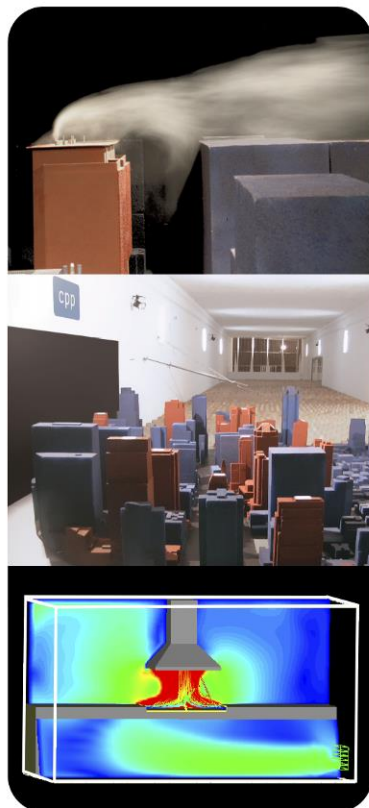




CERMAK
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WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT



Wind Assessment for:

HARBOURSIDE SHOPPING CENTRE

Sydney, Australia

Prepared for:

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November 2016

CPP Project: 9079

DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
04/11/16	Final Report	AVD	MNC	GSW

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Client Provided Information

Introduction

This report supports a State Significant Development Application (SSDA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Mirvac Projects Pty Ltd (Mirvac) is seeking to secure approval to establish concept proposal details for the redevelopment of the Harbourside Shopping Centre (Harbourside), including a new retail shopping centre, residential apartment tower and substantial public domain improvements.

The project supports the realisation of the NSW State Government's vision for an expanded 'cultural ribbon' spanning from Barangaroo, around to Darling Harbour and Pyrmont. The project importantly will add further renewed diversity in tourism and entertainment facilities to reinforce Sydney's CBD being Australia's pre-eminent tourist destination.

Background

Mirvac acquired Harbourside, a key location within the Darling Harbour precinct, in November 2013. Harbourside, which was opened in 1988 as part of the Bicentennial Program, has played a key role to the success of Darling Harbour as Australia's premier gathering and entertainment precinct.

Despite its success, with an annual pedestrian visitation of around 13 million people, Harbourside is now outdated and in decline. The building lacks a quality interface to the Darling Harbour public domain and Cockle Bay and does not integrate well with the major transformation projects underway and planned for across Darling Harbour.

Harbourside is at risk of being left behind and undermining the significant investment being made in Darling Harbour that will see it return to the world stage as a destination for events and entertainment.

Accordingly, Mirvac are taking a carefully considered and staged approach to the complete revitalisation of the site and its surrounds.

Site Description

The Site is located within Darling Harbour. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

More generally the site is bound by Pyrmont Bridge to the north, the Sydney International Convention, Exhibition and Entertainment Centre Precinct (SICEEP) to the south, Darling Drive and the alignment of the Light Rail to the west and Cockle Bay to the east.

A locational context area plan and location plan are provided in Figure 1 and Figure 2 below.

The Darling Harbour precinct is undergoing significant redevelopment as part of the SICEEP, Darling Square, and IMAX renewal projects. The urban, built form and public transport / pedestrian context for Harbourside will fundamentally change as these developments are progressively completed.

