

BOVIS LEND LEASE PTY LTD

PROPOSED TOP RYDE SHOPPING CENTRE DA STAGE 2 –

PHASE 1 REDEVELOPMENT

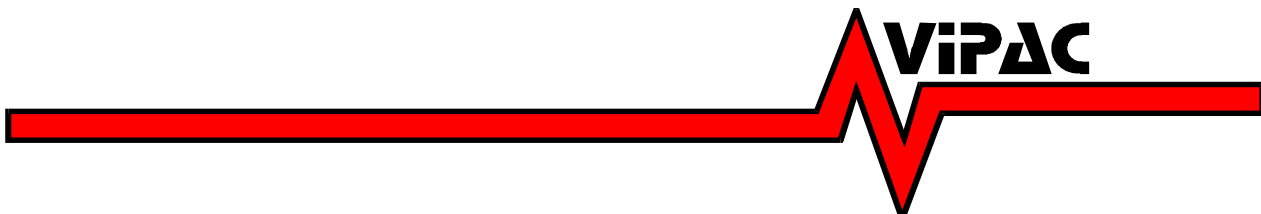
WIND EFFECTS STATEMENT

Report No. 30B-06-0084-TNT-206141-3-

VIPAC Engineers & Scientists Ltd

Sydney, NSW

16th April 2007





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DOCUMENT CONTROL

PROPOSED TOP RYDE SHOPPING CENTRE DA STAGE 2 – PHASE 1 REDEVELOPMENT Wind Effects Statement																				
REPORT NO: 30B-06-0084-TNT-206141-3- PREPARED FOR: Bovis Lend Lease Pty Ltd Level 4, 30 Hickson Street Millers Point NSW 2000 Contact: Mark Turner Phone: (02) 92366111 Fax: (02) 92772828	LIBRARY CODE: PREPARED BY: VIPAC Engineers & Scientists Ltd 2 Sirius Road LANE COVE NSW 2066 AUSTRALIA Email: sydney@vipac.com.au Phone: (02) 9422 4222 Fax : (02) 9420 5911																			
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EXECUTIVE SUMMARY

Bovis Lend Lease commissioned Vipac Engineers and Scientists to prepare a statement of pedestrian level wind effects for the proposed Top Ryde Shopping Centre DA Stage 2 - Phase 1 Redevelopment, Ryde. This appraisal is based on VIPAC's experience as a wind-engineering consultancy and previous model scale wind tunnel tests of various configurations of the proposed Redevelopment (refer to Vipac Report no. 30B-06-0084-TRP-235022-1 [4]).

VIPAC predicts wind conditions in some public areas and access-ways in and adjacent to the Redevelopment as proposed could exceed the relevant criteria.

The findings of this study can be summarised as follows:

- The proposed development is significantly taller and more exposed than many of the surrounding developments and is therefore expected to contribute to a significant increase in ground level wind conditions in adjacent public areas, access-ways and retail areas.
- Ground level wind conditions on the Devlin Street footpath and at the northwest and south-west building corners are likely to be similar to those measured in our wind tunnel studies.
- Wind conditions in the Strada are likely to be similar to those measured in our wind tunnel studies.
- Wind conditions in the Plaza are likely to be lower than those measured in our wind tunnel studies.
- A number of podium roof top areas adjacent to the proposed residential Towers B and F are likely to be in excess of the recommended criterion for walking comfort and may exceed the criterion for safety.
- VIPAC recommend a wind tunnel test be conducted to determine the type and scope of wind-break features that may be required to achieve acceptable wind conditions in adjacent ground level and podium roof top areas.

The recommendations and assessments provided in this report have been made based on wind tunnel test results from other configurations of this Redevelopment [4] 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 wind tunnel model testing can be in error.

Since, in our opinion, adverse ground level wind conditions adjacent to the proposed redevelopment are likely, VIPAC recommend a wind tunnel study of the proposed redevelopment and surrounds be conducted to verify the predictions in this statement.

VIPAC is confident that, with the use of wind tunnel testing, solutions to the predicted exceedences of the recommended criteria will be determined without the need to significantly modify the overall size and form of the proposed Stage (2) - Phase 1 development.



