



# HILLS SHOWGROUND STATION PRECINCT, CASTLE HILL PEDESTRIAN WIND ENVIRONMENT STATEMENT

WF043-01F02(REV1)- WS REPORT

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Prepared for:

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## DOCUMENT CONTROL

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## EXECUTIVE SUMMARY

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This report is in relation to the Hills Showground Station Precinct Concept Proposal located in Castle 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 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 master plan drawings set prepared by Cox Architecture, received September 26, 2019. 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 once built. Similarly, further shielding from the prevailing winds is expected once the future development of the surrounding area is complete. Certain regions of the development may be prone to adverse wind effects due to the interaction of the prevailing winds with the built form. Specifically, the proposed north-west plaza within Doran Drive Precinct, the station plaza adjacent the showground metro station, the existing plaza east of the Hills Showground Car Park, the east-west pedestrian link through Precinct East, the communal spaces between the podia of Precinct East and the proposed Precinct East Park adjacent to the pedestrian link are affected by the prevailing winds. 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:

- Retention 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.

The outdoor trafficable areas within the site are expected to be suited for their intended uses such as sitting for plaza areas through the consideration of the above generalised wind mitigation treatment recommendations. We have reviewed the Concept Proposal and consider the design to be capable of conforming to the recommendations within this report. Appropriate treatments of specific areas within the site will be confirmed through quantitative wind tunnel testing during detailed design at the Development Application stage.

# 1 INTRODUCTION

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This report has been prepared for Landcom on behalf of Sydney Metro to support a Concept development application (DA) under Section 4.22 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This report also addresses the Planning Secretary's environmental assessment requirements (SEARs) regarding the wind conditions at the development site through the Hills Development Control Plan and provides an analysis of the expected wind impacts to existing and proposed public domain areas and open spaces. The wind impact assessment will also determine the existing wind characteristics of the site and its locality, significant locations for wind sensitivity and mitigating measures through wind tunnel testing at a later detailed design stage.

Buildings 8 or more storeys in height or over 25 metres in height require wind tunnel testing to demonstrate satisfaction of the wind criteria stipulated in Part D Section 19 of the Hills Development Control Plan for the Showground Station Precinct. Hence it is recommended that wind tunnel testing is conducted during the detailed design stage to verify the wind conditions and enable more detailed feedback and design of the potential wind mitigation measures.

The concept for which approval is sought (the 'Concept Proposal') is for a high-density mixed-use precinct with a new public park and plaza, and associated facilities on land located within the Hills Showground Station Precinct (the 'Site') on development lots (Lot 53, Lot 55 and 56 in DP 1253217) (the 'DA Area') as shown in Figure 1.

This report considers the likely impact of the proposed design on the local wind environment affecting pedestrians within the critical outdoor areas within and around the subject development. The analysis of wind effects relating to the proposed development was carried out in the context of the predominant wind directions for the region, building morphology of the development and nearby buildings, and local land topography. The conclusions of this report are drawn from our extensive experience in the field of wind engineering and studies of wind environment effects.

No wind tunnel testing was undertaken for this assessment. Hence this report addresses only the general wind effects and any localised effects that are identifiable by visual inspection, and any recommendations in this report are made only in-principle.

## 2 DESCRIPTION OF THE DEVELOPMENT AND SURROUNDINGS

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The Concept Proposal comprises residential, retail and commercial uses and building envelopes of varying heights from four (13m) to up to twenty storeys (68m). The proposal also includes a new road, landscaping, services and the provision of publicly accessible open space in the form of Doran Drive Plaza and a park. An indicative yield of up to 1,900 dwellings is anticipated to be provided by the proposal.

More specifically, the Concept Proposal comprises:

- total gross floor area (GFA) of 175,796m<sup>2</sup> across all three development lots
- a maximum residential GFA of 169,096m<sup>2</sup> equating for up to 1,900 dwellings including a minimum of five percent for affordable housing
- maximum GFA for non-residential uses of 13,600m<sup>2</sup>
- Doran Drive Plaza – minimum of 1,400m<sup>2</sup>
- a new public park to referred to as Precinct East Park – minimum of 3,500m<sup>2</sup>
- building envelopes, and allocation of GFA to the three development lots
- provision of car parking up to a maximum of 2,293 car spaces and Bicycle parking in accordance with The Hills Shire Council DCP
- strategies for utilities and services provision, managing stormwater and drainage, achievement of ecologically sustainable development (ESD) and design excellence
- civil plan addressing the timing of future subdivision, construction, release and development of land
- concept principal subdivision of development Lot 56 DP 1253217 (Hills Showground Precinct East) into future major lots, public domain areas and roads.

No building or construction works are proposed to be undertaken as part of this Concept Proposal. Once the SSDA is approved, the successful purchasers of the development precincts and/or lots from Sydney Metro, will be responsible for submitting subsequent DAs for the design and construction of the buildings and public domain areas in accordance with the approved Concept.

