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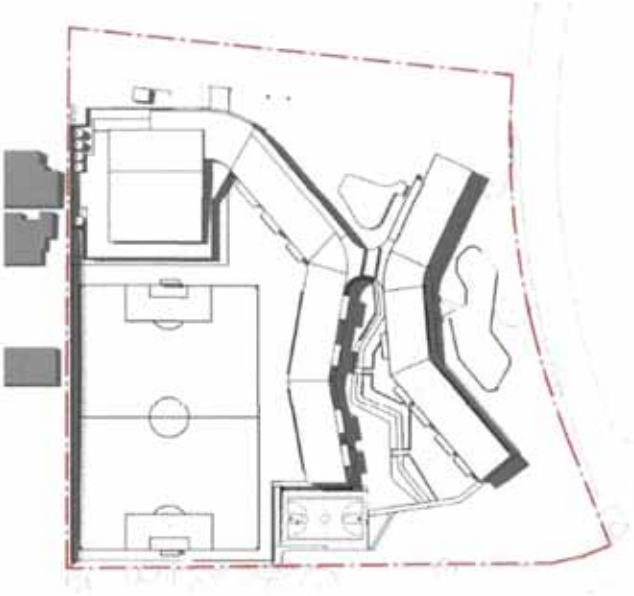
Vipac Engineers & Scientists

Tanner Kibble Denton Architects Pty Ltd

Kellyville South Public School

Wind Impact Assessment



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Report Title: Wind Impact Assessment **Job Title: Kellyville South Public School**	
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REVISION HISTORY

Revision No.	Date Issued	Reason/Comments
0	28 Oct 2016	Initial Issue
1	03 Nov 2016	Updated drawings
2	21 Dec 2016	Tidy Up
3		

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KEYWORDS:

EXECUTIVE SUMMARY

Tanner Kibble Denton Architects Pty Ltd commissioned Vipac Engineers and Scientists Pty Ltd to investigate the pedestrian wind environment in and adjacent to the proposed development of **Kellyville South Public School** at 23 Fairway Drive, Kellyville. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Drawings of the proposed development were supplied by **Tanner Kibble Denton Architects Pty Ltd** in **November 2016**, as described in Appendix C of this report.

The findings of this study can be summarised as follows:

- With the proposed design, the adjacent footpath, play courts, and covered walkways would be expected to have wind levels within the Walking comfort criterion.
- The wind conditions near the entrance areas and outdoor learning areas would be within the criterion for Standing.
- With the proposed design, the Amphitheatre would be expected to be within the recommended Sitting comfort criterion.
- The proposed development would not generate significant adverse wind impacts to the adjacent neighbors.

The recommendations and assessments provided in this report have been made based on empirical data and experience of similar situations in Sydney and around the world. As with any opinion, it is possible that an assessment of wind effects based on experience and without experimental validation may not account for all complex flow scenarios in the vicinity.

TABLE OF CONTENTS

1 INTRODUCTION

Tanner Kibble Denton Architects Pty Ltd commissioned Vipac Engineers and Scientists Ltd to prepare a statement of wind effects for the ground level areas adjacent to the proposed development of **Kellyville South Public School** at 23 Fairway Drive, Kellyville. This appraisal is based on Vipac's experience as a wind-engineering consultancy.

The proposed development consists of 4 blocks (A, B, C and D) which form an H shape, and a squared sports hall proposed at the northwest corner, an open sports field at the southwest corner. The site is bounded by Fairway Dr to the east, some residential dwellings and parkland to the west and open parkland sites to the north and south (see Figure 1). The east elevation of the proposed development is shown in Figure 2. The surrounding developments within a 1 km radius are low density suburban dwellings and open parkland areas (Figure 3). The Sydney Int. Airport is 30 km away in the SSE direction.

This report details the opinion of Vipac as an experienced wind engineering consultancy regarding the wind effects in ground level public areas and access-ways adjacent to the development as proposed. No wind tunnel testing has been carried out for this development at this stage. Vipac has carried out wind tunnel studies on a large number of developments of similar shape and having similar exposure to that of the proposed development. These serve as a valid reference for the prediction of wind effects for this development. Empirical data for typical buildings in boundary layer flows has also been used to estimate likely ground level wind conditions adjacent to the proposed development [2] & [3].

