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Vipac Engineers & Scientists

Hanson Australia Pty Ltd

Lot 10 Glebe Island NSW

Wind Impact Statement

30N-17-0233-TNT-635778-2

9 January 2018

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EXECUTIVE SUMMARY

Hanson Australia Pty Ltd commissioned Vipac Engineers and Scientists Pty Ltd to prepare a statement of wind effects for the proposed development at **Lot 10 Glebe Island NSW.** This appraisal is based on Vipac's experience as a wind-engineering consultancy.

Drawings of the proposed development were supplied by **Hanson Australia Pty Ltd** in **December 2017**, as described in Appendix C of this report.

The findings of this study can be summarised as follows:

- The development would be expected to generate wind conditions in the ground level footpath areas within the walking criterion;
- The development would be expected to generate wind conditions in the building entrance areas within the standing criterion;
- The development would be expected to generate wind conditions in the vehicle parking and work areas within the fast walking criterion;

The assessments provided in this report have been made based on experience of similar situations in Sydney and around the world.

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1 INTRODUCTION

Vipac Engineers and Scientists has been commissioned by Hanson Australia Pty Ltd to carry out an appraisal of the pedestrian wind effects at the ground level of the proposed development at **Lot 10 Glebe Island NSW.**

Strong winds in pedestrian areas are frequently encountered in central business districts of cities around the world; including Sydney, Melbourne and Brisbane. Wind characteristics such as the mean speed, turbulence and ambient temperature determine the extent of disturbance to users of pedestrian areas. These disturbances can cause both comfort and safety problems and require careful consideration to mitigate successfully.

The proposed development is an Aggregate Facility and Concrete Plant located at Glebe Island (Lot 10 DP 1170710). The site is bounded by James Craig Road, Jones Bay, and existing industrial buildings. Drawings of the proposed development were supplied to Vipac by **Hanson** in **December 2017**. A list of drawings supplied is provided in Appendix C of this report. The site plan of the proposed development is shown in Figure 1 and the west elevation is shown in Figure 2.

This report details the opinion of Vipac as an experienced wind engineering consultancy regarding the wind effects in ground level footpath areas 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. Empirical data for typical buildings in boundary layer flows has also been used to estimate the likely wind conditions on the ground level areas of the proposed development [2] & [3].