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1.0 INTRODUCTION

Vipac Engineers & Scientists Ltd (VIPAC) was commissioned by **Bovis Lend Lease Pty Ltd** to carry out an appraisal of the pedestrian level wind effects for the proposed “**Top Ryde Shopping Centre DA Stage 2 – Phase 1**” Redevelopment, Ryde.

The site is located on a block in Ryde bounded by Pope Street to the north, Tucker Street to the east, Blaxland Road and an existing development to the south and Devlin Street to the west as shown in the DA documentation to be submitted to the City of Ryde.

The proposed Top Ryde Shopping Centre DA Stage 2 – Phase 1 Redevelopment, Ryde, (referred to hereafter as “the proposed Redevelopment”) consists of 5 medium rise tower structures on a low-rise retail building in a mixed low and medium-rise commercial/residential area approximately 10km to the northwest of the Sydney central business district.



Figure 1: Schematic plan view of the proposed Top Ryde Shopping Centre DA Stage 2 – Phase 1 Redevelopment, Ryde.

This report details the opinion of VIPAC as an experienced wind consultancy regarding the wind effects in ground level public areas and access-ways in and adjacent to the Redevelopment as proposed. Wind tunnel testing has not been carried out for this specific configuration of the proposed Redevelopment. VIPAC has carried out wind tunnel studies on other configurations of this Redevelopment and on a large number of developments of similar shape and having similar exposure to that of the proposed Redevelopment. These serve as a valid reference for the prediction of wind effects for the proposed Redevelopment.

This assessment is based on the drawings supplied to VIPAC dated October 2006. A list of the drawings supplied are provided in Appendix A.

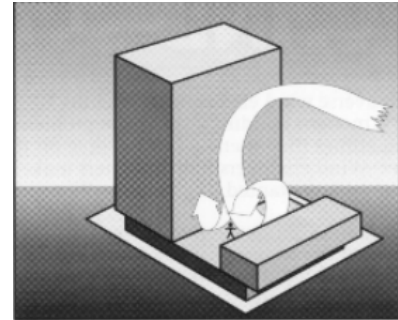
1.1 ENVIRONMENTAL WIND EFFECTS

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 Redevelopment is based on the aerodynamic mechanism, direction and nature of the wind flow.

Downwash – refers to the rush of air down the exposed face of a tower. A tall tower can catch the fast moving wind at higher elevations and deflect it down to its base.

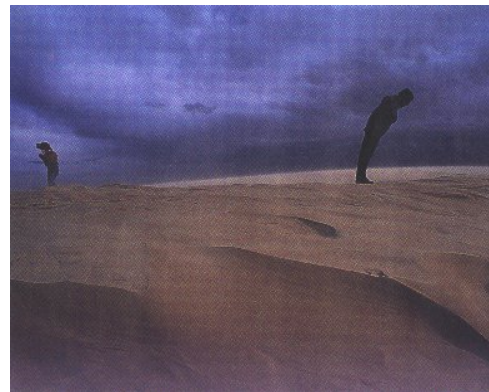


Corner Accelerations – when wind is forced to bend around the corner of a building it tends to accelerate in a similar manner to that of flow over the top of an aeroplane wing.

Flow separation – when wind flowing along a surface suddenly detaches from that surface, 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 and forced to travel within a constricted pathway. To maintain flow continuity the wind must speed up as it passes between two towers or a narrowing street or under a bridge for example.

Direct Exposure – a location with little upstream shielding, which would experience the mean and gust velocity of the unabated wind flow during a key prevailing wind direction. Locations such as a pier, or open water frontage may have such exposure.





