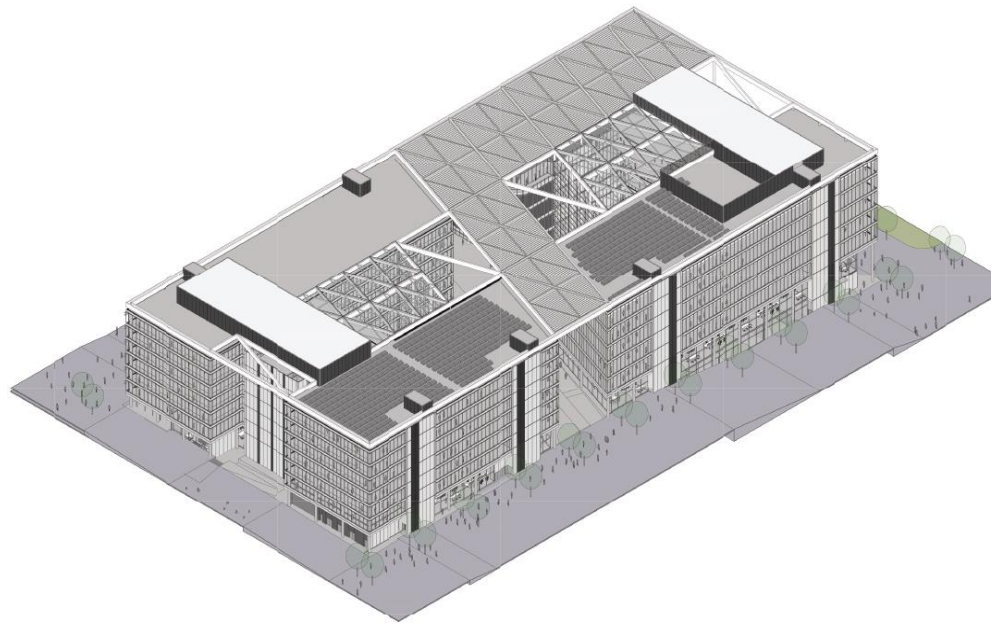




PEDESTRIAN WIND ENVIRONMENT STATEMENT

8-12 MACQUARIE UNIVERSITY PROJECT (PHASE A:
CONCEPT DESIGN)

WD111-01F03(REV4)- WS REPORT

14 NOVEMBER 2018

Prepared for:

Macquarie University

ABN 90 952 80 237 Building Y6A Link Road,
Macquarie University, NSW, 2109

WINDTECH Consultants Pty Ltd

Head Office: 607 Forest Road, Bexley NSW 2207, Australia

P +61 2 9503 0300 **E** reception@windtechglobal.com **W** www.windtechconsult.com

Sydney | Abu Dhabi | London | Melbourne | Mumbai | New York | Hong Kong | Singapore

DOCUMENT CONTROL

Date	Revision History	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
March 30, 2017	Initial	0	JG	KP	HK
June 1, 2017	Update Exec. Summary and Results and Discussion	1	JG	KP	KP
November 22, 2017	Updated Drawing Package and Treatments	2	JG	KP	HK
January 29, 2018	Update Exec. Summary and Results and Discussion	3	JG	KP	HK
November 14, 2018	Updated Drawing Package	4	JG	SWR	BU

The work presented in this document was carried out in accordance with the Windtech Consultants Quality Assurance System, which is based on International Standard 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.

EXECUTIVE SUMMARY

This report is in relation to the proposed development located at 8-12 University Avenue, Macquarie University, and presents an opinion on the likely impact of the proposed design on the local wind environment to 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 Sydney region; namely the north-easterly, southerly 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 latest architectural drawing package prepared by Kann Finch Group, dated November 21, 2017. Since the receipt of this drawing package, an updated drawing package from the project architect (Issued for SSD Approval – 2.11.2018) has been received and no significant design changes to the development are noted between the drawing packages. 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 there is the possibility of adverse wind conditions along the outdoor trafficable areas of the subject development. The pedestrian footpath areas along Macquarie Walk and University Avenue are exposed to the predominant westerly winds. The wide northern façade of the development will capture the north-easterly winds with the potential for down wash winds to impact the pedestrian areas along Macquarie Walk. There is the potential for pressure driven flow of the north-easterly winds at the north-eastern corner of the development, particularly in the area between the collaboration/retail and foyer. The Galleria area is expected to experience adverse wind conditions due to the orientation of the area to the predominant north-easterly and southerly winds resulting in the funnelling of winds through this space. The presence of nearby buildings provides some benefits from shielding of the predominant north-easterly, southerly and westerly winds.

