

Crown Prosha Joint Venture

Eastlakes Town Centre Redevelopment Wind Effect Statement



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EXECUTIVE SUMMARY

Crown Prosha Joint Venture has commissioned Vipac Engineers and Scientists Ltd to prepare a statement of wind effects for the ground level areas adjacent to the proposed **Eastlakes Town Centre Redevelopment, NSW**. This appraisal is based on Vipac's experience as a wind engineering consultancy.

Drawings of the proposed Redevelopment were supplied by **Rice Daubney** dated April 2012.

The findings of this study can be summarised as follows:

- The proposed development expected to fulfil the walking criteria in all ground level areas with the proposed and recommended landscape plantings.
- Wind conditions in the entrance areas expected to fulfil the recommended criterion for standing with the proposed and recommended landscape plantings.
- Wind conditions within the east west through site link at the south site will likely fulfil the walking criterion with the proposed landscape plantings.
- Wind conditions in the podium level expected to fulfil the recommended criteria for walking/sitting with the proposed landscape plantings and recommended windscreens.
- All the above recommended plantation and windscreens should be validated by wind tunnel test in detail design stage.
- Educating residents about wind conditions at high-rise balconies during high-wind events and tying down loose lightweight furniture are highly recommended.

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 might be in error, where it is based on experience only without wind tunnel model testing. Vipac recommends a wind tunnel test to verify the assessment and to determine the proper wind measures wherever necessary.

TABLE OF CONTENTS

1. INTRODUCTION.....	5
2. ANALYSIS APPROACH	6
2.1. SITE EXPOSURE	7
2.2. REGIONAL WIND CLIMATE	8
2.3. BUILDING GEOMETRY AND ORIENTATION	9
2.4. FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS	11
2.5. ASSESSMENT CRITERIA.....	11
3. PEDESTRIAN LEVEL WIND EFFECTS AND RECOMMENDATIONS.....	15
3.1. RECOMMENDATIONS.....	15
4. CONCLUSIONS.....	18
APPENDIX A - ENVIRONMENTAL WIND EFFECTS	19
APPENDIX B - REFERENCES	20
APPENDIX C – DRAWING LIST.....	21

1. INTRODUCTION

Vipac Engineers & Scientists Ltd was commissioned by **Crown Prosha Joint Venture** to carry out an appraisal of wind effects in pedestrian areas in and adjacent to the proposed **Eastlakes Town Centre Redevelopment, Sydney, NSW**.

The site of the proposed Development is at the block bounded by Gardeners Rd to the north, Barber Ave to the south and east, the existing buildings and parklands to the west as shown in Figure 1.

The proposed redevelopment is a mixed use development located on two building sites (north and south) separated by Evans Ave. Figures 2a is the north site south elevation and Figure 2b, the south site north elevation of the proposed development. The maximum height for the residential buildings is 30 m (8 storeys).



Figure 1 Satellite image of the site of the proposed Eastlakes Town Centre Redevelopment, NSW.

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 in and adjacent to the redevelopment as proposed. No wind tunnel testing has been carried out for this Development. 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 ground level wind conditions adjacent to the proposed redevelopment [2] & [3].

Drawings of the proposed redevelopment were supplied by Rice Daubney dated April 2012. A complete list of drawings supplied is provided in Appendix C of this report.



Figure 2a South site north elevation of the proposed Eastlakes Town Centre Redevelopment.



Figure 2b North site south elevation of the proposed Eastlakes Town Centre Redevelopment.

2. ANALYSIS APPROACH

In assessing whether a proposed Development is likely to generate adverse wind conditions in adjacent ground level 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 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. 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 site of the proposed Eastlakes Town Centre Development is at the block bounded by Gardeners Rd to the north, Barber Ave to the south and east, the existing buildings and parklands to the west. Within a 2km radius of the site of the proposed development there is a built up areas of low-rise developments, parklands and water areas (Figure 3).

Immediately adjacent developments are shown in Figure 4. To the north of the site of the proposed development there are 1 - 2 storeys low-rise developments. At the west side of the development there are 4 storeys high buildings to the north block and parklands to the south block. At east and south sides of the development there are 3 – 4 storeys high buildings.

The site of the proposed development is therefore considered to be within a Terrain Category 3 (suburban terrain) for winds from all directions [1](see Figure 3).