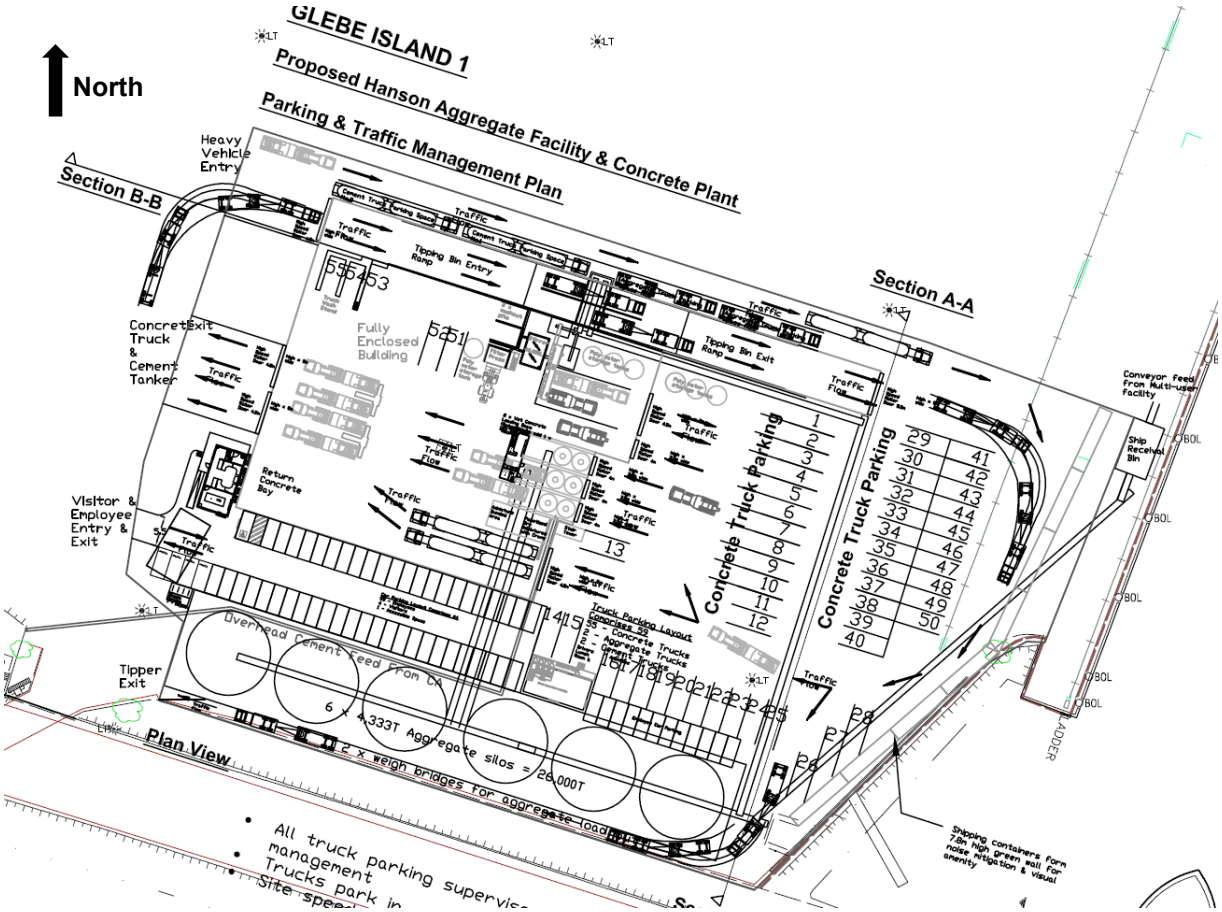


Figure 1: Site plan showing the proposed Aggregate Facility and Concrete Plant at Lot 10 Glebe Island NSW.

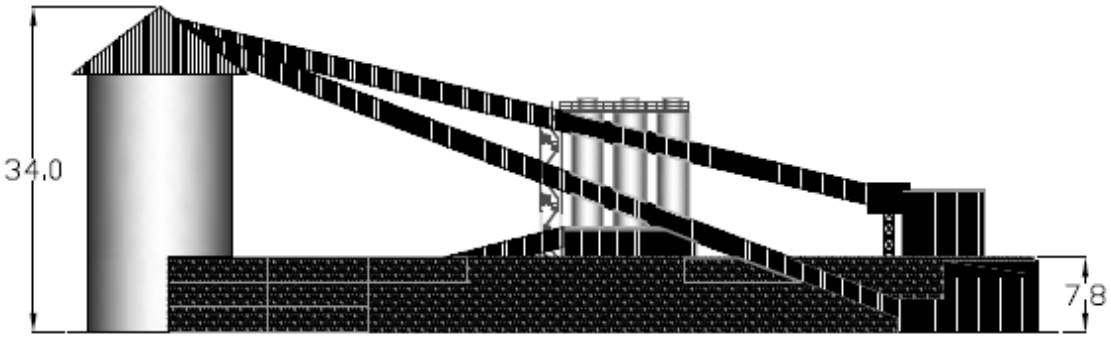


Figure 2: East elevation of the proposed development showing the approximate height of the building.

2 ANALYSIS APPROACH

In assessing whether a proposed development is likely to generate adverse wind conditions in ground level footpath areas, Vipac has considered 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 areas affected by wind flows generated or augmented by the proposed development.

The pedestrian wind comfort at specific locations of ground level footpath areas 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. Where Vipac predicts that a location would not meet its appropriate comfort criterion, the use of wind control devices and/or local building geometry modifications to achieve the desired comfort rating may be recommended. For complex flow scenarios or where predicted flow conditions are well in excess of the recommended criteria, Vipac recommend 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 located on a relatively flat terrain, surrounded within a 2 km radius by suburban housing with larger built forms to the east. Sydney CBD is approximate 2km east of the site. A satellite image showing these site surroundings is shown in Figure 3.

Considering the immediate surroundings and terrain, the site of the proposed development is assumed to be within Terrain Category 3.5 between the azimuth degrees of ~50 ^{o} and ~140 ^{o}; and Terrain Category 3 for all other directions (Figure 3).