The outdoor terrace areas on Levels 4 and 5 are susceptible to adverse wind conditions, as they are potentially exposed to accelerated flows around the building corners due to the pre-dominant north-easterly winds and westerly winds. The terrace areas are potentially exposed to direct winds up-washing from the northern façade.

The following treatment recommendations are made to mitigate these potential wind effects:

- Retain the proposed tree planting as indicated in the landscaping plan. The trees should be of a dense evergreen species and capable of growing to a height of at least 3-5m with a minimum 3m wide canopy.

- Retain the proposed shrub/planting layout as indicated in the landscaping plan, especially the densely foliating evergreen shrubs at the southern entrance to the Galleria. The shrubs should be capable of growing to a height of 1.5m above the planter box.
- Retain the localised shrub/planting as indicated in the landscaping plan along the Lower Ground pedestrian areas at the north-eastern aspect of the development. The shrubs should be capable of growing to a height of 1.5m above the planter box.
- Retention of 1.6m high impermeable balustrades along the perimeter of the terrace areas on Levels 4 and 5.

The treatment recommendations provided above are provided as input design guidance during the concept design phase of the development. Future wind tunnel testing of the development should be undertaken to identify the extent of the potential wind effects due to the predominant winds within and around the site. Treatment solutions will need to be investigated and advised in further detail during the detailed design phase of the project to determine the extent of any adverse wind conditions and ensure that pedestrian/communal areas are acceptable for their intended uses.

1 DESCRIPTION OF THE DEVELOPMENT AND SURROUNDINGS

The development site is located at 8-12 University Avenue, Macquarie University and is bounded by Macquarie Drive to the north and University Avenue to the south. The site is located adjacent to the Macquarie University Library Building to the north, the Cochlear Building to the south and the Australian Hearing Hub Building to the west. The site is located within the Macquarie University campus and as such it is encompassed by mid-rise and low-rise buildings. To the east beyond the immediate vicinity is the Macquarie Shopping Centre.

A survey of the site indicates that the land across the site slopes down from the north to the south as well as from the west to the east. An aerial image of the subject site and the local surroundings is shown in Figure 1. The proposed development consists of two developments, 8 University Avenue and 12 University Avenue which consists of 8 levels above ground and multiple shared basement levels. 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:

- The pedestrian footpath along Macquarie Drive and University Avenue
- The Ground Floor Plan Galleria
- The Level 4 and Level 5 terrace spaces