2.0 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 expected there. 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. 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 voted as unacceptable. The threshold gust velocity criteria are:

Annual Maximum Gust Speed	Result on Perceived Pedestrian Comfort
>23m/s	Unsafe (frail pedestrians knocked over)
<16m/s	Acceptable for Walking (unsteady steps for some pedestrians)
<13m/s	Acceptable for Standing (window shopping, vehicle drop off, queuing)
<10m/s	Acceptable for Sitting (outdoor café's, pool area, gardens)

Table 1: Internationally Adopted Wind Comfort Criteria

It is suggested that for the proposed Redevelopment the applicable criteria would be:

- ⇒ Wind gusts less than the unsafe condition (i.e., under 23m/s annual gust) for all public and residential areas adjacent to and within the proposed Redevelopment.
- ⇒ Wind conditions meeting the “Acceptable for Walking” criterion for all access-ways within the proposed Redevelopment, adjacent roadways and properties
- ⇒ Wind conditions meeting the “Acceptable for Standing Comfort” criterion at major building entrances and retail window display areas.
- ⇒ Wind conditions meeting the “Acceptable for Sitting Comfort” in outdoor retail areas within the proposed Redevelopment.
- ⇒ In the event that existing wind conditions are deemed acceptable, the proposed Redevelopment should not substantially change these conditions.

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 recommend scale model wind tunnel testing to determine the type and scope of the wind control measures required to achieve acceptable wind conditions.

3.0 THE SITE WIND ENVIRONMENT

3.1 SITE DESCRIPTION

The site is located on a block in Ryde bounded by Pope Street to the north, Tucker Street to the east, Blaxland Road and an existing development to the south and Devlin Street to the west.

There are existing low and medium-rise residential and commercial developments on undulating terrain in all directions within a 2-kilometre radius of the proposed Redevelopment. The site of the proposed Redevelopment is therefore considered to be within a Terrain Category 3 for all wind directions [Reference 1].

3.2 SYDNEY APPROACH WINDS

The mean and gust wind speeds have been recorded in the Sydney area for 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 (≈500m), with a probability of occurring once per year (i.e. 1 year return period) is shown in Figure 2. The wind data at this freestream 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 2 indicates that the stronger winds can be expected from the northeasterly, southerly and westerly directions.

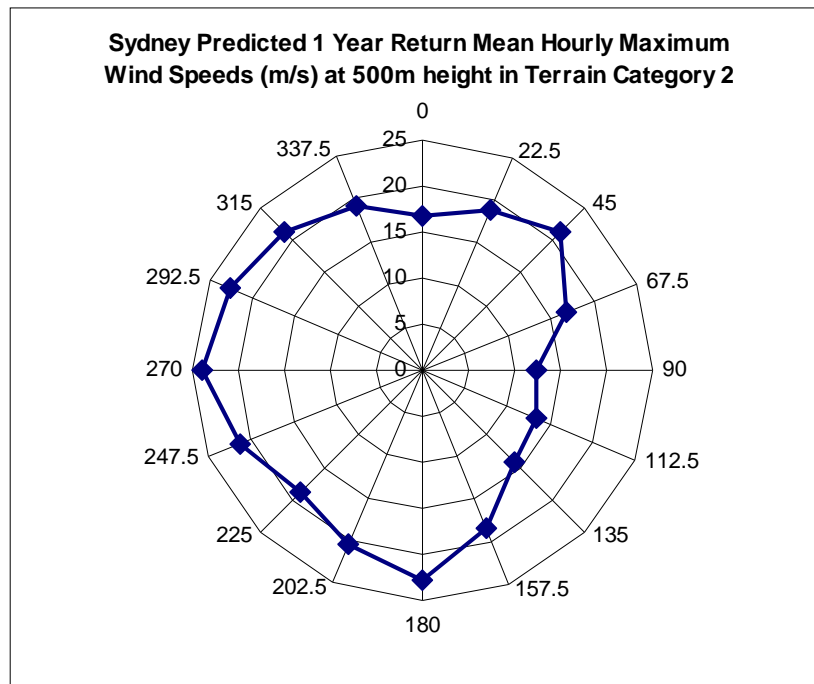


Figure 2: Directional Distribution of Annual Return Period Maximum Mean Hourly Wind Velocities (ms-1) at gradient height of 500m for Sydney.



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4.0 PEDESTRIAN LEVEL WIND EFFECTS AND RECOMMENDATIONS

4.1 ANALYSIS APPROACH

When considering whether a proposed development is likely to generate adverse wind conditions in adjacent ground level areas, 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 intended use of the public areas and access-ways affected by wind flows generated or augmented by the proposed development.