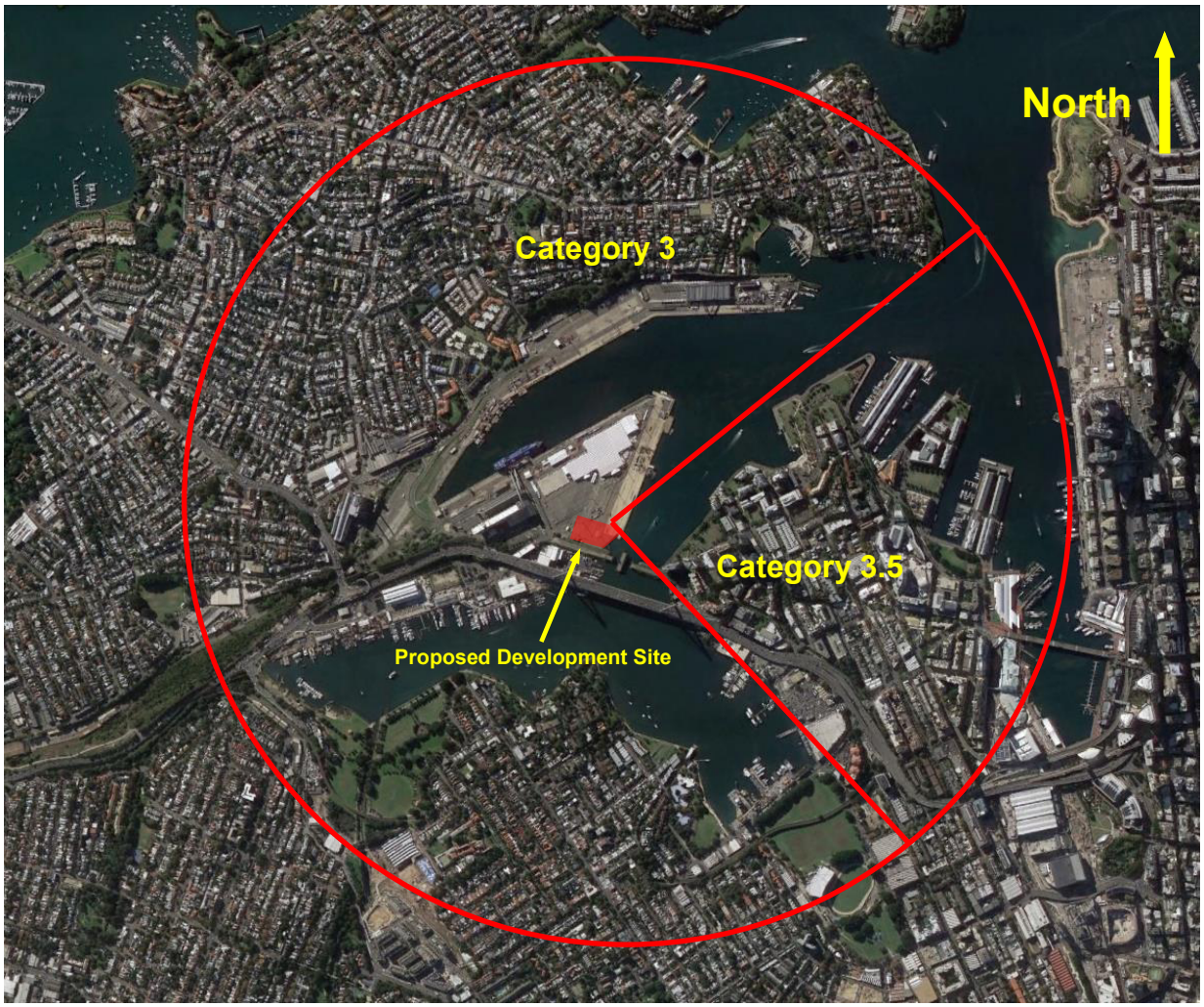


Figure 3: Assumed terrain roughness for wind speed estimation.

2.2 REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Sydney area for over 30 years. These data have been analyzed and the directional probability distribution of wind speeds has been determined. The directional distribution of hourly mean wind speed at the reference height, 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 is common to all Sydney city sites and may be used as a reference to assess ground level wind conditions at the site.