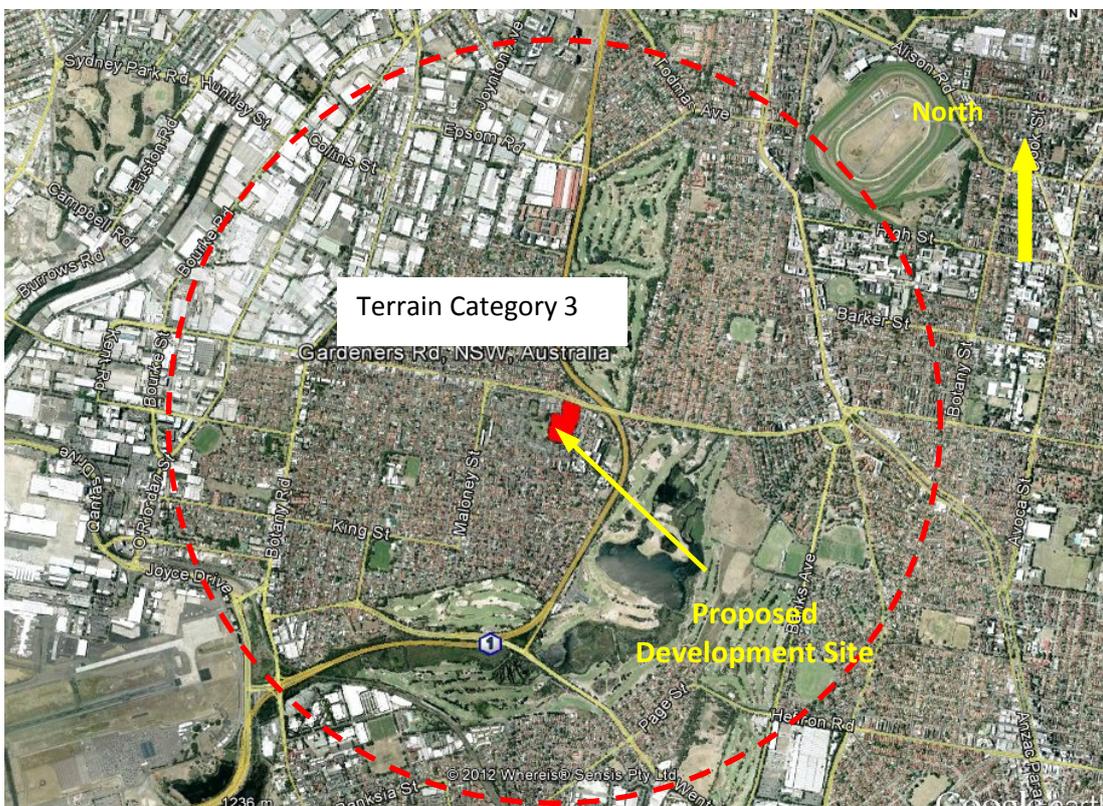


Figure 3 Terrain Category for approaching wind directions to the site



Figure 4 Immediately adjacent surroundings and their number of storeys

2.2. REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Sydney area for over 30 years. This data has 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 with a probability of occurring once per year (i.e. 1 year return period) is shown in Figure 5. 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.

The winds from west are strongest and those from south are stronger than the winds from north east.

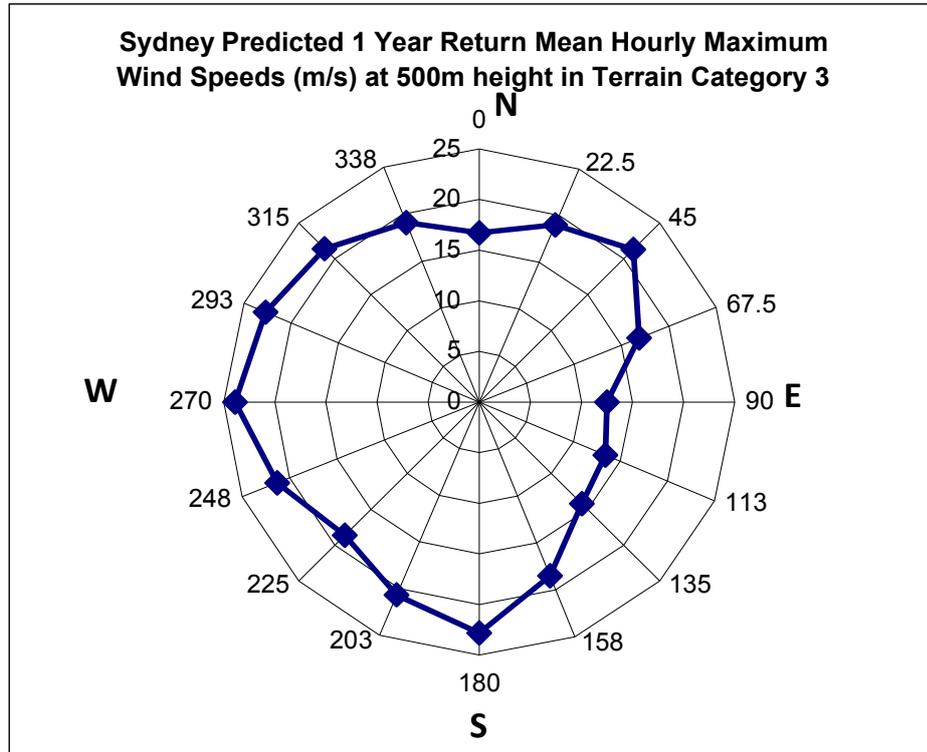


Figure 5 Directional Distribution of Annual Return Period Mean Hourly Wind Velocities (m/s) at Gradient Height for Sydney.