Exposure of the proposed Redevelopment

The proposed Redevelopment is considered to be significantly exposed to wind flows, being approximately 2 to 4 times taller than the majority of adjacent developments.

The north-western and south-western building corners are expected to be exposed to flows generated by the strong westerly and northwesterly winds. The Strada is expected to be exposed to through-flows due particularly to northeasterly, northerly and southerly winds. The podium roof top areas are expected to be exposed to adverse wind conditions from a wide range of wind directions. Elsewhere, the proposed Stage (2) - Phase 1 Redevelopment is expected to experience modest exposure.

These predictions are reflected in the wind tunnel test results for similar configurations of the proposed Redevelopment.

The Regional Wind Climate

As discussed in Section 3.2, the Sydney wind climate generally experiences stronger winds from the northeasterly, southerly and westerly directions.

Geometry and Orientation of the proposed Redevelopment

The proposed Redevelopment has medium to high-rise, wide, flat facades in some cases approximately continuous to ground level facing the strong north-westerly and westerly winds of the Sydney region. The open-ended Strada is expected to be directly exposed to north-easterly and southerly winds.

Flow interactions with adjacent developments

The adjacent developments are considered too small or too far away to generate any significant direct flow interactions with the proposed Redevelopment.

Intended use of adjacent ground level areas



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The ground floor tenancies of the proposed Redevelopment facing Devlin Street, Pope Street and Blaxland Road are retail tenancies. Ground level building entrances are proposed along the length of the retail frontages. There are main building entrances at the northern and southern ends of the proposed Redevelopment. The Tucker Street footpath is expected to be used for pedestrian transit only. The Plaza and Strada areas expected to be used for window shopping, recreational activities/relaxation, outdoor dining etc. The podium roof top areas are residential recreation areas and may be expected to be used for garden areas and outdoor relaxation, dining etc. eg. barbeques.

4.2 RECOMMENDED CRITERIA

Area	Recommended Criteria
General footpath areas	Acceptable for walking (steady steps for most pedestrians)
Footpaths adjacent to retail areas	Acceptable for standing (window shopping, vehicle drop off, queuing, building entrances)
Strada and plaza	Acceptable for sitting (outdoor café's, pool area, gardens)
Adjacent businesses	Acceptable for standing/no significant change over existing conditions
Podium Roof Top and Apartment Balconies	Acceptable for Walking – refer to notes on Podium Roof Top in Section 4.3

Table 2: Recommended Criteria for Key Areas (See Appendix 1).