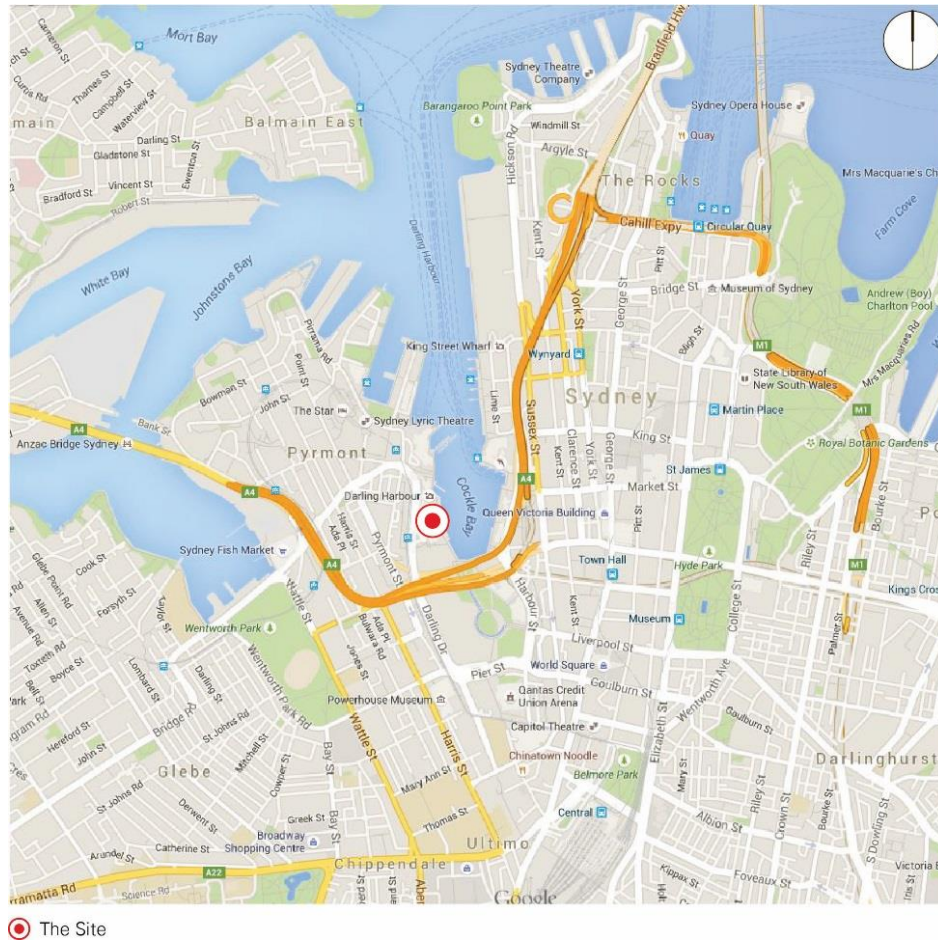


Figure 1: Site location

Overview of Proposed Development

The proposal relates to a staged development application and seeks to establish concept proposal details for the renewal and re-imagining of Harbourside.

The concept proposal establishes the vision and planning and development framework which will be the basis for the consent authority to assess future detailed development proposals.

The Harbourside site is to be developed for a mix of non-residential and residential uses, including retail and restaurants, residential apartments, and open space.

The Concept Proposal seeks approval for the following key components and development parameters:

- Demolition of existing site improvements, including the Harbourside Shopping Centre, pedestrian bridge links across Darling Drive, obsolete monorail infrastructure, and associated tree removal;
- A network of open space areas and links generally as shown within the Public Domain Concept Proposal, to facilitate re-integration of the site into the wider urban context;
- Building envelopes;
- Land uses across the site, non-residential and residential uses;
- A maximum total Gross Floor Area (GFA) across the Harbourside site of 87,000m² for mixed use development (non-residential and residential development);
- Basement car parking;
- Car parking rates to be utilised in subsequent detailed (Stage 2) Development Applications);
- Urban Design and Public Realm Guidelines to guide future development and the public domain; and
- Strategies for utilities and services provision, drainage and flooding, and ecological sustainable development.

A more detailed and comprehensive description of the proposal is contained in the Environmental Impact Statement (EIS) prepared by JBA.

Planning Approvals Strategy

The Site is located within the Darling Harbour precinct, which is identified as a State Significant Site in Schedule 2 of *State Environmental Planning Policy (State and Regional Development) 2011*. As the proposed development will have a capital investment exceeding \$10 million, it is declared to be State Significant Development (SSD) for the purposes of the *Environmental Planning and Assessment Act 1979* (EP&A Act), with the Minister for Planning the consent authority for the project.

This State Significant Development Application (DA) is a staged development application made under section 83B of the EP&A Act. It seeks approval for the concept proposal for the entire site and its surrounds.

More specifically this staged DA includes establishing land uses, gross floor area, building envelopes, public domain concept, pedestrian and vehicle access and circulation arrangements and associated car parking provision.

Detailed development application/s (Stage 2 DAs) will accordingly follow seeking approval for the detailed design and construction of all or specific aspects of the proposal in accordance with the approved staged development application.

The Department of Planning and Environment provided the Secretary's Environmental Assessment Requirements (SEARs) to the applicant for the preparation of an Environmental Impact Statement for the proposed development on 30 August 2016. This report has been prepared having regard to the SEARs as relevant.

Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Mirvac Projects Pty. Ltd. to provide an opinion based assessment of the impact of the proposed Harbourside Shopping Centre redevelopment, Sydney, on the pedestrian level local wind environment in and around the proposed development.

The site is located to the west of Sydney CBD in Darling Harbour and is surrounded by medium- to high-rise buildings, including the neighbouring SICEEP site currently under construction, Figure 2.



Figure 2: Site location for the proposed Harbourside Shopping Centre development

Sydney Wind Climate

To enable a qualitative assessment of the wind environment, the wind frequency and direction information measured by the Bureau of Meteorology at a standard height of 10 m at Sydney Airport from 1995 to 2015 have been used in this analysis, Figure 3. It is noted from Figure 3 that strong prevailing winds are organised into three main groups which centre at about north-east, south, and west. This wind assessment is focused on these prevailing strong wind directions.

Strong summer winds occur mainly from the south quadrant and the north-east. Winds from the south are associated with large synoptic frontal systems and generally provide the strongest gusts during summer. Moderate intensity winds from the north-east tend to bring cooling relief on hot

summer afternoons typically lasting from noon to dusk. These are small-scale temperature driven effects; the greater the temperature differential between land and sea, the stronger the breeze.

Winter and early spring winds typically occur from the south and west quadrants. West quadrant winds provide the strongest winds affecting the area throughout the year.

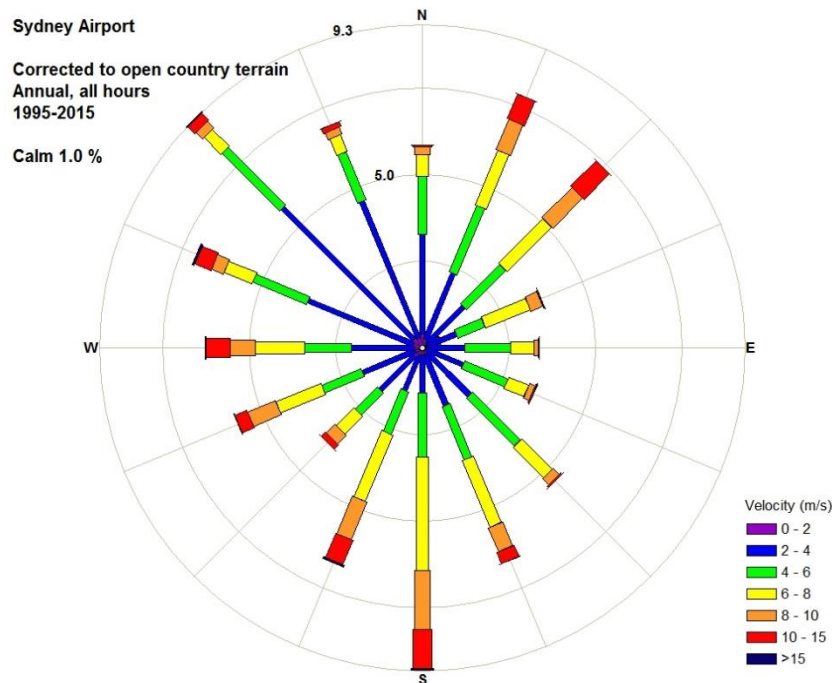


Figure 3: Wind rose of direction and speed for Sydney Airport

Wind Flow Mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 4; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward and sides of the building. In Figure 4 smoke is being released into the wind flow to allow the wind speed, turbulence, and direction to be visualised. The image on the left shows smoke being released across the windward face, and the image on the right shows smoke being released into the flow at about third height in the centre of the face.

Techniques to mitigate the effects of downwash winds on pedestrians include the provision of horizontal elements, the most effective being a podium to divert the flow away from pavements and building entrances. Awnings along street frontages perform a similar function and the deeper the horizontal element generally the more effective it will be in diverting the flow.

Channelling occurs when the wind is accelerated between two buildings or along straight streets with buildings on either side.