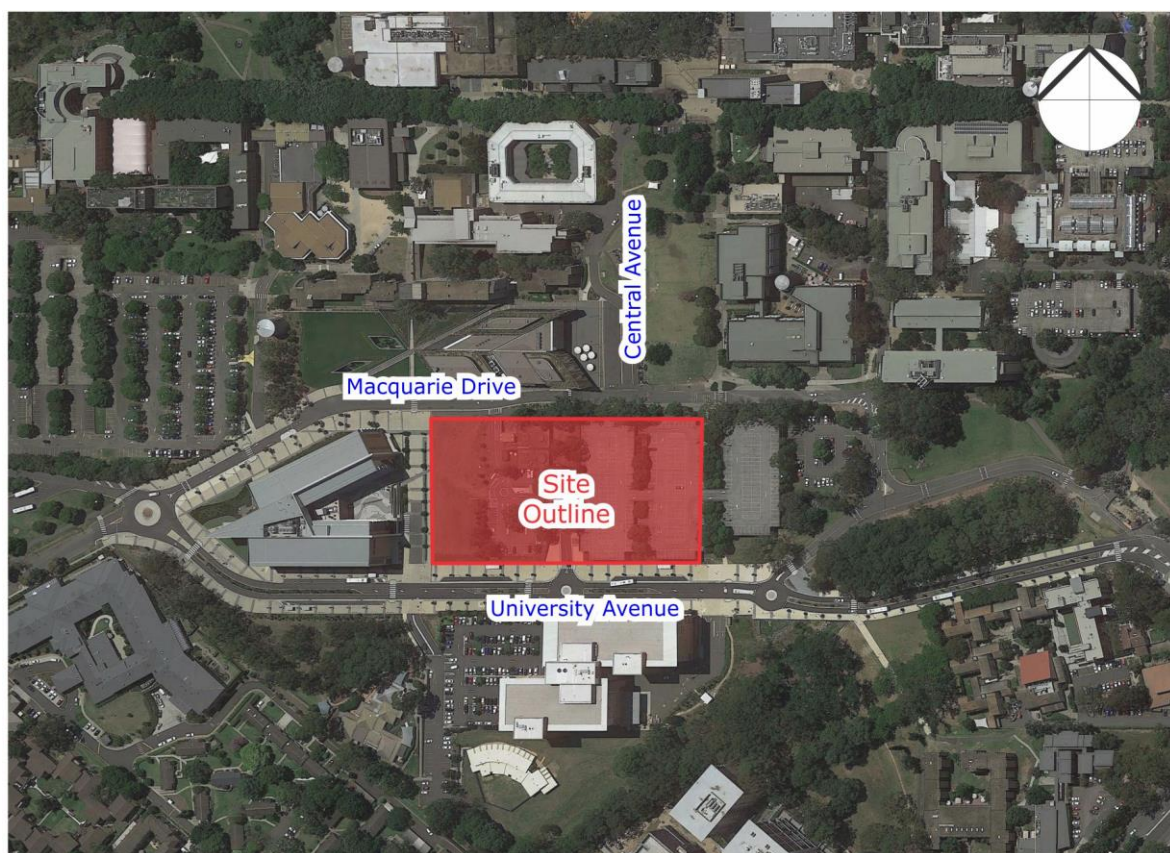


Figure 1: Aerial Image of the Site Location

2 WIND CLIMATE OF THE SYDNEY REGION

The Sydney region is governed by three principal wind directions, and these can potentially affect the subject development. These winds prevail from the north-east, south and west. A summary of the principal time of occurrence of these winds throughout the year is presented in Table 1 below. This summary is based on a detailed analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1995 to 2016). From this analysis, a directional plot of the annual and weekly recurrence winds for the Sydney region is also determined, as shown in Figure 2. The frequency of occurrence of these winds is also shown in Figure 2.

As shown in Figure 2, the southerly winds are by far the most frequent wind for the Sydney region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Sydney region, and although they are typically not as strong as the southerly winds, they are usually a cold wind since they occur during the winter and hence can be a cause for discomfort for outdoor areas. North-easterly winds occur most frequently during the warmer months of the year for the Sydney region, and hence are usually welcomed within outdoor areas since they are typically not as strong as the southerly or westerly winds.