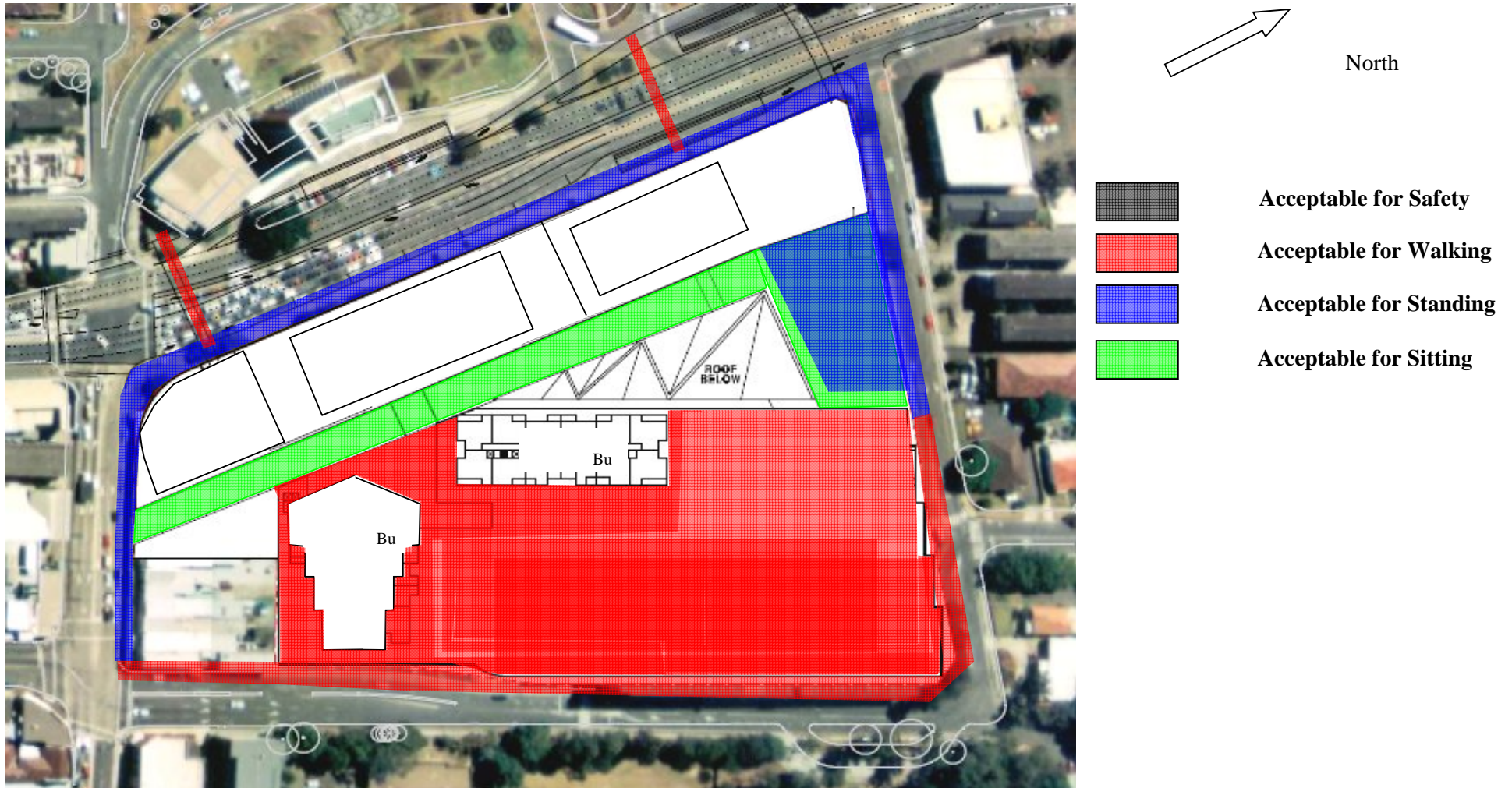


Figure 3: Recommended wind criteria for the proposed Redevelopment

A Schematic plan view of the development is shown with the recommended wind criteria are overlaid on adjacent ground and podium level areas.



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4.3 PREDICTED WIND EFFECTS

The proposed Redevelopment is significantly taller than the adjacent developments in all directions and is therefore exposed to wind flows moving above the surrounding developments. The proposed Redevelopment has some large, continuous façades to ground level which are exposed to the stronger north-easterly, north-westerly and westerly winds of the Sydney region. Ground level areas adjacent to the proposed Redevelopment are somewhat wind sensitive due to their intended use as retail areas and building entrances. The podium roof top areas are expected to be wind sensitive due to their likely use as residential recreation areas

Due consideration has been taken of the exposure of the proposed Redevelopment to the Sydney region wind climate, the geometry of the proposed Redevelopment and adjacent developments and the intended use of the ground and upper level areas likely to be affected by wind flows generated by the proposed Redevelopment. Test results have also indicated areas of likely adverse wind conditions (the reader is referred to VIPAC's wind tunnel study, VIPAC Report no. 30B-06-0084-TRP-235022-1 [4]). VIPAC concludes that, without any wind control measures such as awnings or landscape/trees, some wind conditions adjacent to the proposed Redevelopment will be in excess of the recommended criteria. The areas predicted to be most exposed to adverse wind conditions are the Devlin Street footpath retail frontage, north-west and south-west building corner areas, the Strada retail area and the podium roof top. Conditions could be ameliorated with the inclusion of some awnings, screens and trees, the scope and position of which may be determined using scale model wind tunnel testing.

