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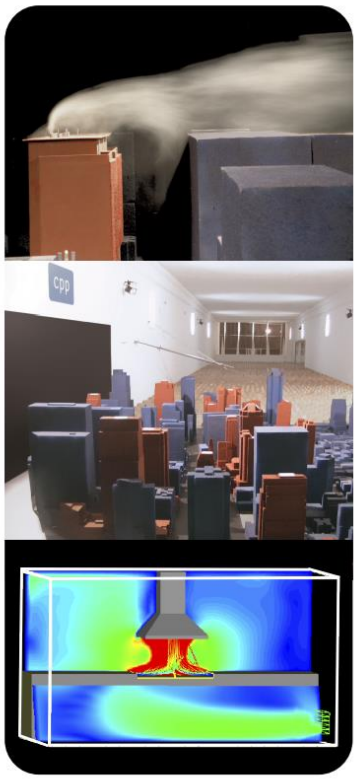
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT



Section 96 Wind Assessment for:

SYDNEY 1, 1 ALFRED STREET

Sydney, NSW, Australia

Prepared for:

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12/04/16	Initial release for review	GSW	PAB	GSW
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Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Wanda to provide an expert opinion qualitative assessment of the impact of the proposed Sydney 1 development at, 1 Alfred Street, Sydney, on the pedestrian level local wind environment in and around the proposed development. This report is intended for the Section 96 application for the site and qualitatively assesses the impact of the revised geometry on the pedestrian level wind environment around the site compared with the amended geometry reported in Cermak Peterka Petersen (2015a). The geometry for the previous report is the current approved scheme for the building. This report references previous wind-tunnel testing results reported in Cermak Peterka Petersen (2010, 2015b) for the previous applications for this site.

The site is located on the block bounded by Alfred Street, Pitt Street, Crane Place, and George Street. The site is located approximately 100 m from Circular Quay and is surrounded by high rise towers to the south and low to medium rise to the north, Figure 1. The development consists of two towers of varying height and plan form. Comparative images of the existing and proposed designs are presented in Figure 2 and Figure 3. The site is located close to the water line with local topography rising gently to the west and south-east.

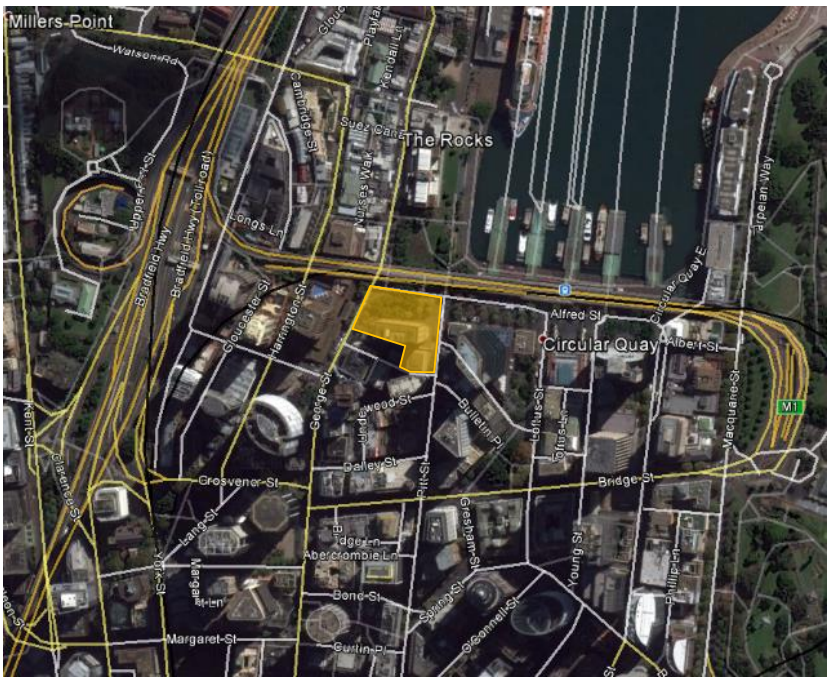

Figure 1: Location of the proposed development (Google Earth 2015)