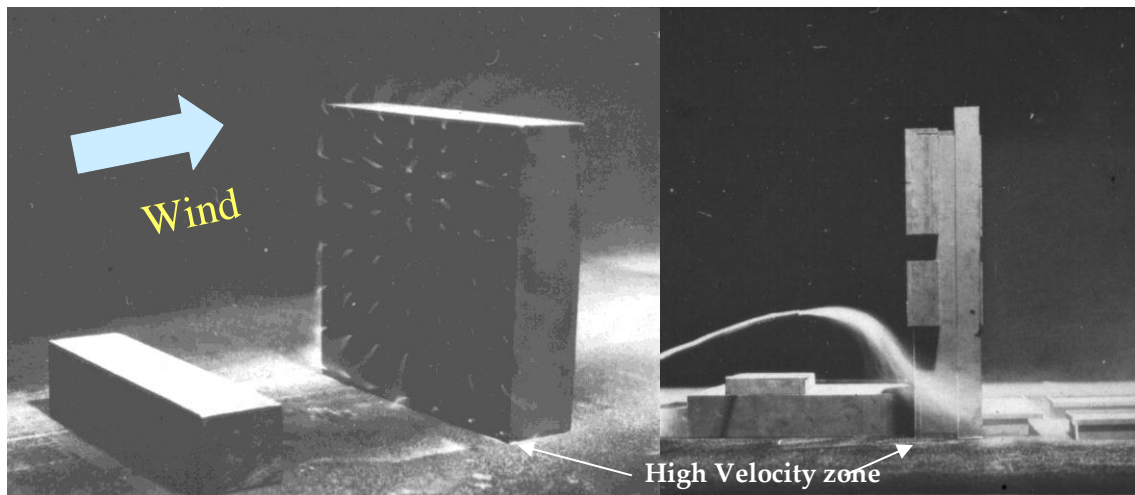


Figure 4: Flow visualisation around a tall building

Environmental Wind Speed Criteria

It is generally accepted that wind speed and the rate of change of wind velocity are the primary parameters that should be used in the assessment of how wind affects pedestrians. Over the years, a number of researchers have added to the knowledge of wind effects on pedestrians by suggesting criteria for comfort and safety. Because pedestrians will tolerate higher wind speeds for a smaller period of time than for lower wind speeds, these criteria provide a means of evaluating the overall acceptability of a pedestrian location. A location can further be evaluated for its intended use, such as for an outdoor café or footpath.

The current City of Sydney (2012) DCP specifies wind effects not to exceed 16 m/s, as the area around the site is not classified as an 'active frontage'. With reference to the wind rose in Figure 3, there are few locations in Sydney that would meet this criterion without some level of shielding from surrounding buildings, or local treatments. From discussions with Council this is a once per annum gust wind speed similar to the wind criteria in City of Sydney 2004 DCP, but is meant to be interpreted as a comfort level criterion and is not intended to be used as a distress requirement. The once per annum gust wind speed criterion used in the City of Sydney (2012) DCP is based on the work of Melbourne (1978), and the 16 m/s level is classified as generally acceptable for use as a main public accessway. This criterion gives the once per annum wind speed, and uses this as an estimator of the general conditions at a site, which may be more relevant. To combat this limitation, as well as the once per annum maximum gust wind speed, this study is based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. The limiting criteria are defined for both a mean and gust equivalent mean (GEM) wind speed. The criteria based on the mean wind speeds define when the steady component of the wind causes discomfort, whereas the GEM wind speeds define when the wind gusts cause discomfort.

From ongoing findings using the criteria and clients who have issues with strong wind, a more stringent criterion is required for outdoor dining style activities and a value of 2 m/s for 5% of the time is recommended for such intended use. As the 5% of the time wind speed recorded at the airport is about 9 m/s, and even with the benefits of shielding from the city compared with the airport, any location in the city requires significant shielding to meet such a criterion.

Assessment using the Lawson criteria provides a similar classification as using the once per annum gust, which is the basis of the City of Sydney (2011) DCP, however also provides information regarding the serviceability wind climate.

Comfort (maximum of mean or gust equivalent mean (GEM ⁺) wind speed exceeded 5% of the time)	
< 4 m/s	Pedestrian Sitting (considered to be of long duration)
4 - 6 m/s	Pedestrian Standing (or sitting for a short time or exposure)
6 - 8 m/s	Pedestrian Walking
8 - 10 m/s	Business Walking (objective walking from A to B or for cycling)
> 10 m/s	Uncomfortable
Distress (maximum of mean or GEM wind speed exceeded 0.022% of the time)	
<15 m/s	not to be exceeded more than two times per year (or one time per season) for general access
<20 m/s	not to be exceeded more than two times per year (or one time per season) where only able bodied people would be expected; frail or cyclists would not be expected

The wind speed is either a mean wind speed or a gust equivalent mean (GEM) wind speed. The GEM wind speed is equal to the 3 s gust wind speed divided by 1.85.