From testing, wind conditions on the podium roof top adjacent to the proposed Residential Towers B and F were found to be in excess of the criterion for acceptability for walking and some localised areas were shown to be in excess of the criterion for safety. This is typical of podium roof top areas that are very windy by nature, however, wind conditions will need to be improved to at least within the criterion for safety in any residential areas. VIPAC note that residential podium roof top areas in excess of the criterion for acceptability for walking are likely to be regarded as unsatisfactory by residents. The scope and position of any wind mitigating features to reduce these conditions may be determined using scale model wind tunnel testing.

Adjacent developments are not expected to be adversely affected by the proposed Redevelopment.

Tucker Street Footpath

The Tucker Street footpath areas adjacent to the proposed Redevelopment are predicted to meet the minimum criterion of acceptability for walking.

Retail Frontages on Devlin Street, Pope Street and Blaxland Road Footpaths

Without the use of any wind control measures such as awnings or landscape/trees, wind conditions on the Devlin Street, Pope Street and Blaxland Road footpaths are expected to exceed the recommended criterion for standing comfort for retail areas. Calculations from empirical data [References 2 and 3] and wind tunnel test result suggest wind conditions at the north and south-western building corners could be in excess of the criterion for acceptability



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for walking. With the use of awnings and wind-break trees, conditions should be reduced to within the recommended criterion.

Plaza Area

The addition of local 50% porous wind-screens 2m high and 4m wide in the outdoor dining areas will assist to ensure conditions are reduced to within the recommended criterion at the retail frontage areas in the Plaza.

Strada Area

Without the use of any wind control measures such as awnings or screens, wind conditions in the Strada area will exceed the recommended criterion of acceptability for sitting during northerly, north-easterly and southerly winds. Mean velocities may be high enough to ruffle newspaper, remove paper napkins and produce strong cooling effects reducing perceived amenity on colder days.

Podium Roof Top and Apartment Balconies

The podium roof top and apartment balconies will be exposed to strong, gusty wind flows. It is very difficult to achieve frequently occurring good wind conditions on balconies and podium roof top areas as these areas are, by their nature, highly exposed. In VIPAC's experience, outdoor recreation areas that do not meet the criterion for acceptability for sitting are likely to become disused, however, as minimum for requirement, VIPAC recommend the podium roof top and balcony areas meet the criterion for acceptability for walking. Wind conditions close to or within the criterion for acceptability for walking will most likely result in safe wind conditions with regular periods of sufficiently calm conditions to allow some use. That said, it should be noted that wind conditions will frequently be too windy for comfort for activities such as having a barbeque, reading the newspaper, sunbathing etc. For these reasons, even with significant screening, VIPAC indicate the balcony and podium roof top areas of the proposed Redevelopment are likely to have limited use as outdoor recreation areas.

The following specific recommendations have been made in regard to the use of these elevated areas:

Apartment balconies in certain areas on the facades will be more likely to experience high wind conditions than others. Balconies located centrally on the tower facades should experience acceptable wind conditions. Balconies located within approximately 5-10m of building corners may experience adverse wind conditions.

