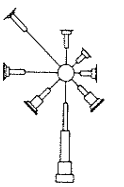
9 am January 1933 observations



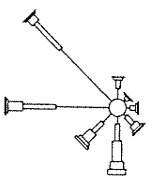
9 am February 1755 observations



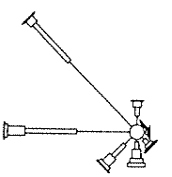
9 am March 1922 observations



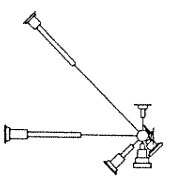
9 am April 1834 observations



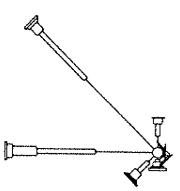
9 am May 1866 observations



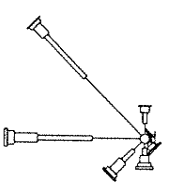
9 am June 1806 observations



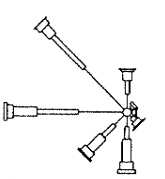
9 am July 1873 observations



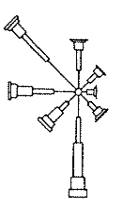
9 am August 1876 observations



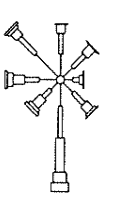
9 am September 1814 observations



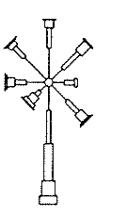
9 am October 1901 observations



9 am November 1835 observations



9 am December 1906 observations



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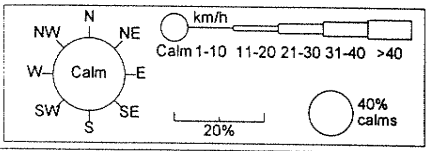
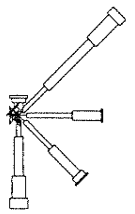
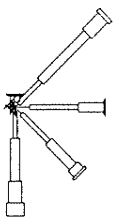


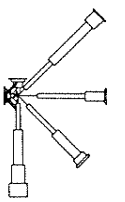
3 pm January 1939 observations



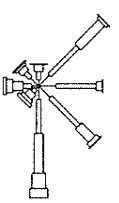
3 pm February 1771 observations



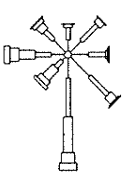
3 pm March 1925 observations



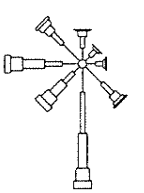
3 pm April 1832 observations



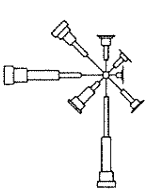
3 pm May 1877 observations



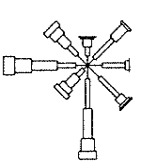
3 pm June 1821 observations



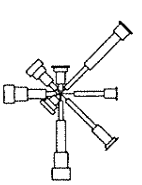
3 pm July 1882 observations



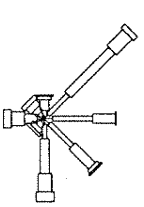
3 pm August 1882 observations



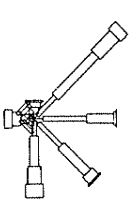
3 pm September 1811 observations



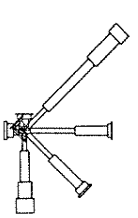
3 pm October 1904 observations



3 pm November 1839 observations



3 pm December 1906 observations



Prepared by Climate and Consultancy Section in the New South Wales Regional Office of the Bureau of Meteorology
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