2.3. BUILDING GEOMETRY AND ORIENTATION

The proposed Development is a mixed use development with retail development on the ground floor and residential apartment buildings above, located on north and south sites. The north site is 61m by 105 m rectangular plan, with the long axis running northwest to southeast direction. The south site is 132m by 141 m rectangular plan, with the long axis running north south direction. The building orientation is shown in Figure 6.

There are ground level pedestrian access-ways adjacent to the proposed development at Evans Avenue and Barber Avenue. The main mall entrances are proposed at Evans Avenue and Barber Avenue.

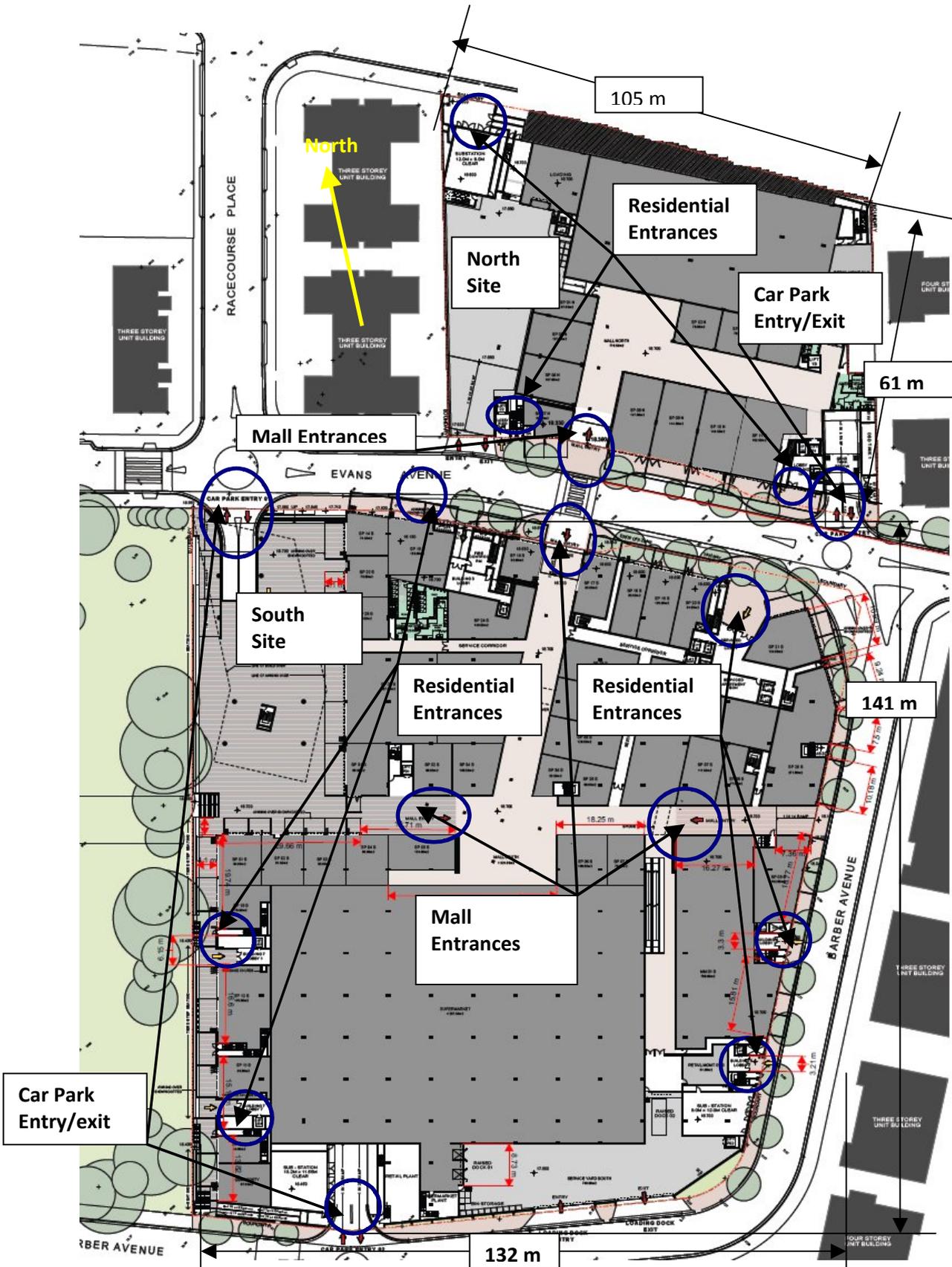


Figure 6 Ground floor plan of the proposed redevelopment.

