



PEDESTRIAN WIND ENVIRONMENT STATEMENT

39-49 HENRY STREET, PENRITH

WD977-01F02(REV0) - WS REPORT
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Prepared for:

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DOCUMENT CONTROL

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November 28, 2017	Initial	0	HK	KP	BU

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EXECUTIVE SUMMARY

This report is in relation to the proposed development located at 39-49 Henry Street, Penrith, and presents an opinion on the likely impact of the proposed design on the local wind environment of the critical outdoor areas within and around the subject development. The effect of wind activity is examined for the three predominant wind directions for the Penrith region; namely the northerly to north-easterly, southerly to south-easterly and westerly winds. The analysis of the wind effects relating to the proposed development was carried out in the context of the local wind climate, building morphology and land topography.

The conclusions of this report are drawn from our extensive experience in this field and are based on an examination of the architectural drawings which have been prepared by project architects SJB Architects, received November 21, 2017. No wind tunnel testing has been undertaken for the subject development, and hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection. Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

The results of this assessment indicate that the wind conditions within and around the site benefit from shielding provided by the development itself. It is expected that the potentially adverse wind effects identified in the report can be ameliorated through the following treatment strategies to achieve suitable wind conditions throughout the trafficable areas within and around the site:

- Retain the proposed densely foliating tree planting and other landscaping for all areas of the development. Note that evergreen tree planting should be implemented for areas affected by westerly and southerly to south-westerly winds to ensure its effectiveness throughout the year.
- Awnings over the pedestrian footpaths within and around the site.
- Retain the porous façade of Site A podium.
- Localised operator controlled screening for longer duration activities such as café seating areas.
- Screens and/or further planting for the Ground Floor Plaza and Open Spaces.
- Screens and/or further planting between each site.
- Screens around the perimeter of the communal podium open spaces.
- Full height screens or louvres for the private corner balconies of the development.

With the inclusion of the abovementioned treatments, it is possible to achieve suitable conditions for the outdoor accessible areas. Note that due to the overall massing of the proposed subject development, wind tunnel testing is recommended to be undertaken as part of the detailed design phase of the subject development. This will provide a quantitative

analysis of the wind conditions and determine the size and extent of the treatments required to ensure suitable wind conditions are achieved at all outdoor accessible locations within and around the development.

1 DESCRIPTION OF THE DEVELOPMENT AND SURROUNDINGS

The development site is located 39-49 Henry Street, Penrith, and is currently mainly comprised of low-rise commercial warehouses and empty lots. The proposed subject development consists of four residential towers, each on a predominantly retail and commercial podium, ranging from a massing height of 15 to 34 storeys. Accessways are situated between each podium, with the western-most podium incorporating a pedestrian arcade on the ground floor connecting the southern and western aspects of the site. Communal terraces are also proposed for the podium.

Immediately surrounding the site lies open park space to the north and east along North Street, with low-rise commercial buildings to the south and west. Further from the site lies 1-2 storey residential buildings to the north, a mixture of low-rise residential and commercial buildings to the south, and Penrith CBD and Penrith Station to the west.

A survey of the land topography indicates that the land rises gradually from the west to the east as well as rising slightly from the south to north. An aerial image of the subject site and the local surroundings is shown in Figure 1.

The critical trafficable areas associated with the proposed development, which are the focus of this assessment with regards to wind effects, are detailed as follows:

- Ground Floor pedestrian footpaths.
- Ground Floor Plaza and Open Spaces.
- Communal Podium Open Spaces.
- Private Balconies and Terraces.



Figure 1: Aerial Image of the Site Location

2 WIND CLIMATE OF THE PENRITH REGION

The Penrith region is governed by three principal wind directions, and these can potentially affect the subject development. These winds prevail from the north to north-east, south to south-east and west. A summary of the principal time of occurrence of these winds throughout the year is presented in Table 1. This summary is based on an analysis of wind rose data obtained by the Bureau of Meteorology from Penrith lakes AWS between 1995 and 2010. The wind roses are attached in the appendix of this report. The wind patterns shown in the wind roses for this region are similar to the detailed analyses performed for Sydney Basin airports, including Sydney Airport and Richmond Airport.

For the Penrith region, the north to north-easterly winds occur most frequently during the warmer months of the year. They are typically not as strong as the southerly winds, and are usually welcomed within outdoor areas since they typically occur when it can be quite warm during the summer. The south to south-easterly winds are by far the most frequent wind for the Penrith region, and are also the strongest. Westerly winds occur most frequently during the winter season for the Penrith region. These are usually a cold wind since they occur during the winter, and hence can be a cause for discomfort for outdoor areas.