The Site is bordered by the following:

- North and North-West – De Clamber Drive with a drainage basin Castle Hill and The Showground further North.
- West – De Clambe Drive and Cattai Creek riparian zone with commercial/industrial warehouses further west

- South to southeast – Carrington Road across which are low density residential developments, a child care and medical/physiotherapy
- East – Showground Road across which are low density residential development.

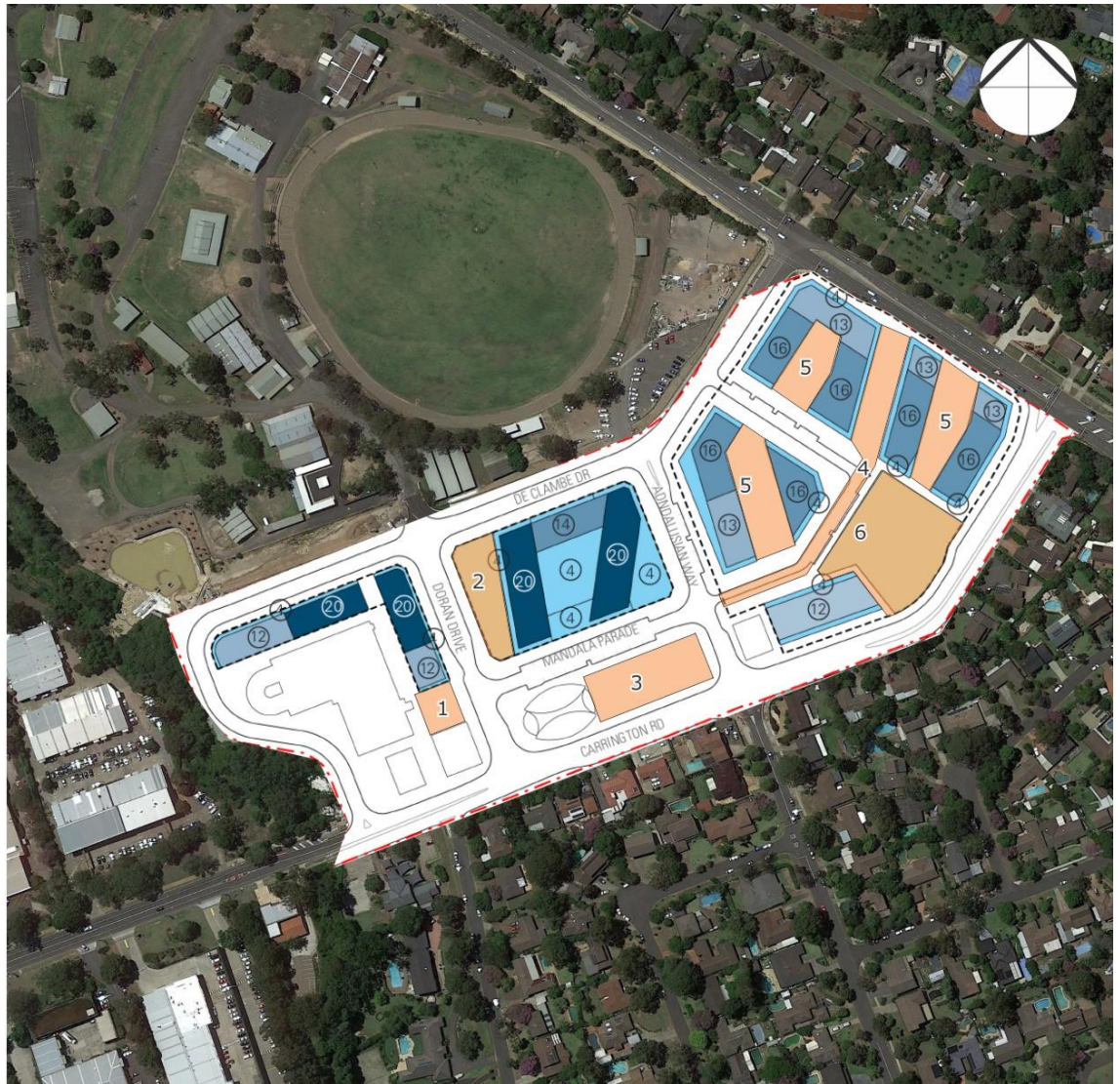
A survey of the local land topography around the site indicates that the terrain gradually rises to the north-east from the south-west of the development. An aerial image of the site and the local surroundings is shown in Figure 1a. The critical trafficable outdoor areas associated with the proposed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

- The pedestrian footpaths and accessible areas within and around the site.
- The existing western plaza east of the Hills Showground Car Park. (1)
- The proposed Doran Drive plaza at the north-west of Doran Drive Precinct. (2)
- The station plaza south of the Doran Drive Precinct and east of the Showground Metro Station. (3)
- The east-west pedestrian link through Precinct East. (4)
- The communal spaces between the podia of Precinct East. (5)
- The proposed south-eastern Precinct East Park adjacent to the pedestrian link. (6)



