Appendix Q

Wind Environment Statement

PEDESTRIAN WIND ENVIRONMENT STATEMENT
CUDGEGONG ROAD STATION PRECINCT SOUTH

WD965-01F02(REV2)- WS REPORT

FEBRUARY 12, 2018

Prepared for:
Landcom ABN 79 268 260 688
Trading as UrbanGrowth NSW
Level 14, 60 Station Street,
Parramatta, NSW 2150

WINDTECH Consultants Pty Ltd ABN 72 050 574 037
Head Office: 607 Forest Road, Bexley, NSW 2207, Australia
P +61 2 9503 0300 **E** reception@windtechglobal.com **W** www.windtech.com.au

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

DOCUMENT CONTROL

Date	Revision History	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
December 8, 2017	Initial	0	HK	KP/NT	BU
February 9, 2018	Update for revised site drawings	1	HK	KP	BU
February 12, 2018	Updated site plan figure	2	HK	KP	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. The information herein 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 Cudgegong Road Station Precinct South concept proposal located in Rouse Hill, and presents an opinion on the likely wind conditions affecting the various trafficable outdoor areas within and around the subject development. The effect of wind activity is examined for the predominant wind directions for the North-Western Sydney region. The analysis of the wind effects relating to the subject site has been 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 conceptual masterplan drawings set prepared by Bennett and Trimble, received February 6, 2018. No wind tunnel tests have 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 subject development will be exposed to the prevailing winds from all directions due to the low-rise surrounding structures. However, the prevailing winds are expected to be shielded by the development itself for specific wind directions. Certain regions of the development may be prone to adverse wind effects due to the interaction of the prevailing winds with the built form. These potentially adverse wind effects include the direct impact of the prevailing winds, funnelling winds between the various podia and towers due to the alignment of the buildings with respect to the prevailing winds, the side-streaming and acceleration of winds around the various corners of the development and downwash caused by the prevailing winds impacting the building and redirecting winds downwards.

To address the potential for adverse wind effects impacting the comfort of pedestrians within and around the development, generalised wind mitigation treatments that should be considered are discussed within this report, and are summarised as follows:

- Inclusion of proposed planting and vegetation throughout the site. Undergrowth such as shrubs or hedges are expected to further improve wind conditions.
- Inclusion of continuous awnings over trafficable areas below towers or podia of a significant height which are exposed to the prevailing winds.
- Inclusion of localised screening where longer duration activities are expected.
- Inclusion of operable screening to be utilised by the various retail tenancy owners for patron flexibility.
- Inclusion of wind screens or planting within through site links, and at corners of buildings.

Note that for tree planting/landscaping to be effective as a wind mitigation device, the species should be of a densely foliating evergreen variety to ensure year-round effectiveness. Trees should also be planted in clusters with interlocking canopies to effectively absorb incident winds.

With the inclusion of these considerations in the detailed design of the development, wind conditions within outdoor trafficable areas are expected to be suitable for their intended uses. Note that wind tunnel testing is recommended to provide quantitative results.

1 DESCRIPTION OF THE PROPOSED DEVELOPMENT AND SURROUNDS

The NSW Government is currently building the Sydney Metro Northwest (SMNW) that is due to start operations in 2019. The SMNW is Stage 1 of the overall Sydney Metro project and involves the construction of eight new metro stations supporting infrastructure between Cudgegong Road and Epping and converting five existing stations between Epping and Chatswood. Stage 2 will deliver a new metro rail line from Chatswood through Sydney's CBD to Sydenham (Sydney Metro City and Southwest).

The site is bounded by Cudgegong Road to the east, Schofields Road to the south, empty lots to the west, and Precinct Street A and the rail corridor to the north. The site is currently used as a site compound associated with the construction of the Sydney Metro Northwest.

The development precinct will be primarily comprised of mixed-use developments ranging from approximately two to eight storeys high over two sites as shown in Figure 1b (Site 1 comprised of Site 1A and 1B to the north, and Site 2 comprised of Site 2A, 2B, 2C and 2D to the south) with active street frontages and commercial areas proposed primarily on the ground floor close to the station.

Cudgegong Reserve and the Cudgegong Road Railway Station are located to the north of the site, while commuter car parking is located to the west. One to two storey residential developments are located to the south of the site. Second Ponds Creek lies to the east.

A survey of the local land topography around the site indicates that the terrain gradually rises to the north-west from the south-east of the development. An aerial image of the site and the local surroundings is shown in Figure 1a. The critical trafficable outdoor areas associated with the proposed development, which are the focus for pedestrian wind effects in this assessment, are detailed as follows:

- The pedestrian accessible areas within and around the site.
- The proposed recreation and park areas within and around the site.