2.4. FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS

As shown in Figure 4 the immediately adjacent surroundings constitute good shelters in the directions from south through east to north for the ground level wind conditions. However, there is no significant shelter for the winds from west direction for the south site of the development.

2.5. ASSESSMENT CRITERIA

Vipac's assessment criteria for pedestrian wind comfort are based on some consensus of international opinion. A set of annual maximum peak 3-second gust velocities is derived from meteorological data for the geographical location under consideration, for each wind direction to be assessed. For each wind direction, the regions where the wind speed criteria may be exceeded are then considered.

Most people will consider a site completely unacceptable for a given activity if the mean and/or gust speeds exceed the annual maximum wind speed criterion for that activity. Studies have shown that if the annual wind speed criterion is exceeded, the site would also be considered excessively windy for that activity during more moderate winds [4]. Therefore, the suitability of any site for a particular usage can be reasonably assessed by predicting the annual maximum wind speeds and comparing these against the following criteria:

The threshold gust speed criteria are:

Annual Maximum Gust	Result on Perceived Pedestrian Comfort
>23m/s	Unsafe (frail pedestrians knocked over)
<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 café's, pool area, gardens)

Table 1 – Internationally adopted Wind Comfort and Safety Gust Criteria

In a similar manner, a set of hourly mean speed criteria with a 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 speed criteria are:

Mean, 1% of Time	Result on Perceived Pedestrian Comfort
>15m/s	Unsafe (frail pedestrians knocked over)
<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 café's, pool area, gardens)

Table 2 – Internationally adopted Wind Comfort and Safety Mean Criteria

Intended Use of Adjacent Ground Level Areas

Footpaths are at Evans Avenue and Barber Avenue of the proposed development. There is a walk way at the west side of the south site of the proposed development at the ground level. Mall entrances are at Evans Avenue and Barber Avenue. The residential entrances are at Barber Avenue for the south site and at Evans Avenue, Gardeners Road for the north site of the development.

Car park entry/exit is at Evans Avenue and Barber Avenue for the proposed redevelopment.

Some gardens and footpaths are proposed at Podium level (Level 1).

Recommended Criteria

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

Area	Recommended Criteria
Public Footpaths	Recommend to fulfil Walking
Mall and Residential entrances	Recommend to fulfil Standing
Sitting areas at Level 1 (Podium level)	Recommend to fulfil Sitting
Residential apartment Balconies	Recommend to fulfil Walking (<i>refer to notes below</i>)

Table 3 – Recommended application of criteria

Apartment Balcony/Terrace Recommended Criterion Discussion

Vipac recommend as a minimum the apartment balconies/terraces meet the criterion for walking since,

- these areas are not public spaces,
- the use of these areas is optional,
- many similar developments in Sydney and other Australian capital cities experience wind conditions on balconies/terraces and elevated deck areas in the vicinity of the criterion for walking.

Vipac wish to clearly state that meeting the walking criterion on elevated recreation areas will be no guarantee that occupants will find wind conditions in these areas acceptable.

It is Vipac’s experience that outdoor recreation areas should be close to the criterion for sitting comfort in order that the majority of reasonable people consider such areas acceptable for their intended use from a wind point-of-view. Wind conditions over this criterion will tend to result in a perceived reduction in amenity of the area.

This perception may be due to:

- the cooling effect of the wind on the human body (particularly for pool deck areas),
- the removal of lightweight items such as towels, serviettes, newspapers, lightweight furniture (eg. plastic banana lounges),
- difficulty hearing others speak.

Wind conditions meeting the criterion for walking may still result in the following adverse effects whilst the roof top area is unoccupied:

- the removal of lightweight furniture during storms,
- the removal of some water from pools during storms.