Table 1: Principal Time of Occurrence of Winds for Penrith

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

3 WIND EFFECTS ON PEOPLE

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. Various other researchers, such as Davenport, Lawson, Melbourne, Penwarden, etc, have published criteria for pedestrian comfort for pedestrians in outdoor spaces for various types of activities. Some Councils and Local Government Authorities have adopted elements of some of these into their planning control requirements in Australia.

The following table is an example, which was developed by Penwarden in 1975, and describes the effects of various wind intensities on people. Note that the applicability column relates to the indicated wind conditions occurring frequently (exceeded approximately once per week on average). Higher ranges of wind speeds can be tolerated for rarer events.

Table 2: Summary of Wind Effects on People (Penwarden, 1975)

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

It should be noted that wind speeds can only be accurately quantified with a wind tunnel study. This assessment addresses only the general wind effects and any localised effects that are identifiable by visual inspection and the acceptability of the conditions for outdoor areas are determined based on their intended use (rather than referencing specific wind speeds). Any recommendations in this report are made only in-principle and are based on our extensive experience in the study of wind environment effects.

4 RESULTS AND DISCUSSION

The expected wind conditions are discussed in the following sub-sections of this report for the various outdoor areas within and around the subject development for each of the three predominant wind directions for the Penrith region. The interaction between the wind and the building morphology in the area is considered and important features taken into account including the distances between the surrounding buildings and the proposed building form, their overall heights and bulk, as well as the surrounding landform. Note that only the potentially critical wind effects are discussed in this report.

4.1 Ground Floor Pedestrian Footpaths

The pedestrian footpaths are located around the site boundary and between each podium. With the additional massing of the development, wind conditions are expected to be stronger than existing site conditions, as the current site is comprised of low-rise buildings or empty lots. Any building massing within the site boundary is generally expected to have this effect especially at the corners of the development. Shielding from the prevailing winds by adjacent developments is limited due to the exposed nature of the site. The shielding is limited to low level westerly and southerly sector winds to a small extent. The staggering of the heights of the tower, decreasing from west to east, is beneficial in decreasing the amount of downwash caused by the westerly prevailing winds affecting the areas between the podia.

The northerly to north-easterly prevailing winds are expected to impact the site directly due to its exposure from this wind direction. Due to the orientation and form of the development, the winds are also expected to funnel in between the various podia and cause adverse wind conditions in this area. Sidestreaming is expected to occur at the north-eastern and north-western corners of the site, where the winds tend to accelerate around the corner. Further to this, a higher podium (e.g. Site A) is expected to induce a downwash effect as the winds impact the building and are redirected downwards onto the pedestrians below. This wind effect has the potential to combine with the sidestreaming as well as funnelling effects between the podia.

The south to south-easterly prevailing winds are expected to impact the site in a similar way to the north to north-easterly winds, causing adverse direct winds, funnelling between the podia, sidestreaming at the south-eastern and south-western corners of the development site and downwashing winds, particularly for Site A. Westerly sidestreaming winds are expected to impact primarily the north-western and south-western corners of Site A, and the western aspect of Site A through downwash. The south-eastern corner of each site will also be affected by sidestreaming winds. The development is expected to provide effective shielding from the majority of westerly winds for the rest of the site.

The proposed densely foliating planting along the entire northern aspect of the development is expected to help mitigate adverse conditions caused by the north to north-easterly winds significantly by slowing down direct winds upstream of the site. Additional planting is recommended at the south of the site. Awnings on the northern, southern and western aspects

wrapping around the corners are expected to aid in mitigating the downwash effects and prevent them from combining with other wind effects at the corners of the buildings. Implementing a porous façade for the podium car park for Site A, when combined with the recommended awning, is expected to help in mitigating conditions on the south-western corner of the development, reducing the effect of downwash and sidestreaming by absorbing rather than redirecting the winds downwards or around the corner of the development. Further wind mitigation measures that could be implemented in between the podia to reduce the funnelling or and sidestreaming effects include screens or planting. This has the effect of obstructing the path of the wind and/or absorbing the wind energy.