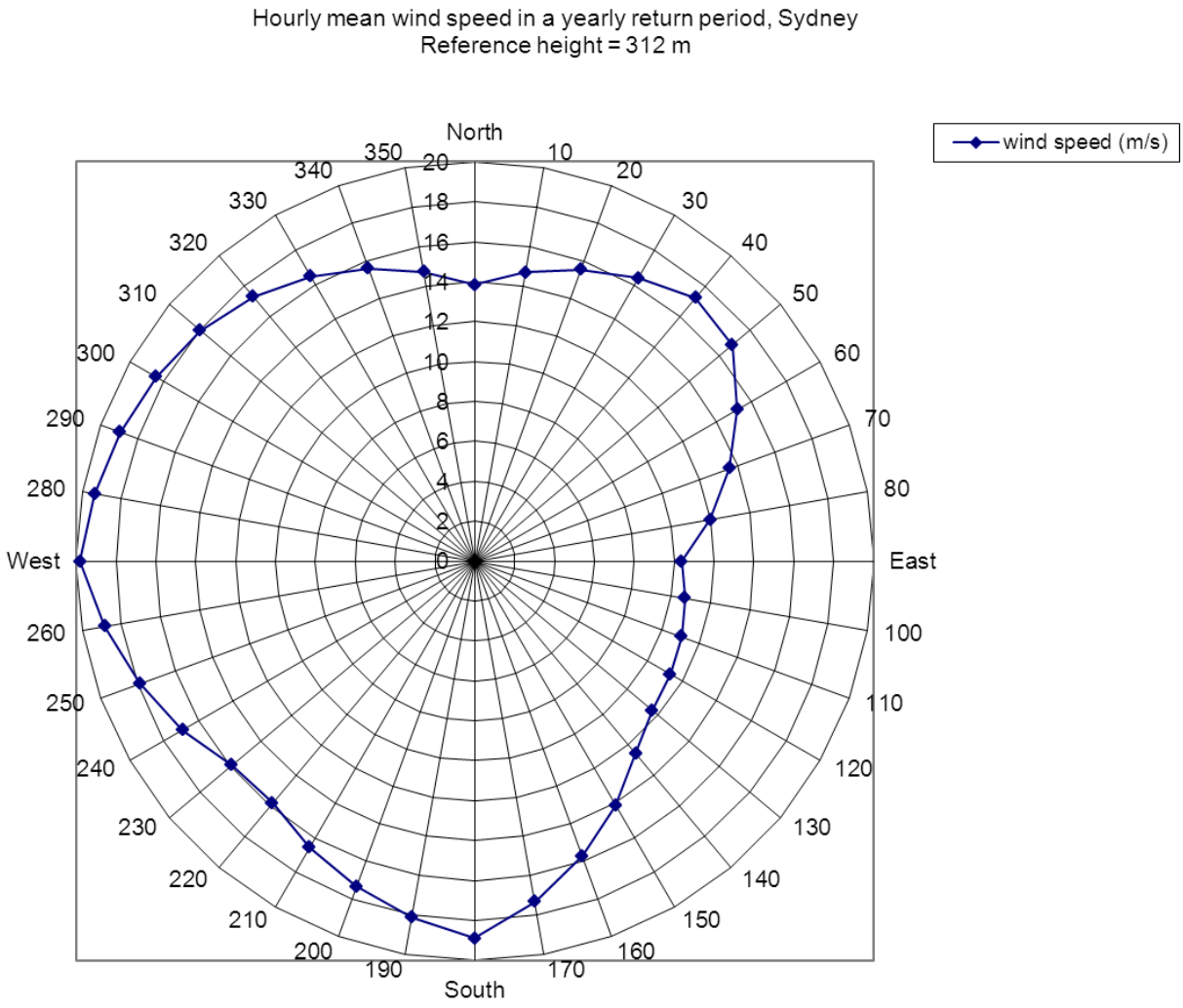


Figure 4: Directional distribution of annual return period mean hourly wind velocities (m/s) at the reference height 312m for Sydney.

2.3 BUILDING GEOMETRY AND ORIENTATION

The proposed development site has an irregular plan, with the dimensions of approximately 170 m x 104 m as shown in Figure 5. The proposed development is an Aggregate Facility and Concrete plant with a maximum height of approximately 34 m above ground level (Figure 2). The tallest structure, the storage silos, runs east to west. The site is bounded by James Craig Road to the south, Sommerville road to the west, Glebe Island Bridge, Jones Bay and existing industrial developments in other directions.