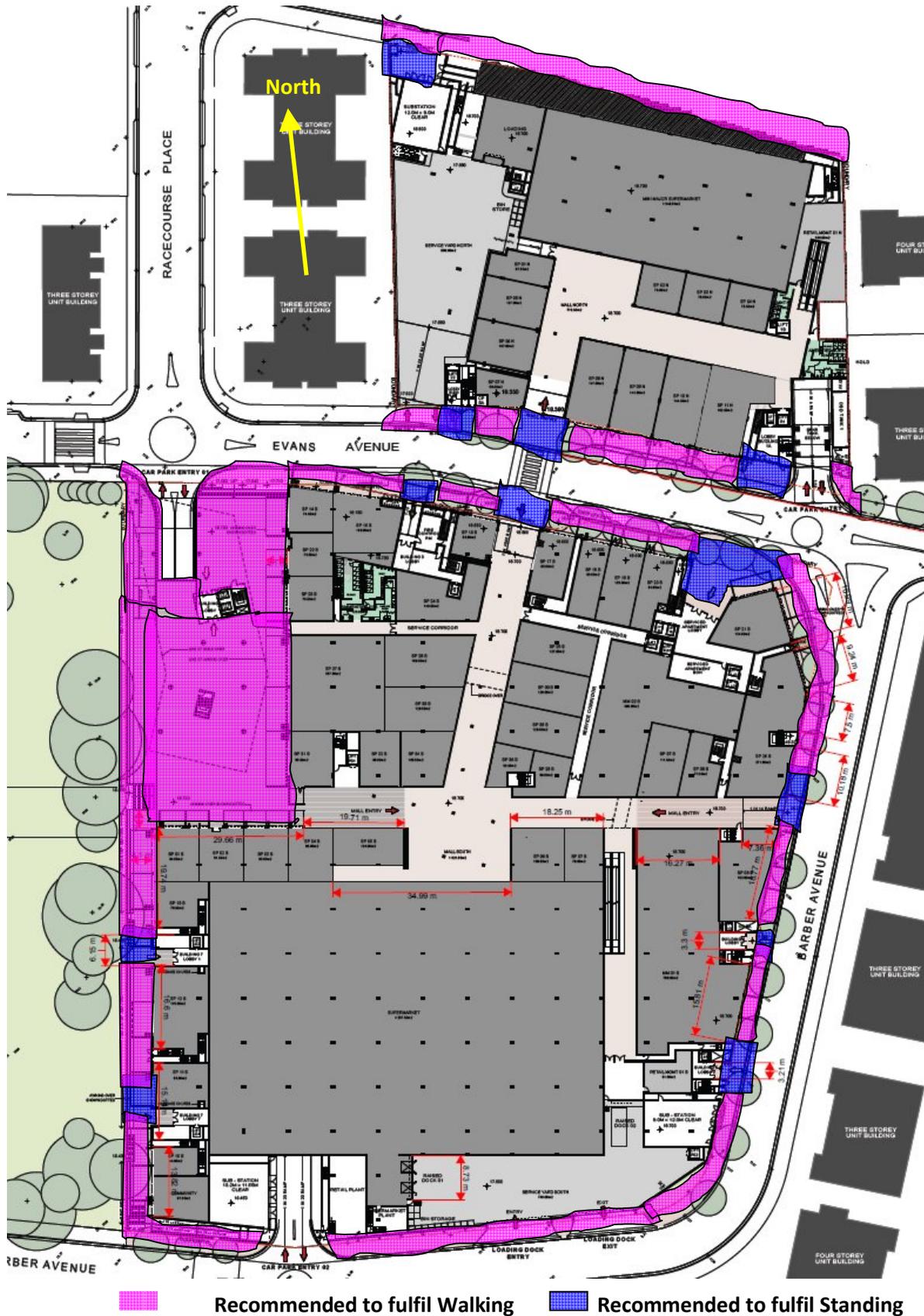
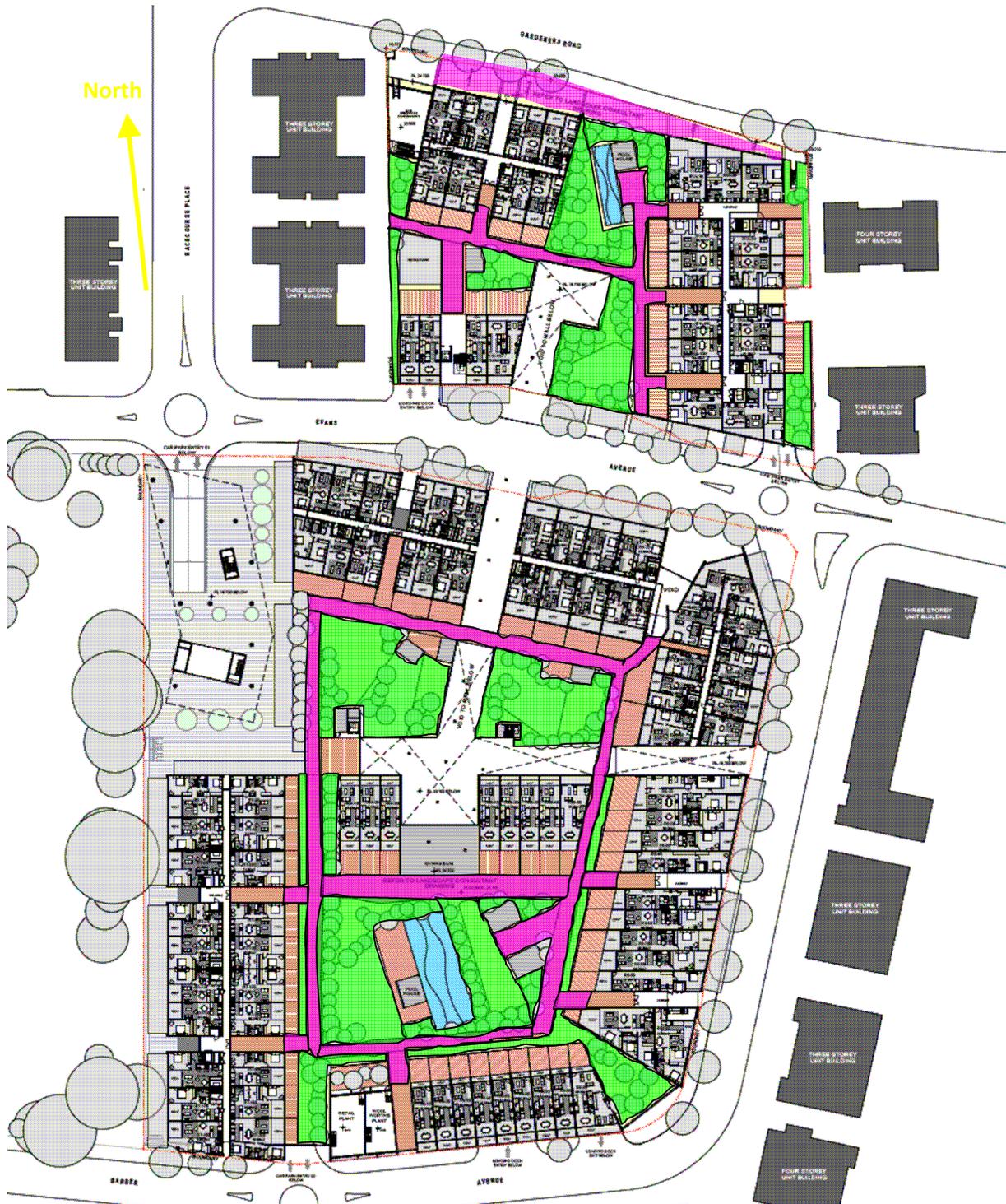