Table 1: Pedestrian comfort criteria for various activities

Environmental Wind Assessment

The development site is situated on the west side of Darling Harbour, adjacent to Pyrmont Bridge and the SICEEP development, Figure 2. The proposed Harbourside Shopping Centre development comprises a 4 storey retail podium with rooftop recreational areas, and a single residential tower of 39 storeys extending from the northern end of the podium, Figure 5 and Figure 8. The proposed development is surrounded by medium to high-rise buildings, which will provide some shielding for certain wind directions. Topography surrounding the site is relatively flat.

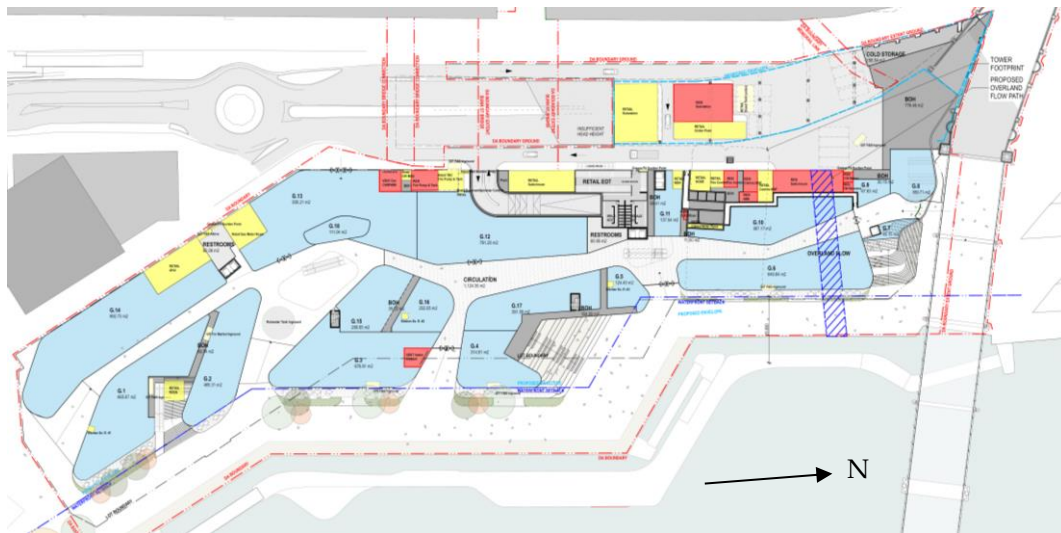


Figure 5: Ground floor plan for the proposed Harbourside Shopping Centre development

Winds from the north-east

Winds from the north-east will be somewhat ameliorated by the massing of the city, but accelerate across Darling Harbour resulting in a relatively exposed site. On reaching the site, winds from the north-east would impinge on the north-east corner of the tower at an oblique angle, encouraging the flow to pass around the tower horizontally thereby reducing the quantity of downwash. Flow will accelerate around the north-west and south-east corners of the tower, with any downwash discharging over the podium roof. However, the stepped nature of the tower's southern façade is expected to dissipate the majority of flow around the south-east corner away from the podium roof. Wind conditions on the podium roof are expected to be windy, particularly close to the tower corners.

The podium extending to the south of the tower will be exposed to winds from the north-east. The relatively long, low podium, that steps down in height to the south, is expected to divert the majority of flow over the roof rather than accelerate it around the south corner towards the SICEEP Hotel. The wind conditions on this corner would be expected to be similar to the existing conditions. The roof top of the development shows a number of outdoor retail facilities, Figure 6 and Figure 7. These areas are located between smaller kiosk buildings. The wind across the podium roof is expected to be relatively strong and additional amelioration would be required to meet the intended use of the space. All locations would be expected to meet the distress criteria.