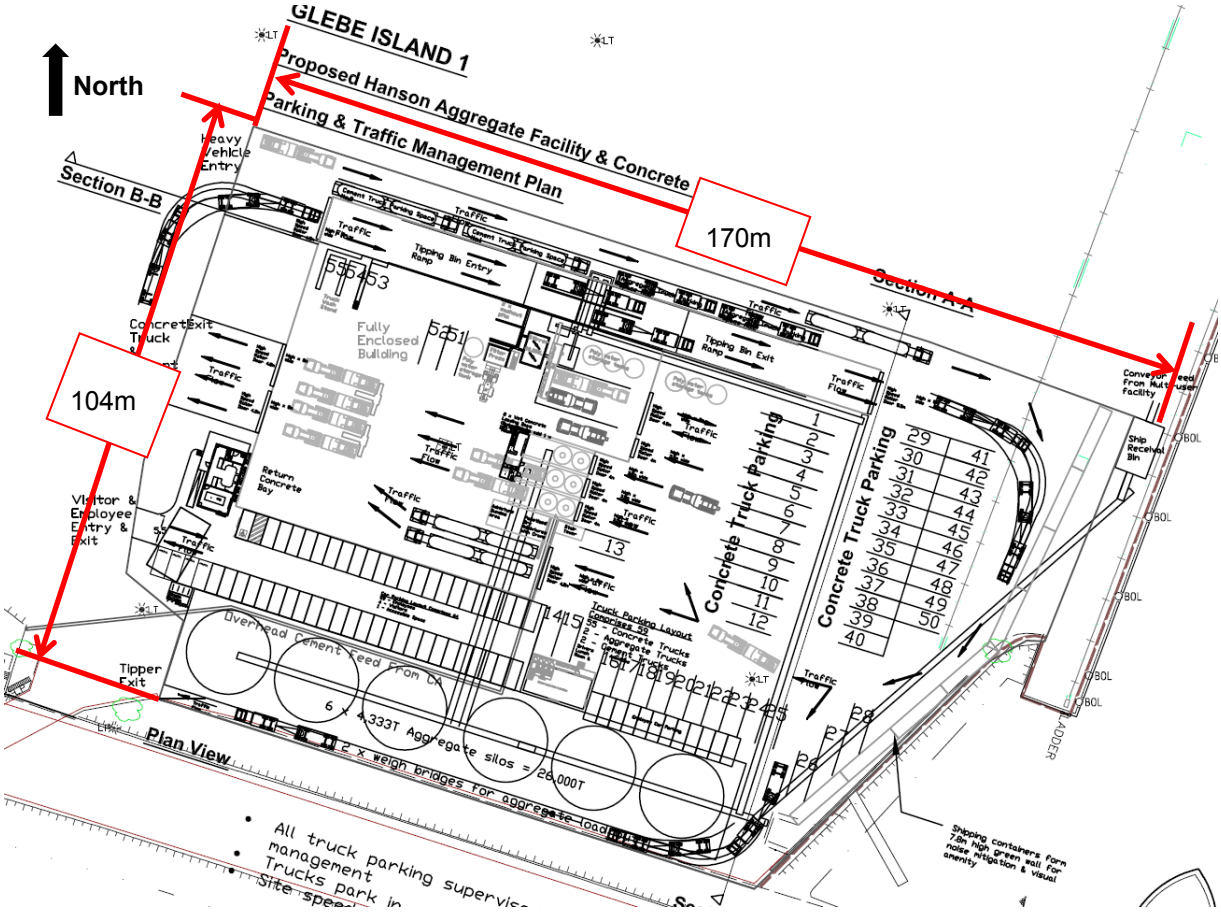


Figure 5: Ground level plan showing the approximate site dimensions.

2.4 FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS

Immediately adjacent to the proposed developments are shown in Figure 6. There are 10-55 meter high buildings surrounding the development, ranging from industrial silos to residential apartments. The proposed development is relatively exposed from winds for most directions, particularly to the north east and south east. The line of storage silos are expected to catch southerly winds. Some channelling is expected from the north, along Jones Bay and along the southern side of the proposed development.

Figure 6: Immediately adjacent surroundings and their approximate heights.