Figure 7a Schematic plan view of the proposed Development with recommended wind criteria overlaid on adjacent ground level areas



Recommended to fulfil Walking Recommended to fulfil Sitting

Figure 7b Schematic plan view of the proposed Development with recommended wind criteria overlaid at the podium level (Level 1)

3. PEDESTRIAN LEVEL WIND EFFECTS AND RECOMMENDATIONS

Key points:

- The proposed development is considered likely to have wind conditions on the adjacent ground floor public access-ways in fulfilling of the recommended criteria for walking/standing with proposed and recommended landscape plantings.
- Vipac predicts wind conditions on the elevated balconies would be close to or in excess of the walking criterion. Vipac note that such wind conditions are typical of balcony areas on many high-rise residential buildings in Australian capital cities.
- Vipac predicts wind conditions at some open locations on the podium level would be close to or in excess of the recommended criterion.

Ground level

The proposed development is expected to likely fulfil walking criteria at most of footpath areas in ground level and fulfil the standing criterion at the entrance areas. The east west through site link at the south site will likely fulfil the walking criterion. However there is possibility that expected to likely exceed standing criterion at southwest residential entrance of the south site of the proposed redevelopment.

Podium level

The most of the podium level outdoor areas are expected to likely fulfill the recommended sitting and walking criteria. However, windscreens are recommended at some open areas to reduce the wind speeds.