Drawings of the proposed development were provided by **Tanner Kibble Denton Architects Pty Ltd** in **November 2016** as listed in Appendix C of this report.

Figure 1: Aerial view of the proposed development site at 23 Fairway Dr, Kellyville.

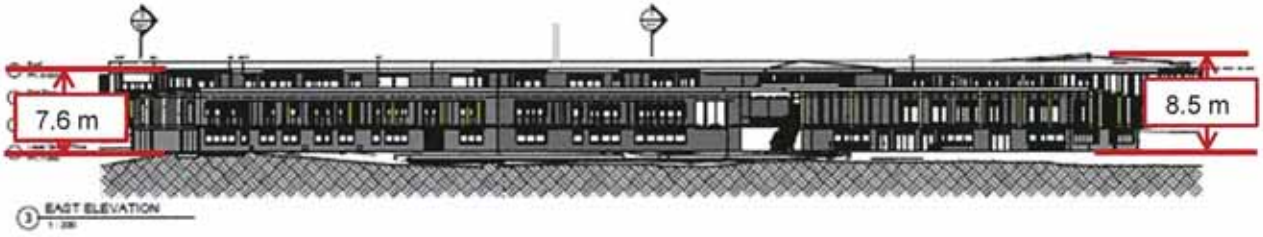


Figure 2: East Elevation of the proposed development

2 ANALYSIS APPROACH

When considering whether a proposed development is likely to generate adverse wind conditions in adjacent ground level areas and adjacent neighbours, Vipac considers five main points:

- The exposure of the proposed development to wind;
- The regional wind climate;
- The geometry and orientation of the proposed development;
- The interaction of flows with adjacent developments;
- The assessment criteria, determined by the intended use of the public areas affected by wind flows generated or augmented by the proposed development.

The pedestrian wind comfort at specific locations around a site may be assessed by predicting the worst annual 3-second wind gust expected at that location. The location may be deemed generally acceptable for its intended use if the annual 3-second gust is within the threshold values noted in Section 2.5. For cases where Vipac predicts that a location would not meet its appropriate comfort criterion we may recommend the use of wind control devices and/or local building geometry modifications to achieve the desired comfort rating. For complex flow scenarios or where predicted flow conditions are well in excess of the recommended criteria, Vipac recommends scale model wind tunnel testing to determine the type and scope of the wind control measures required to achieve acceptable wind conditions.

2.1 SITE EXPOSURE

The proposed development is predominantly surrounded within a 1 km radius by suburban housing and open parklands. Therefore, for the current study, the site of the proposed development is considered to be Terrain Category 3 for wind directions SSE to WSW and Terrain Category 2.5 for all other wind directions [1] (see Figure 3).

Figure 3: Assumed terrain categories for wind speed estimation.

2.2 REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Sydney area for 30 years. These data have been analysed and the directional probability distribution of wind speeds have been determined. The directional distribution of hourly mean wind speed at the gradient height (≈500m), with a probability of occurring once per year (i.e. 1 year return period) is shown in Figure 4. The wind data at this free stream height are common to all Sydney city sites and may be used as a reference to assess ground level wind conditions at the site. Figure 4 indicates that the stronger winds can be expected from the south to north-westerly directions, followed by south, then North Easterly directions.