Other ground floor pedestrian footpaths further away from the site are expected to be similar or equivalent to existing conditions. Due to the overall massing of the proposed subject development, wind tunnel testing is recommended to be undertaken as part of the detailed design phase of the subject development. This will provide a quantitative analysis of the wind conditions and determine the size and extent of the treatments to ensure suitable wind conditions are achieved in all trafficable areas within and around the development.

4.2 Ground Floor Plaza and Open Spaces

The Ground Floor Plaza is located at the south-eastern corner of Site A, and the Open Spaces are located under the Site A podium connecting the western aspect to the southern aspect. Other open spaces are to the north of Sites A and B, and to the east of Site D. These areas are expected to accommodate longer duration activities.

The Ground Floor Plaza is affected by funnelling northerly and southerly winds, and sidestreaming westerly winds. Including landscaping in this area is expected to aid in mitigating these adverse wind conditions. Other treatments include screens within this area in the form of public art, corner screening along the façade at the south-eastern corner of Site A, and baffle screens in the open space to the north-west of this area. An awning or canopy is also recommended to mitigate the downwash expected from the façade of the podium.

The outdoor open space under Site A is expected to be impacted significantly by the south to south-easterly and westerly prevailing winds. These winds are expected to funnel through this area due to the orientation of the through site link with the prevailing winds. Combined with the downwashed winds off the façade, adverse wind conditions are expected to occur in this area. It is recommended that the landscaping and porous podium façade be retained in the final design. Wind screens are recommended throughout this open space to baffle the winds, and further inclusion of operator controlled localised screening may be required in areas where longer duration stay is expected (e.g. café seating). The awning previously recommended should be included on the southern and western aspect of this area in order to prevent the downwashed winds from funnelling into this area as well.

The outdoor open spaces to the north and east of the development site are expected to be primarily affected by side-streaming winds. The retention of the proposed landscaping is expected to ameliorate conditions in these areas.

Due to the overall massing of the proposed subject development, wind tunnel testing is recommended to be undertaken as part of the detailed design phase of the subject development. This will provide a quantitative analysis of the wind conditions and determine the size and extent of the treatments to ensure suitable wind conditions are achieved in the plaza and various open spaces of the development.

4.3 Communal Podium Open Space

Communal open spaces have been proposed on the podium. Due to the elevated nature of these areas, they are exposed to direct winds and upwashed winds from the podium form which reattach on top of the podium. In addition, sidestreaming and downwashing winds caused by the tower massing and form are also expected to impact the communal podium open spaces. Areas where these wind effects are expected to be concentrated are at the base of the towers at the corners. The large distance between the towers of each site is expected to reduce the effect of funnelling winds for these areas.

For Site A, the northerly and southerly winds are expected to affect the communal open space at the base of the tower on the north-eastern and south-eastern corners, whilst the westerly winds are expected to be shielded by the Site A tower. The Site B podium open space is expected to be affected by the northerly winds at the north-eastern and north-western corners of the tower. The Site A tower also shields the open space to the west of the Site B tower from the westerly winds. The Site C podium open space is shielded from the southerly and westerly winds by the L-shaped tower itself. However, sidestreaming south-easterly winds are still expected to affect the open space. Direct northerly and north-easterly winds are expected to affect this area, as well as downwash effects. The Site D podium open space located at the north-eastern corner of the tower is expected to experience strong sidestreaming northerly and north-westerly winds, while the south-easterly and westerly winds are shielded by the development itself.

The proposed landscaping throughout the communal podium open spaces in combination with wind screens around the perimeter of these areas are expected to mitigate these adverse wind conditions. Canopies or pergolas should be considered in areas where longer duration stay is proposed to further ameliorate conditions, and keep the downwashed winds and reattaching upwashed winds from impacting these areas.

Due to the overall massing of the proposed subject development, wind tunnel testing is recommended to be undertaken as part of the detailed design phase of the subject development. This will provide a quantitative analysis of the wind conditions and determine the size and extent of the treatments to ensure suitable wind conditions are achieved in the communal podium open spaces of the various sites.

4.4 Private Balconies and Terraces

The various private residential balconies and terraces of the development benefit from several wind mitigating features such as impermeable balustrades and recessing of the balconies into

the building form. These features should be retained in the final design. Some shielding is provided by the towers of the building itself, and is expected to reduce the impact of westerly winds.

The various private corner balconies and terraces are expected to experience significant sidestreaming winds due to their overall exposure to the prevailing winds. The winds are expected to accelerate around these corners and cause adverse wind conditions. In order to mitigate these effects, treatments in the form of full-height screens or louvres on the eastern or western aspect of each corner balcony are recommended.