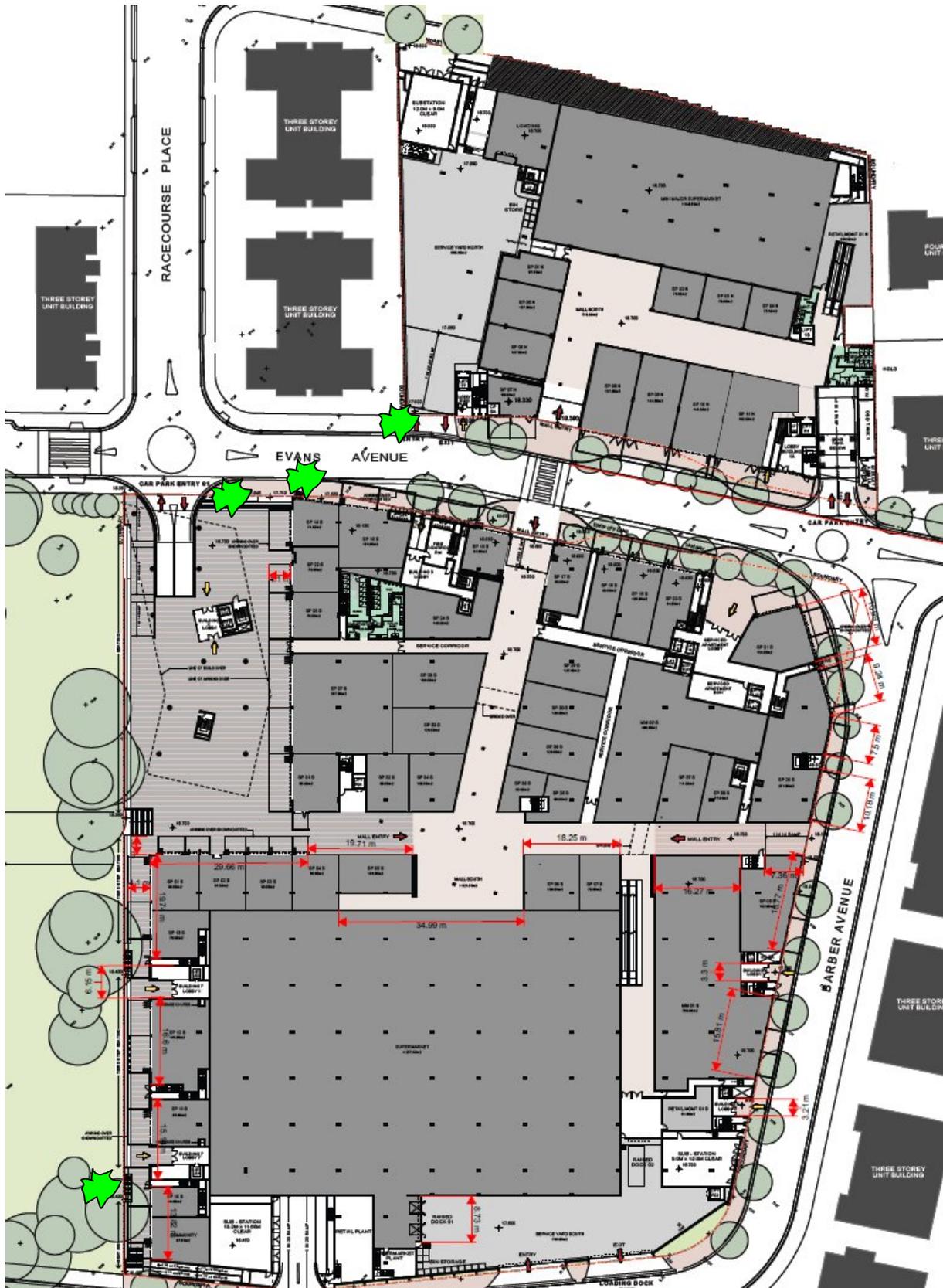
Residential apartment balconies

Whilst wind conditions on the proposed apartment balcony areas will frequently be acceptable for outdoor recreation, during moderate to strong winds conditions in these areas may rapidly exceed human comfort criteria. As discussed in Section 2.5, balconies at high level of exposed building structures typically experience elevated wind conditions. Downwash, corner acceleration flows and standing vortices from the structures will frequently preclude these areas from use for outdoor recreation. Lightweight items left in these areas would be at risk of being removed by the wind. Recommendations have been made in this regard in Section 3.1.