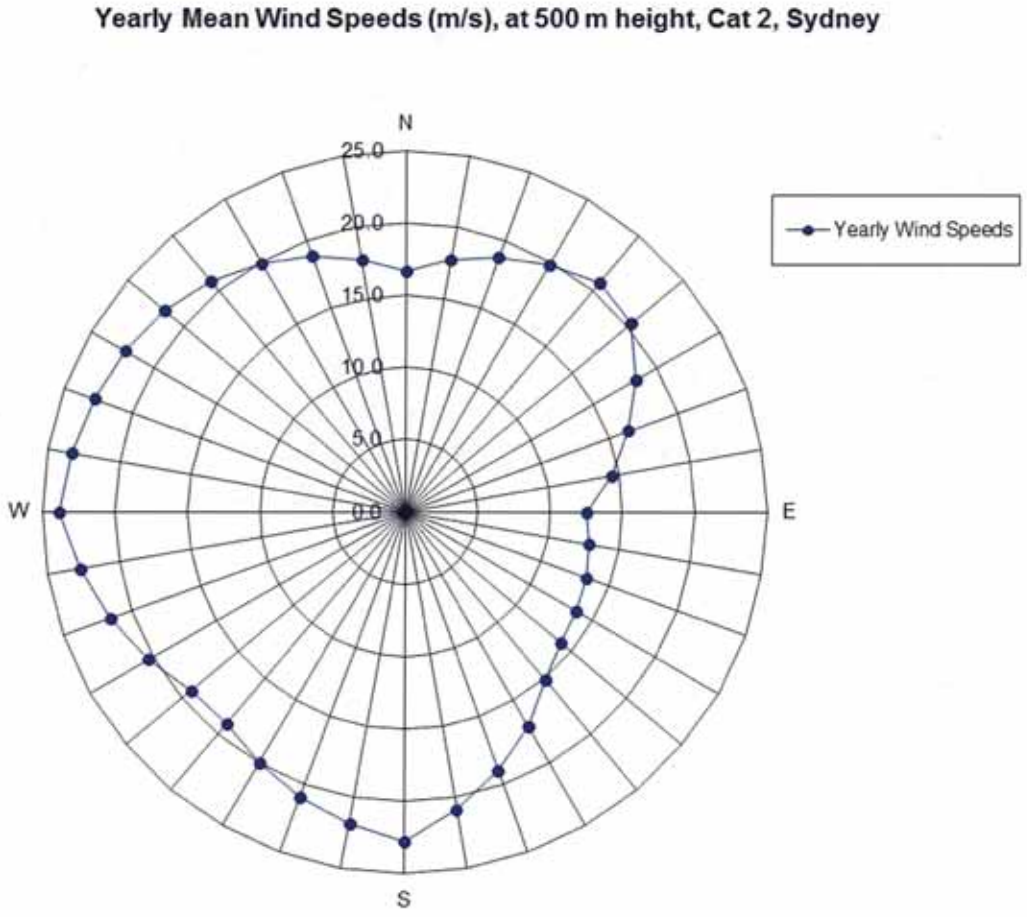


Figure 4: Directional Distribution of Annual Return Period Maximum Mean Hourly Wind Velocities (m/s) at gradient height of 500m in Sydney.

2.3 BUILDING GEOMETRY AND ORIENTATION

The proposed development site has a generally rectangular plan with dimensions approximately 210 m x 210 m. The proposed development consists of 4 blocks (A, B, C and D) which form an H shape, and a squared sports hall proposed at the northwest corner, an open sports field at the southwest corner (Figure 5).