**Figure 1a: Aerial Image of the Proposed Development Site**





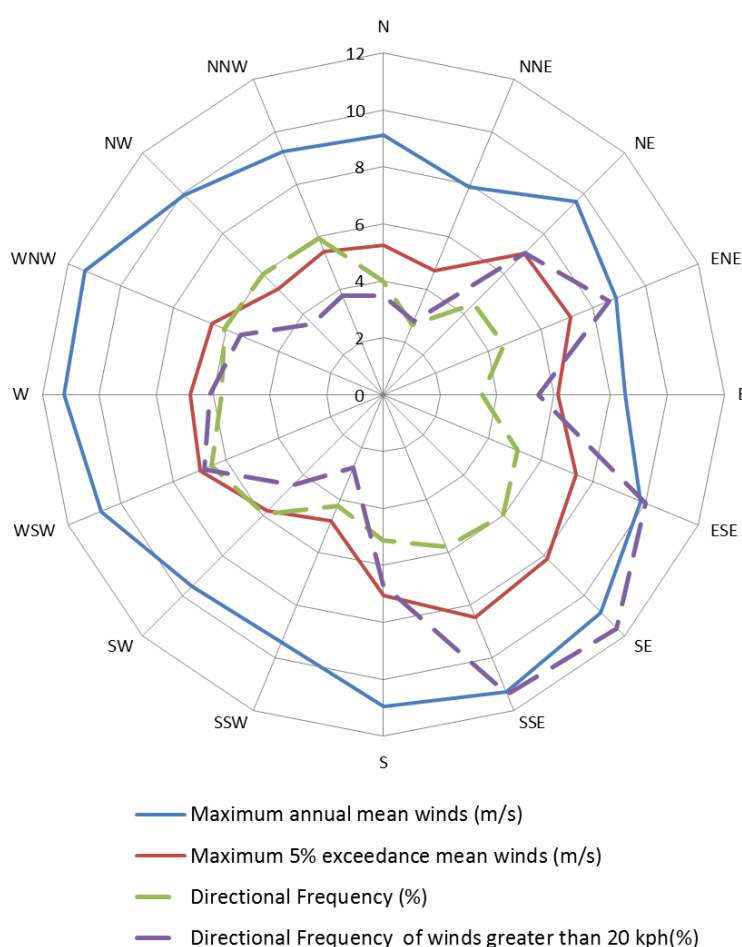
**Figure 1b: Critical Trafficable Outdoor Areas within Proposed Development Site**



### 3 REGIONAL WINDS

The regional winds of the Sydney Basin Region are governed by three principal wind directions. These winds prevail from the north-east, south-south-east and west.

These wind directions were determined from an analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station located at Bankstown Airport by the Bureau of Meteorology (recorded from 1993 to 2016). From this analysis, directional probabilities of exceedance and directional wind speeds for the region are determined. The directional wind speeds and corresponding directional frequencies of occurrence are presented in Figure 2.



**Figure 2: Annual and 5% Exceedance Hourly Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Basin Region (referenced to 10m above ground in standard open terrain)**

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, and A.D. Penwarden, 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.

For example, A.D. Penwarden (1973) developed a modified version of the Beaufort scale which describes the effects of various wind intensities on people. Table 1 presents the modified Beaufort scale. Note that the effects listed in this table refers to wind conditions occurring frequently over the averaging time (a probability of occurrence exceeding 5%). Higher ranges of wind speeds can be tolerated for rarer events.

**Table 1: Summary of Wind Effects on People (A.D. Penwarden, 1973)**

Type of Winds	Beaufort Number	Mean Wind Speed (m/s)	Effects
Calm	0	Less than 0.3	Negligible.
Calm, light air	1	0.3 – 1.6	No noticeable wind.
Light breeze	2	1.6 – 3.4	Wind felt on face.
Gentle breeze	3	3.4 – 5.5	Hair is disturbed, clothing flaps, newspapers difficult to read.
Moderate breeze	4	5.5 – 8.0	Raises dust, dry soil and loose paper, hair disarranged.
Fresh breeze	5	8.0 – 10.8	Force of wind felt on body, danger of stumbling
Strong breeze	6	10.8 – 13.9	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, wind noise on ears unpleasant.
Near gale	7	13.9 – 17.2	Inconvenience felt when walking.
Gale	8	17.2 – 20.8	Generally impedes progress, difficulty balancing in gusts.
Strong gale	9	Greater than 20.8	People blown over.

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.

## 5 RESULTS AND DISCUSSION

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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 Basin 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.