Due to the overall massing of the proposed subject development, wind tunnel testing is recommended to be undertaken as part of the detailed design phase of the subject development. This will provide a quantitative analysis of the wind conditions and determine the size and extent of the treatments (if required) to ensure suitable wind conditions are achieved for the private balconies and terraces.

APPENDIX A - WIND ROSE FOR THE PENRITH REGION

Rose of Wind direction versus Wind speed in km/h (15 Sep 1995 to 30 Sep 2010)

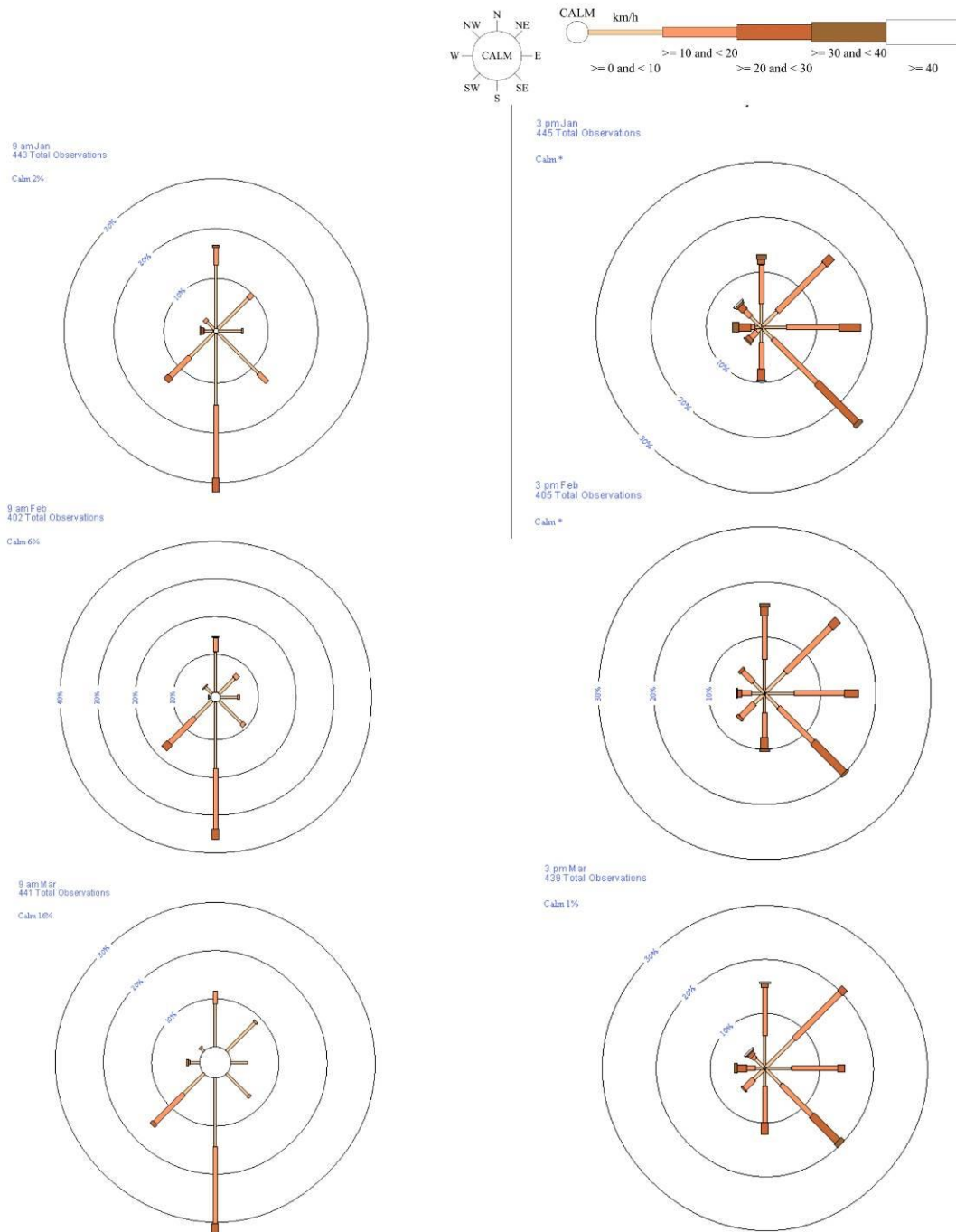
Custom times selected, refer to attached note for details

PENRITH LAKES AWS

Site No: 067113 • Opened Aug 1995 • Still Open • Latitude: -33.7195° • Longitude: 150.6783° • Elevation 24.m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.