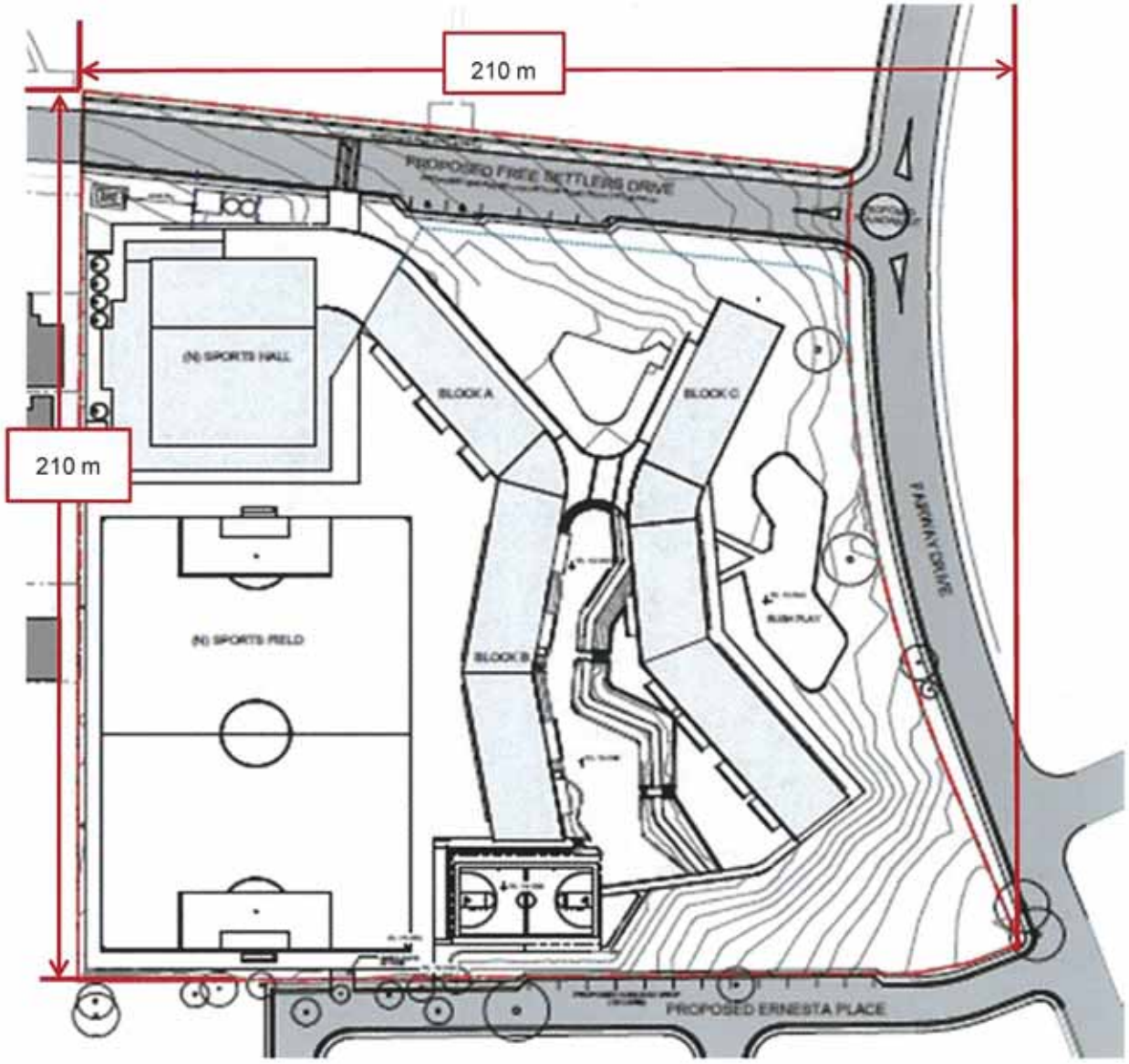


Figure 5: Site plan of the proposed development showing the approximate dimensions.

2.4 FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS

The buildings immediately adjacent to the proposed development site, with their approximate height in meters are shown in Figure 6.

The proposed development is immediately surrounded by open parkland with dense trees. There are some 4-5 m high residential dwellings to the west. The prevailing winds are from the west to the south. The ground level areas are relatively exposed to the prevailing winds.

Figure 6 : Immediately adjacent buildings and their approximate height in meters (m)

2.5 ASSESSMENT CRITERIA

With some consensus of international opinion, pedestrian wind comfort is rated according to the suitability of certain activities at a site in relation to the expected annual peak 3-second gust velocity at that location for each wind direction. Each of the major areas around the site are characterized by the annual maximum gust wind speeds. Most patrons would consider a site generally unacceptable for its intended use if it were probable that during one annual wind event, a peak 3-second gust occurs which exceeds the established comfort threshold velocity (shown in Table 1). If that threshold is exceeded once per year then it is also likely that during moderate winds, noticeably unpleasant wind conditions would result, and the windiness of the location would be considered as unacceptable.

Table 1: Recommended Wind Comfort and Safety Gust Criteria

Annual Maximum Gust Speed	Result on Perceived Pedestrian Comfort
>23m/s	Unsafe (frail pedestrians knocked over)
<20m/s	Acceptable for **fast walking** (waterfront or particular walking areas)
<16m/s	Acceptable for **walking** (steady steps for most pedestrians)
<13m/s	Acceptable for **standing** (window shopping, vehicle drop off, queuing)
<11m/s	Acceptable for **sitting** (outdoor cafés, gardens, park benches)

In a similar manner, a set of hourly mean velocity criteria (see Table 2) with a 0.1% probability of occurrence are also applicable to ground level areas in and adjacent to the proposed development. An area should be within both the relevant mean and gust limits in order to satisfy the particular human comfort and safety criteria in question.