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 characterised by the annual maximum gust wind speeds. Most patrons may 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. If that threshold is exceeded once per year then it is also likely that during moderate winds, noticeably unpleasant wind conditions may result, and the windiness of the location may be voted as unacceptable.

The threshold gust velocity criteria are:

Table 1: Gust Velocity Criteria - Recommended Wind Speeds for Comfort and Safety

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 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.

The threshold mean velocity criteria are:

Table 2: Mean Velocity Criteria - Recommended Wind Speeds for Comfort and Safety

Mean wind speed exceeded 0.1% of the 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

2.5.1 USE OF ADJACENT PEDESTRIAN OCCUPIED AREAS & RECOMMENDED COMFORT CRITERIA

The following table lists the specific areas adjacent to the proposed development and the corresponding recommended criteria (see Figure 7).

Table 5: Recommended application of criteria

Area	Specific location	Recommended Criteria
Public Footpaths and arcade	Along James Craig Road	Walking
Building entrances	At the Visitor/Employee Entry and Exit.	Standing

As the development is near the waterfront, the pedestrian pathways, vehicle parking and worksites along the docks are relaxed to Fast Walking comfort criterion.

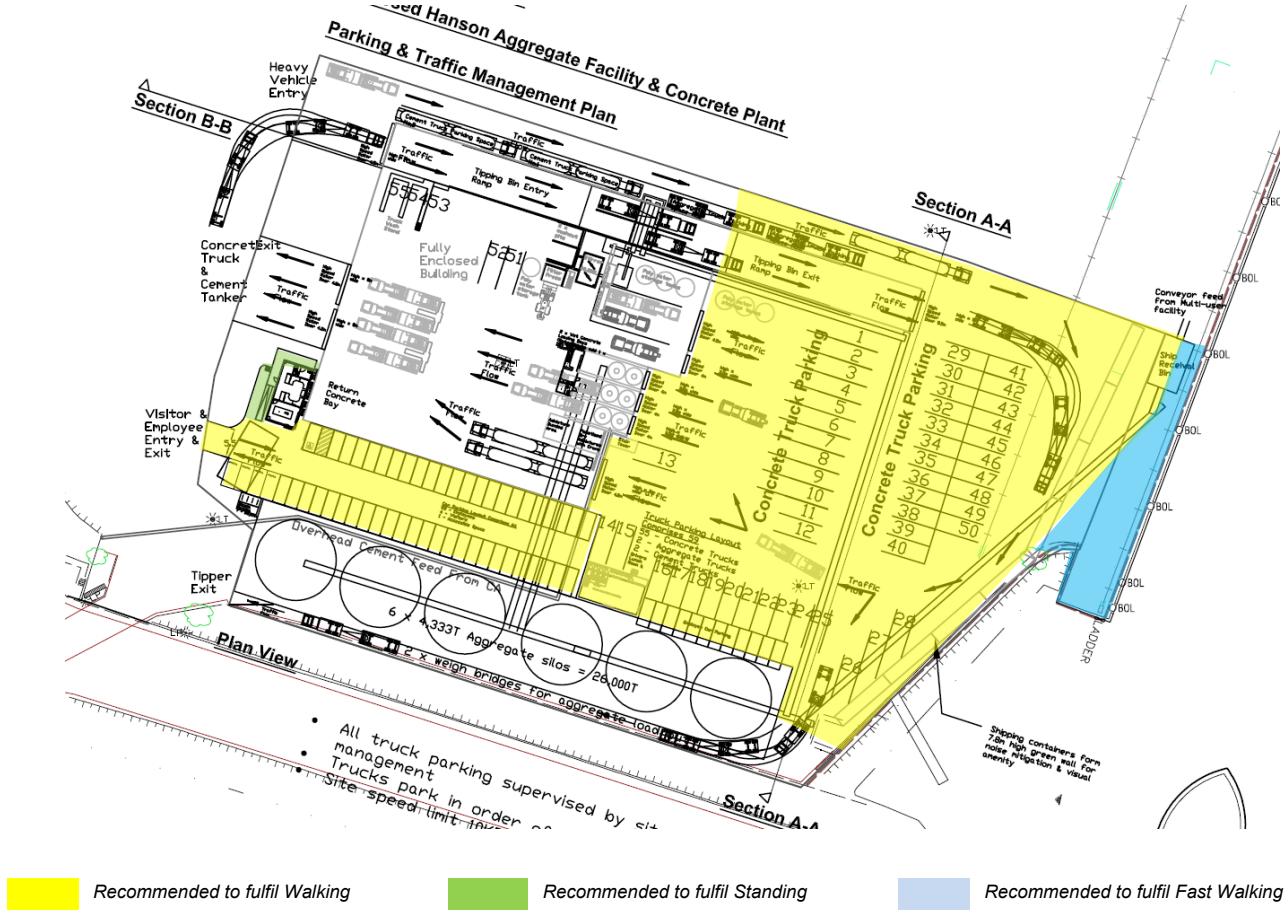


Figure 7: Plan view of the ground level of the proposed development with the recommended wind criteria overlaid.

3 PEDESTRIAN LEVEL WIND EFFECTS

3.1 DISCUSSION

Ground Level

The tallest structure of the proposed development is a 34m high silo running east to west. This is expected to catch prevailing westerly and southerly winds. Channelling westerly winds between the silos and the warehouse are expected, however the round shape of the silos as well as similarly sized development to the west is expected to provide adequate shielding. Additionally, the stacked shipping containers to the east is expected to provide shelter from adverse winds.

Therefore we expect the Visitor and Employee Entry/Exit area to be within the recommended walking comfort criteria; we expect the carpark nearby to be within the recommended walking comfort criterion, and we expect the heavy vehicle carpark and work areas to be within the recommended fast walking comfort criterion.