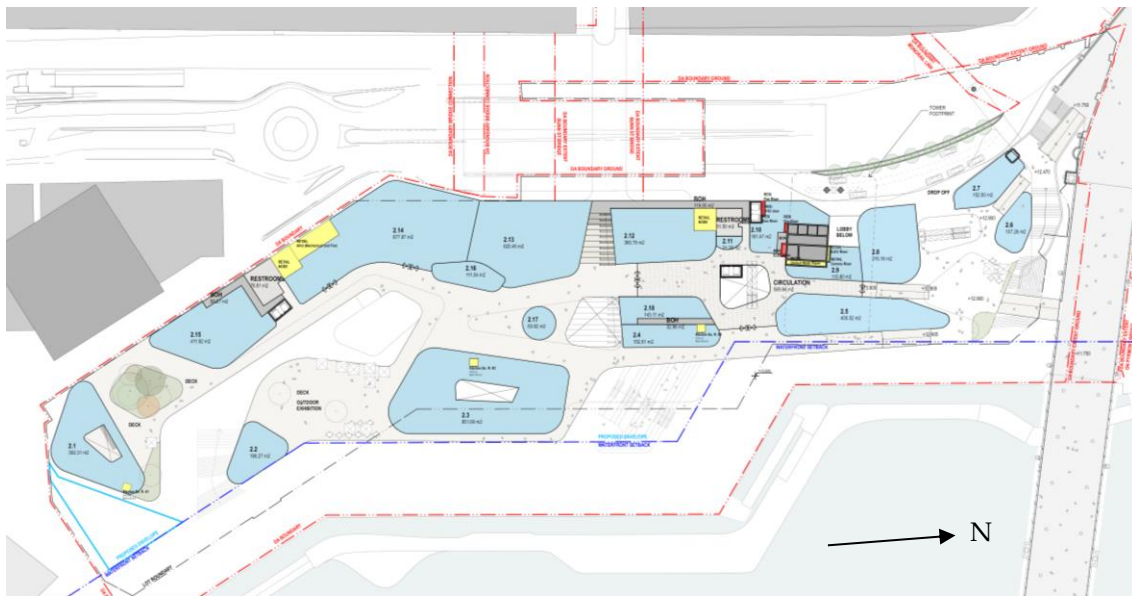


Figure 6: Level 2 plan

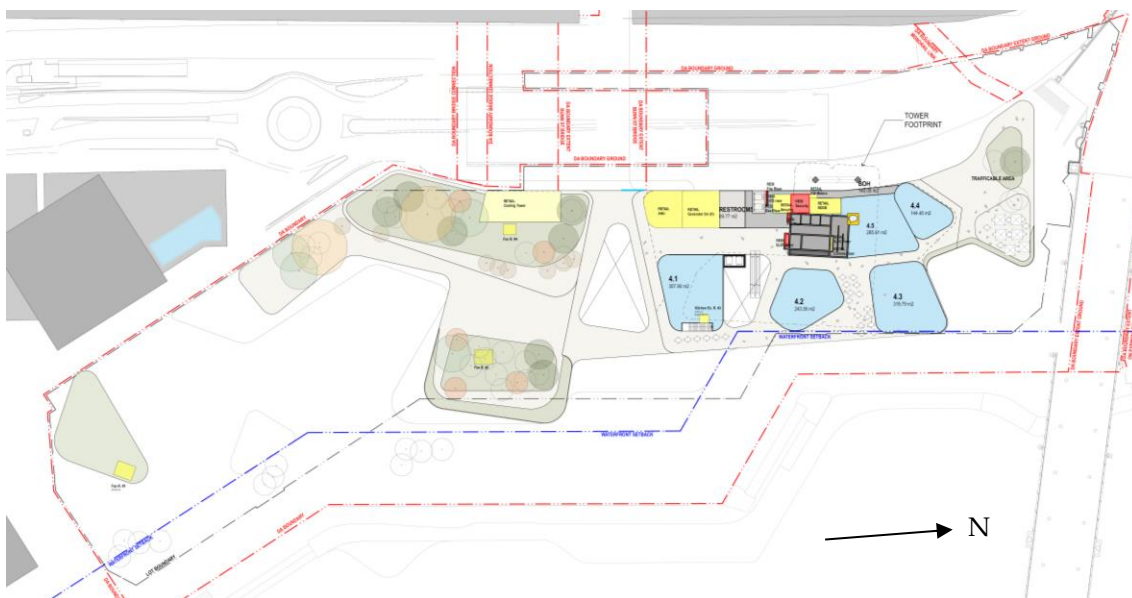


Figure 7: Level 4 plan

Winds from the south

The neighbouring SICEEP development currently under construction to the south will effectively shield the podium of the proposed development for winds from the south. Higher level flow will be less affected and the tower will be relatively exposed. As these winds reach the tower downwash will result, with flow accelerating around the south-east and south-west corners before discharging along the waterfront boardwalk and Darling Drive respectively, Figure 8(L). Given the lack of pedestrian access to this region of Darling Drive, the increase in flow is unlikely to be of concern. The stepped nature of the tower's south façade would likely reduce the amount of downwash reaching the

waterfront boardwalk. Furthermore, the proximity of the tower to Pyrmont Bridge would be expected to ameliorate the impact of the downwash along the boardwalk. Additional amelioration in the form of an awning, or increased setback of the tower from the east edge of the podium would be beneficial.