Table 2: Recommended Wind Comfort and Safety Mean Criteria

Mean Speed in 0.1% of Time	Result on Perceived Pedestrian Comfort
>15m/s	Unsafe (frail pedestrians knocked over)
<13m/s	Acceptable for **fast walking** (waterfront or particular walking areas)
<10m/s	Acceptable for **walking** (steady steps for most pedestrians)
<7m/s	Acceptable for **standing** (window shopping, vehicle drop off, queuing)
<5m/s	Acceptable for **sitting** (outdoor cafés, gardens, park benches)

The Beaufort Scale is an empirical measure that related the wind speed to observed conditions on the land and sea. Table 3 describes the categories of the Beaufort Scale. The comparison between these observed conditions and the comfort criteria described above can be found in Table 4.

Table 3: Beaufort Scale - empirical measure relating wind speed to observed conditions on land

Beaufort Number	Descriptive Term	Wind Speed at 1.75 m height (m/s)	Specification for Estimating Speed
0	Calm	0-0.1	
1	Light Air	0.1-1.0	No noticeable wind
2	Light Breeze	1.1-2.3	Wind felt on face
3	Gentle Breeze	2.4-3.8	Hair disturbed, clothing flaps, newspapers difficult to read
4	Moderate Breeze	3.9-5.5	Raises dust and loose paper; hair disarranged
5	Fresh Breeze	5.6-7.5	Force of wind felt on body, danger of stumbling when entering a windy zone
6	Strong Breeze	7.6-9.7	Umbrellas used with difficulty, hair blown straight, difficult to walk steadily, sideways wind force about equal to forwards wind force, wind noise on ears unpleasant
7	Near Gale	9.8-12.0	Inconvenience felt when walking
8	Gale	12.1-14.5	Generally impedes progress, great difficulty with balance in gusts
9	Strong Gale	14.6-17.1	People blown over

Table 4: Comparison between Mean comfort criteria and the observed conditions

Comfort Criteria	Beaufort Scale Equivalent
Safety	9 – Strong Gale
Walking	5 – Fresh Breeze
Standing	4-5 – Moderate to Fresh Breeze
Sitting	<4 – Moderate Breeze

2.6 USE OF ADJACENT PEDESTRIAN OCCUPIED AREAS & RECOMMENDED COMFORT CRITERIA

The following table lists the specific areas adjacent to the development and the corresponding recommended criteria. These are shown in Figure 7 to Figure 8.

Table 5: Recommended application of criteria

Area	Specific location	Recommended Criteria
Public Footpaths and Access ways Play courts	Around the building blocks A B C and D as well as the play courts including open sports courts	Walking
Building entrances Outdoor learning areas	Building Entrances at ground floor Outdoor learning areas at Level 1	Standing
Steps at Amphitheatre	At the south of the link areas of the four building blocks	Sitting