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Rose of Wind direction versus Wind speed in km/h (15 Sep 1995 to 30 Sep 2010)

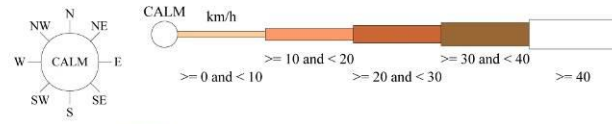
Custom times selected, refer to attached note for details

PENRITH LAKES AWS

Site No: 067113 • Opened Aug 1995 • Still Open • Latitude: -33.7195° • Longitude: 150.6783° • Elevation 24.m

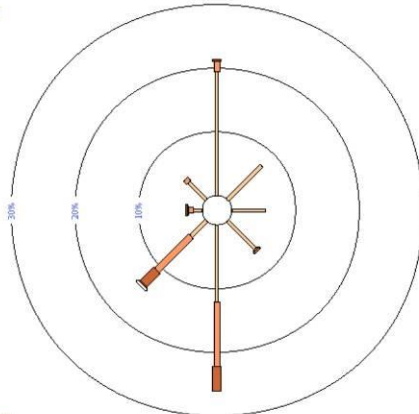
An asterisk (*) indicates that calm is less than 0.5%.

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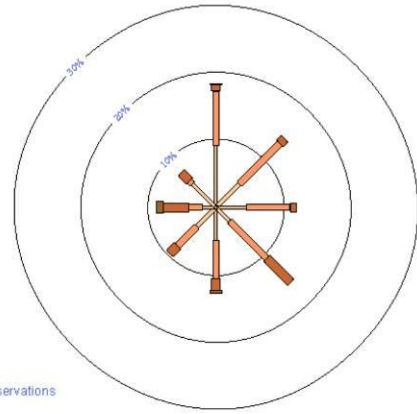
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Calm 11%



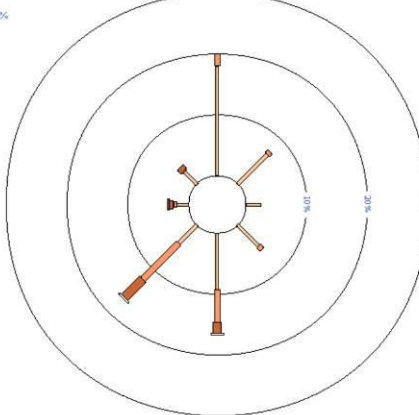
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437 Total Observations

Calm 1%



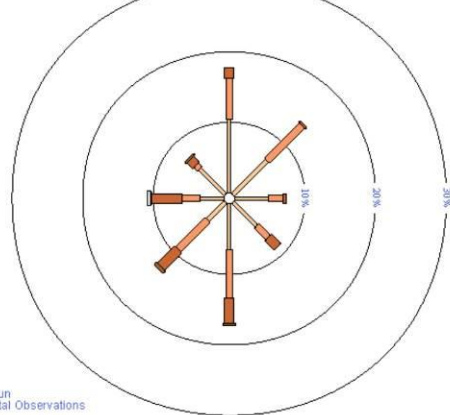
9 am May
444 Total Observations

Calm 22%



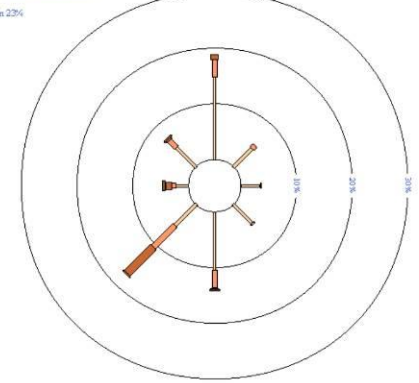
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442 Total Observations