The public footpaths in the surroundings area are well away from the tallest structure of proposed development (approximately 80m), as this industrial area is only accessed by authorised persons. Therefore we expect that all public footpaths will be within the recommended walking criterion.

3.2 RECOMMENDATIONS

After careful consideration of the form and exposure of the proposed development, Vipac predicts that the design will present some changes to existing wind conditions in adjacent ground level areas. However, Vipac does not predict any exceedance of the various recommended criteria for the pedestrian level wind at ground level. Therefore Vipac makes no recommendations for the alteration of the design as proposed.

It should be noted that this study is based on experience only and has not utilised any experimental data for the analysis.

4 CONCLUSIONS

An assessment of the likely wind conditions for the proposed extension to the **Lot 10 Glebe Island NSW** has been made.

Vipac has carefully considered the form and exposure of the proposed development, nominated criteria for various public and communal 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 development would be expected to generate wind conditions in the ground level footpath areas within the walking criterion;
- The development would be expected to generate wind conditions in the building entrance areas within the standing criterion;
- The development would be expected to generate wind conditions in the vehicle parking and work areas within the fast walking criterion;

The recommendations and assessments provided in this report have been made based on experience of similar situations in Sydney and around the world.

This Report has been Prepared

For

Hanson Australia Pty Ltd

By

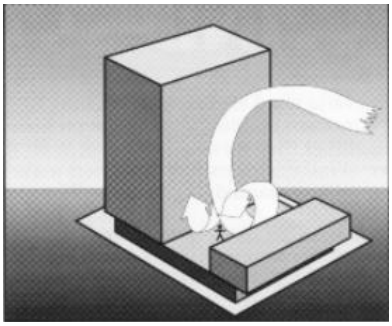
VIPAC ENGINEERS & SCIENTISTS LTD.

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.



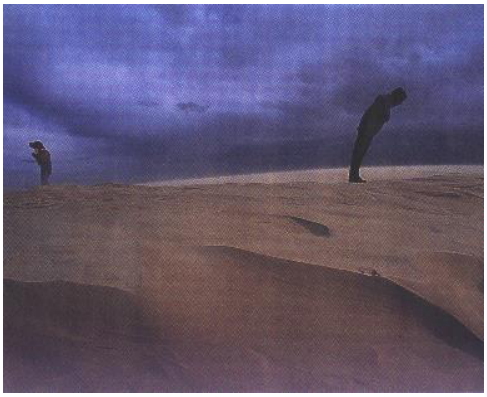
Downwash – refers to a flow of air down the exposed face of a tower. A tall tower can deflect a fast moving wind at higher elevations downwards.

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

File Received 4/12/2017

Glebe Island 1 GAs – V13B_Overlaid