APPENDIX 23

Wind Assessment

Wind Effects Statement

for the proposed modification
to the approved Concept Plan for

Barangaroo Headland Park, Sydney

October 8, 2010

Report Reference No. WA078-03F02-rev1- WS report

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

Document Control

Revision Number	Date	Revision History	Prepared By (initials)	Reviewed & Authorised By (initials)
0	06/09/2010	Initial	TR	
1	08/10/2010	Updated figures for the latest drawings.	AB	TR

The work presented in this document was carried out in accordance with the Windtech Consultants Pty Ltd Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for our Client's particular requirements which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Windtech Consultants Pty Ltd. This report should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

The information contained herein is for the purpose of wind, thermal and or solar effects only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the scope of this report.

1.0 Executive Summary

This report presents a desktop assessment of the wind environment within the proposed Barangaroo Headland Park, at Millers Point, Sydney. The assessment will include comments regarding the potential impact of the proposed building massing for the Barangaroo Development immediately south of the subject site.

The subject site is currently impacted on by the various principal winds for Sydney, namely the north-easterly, southerly and westerly winds. The changes to the site as a result of the proposed earthworks are likely to significantly exacerbate the effect of the prevailing winds. However, the extensive planting proposed in conjunction with the specifications regarding the layout, general type, size and height of the proposed planting in certain critical areas, is expected to mitigate these wind effects.

2.0 Introduction

The northern half of the Barangaroo development is intended as a public outdoor space. The currently flat concrete platform will be transformed into a small landscaped escarpment the top of which meets with Merriman Street. A walkway is proposed along its perimeter, which meets the water. In addition, winding paths are proposed down the northern face of the escarpment, where the slope is relatively gentle. The southern and western faces of the escarpment have a steep slope half way up, at a grade of approximately 1:1.3. The top of the escarpment, referred to as the "Upper Bluff" is surrounded by a walkway and is intended for casual seating.

An underground cultural facility is proposed within the proposed escarpment and is accessed from the top via Merriman St on the eastern side and from the base via Towns Place to the north-east.

This report presents an assessment of the wind conditions within the proposed Headland Park as well as an assessment of the likely impact of the current building massing for Barangaroo South on these wind effects. Figure 1 shows an artistic rendering of the building massing of the current proposal for Barangaroo South, located immediately south of the subject precinct.

Figure 2 shows an aerial image of the location of the subject precinct, within the context of the Sydney Central Business District.

Figure 1: Perspective image looking South-West at the Current Proposal for the Barangaroo South Development