Winds from the west

Winds from the west will be partially shielded by the neighbouring hotels to the west. However, near the tower, the shielding buildings would be expected to result in an increased amount of downwash, Figure 8(R). This mechanism would direct high level flow towards ground level, with flow discharging over the lower podium roof. The narrow tower face, presented to incoming flow, and significant tower setback from the podium north edge would be expected to minimise the effect of downwash winds on Pyrmont Bridge. Wind conditions on the lower podium roof are expected to be windy, particularly close to the tower corners.

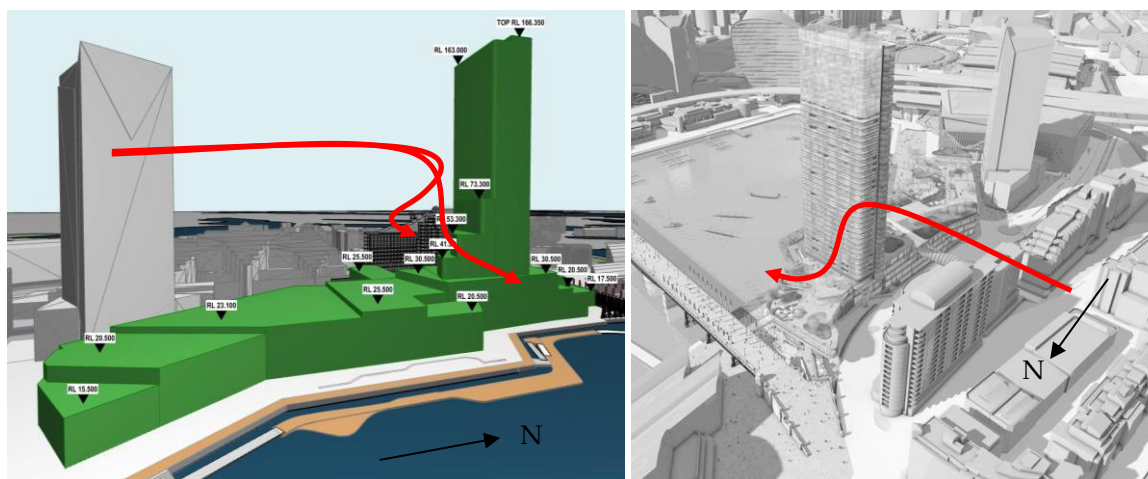


Figure 8: Aerial view from the south (L) and north-west (R)

Summary

Qualitatively, integrating the expected directional wind conditions around the site with the wind climate, it is considered that wind conditions at the majority of locations around the site would be classified as suitable for pedestrian standing or walking under the Lawson criterion from a comfort perspective and pass the distress criterion. At the windier locations along the waterfront boardwalk, the wind conditions are likely to be classified as suitable for pedestrian walking. All locations would be expected to meet the distress criterion with the potential exception of the north-west tower corner, which could be dealt with during detailed design.

The primary purpose of the podium is to protect pedestrians at ground level and is therefore expected to be windy. Without localised amelioration to create local calm areas, the majority of the

podium roof would be expected to classify as suitable for pedestrian standing, with locations close to the tower expected to rate as suitable for walking or business walking.

Conclusions

Cermak Peterka Petersen Pty. Ltd. has provided an opinion based assessment of the impact of the proposed Harbourside Shopping Centre development, Sydney on the local wind environment. Our summary assessment of the proposed development is as follows:

Wind conditions around the site for the proposed development are generally expected to be similar to existing conditions with windier locations close to the tower. The majority of locations would be expected to meet the Lawson pedestrian standing or walking criterion and pass the distress criterion. It is considered that the design would meet the intended use of space for pedestrian comfort and safety. Additional amelioration measures may be required for specific locations where local wind speeds may be greater such as close to the corners of the tower, but this would be conducted during detailed design. Wind-tunnel testing would be required to quantify the wind advice provided herein and for specific amelioration.

References

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