The ground plane will be used primarily for circulation. However, there are potential seating areas such as in the various plazas, communal open spaces and the proposed park. The recommended criterion for wind conditions for the circulation area is 7.5m/s with a 5% probability of exceedance, whereas the proposed plaza and open communal areas will need to satisfy a more stringent comfort criterion of 5.5m/s with a 5% probability of exceedance, and the proposed park should satisfy the long exposure comfort criterion of 3.5m/s with a 5% probability of exceedance. Although this assessment is of a qualitative nature, the abovementioned criteria are considered when assessing the wind environment impacts.

### 5.1 Site Location

The development site is located at the north-eastern edge of a low-rise industrial area, with residential buildings to the south of the site. The low-rise industrial buildings developments are not expected to offer significant shielding due to their relatively low height, and distance away from the site. Similarly, the low-rise residential buildings to the south are not expected to shield the site from the prevailing winds to any significant extent. These low-rise residential buildings are expected to be redeveloped in the future to mid-rise residential buildings which, once redeveloped, are expected to provide shielding to the proposed development from southerly prevailing winds. The adjacent Hills Showground car park building is expected to provide some shielding from the westerly winds to the central site area. The rise in terrain from the south-west to north-east may accelerate the westerly and southerly winds, however, this effect is expected to be minimal. The proposed buildings of the development are expected to shield areas within the development itself from the prevailing winds.

### 5.2 North-Easterly Sector Winds

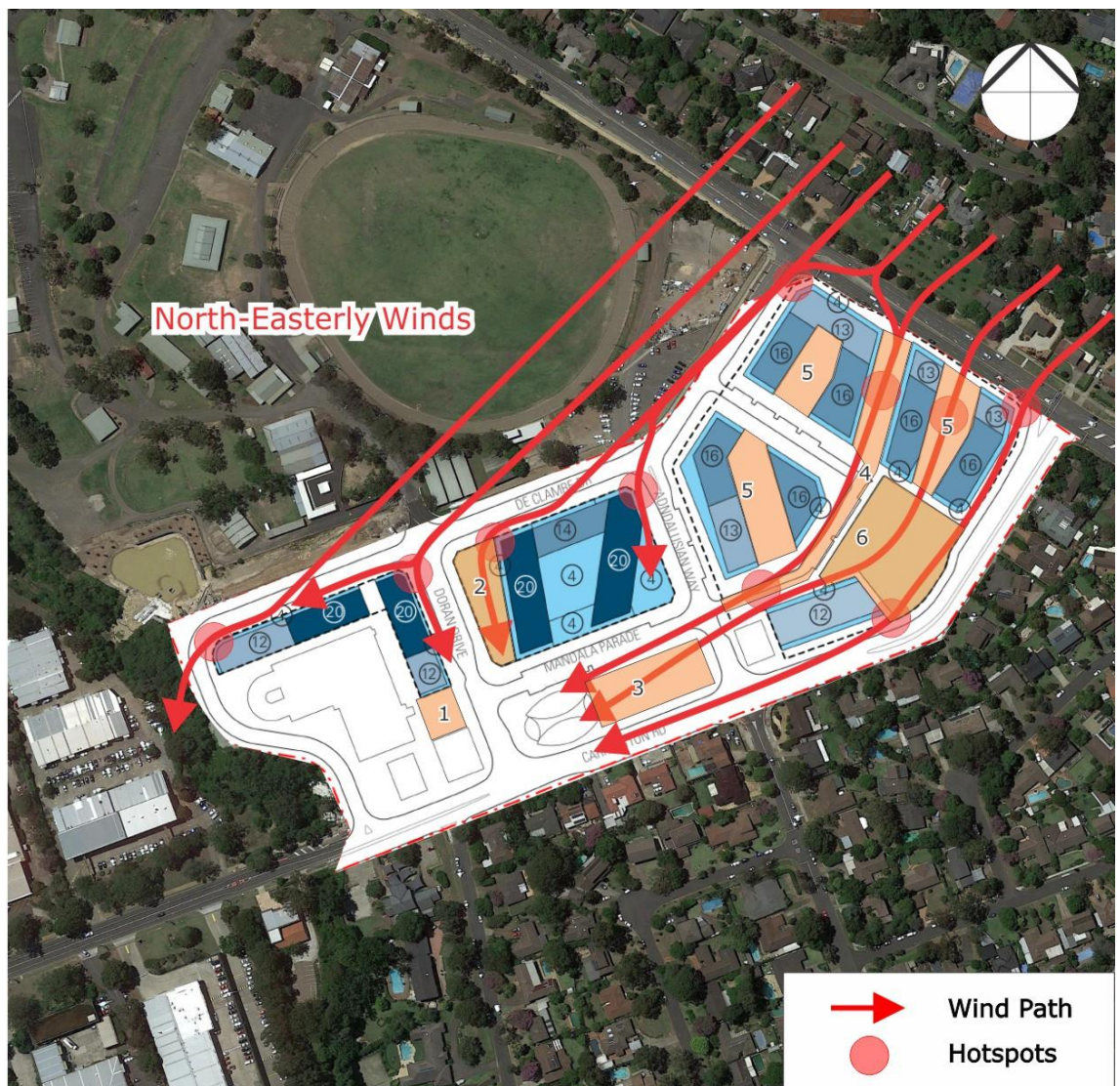
The north-easterly winds prevail throughout the summer months, and impact the site directly. The expected paths of the north-easterly wind flows and hotspots are shown in Figure 2. These prevailing winds are also expected to accelerate around the corners of buildings along De Clambe Drive. These flows are expected to side-stream along the adjacent building facades along De Clambe Drive to the north, Carrington Road to the south, Doran Drive and Andalusian Way within the site.