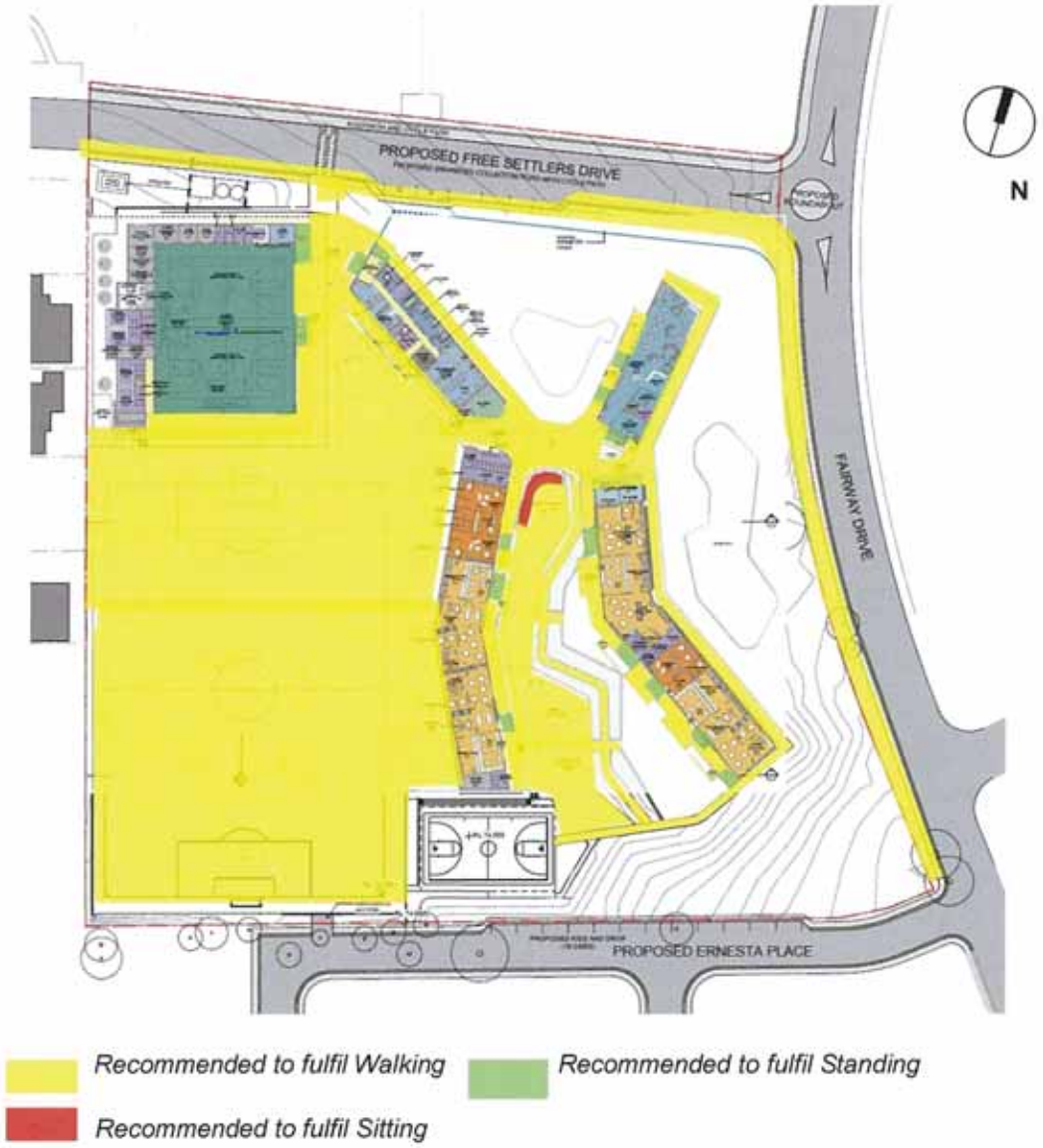


Figure 7: Plan of the ground level of the proposed development with the recommended wind criteria overlaid.

Figure 8: Plan of Level 1 of the proposed development with the recommended wind criteria overlaid.

3 PEDESTRIAN LEVEL WIND EFFECTS

3.1 DISCUSSION

Key Points

- With the proposed design, the adjacent footpaths and play courts would be expected to have wind levels within the walking comfort criterion.
- The entrance areas are well protected and wind conditions would be expected to be within the comfort criterion for standing. The outdoor learning areas would be expected to be within the standing criterion as well.
- The steps at the Amphitheatre would be expected to have wind conditions close to sitting criterion.
- The proposed development would not generate significant adverse wind impacts to the adjacent neighbors.

Ground Floor

Wind conditions at most of the footpath areas surrounding the development are relatively exposed to westerly winds; however, the proposed development is not expected to generate wind levels in excess of the criterion for walking. The covered walkways near building blocks would be expected to have wind conditions well below the walking criterion.

The entrances for the sport hall at the NW corner are well protected and would be expected wind conditions within the standing criterion. Other entrances for the building blocks are covered by canopy structure and would fulfil standing as well.

The Amphitheatre areas would experience wind conditions close to/within sitting criterion.

The proposed development would not generate significant adverse wind impacts to the adjacent neighbours due to the low rise features.

Corridors and outdoor leaning areas

The corridors at Level 1 and ground level (with some outdoor learning areas) would be expected to have wind conditions within the Walking/Standing criteria.