Calm 4%



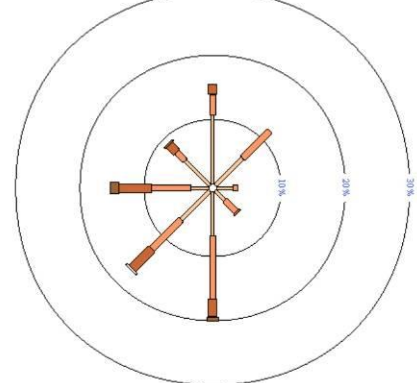
9 am Jun
440 Total Observations

Calm 22%



3 pm Jun
439 Total Observations

Calm 3%



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Rose of Wind direction versus Wind speed in km/h (15 Sep 1995 to 30 Sep 2010)

Custom times selected, refer to attached note for details

PENRITH LAKES AWS

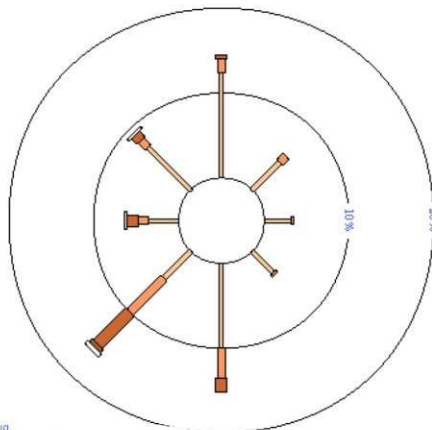
Site No: 067113 • Opened Aug 1995 • Still Open • Latitude: -33.7195° • Longitude: 150.6783° • Elevation 24.m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.

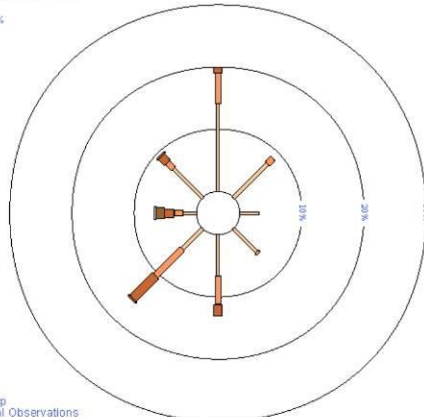
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Calm 25%



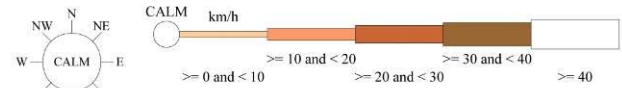
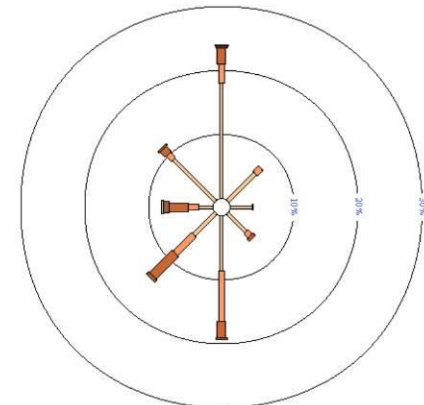
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Calm 17%



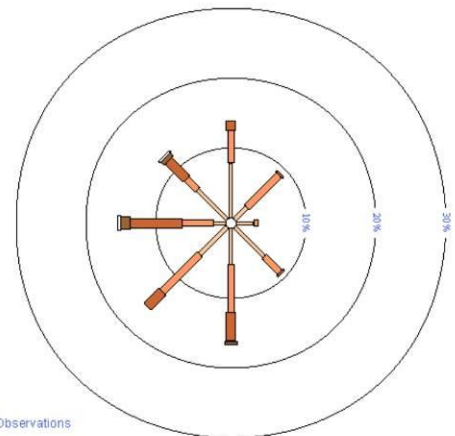
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442 Total Observations

Calm 7%



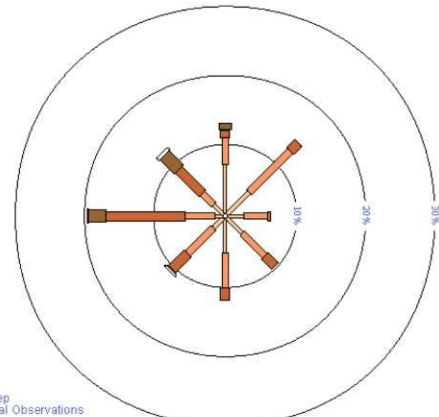
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447 Total Observations