Figure 1a: Aerial Image of the Proposed Development Site

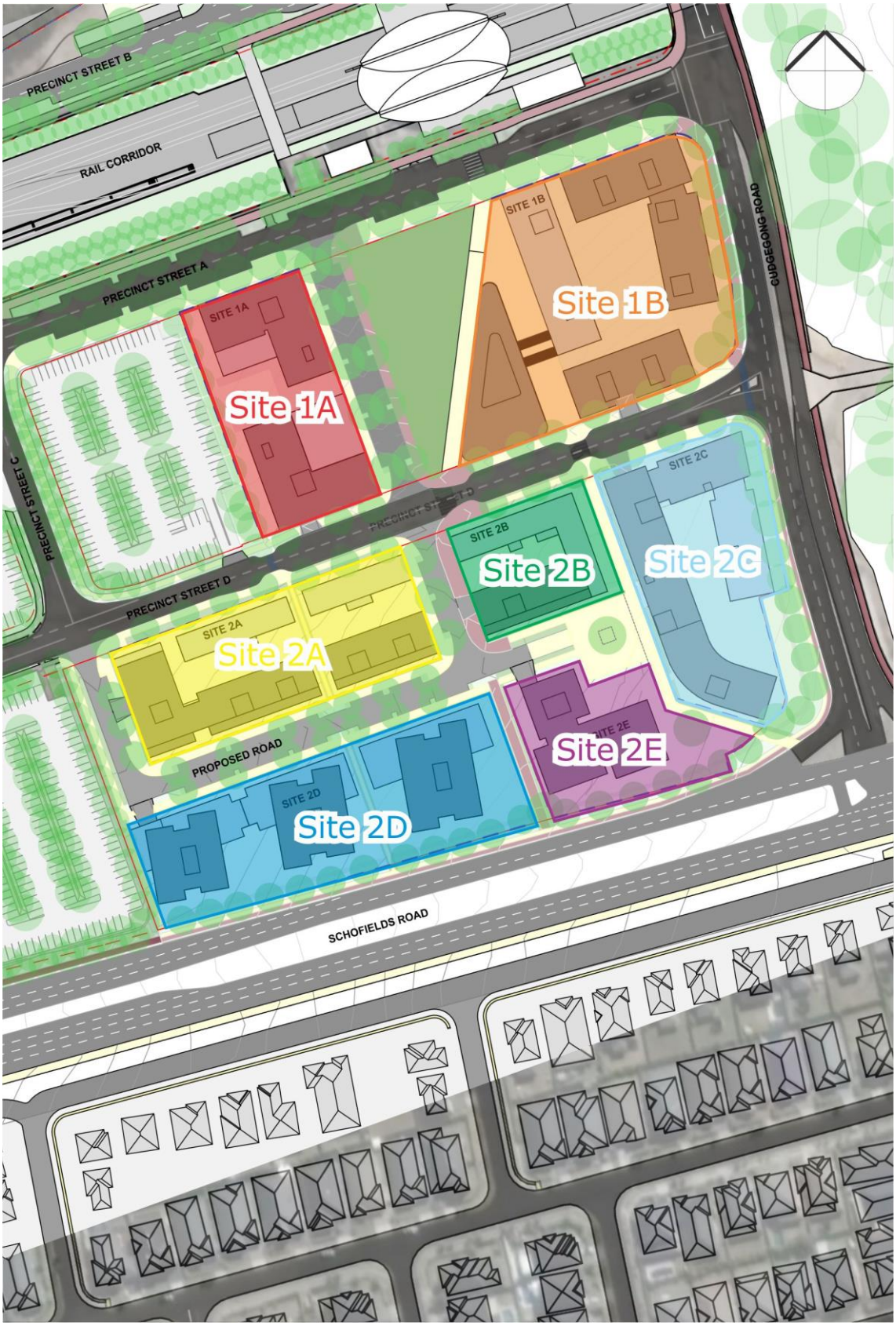

Figure 1b: Proposed Site Plan

2 WIND CLIMATE OF THE NORTH-WESTERN SYDNEY REGION

The North-Western Sydney region is governed by two principal wind directions, and these can potentially affect the subject development. These winds prevail from the southerly sector and the westerly sector. The north-easterly winds are not very strong, however, they have a high frequency of occurrence, and have been taken into consideration. A summary of the principal time of occurrence of these winds 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 recording station located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1939 to 2008). Consideration has been given to the prevailing winds for Richmond Airport which is located to the north-east of the site.

The southerly winds are by far the most frequent wind for the Hawkesbury region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Hawkesbury 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 North-Western Sydney region, and are typically not as strong as the southerly or westerly winds.

Table 1: Principal Time of Occurrence of Winds for the Hawkesbury 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	

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 A.G. Davenport, T.V. Lawson, W.H. Melbourne, A.D. 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 also adopted elements of some of these into their planning control requirements in Australia. The following table is an example, which was developed by A.D. 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 (A.D. 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 prevailing wind directions for the Sydney region. The interaction between the wind and the building morphology in the area was considered, and important features taken into account include the distances between the building forms, their overall heights and bulk, as well as the landform. Note that only the potentially critical wind effects are discussed in this report.