Due to the orientation of the towers at the north-east of the proposed development, the prevailing north-easterly winds are expected to funnel along the sides of the towers and along the ground level between the north-eastern podiums affecting the communal open spaces (5),

the pedestrian site-link (4) and the proposed Precinct East Park (6). Down wash is also expected at these towers, due to their height, along their north-eastern aspect impacting the pedestrian ground level areas along Showground Road to the north-east.

Further downstream, funnelling is expected to occur along the pedestrian site-link (4) adjacent to Andalusian Way. While the buildings of the development are expected to provide shielding against the prevailing north-easterly winds to the station plaza (3), the funnelled winds previously mentioned are expected to travel across Andalusian Way and along the Mandala Parade impacting the plaza area.

The prevailing north-easterly winds are also expected to side stream along the northern façade of the Doran Precinct buildings and accelerate around the façade corner at the northern end of the proposed Doran Precinct Plaza (2). These winds and the direct prevailing north-eastern winds are expected to create adverse wind conditions along the northern end of the plaza area.



**Figure 2: North-Easterly Wind Flow and Hotspots**

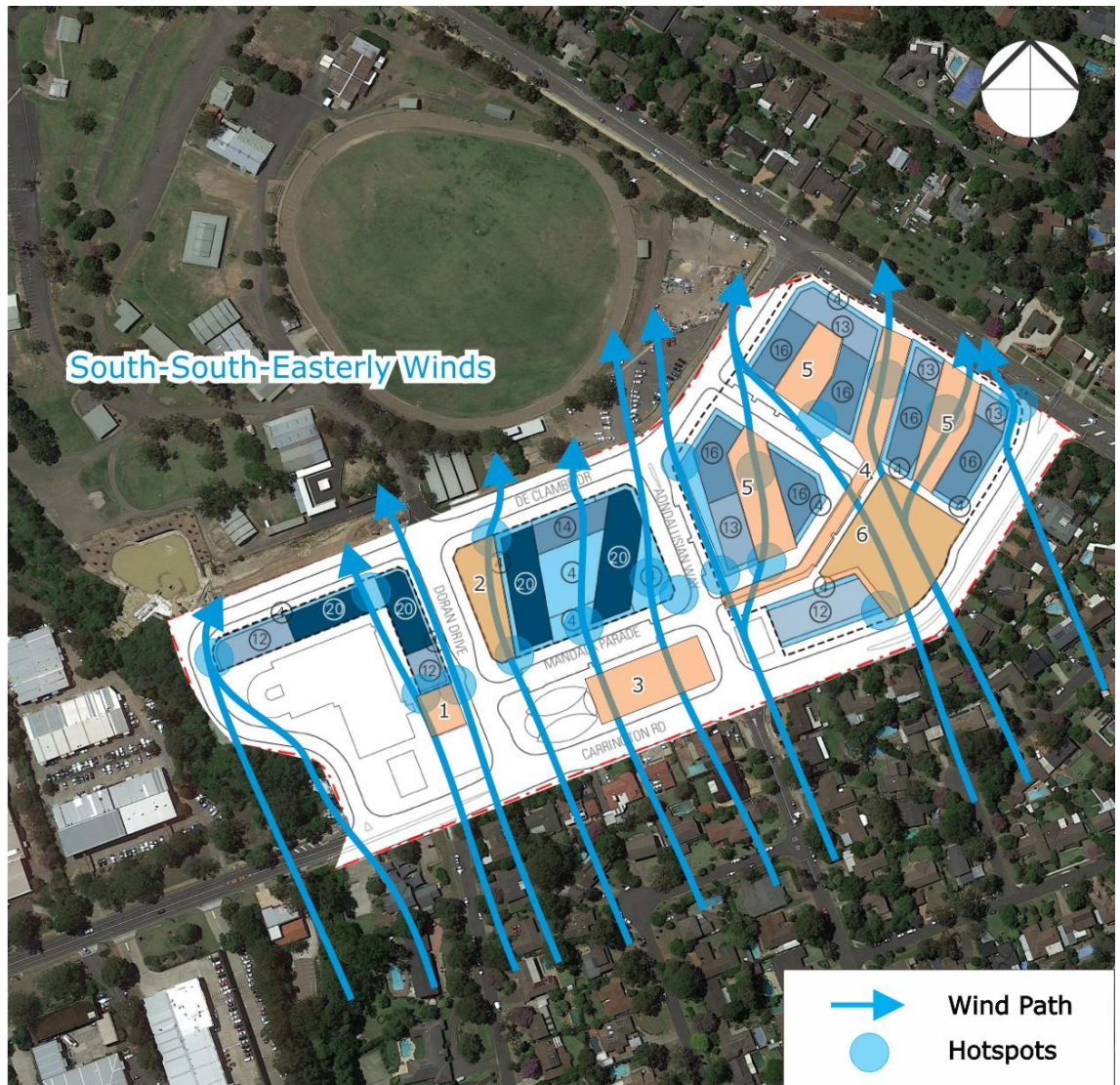
### 5.3 South-South-Easterly Sector Winds