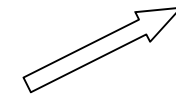
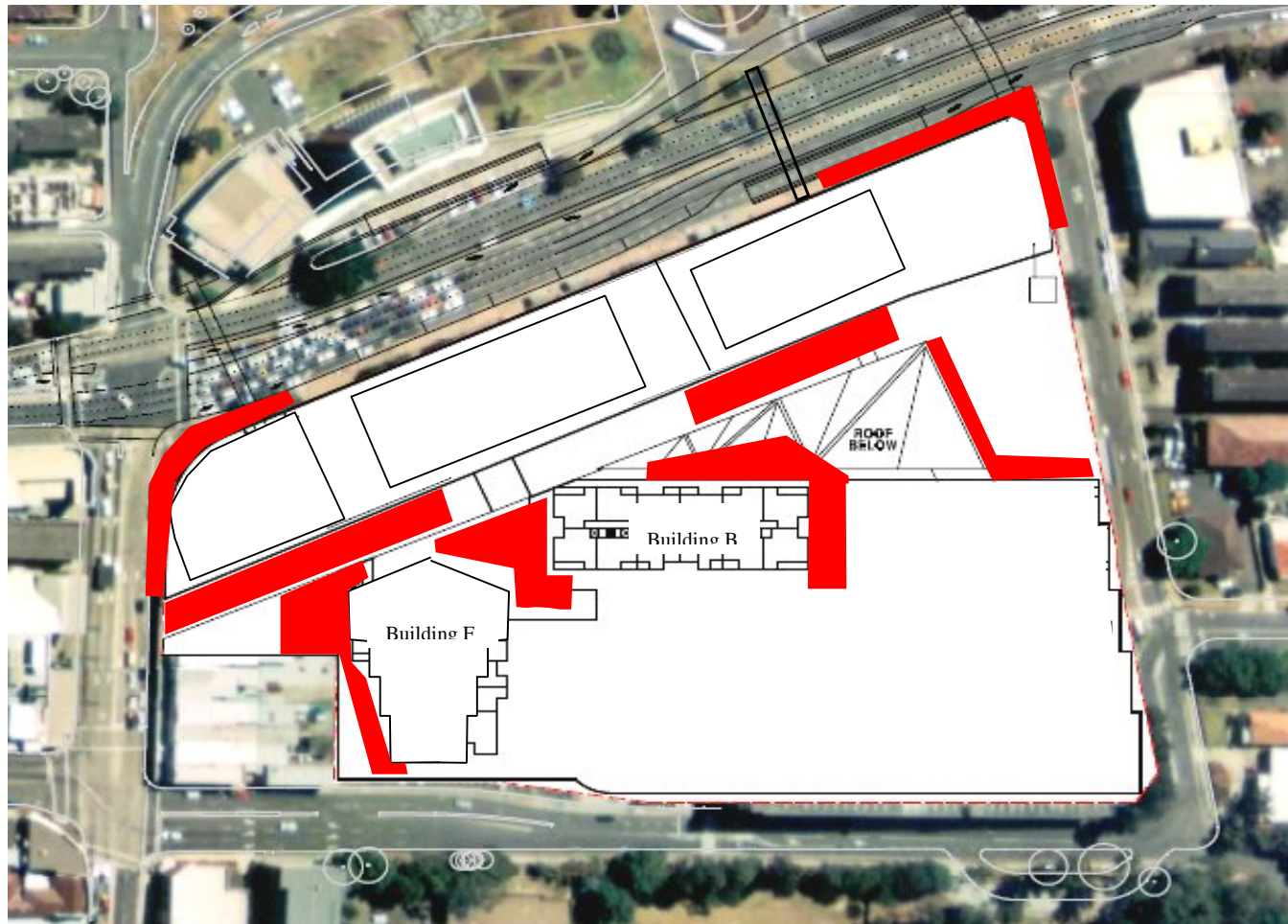
VIPAC recommends avoiding placing tower balconies within 5m of building corners without substantial screening. This screening would vary depending on balcony location and could include moveable screening capable of completely enclosing the balconies as required (eg. sliding screens).

Occupants should be warned not to leave outdoor furniture on the podium roof top and balconies as lightweight outdoor lounges, tables and chairs may be at risk of being blown off the elevated areas. VIPAC recommends the provision of storage cabinets on balconies and podium roof top areas for such items that might be blown away.



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In addition, VIPAC recommends that doors from apartments onto the decks and balconies be sliding doors, not swinging doors, in order to avoid the risks of doors slamming during gusty wind flows.



North



Areas predicted to exceed the recommended criteria

Figure 4: Areas where Exceedance of the Recommended Criteria are Predicted.

Schematic plan view of the proposed Redevelopment showing the areas predicted, by a combination of testing and experience, to exceed the recommended criteria without mitigation measures.



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4.4 RECOMMENDATIONS

VIPAC predicts that the proposed Redevelopment will present a significant change in wind conditions in adjacent ground level areas without the use of wind control measures such as awnings, screens and trees. Wind conditions generated by the proposed Redevelopment in some adjacent areas are predicted to exceed the recommended criteria. Some podium roof top residential areas are also predicted to exceed the relevant criteria.

Therefore it seems likely that, for the Redevelopment as proposed, some wind mitigating modifications or additions to the design would be required to achieve acceptable ground and residential level wind conditions.