4.1 Site Location

The development site is located within a development precinct, with several adjacent developments under construction. These developments are not expected to offer significant shielding due to their relatively low height, and distance away from the site. Similarly the low-rise buildings to the south are not expected to shield the site from the prevailing winds to any significant extent. The rise in terrain from the south-east to north-west may accelerate southerly winds, however, this effect is expected to be minimal. The development is expected to shield areas within the development itself from prevailing winds.

4.2 North-Easterly Sector Winds

The north-easterly winds prevail throughout the summer months, and impact the site directly. These winds are also expected to sidestream at the north-western corner of Sites 1B and 1A, as well as the south-eastern corner of Sites 1A, 1B, 2B and 2D. The sidestreamed winds from the Site B buildings are expected to impact the Public Park space. Funnelling due to the north-easterly prevailing winds is expected to occur along Precinct Street D between Sites 1B and 2B, and between Sites 1A and 2A. Downwash is expected to occur at the northern aspect of Sites 1A and 1B due to the relatively tall height of the towers at 8 storeys tall in comparison to the surrounding buildings.

Winds approaching the site from a more northerly direction are expected to sidestream at the abovementioned locations, as well as introduce some funnelling effects between the various proposed buildings along the roads connecting the Proposed Road and Precinct Street D, as well as direct winds to the Public Park. The station is not expected to offer significant shielding to the site due to its low height, distance from the site, and relatively small massing.

Figure 2: North-Easterly Wind Flow and Hotspots

4.3 Southerly Sector Winds

The southerly sector winds primarily approach from the south and south-east throughout most of the year. These winds are expected to impact the development directly as the low-rise residential buildings to the south are not expected to offer any significant amount of shielding for the site, due to their small massing and distance away from the site. The main wind effects that the southerly winds cause are sidestream at the south-eastern and south-western corners of the development, and funnelling between adjacent buildings on the southern aspect of the development.

The south-easterly winds will have a similar effect, in terms of funnelling winds, but will also impact the north-eastern corner of the development due to sidestream. Some winds may also affect the north-eastern corner of Site 2D, and funnel through Precinct Street D.