The south-south-easterly sector winds primarily occur 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. It is noted that these low-rise residential buildings are expected to be redeveloped in the future to mid-rise residential buildings which, once redeveloped, are expected to provide shielding to the proposed development from southerly prevailing winds. The expected paths of the south-south-easterly wind flows and hotspots are shown in Figure 3.

The main wind effects that the south-south-easterly winds cause are accelerations at the south-eastern and south-western corners of the development, and funnelling between adjacent buildings on the southern aspect of the development. Corner accelerations at the western building of Precinct West, eastern corner along Showground Road and at the southern building adjacent the proposed Precinct East Park are expected to be particularly strong. Due to the alignment of the buildings on the western half of the development and the streets, Doran Drive and Andalusian Way, these prevailing south to south-easterly winds are expected to funnel between the buildings of the development and side-stream along the façade aspects parallel to the prevailing wind direction affecting the existing western plaza (1) and the proposed north-western Doran Drive plaza (2). The direct south-south-easterly winds are also expected flow over the southern low-rise residential buildings and directly impact the station plaza area (3), the pedestrian site-link (4) and the proposed Precinct East Park (6).

Downwash from the prevailing south to south-easterly winds is also expected at the western buildings of West Precinct, southern buildings of the Doran Drive Precinct and the southern building of the East Precinct adjacent the proposed park due to their exposed flat southern aspects. The down washed flows are expected to flow down to the ground level areas along the northern perimeter of the western carpark, the Carrington Street frontage and along Mandala Parade at the northern end of the station plaza area (3). These flows are expected to combine with the abovementioned side-streamed, direct and funnelled winds and exacerbate conditions further.