Table 1: Principal Time of Occurrence of Winds for Sydney

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	

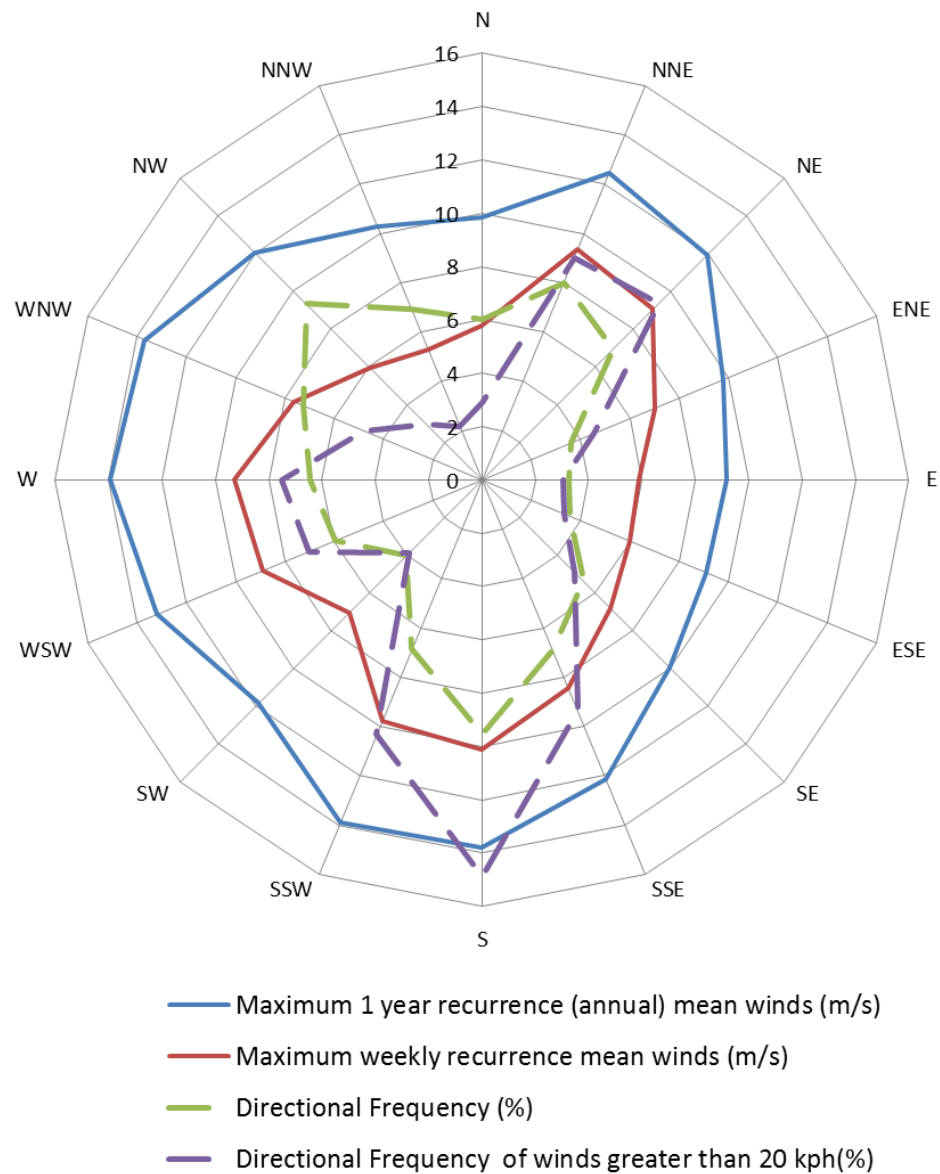


Figure 2: Annual and Weekly Recurrence Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (based on 10-minute mean observations from Kingsford Smith Airport from 1995 to 2016, corrected to open terrain at 10m)

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 Sydney 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 Level Pedestrian Accessible Areas and Galleria

It is noted that the pedestrian footpath areas along Macquarie Walk and University Avenue will be exposed to the predominant westerly winds due to their east-west orientation. The presence of the Australian Hearing Hub building to the west and the wide façade of the development may result in the side streaming of the westerly winds along these footpath areas resulting in adverse wind conditions. The Lower Ground pedestrian areas at the north-eastern corner of the development may be potentially exposed to accelerated flow conditions due to the westerly winds travelling along Macquarie Walk and wrapping around the corner of the development towards the south.

It is expected that with the inclusion of the densely foliating evergreen trees as shown in the proposed landscaping plan along Macquarie Walk and University Avenue that they will assist in reducing the adverse wind conditions along the footpath areas. The trees should be of a dense evergreen species capable of growing to a height of at least 3-5m with a minimum of a 3m wide canopy. It is recommended to retain the proposed shrub/planting layout as indicated in the landscaping plans, especially at the southern entrance to the Galleria. The shrubs should be capable of growing to a height of 1.5m above the planter box.

The pedestrian footpath area along the Macquarie Walk frontage of the site may experience adverse wind conditions caused by the prevailing north-easterly winds down-washing off the northern façade of the development onto these pedestrian areas. There is the potential for pressure driven flow of the north-easterly winds at the north-eastern corner of the development, particularly in the area between the collaboration/retail and foyer. The site benefits from some shielding of these winds from the neighbouring buildings towards the north. The presence of the Cochlear Building to the south should provide similar shielding of the prevailing southerly winds from down washing off the southern façade of the development.

The orientation of the Galleria and the large opening above this space will propagate the predominant north-easterly and southerly winds. The Galleria is expected to experience a funnelling effect, with the potential for winds to accelerate through these areas due to the alignment of the upstream buildings, resulting in potentially adverse wind conditions. The location of the southern entrance and the location of the adjacent buildings to the south and west of the site has the potential to direct the southerly winds towards the Galleria entrance. It

is recommended to retain the proposed shrub/planting layout as indicated in the landscaping plan, especially the densely foliating evergreen shrubs at the southern entrance to the Galleria. The shrubs should be capable of growing to a height of 1.5m above the planter box.

It is expected that the inclusion of the densely foliating evergreen trees as shown in the proposed landscaping plan along the Galleria will assist in reducing the wind conditions. These trees should be of a dense evergreen species capable of growing to a height of at least 3-5m with a minimum of a 3m wide canopy.

The extent of the potential wind effects through the Galleria area due to the north-easterly and southerly winds and the treatments recommended will need to be investigated in further detail through wind tunnel testing during the detailed design phase for the subject development.

4.2 Terrace Areas

The various terrace spaces located on Levels 4 and 5 of the LOT E03 development along the northern aspect of the development are susceptible to adverse wind effects. The Level 4 terrace space is potentially exposed to adverse conditions from the accelerated flows around the north-eastern corner due to the westerly winds and direct north-easterly winds. Similarly, the Level 5 terrace at the north-east is potentially exposed to similar adverse wind conditions due to the accelerated wrap around westerly winds and direct north-easterly winds. The Level 5 terrace located on the north-west is potentially exposed to accelerated flows around the corner due to the north-easterly winds wrapping into the Galleria. The terrace areas are potentially exposed to direct winds up-washing from the northern façade. It is recommended to retain the 1.6m high impermeable balustrades along the perimeter of the terraces areas.