Canopies and wind-break trees are recommended for the Devlin Street, Pope Street and Blaxland Road footpaths adjacent to the proposed development to reduce wind conditions to within the recommended criteria. A significant number of screens for the Plaza and Strada are likely to be necessary. Widespread use of canopies and screens for the podium roof top area will be necessary to achieve acceptable wind conditions for some limited outdoor recreation.

The scope and location of these wind mitigating modifications may be determined using scale model wind tunnel testing of the proposed Redevelopment.

VIPAC is confident that solutions to the predicted exceedences of the recommended criteria will be determined without the need to significantly modify the overall size and form of the proposed Redevelopment.

Some precautions in the design and use of the apartment balcony and podium roof top areas have been presented in Section 4.3.



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5.0 CONCLUSIONS

An appraisal of the wind conditions expected in and adjacent to the proposed Top Ryde Shopping Centre DA Stage 2 - Phase 1 Redevelopment, Ryde has been made.

The proposed Redevelopment consists of a high-rise development on a site approximately 10km northwest of the Sydney Central Business District.

The geometry, orientation, surrounding developments, intended ground and podium level usage and the Sydney regional wind climate have been considered in the assessment of the likely wind conditions in and adjacent to the proposed Redevelopment. VIPAC concludes that some ground and podium level wind conditions in public residential areas in and adjacent to the proposed Redevelopment are expected to exceed the recommended criteria for comfort and safety without the use of wind control measures such as awnings, screens and trees.

The recommendations and assessments provided in this report have been made based on wind tunnel test results of similar configurations of the proposed Redevelopment as tested by VIPAC 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 wind tunnel model testing can be in error. For this reason, if further study of the wind effects is required, we recommend a wind tunnel based assessment to develop the assessment of this report and to finalise the building design.

This Report has been Prepared

For

Bovis Lend Lease Pty Ltd

By

VIPAC ENGINEERS & SCIENTISTS LTD.



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6.0 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] *Assessment of Wind Effects, Top Ryde Shopping Centre Redevelopment, Ryde* Vipac Engineers and Scientists Ltd, Report no. 30B-06-0084-TRP-235022-1-



ARCHITECTURAL DRAWINGS

Stage 1 & 2 – All Phases Drawing List

Drawing number	Issue	Date
DA0010	01	27/10/06
DA1000	01	27/10/06
DA1010	01	27/10/06
DA1020	01	27/10/06
DA1040	01	27/10/06
DA1050	01	27/10/06
DA1060	01	27/10/06
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DA1200	01	27/10/06
DA1510	01	27/10/06
DA1520	01	27/10/06
DA1530	01	27/10/06
DA1540	01	27/10/06
DA1550	01	27/10/06
DA1560	01	27/10/06
DA1570	01	27/10/06
DA1580	01	27/10/06
DA –L-001	K	29/10/06
Sketches from Marchese + Partners titled “Top Ryde Building C Envelope Options” and “Landscaping Schematic”	-	-

Stage 2 – Phase 1 Drawing List

Number	Rev	Title
DA2 2.00	1, 06	PHASE 1 PLAN LEVEL 3
DA2 2.01	1, 06	PHASE 1 PLAN LEVEL 4
DA2 2.02	1, 06	PLASE 1 PLAN LEVEL 5
DA2 2.03	1, 06	PHASE 1 PLAN LEVEL 6
DA2 2.04	1, 06	PHASE 1 PLAN LEVEL 7
DA2 2.05	1, 06	PHASE 1 PLAN LEVEL 8
DA2 2.06	1, 06	PHASE 1 PLAN LEVEL 9
DA2 2.07	1, 06	PHASE 1 PLAN LEVEL 10
DA2 2.08	1, 06	PHASE 1 PLAN LEVEL 11
DA2 2.09	1, 06	PHASE 1 PLAN LEVEL 12
DA2 2.10	1, 06	PHASE 1 PLAN LEVEL 13
DA2 2.11	1, 06	PHASE 1 PLAN ROOF
DA2 2.12	1, 06	NORTH ELEVATION

**This Report Has Been Prepared
For
BOVIS LEND LEASE
by
VIPAC ENGINEERS & SCIENTISTS Ltd**