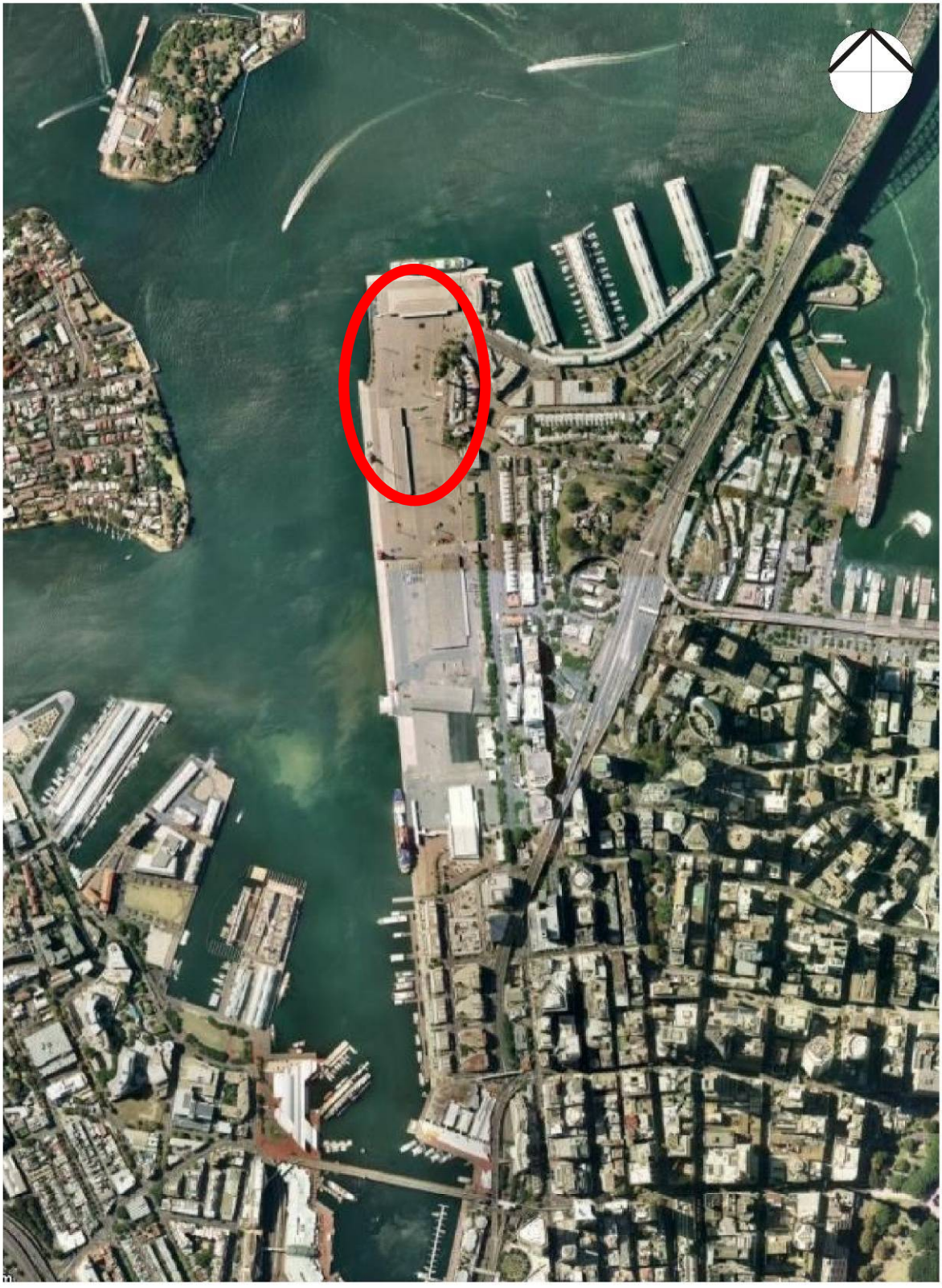


Figure 2: Aerial Image of the Existing Site (circled)

3.0 Local Wind Climate

Three principal wind directions potentially affect the precinct. These winds prevail from the north-east, south and west, Table 1 is a summary of the principal time of occurrence of these winds. This summary is based on data obtained by the Bureau of Meteorology from Sydney Airport, between 1939 and 1992. Table 1 presents a summary of the principal time of occurrence of these winds.

Table 1: Principal Time of Occurrence of Winds – 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	