**Figure 3: South-South-Easterly Wind Flow and Hotspots**

#### 5.4 Westerly Winds

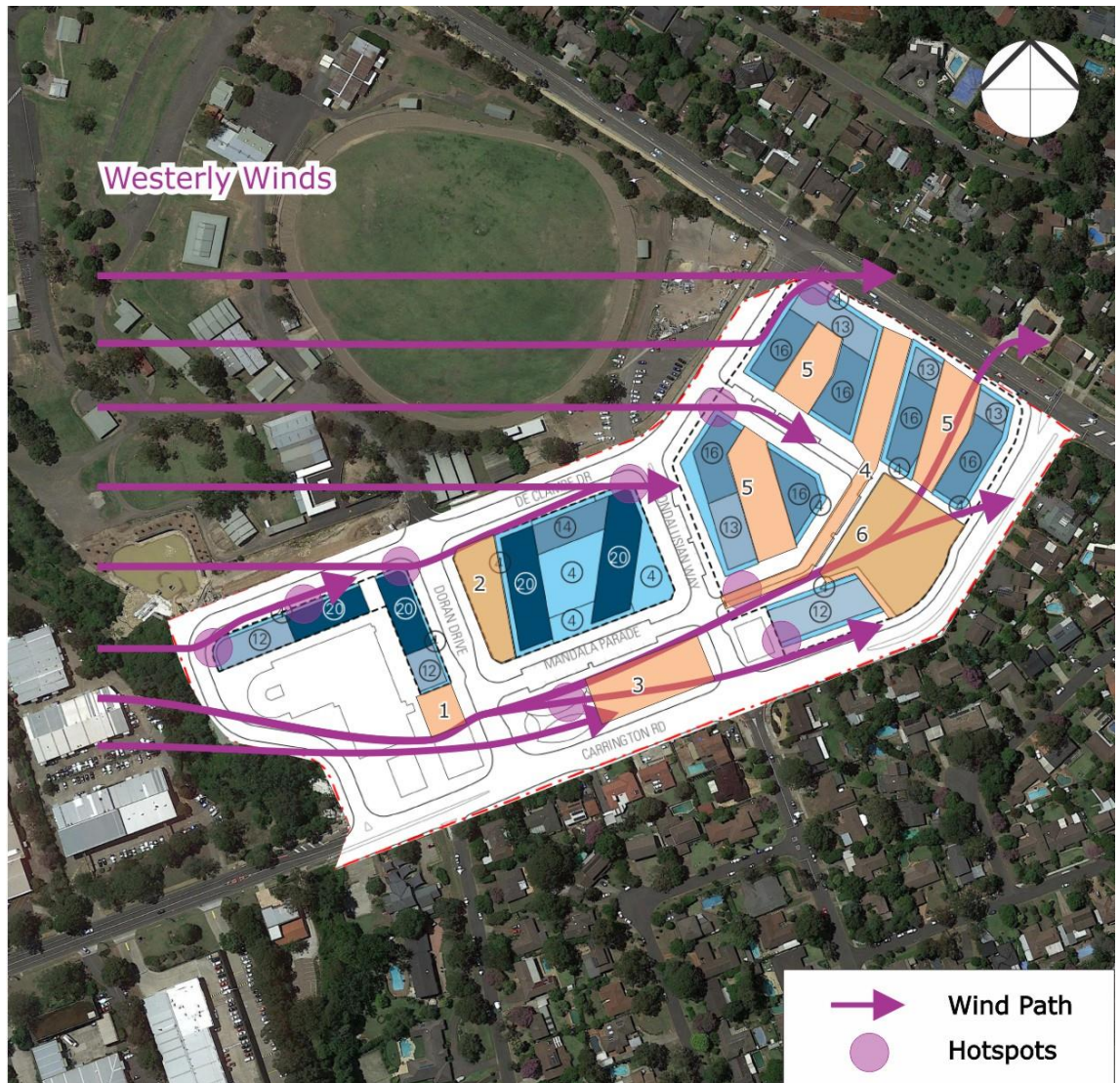
Westerly winds typically occur during the winter months of the year for the Sydney Basin region. These winds are particularly undesirable due to the negative impact upon the human perception of comfort as a result of the cooler winds. It is anticipated that certain areas of the development may be susceptible to undesirable wind effects as a result of these winds. The expected paths of the westerly wind flows and hotspots are shown in Figure 4.

The station plaza (3) at the centre of the site is exposed to the direct westerly winds due to the lack of directly upstream existing and proposed buildings. These westerly winds are expected to flow around the commuter car park and service facility box through to the station plaza. The alignment of Mandala Parade to the west also allows these prevailing winds to funnel along the northern perimeter of the station area. These funnelled winds are expected to continue past Andalusian way along the pedestrian site-link (4) and through the proposed Precinct East Park



(6). The direct westerly winds are also expected to flow through the northern end of the proposed north-western Doran Precinct plaza (2) potentially creating adverse wind conditions.

The prevailing westerly winds are expected to accelerate around the corners of buildings along De Clambe Drive and Carrington Road. Downwash is also expected to occur on the western façades of the eastern building of Precinct West due to its flat exposed façade and height that places it above the rest of the development.