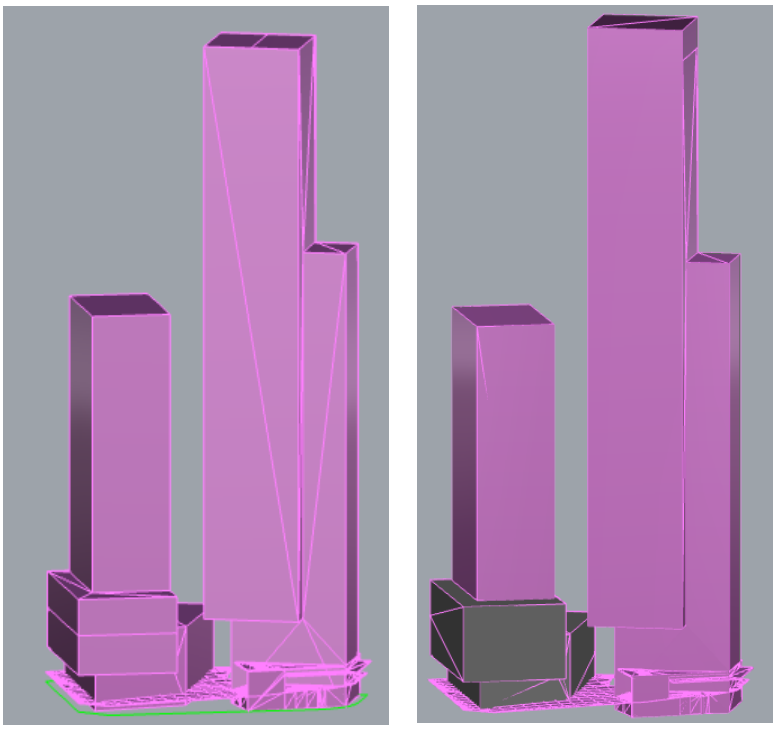

Figure 2: View from the north of current (L) and proposed (R) development

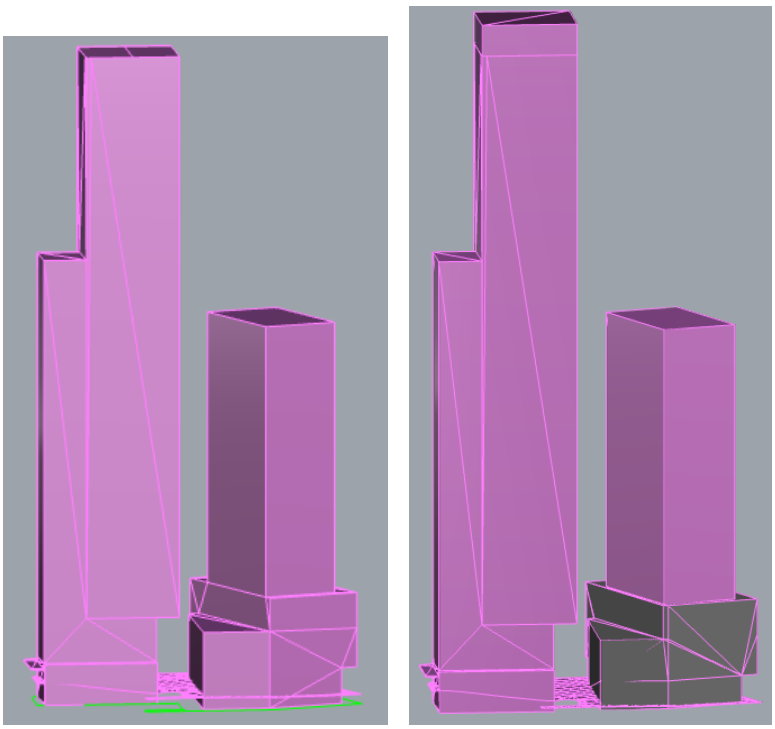

Figure 3: View from the south of current (L) and proposed (R) development

Sydney Wind Climate

The proposed development lies approximately 10 km to the north of Sydney Airport Bureau of Meteorology anemometer. The wind rose for the airport is shown in Figure 4 and is considered to be representative of prevailing winds at the site. It is evident that the prevailing winds for coastal Sydney come from the north-east, south, and west. Winds from the north-east tend to be summer sea breezes and bring welcome relief on summer days. Winds from the south occur throughout the year and tend to be cold, generally associated with frontal systems that can last several days. Winds from the west are the strongest of the year and are associated with large weather patterns and thunderstorm activity. These winds occur throughout the year and can be cold or warm depending on the inland conditions.