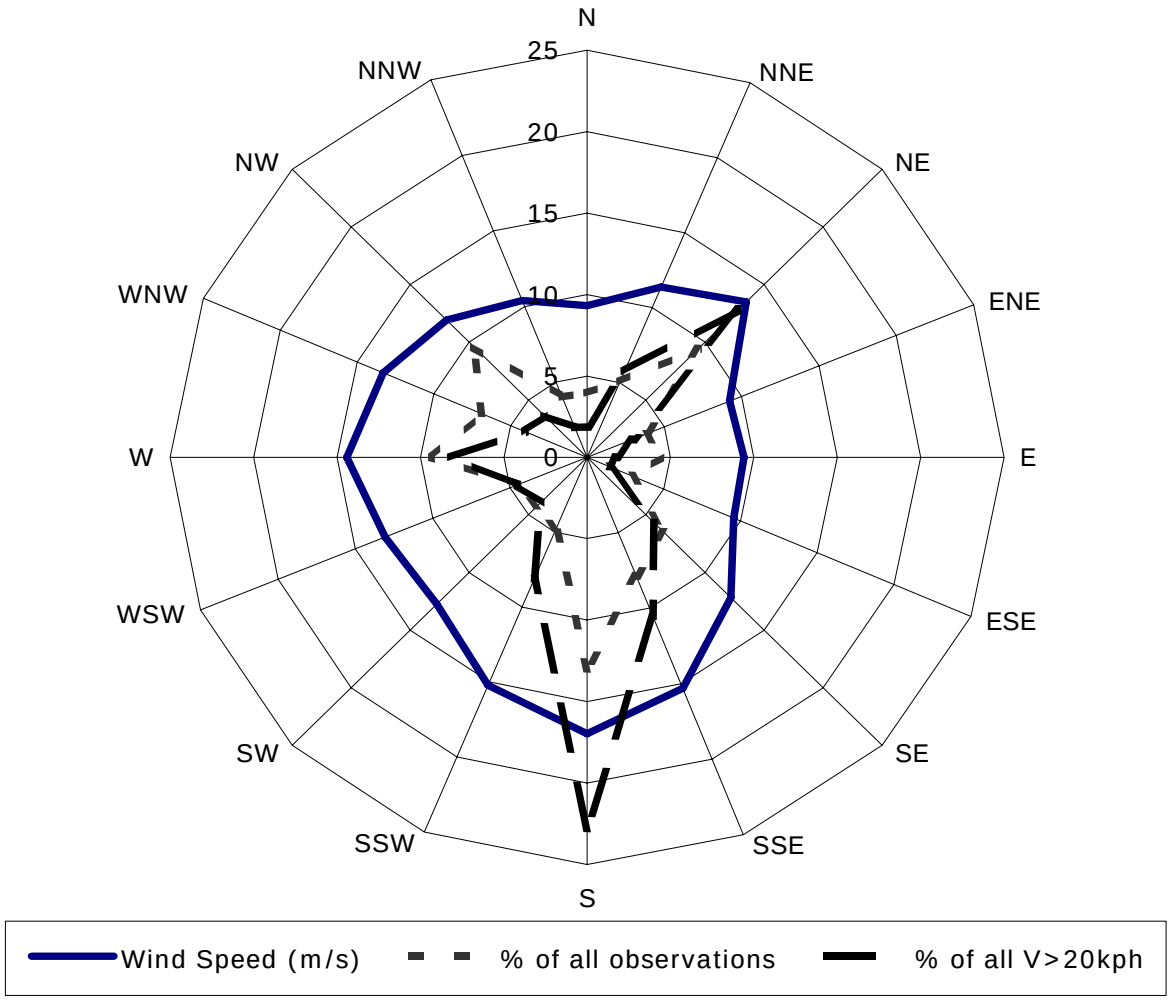


Figure 1: Basic Mean Wind Speed Data for Sydney, 1932-1992 (in metres per second, based on 3 hourly mean wind speeds, at 10m height at Kingsford Smith Airport)

4.0 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.

The following table, 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 (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 (after Penwarden, 1975)

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

5.0 Results

The various wind effects are assessed in respect of the local wind climate (described in Section 4 of this report) and the level of exposure of the site. The impact of wind will differ depending on the type of activity intended for the outdoor space (refer to Section 5 of this report).

5.1 Assessment of the Existing Wind Conditions

The assessment of the existing wind conditions for the subject site is detailed in the following sub-sections for the three primary wind directions for the Sydney region.

5.1.1 North-Easterly Winds

North Easterly winds are generally not as strong or frequent as the other prevailing winds. Furthermore, as they tend to occur during the summer months they are likely to have a positive environmental effect.

The current landform is such that the hill defined by Merriman St provides significant protection from the north-easterly winds. Also, the wharves along Walsh Bay will tend to limit the movement of these winds through the site from the northern end via Towns Place.

5.1.2 Southerly Winds

The southerly winds currently have a significant impact on the local wind environment. Wind tunnel tests obtained for areas south of this site indicate that south to south-westerly winds are expected to result in strong wind conditions along the foreshore area. These winds are currently expected to exceed the safety limit.