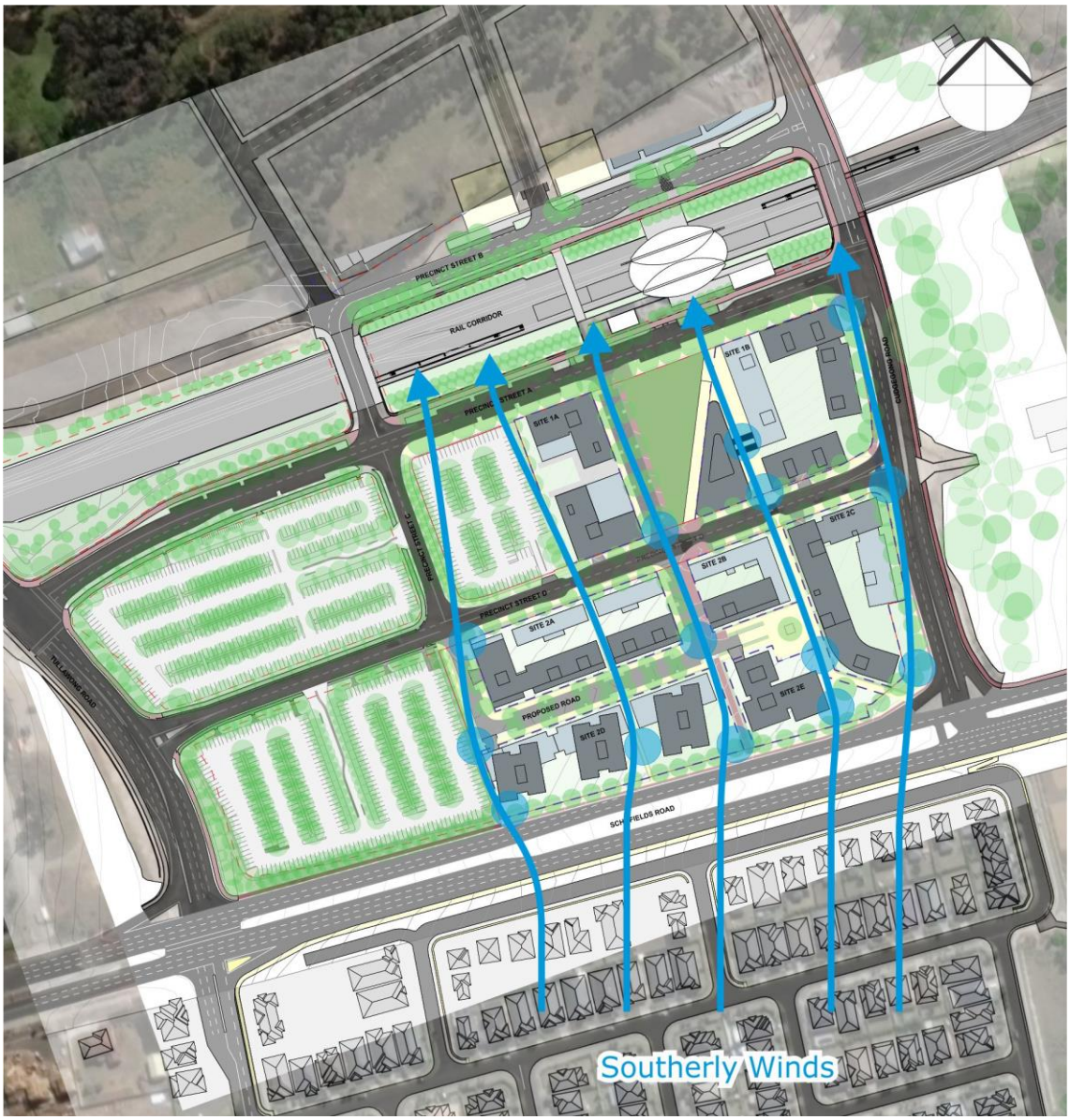

Figure 3: Southerly Wind Flow and Hotspots

4.4 Westerly Winds

Westerly winds typically occur during the winter months of the year for the North-Western Sydney region. These winds are particularly undesirable due to the negative impact upon the human perception of comfort as a result of the cooler winds. It is anticipated that certain areas of the development may be susceptible to undesirable wind effects as a result of these winds.

The proposed car parking to the west of the site exposes the development site to direct westerly winds. These winds are expected to sidestream around the north-western and south-western corners of Sites 1A, 2A and 2C. Downwash is also expected to occur on the western façade of the western buildings of Sites 1A, 2A and 2C due to its height above the rest of the development. These winds are expected to combine with the abovementioned sidestreamed winds and exacerbate conditions further. Due to the orientation of the development, westerly winds are expected to sidestream along Precinct Street A and Schofields Road, and funnel through the Proposed Road and Precinct Street D.

Figure 4: Westerly Wind Flow and Hotspots

4.5 General Recommendations

The significant proposed landscape plan is expected to be very effective in mitigating adverse wind conditions throughout the site. Note that for tree planting/landscaping to be effective as a wind mitigation device, the species should be of a densely foliating evergreen variety to ensure year-round effectiveness, particularly for the areas that are expected to be impacted by westerly winds, which prevail during the winter months. Trees should also be planted in clusters with interlocking canopies to effectively absorb incident winds. In sensitive areas or hotspots where strong winds are expected, mature trees should be used as immature trees have difficulty establishing themselves in strong wind conditions. If immature trees are initially planted, the inclusion of porous screens around these tree plantings, or temporary wind screens is recommended to provide some wind mitigation while the trees develop and also provide some protection as the trees establish. Conditions can be further improved through the use of low level vegetation such as shrubs/hedges or planter boxes. When utilised below a tree canopy, they provide protection from low level winds, especially for more sensitive areas where longer duration activities are expected. In general, landscaping can help mitigate adverse wind conditions caused by winds directly impacting an area, or sidestreaming winds by slowing the winds upstream.

In areas where stronger winds are expected, wind screens may be required. These can be in the form of impermeable screens, porous screens, signage, artwork etc. which are strategically located to mitigate winds at a particular location. In areas where longer duration stay is expected, such as café or restaurant seating areas, or communal recreation areas, additional localised screening, tenancy-operated screening deployable during windy conditions, or planting may be required. The location of these areas at the corners of buildings places them in an area where there is a high potential for adverse winds.

Downwash is most likely to occur at the base of tall buildings that present a flat façade to the prevailing winds, and in these areas, awnings and canopies can be used to deflect the winds away from pedestrian accessible areas. Generally for these to be effective in achieving this, an awning of at least 3m would be required. This combined with tree planting alongside for the winds to be absorbed into would be particularly effective in mitigating this wind effect. Wrap-around awnings at the corners of buildings can also prevent the downwashed winds from combining with winds side streaming around the corners of the development.

Through site links should be oriented to avoid direct alignment with the prevailing winds, incorporate bends, planting or screens in order to mitigate funnelling effects between building massings. The funnelling between buildings may be severe enough for further mitigation measures such as a baffle screen arrangement. This tends to reduce the severity of winds affecting a particular area by redirecting it around obstacles, and thus reducing the wind speed.

It should be noted that wind tunnel testing is recommended to provide quantitative results.