Calm 4%



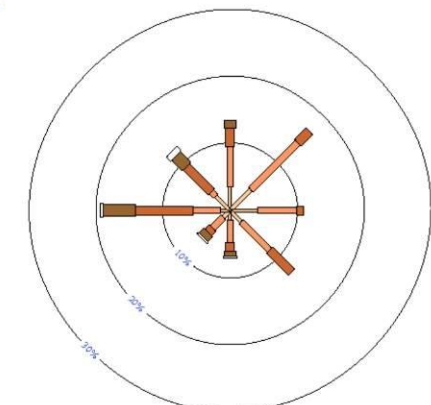
3 pm Aug
439 Total Observations

Calm 2%



3 pm Sep
444 Total Observations

Calm 1%



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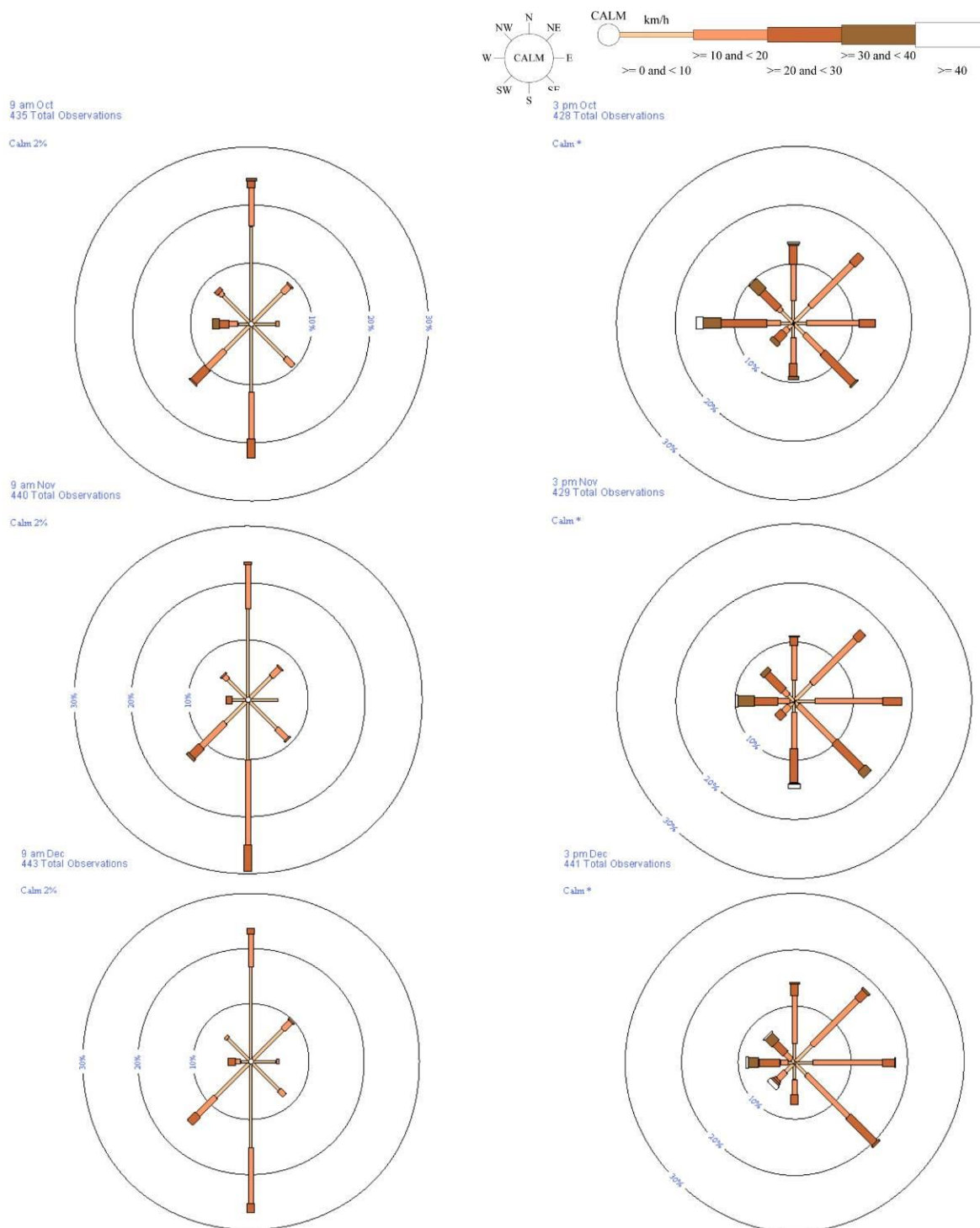
Custom times selected, refer to attached note for details

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