5.1.3 Westerly Winds

The west to north-westerly winds will have the greatest impact on the site due to the exposure of the site to these winds (refer to Figure 5). This is compounded by the fact that these tend to be the dominant winds during the colder winter months, when people tend to be more sensitive to the wind.

5.2 Assessment of the Expected Future Wind Conditions

The assessment of the expected future wind conditions for the subject site is detailed in the following sub-sections for the three primary wind directions for the Sydney region.

5.2.1 North-Easterly Winds

North-easterly winds are generally not critical for the reasons described above. However, care should be taken with regard to the potential speed up of the north-easterly winds as a result of the proposed land topography. The relatively gentle slope will is not expected to affect the potential use of the northern slope as an area for non-stationary

recreational activities, such as a play area for children. Some limited planting is still recommended near the top of the escarpment at the north-eastern corner to provide protection for the seating area on the "upper bluff" area, as shown in Figure 4. Additional planting in that area will provide further improvement to the amenity of the "upper bluff" area in the event of a north-easterly wind.

This recommendation is made in principle only and should be confirmed by wind tunnel testing prior to finalising the landscape plan.

5.2.2 Southerly Winds

Southerly winds are expected to be partially shielded by the proposed buildings on Barangaroo South. The site will remain exposed to the strong south-westerly winds. These winds are expected to affect the waterfront areas, which are intended as a pedestrian thoroughfare. The steep incline in the escarpment facing the south-westerly direction has the potential to generate a significant speed up effect at the top, where stationary activities are proposed. The proposed dense planting of shrubs along the region of steep incline together with the tree planting will assist in mitigating this effect. Figure 4 presents a recommended layout of tree planting that is expected to work with the proposed strip of dense planting. The recommended tree planting strategy is designed to maximise views from the "upper bluff" area by placing the trees in a staggered formation, as shown. The proposed native trees will need to be of an evergreen species as do the shrubs.

The shrubs need to extend to both the lower and upper pathways to be effective in stagnating the south-westerly winds around the lower pathway and also to protect the area downstream of the upper pathway. The trees need to have large densely foliating canopies that almost meet with the shrubs.

5.2.3 Westerly Winds

The westerly to north-westerly winds will have the greatest impact on the wind conditions within the subject site. The long run of steeply inclined landform in the north-south direction will result in potentially strong wind conditions over he entire "upper bluff" area under the effect of the westerly winds.

The landscape treatment highlighted in Figure 4 is expected to provide sufficient protection for stationary activities for the entire "upper bluff" precinct, provided that the native trees as well as the shrubs are of an evergreen, densely foliating species and the trees are capable of growing to at least 10m in height at maturity. If the selected species are not able to grow to 10m height then additional tree planting or screens should be provided along the eastern half of the "upper bluff" area to supplement the protection provided by the trees and shrubs described in Figure 4. Note that the design of the winding staircases and paths near the foreshore will be effective in providing relatively calm wind conditions for pedestrians in those areas if densely foliating vegetation is also used in close proximity.