3.2 RECOMMENDATIONS

After careful consideration of the areas surrounding the proposed buildings, Vipac predicts that the proposed development will present some changes to existing wind conditions in adjacent ground level areas. However, Vipac predicts that all of the adjacent pedestrian pathways and building entrances, play courts, and amphitheatre are expected to achieve acceptable wind levels with the proposed design. The proposed development would not be expected to generate adverse wind impacts to the adjacent neighbors.

Therefore, Vipac makes no recommendations to alter the proposed design.

4 CONCLUSIONS

An assessment of the likely wind conditions at pedestrian level of the proposed development of **Kellyville South Public School** at 23 Fairway Drive, Kellyville has been made.

Vipac has carefully considered the form and exposure of the proposed development, nominated criteria for various adjacent areas according to their function and referred to past experience to produce our opinion of likely wind conditions. Based on this assessment, the following conclusions are drawn:

- With the proposed design, the adjacent footpath, play courts, and covered walkways would be expected to have wind levels within the walking comfort criterion.
- The wind conditions near the entrance areas and outdoor learning areas would be within the criterion for standing.
- With the proposed design, the Amphitheatre would be expected to have wind levels within the recommended Sitting comfort criterion.
- The proposed development would not generate significant adverse wind impacts to the adjacent neighbors.

The assessments provided in this report have been made based on experience of similar situations in Sydney and around the world. As with any opinion, it is possible that an assessment of wind effects based on experience and without experimental validation may not account for all complex flow scenarios in the vicinity.

This Report has been Prepared

For

Tanner Kibble Denton Architects Pty Ltd

By

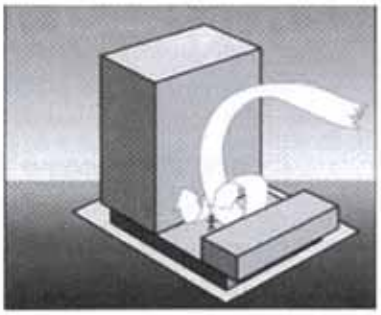
VIPAC ENGINEERS & SCIENTISTS LTD.

Appendix A: ENVIRONMENTAL WIND EFFECTS

Atmospheric Boundary Layer

As wind flows over the earth it encounters various roughness elements and terrain such as water, forests, houses and buildings. To varying degrees, these elements reduce the mean wind speed at low elevations and increase air turbulence. The wind above these obstructions travels with unattenuated velocity, driven by atmospheric pressure gradients. The resultant increase in wind speed with height above ground is known as a wind velocity profile. When this wind profile encounters a tall building, some of the fast moving wind at upper elevations is diverted down to ground level resulting in local adverse wind effects.

The terminology used to describe the wind flow patterns around the proposed Development is based on the aerodynamic mechanism, direction and nature of the wind flow.



Downwash – refers to a flow of air down the exposed face of a tower. A tall tower can deflect a fast moving wind at higher elevations downwards.

Corner Accelerations – when wind flows around the corner of a building it tends to accelerate in a similar manner to airflow over the top of an aeroplane wing.

Flow separation – when wind flowing along a surface suddenly detaches from that surface and the resultant energy dissipation produces increased turbulence in the flow. Flow separation at a building corner or at a solid screen can result in gusty conditions.

Flow channelling – the well-known "street canyon" effect occurs when a large volume of air is funnelled through a constricted pathway. To maintain flow continuity the wind must speed up as it passes through the constriction. Examples of this might occur between two towers, in a narrowing street or under a bridge.

Direct Exposure – a location with little upstream shielding for a wind direction of interest. The location will be exposed to the unabated mean wind and gust velocity. Piers and open water frontage may have such exposure.

Appendix B: REFERENCES

[1] *Structural Design Actions, Part 2: Wind Actions*, Australian/New Zealand Standard 1170.2:2011

[2] *Wind Effects on Structures* E. Simiu, R Scanlan, Publisher: Wiley-Interscience

[3] *Architectural Aerodynamics* R. Aynsley, W. Melbourne, B. Vickery, Publisher: Applied Science Publishers

Appendix C: DRAWING LIST

Drawings received on 3 November, 2016