3.1. RECOMMENDATIONS

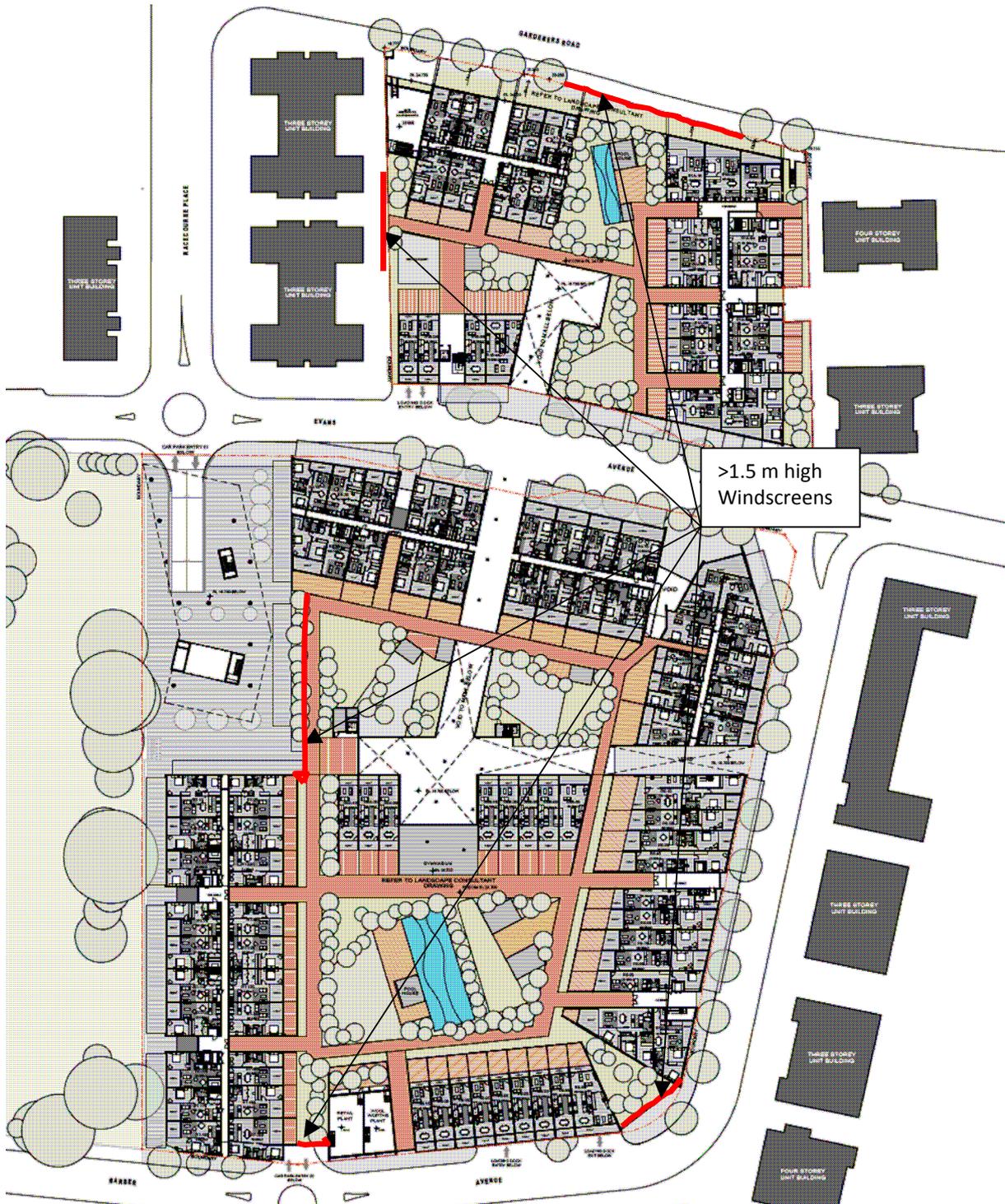
The proposed landscape plantings at ground level and podium level have wind reduction effects to the footpath areas. Vipac recommends some additional landscape plantings at the west side of the south site for the residential entrance areas to fulfil the recommended standing criterion and some other locations to fulfil the recommended walking criterion for footpath areas (Figure 8a).

The proposed landscape plantings at podium level have wind reduction effects to the podium garden areas. Vipac recommended some windscreens at some open areas to protect the public areas from the strong winds flowing into the podium areas (Figure 8b).



 Recommended trees

Figure 8a Recommended wind control measures for the ground level.



 Recommended windscreens

Figure 8b Recommended wind control measures for the podium level (Level 1).

4. CONCLUSIONS

An appraisal of the likely wind conditions adjacent to the proposed Eastlakes Town Centre Development has been made.

Vipac has carefully considered the form and exposure of the proposed Development, nominated criteria for various ground level areas according to their function, made calculations using empirical data and referred to past experience to produce our opinion of likely ground level wind conditions adjacent to the proposed redevelopment.

The proposed development expected to fulfil the walking criteria in all ground level areas with the proposed and recommended landscape plantings.

Wind conditions in the entrance areas expected to fulfil the recommended criterion for standing with the proposed and recommended landscape plantings.

Wind conditions within the east west through site link at the south site will likely fulfil the walking criterion with the proposed landscape plantings.

Wind conditions in the podium level expected to fulfil the recommended criteria for walking/sitting with the proposed landscape plantings and recommended windscreens.

All the above recommended plantation and windscreens should be validated by wind tunnel test in detail design stage.

Educating residents about wind conditions at high-rise balconies during high-wind event and tying down loose lightweight furniture are highly recommended.

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 wind tunnel model testing may be in error. Vipac recommends a wind tunnel test to verify the assessment and to determine the proper wind measures wherever necessary.

This Report has been Prepared

For

Crown Prosha Joint Venture

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.

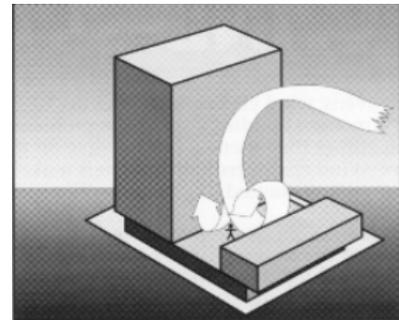
Downwash – refers to a flow of air down the exposed face of a tower. A tall tower can deflect a fast moving wind at higher elevations downwards.

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 1170.2:2002
- [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
- [4] *Criteria for Environmental Wind Conditions*, W. H. Melbourne, Jour. Industrial Aerodynamics, Vol. 3, 241-249,1978

APPENDIX C – DRAWING LIST

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