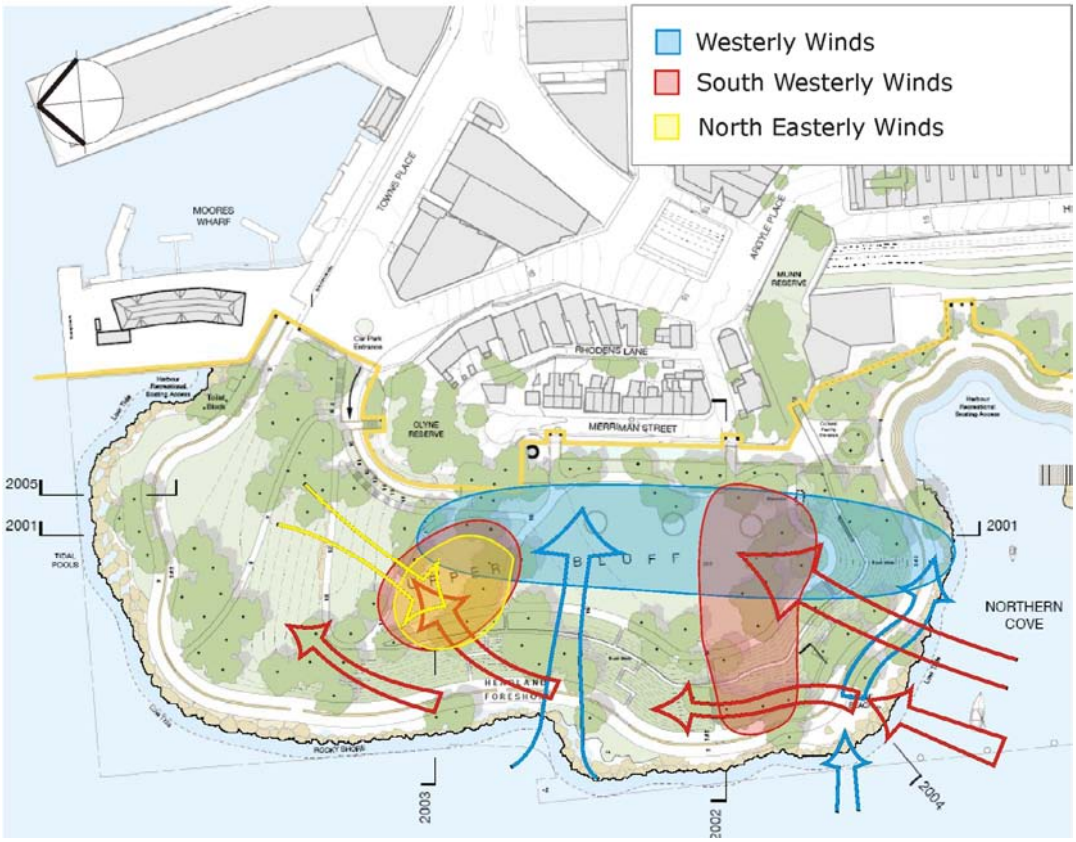


Figure 3: Impacts of the Three Principle Winds for Sydney

Figure 4: Recommended Minimum Planting Strategy

6.0 Conclusions

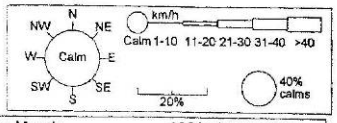
The subject site is currently impacted on by the various principal winds for Sydney, namely the north-easterly, southerly and westerly winds. The changes to the site as a result of the proposed earthworks are likely to significantly exacerbate the effect of the prevailing winds. However, the extensive planting proposed in conjunction with the specifications regarding the layout, general type, size and height of the proposed planting in certain critical areas, is expected to mitigate these wind effects. Furthermore, the effective design of the winding staircases and paths near the foreshore will provide relatively calm wind conditions for pedestrians in those areas with the densely foliating vegetation used in close proximity.

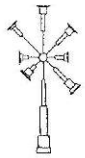
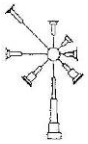
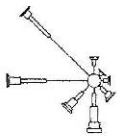
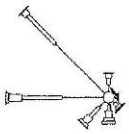
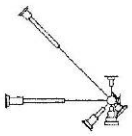
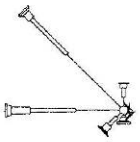
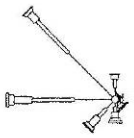
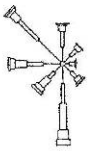
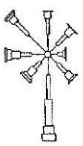
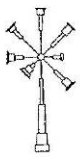
Appendix

Wind Roses for Kingsford Smith (Sydney) Airport, 1939-2000

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

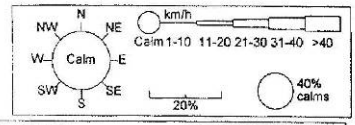
Site Number 066037 • Locality: SYDNEY AIRPORT • Opened Jan 1929 • Still Open
Latitude 33°56'28"S • Longitude 151°10'21"E • Elevation 6m



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**
		

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



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