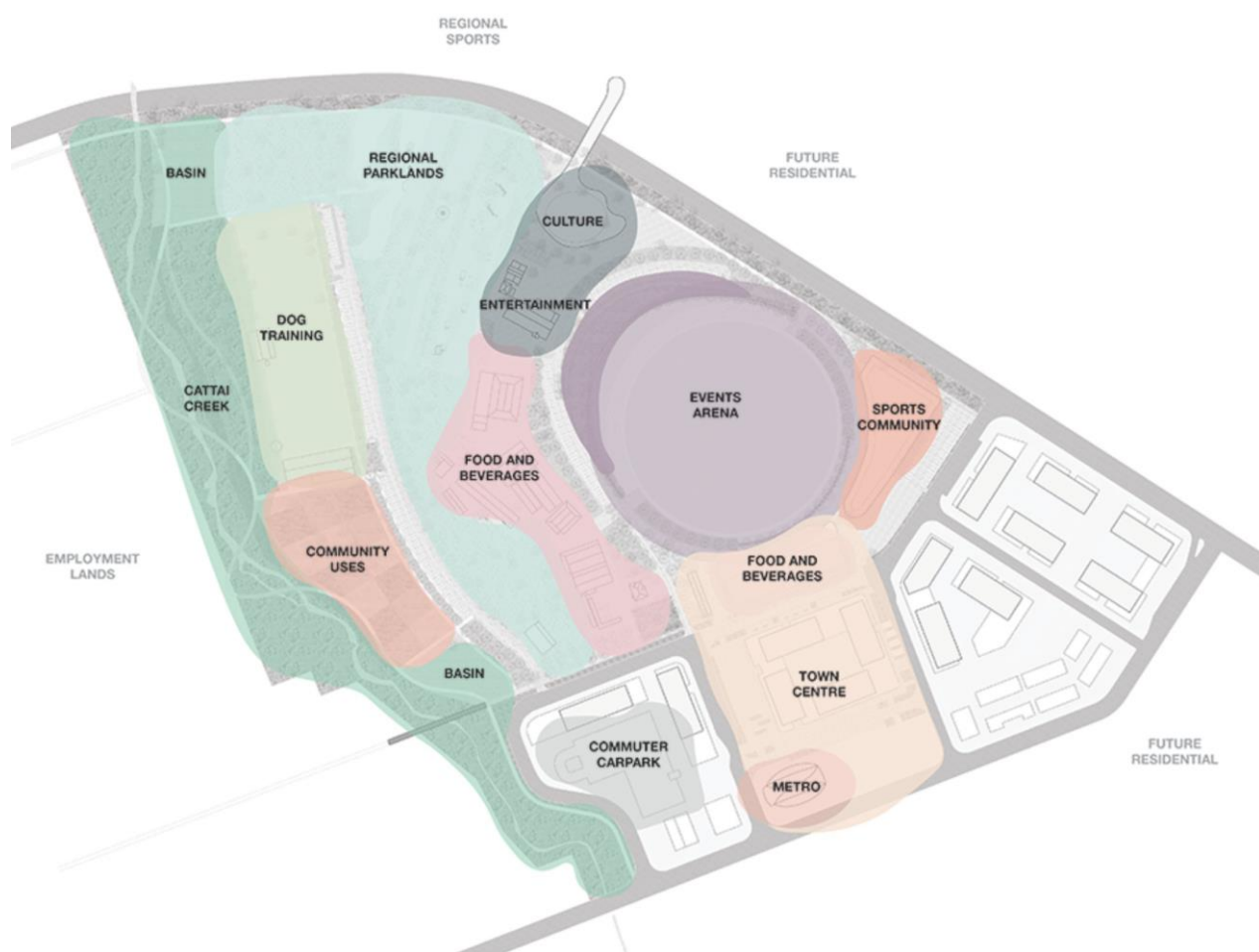


**Figure 4: Westerly Wind Flow and Hotspots**

## 5.5 Future Developments

The site adjoins Castle Hill Showground, which is currently undergoing masterplan design by The Hills Shire Council. The draft masterplan is depicted in Figure 5. The future developments to the north of the site, as depicted in Figure 5, are expected to provide some shielding from the north-easterly and westerly prevailing winds for the proposed development site. The heights of the majority of these developments are not significant relative to the buildings in the proposed development and are not expected to exacerbate any of the adverse wind conditions as described in the previous sections.

The future residential buildings to the north-east and south of the site, if constructed, are expected to provide shielding to the proposed development site from the north-easterly and southerly prevailing winds improving the wind conditions within the site.



**Figure 5: Future Developments**

**Castle Hill Showground is currently being masterplanned by The Hills Shire Council.**

**This diagram is indicative only and subject to change.**

**Source:** <https://www.thehills.nsw.gov.au/Contact-Us/Have-Your-Say/Castle-Hill-Showground-Master-Plan>

## 5.6 General Recommendations

The proposed landscaping, podium and tower setbacks and general layout of buildings within the Concept Masterplan, provided in Figure 6, is expected to be very effective in mitigating adverse wind conditions throughout the site. The proposed planting within the open communal spaces, plazas, along the site-link, around and throughout the proposed Precinct East Park is expected to provide mitigation to the expected wind effects however localised screening and/or additional planting may be required in areas for longer exposure activities. Podium and tower setbacks are also expected to assist in redirecting the down washed flows to the proposed tree lines adjacent to building facades. To further improve the wind conditions within the critical trafficable areas the following general wind mitigation treatments are recommended.

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 side streaming 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. The proposed setback in the various towers of the development is expected to assist in breaking up the downwash flows, however to effective in downwash mitigation it is suggested the setback be at least 3m in length. In downwash affected areas, especially at the ground level, continuous awnings and canopies along the affected aspect 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 down washed winds from combining with winds side streaming around the corners of the development. To reduce the ability of winds to downwash along the tower facades, horizontal feature elements and other façade elements that create a discontinuous façade surface can also be included.

Through-site links and tower aspects should be oriented to avoid direct alignment with the prevailing winds, incorporate bends, planting or screens in order to mitigate funnelling effects between building and tower massing's. 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.

We have reviewed the Concept Proposal and consider the design to be capable of conforming to the recommendations within this report. It should be noted that wind tunnel testing is required for buildings 8 or more storeys in height or over 25 metres in height as stipulated in Part D Section 19 of the Hills Development Control Plan for the Showground Station Precinct. Hence it is recommended that wind tunnel testing is conducted during the detailed design stage to provide quantitative results, verify the wind conditions and enable more detailed feedback and design of the potential wind mitigation measures.



**Figure 6: Proposed Concept Masterplan**