This wind assessment is focused on these prevailing wind directions.

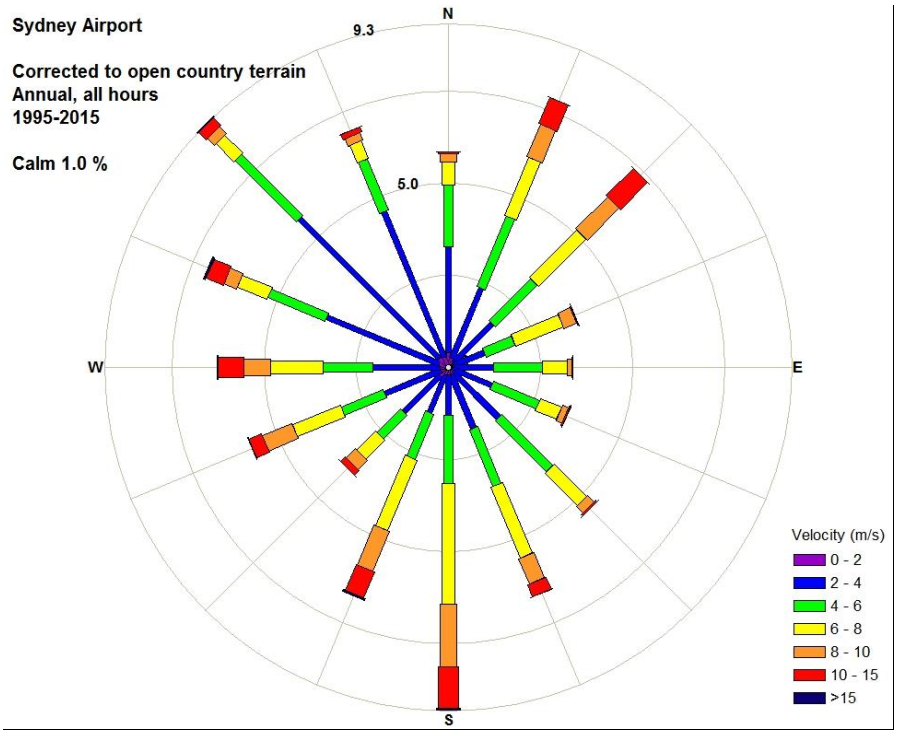

Figure 4: Wind rose for Sydney Airport

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. Local wind effects can be assessed with respect to a number of environmental wind speed criteria established by various researchers. Despite the apparent differences in numerical values and assumptions made in their development, it has been found that when these are compared on a probabilistic basis, there is remarkably good agreement.

The current City of Sydney (2012) DCP specifies wind effects not to exceed 10 m/s around the entire block as this is an active frontage. There are few locations in Sydney that would meet the 'active frontage' criterion without significant shielding to improve the wind conditions. 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 to promote outdoor café style activities and is not intended to be used as an upper bound for pedestrian 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), which is for the probability of the gust occurring in an hour of data for 0.1% of the time, or two peak storm events in a year. The 10 m/s level is classified as generally acceptable for pedestrian sitting, and the 16 m/s for pedestrian walking. The Melbourne criterion gives the 'once per annum gust wind speed', and uses this as an estimator of the general conditions at a site. To combat this limitation, as well as the once per annum maximum gust wind speed in an hour, this study is based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. The benefits of these criteria over many in the field are that they use both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations. 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.

Table 1: Pedestrian comfort criteria for various activities

Comfort (maximum wind speed exceeded 5% of the time)	
<2 m/s	Outdoor dining
2 - 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 wind speed exceeded 0.022% of the time, twice per annum)	
<15 m/s	General access area
15 - 20 m/s	Acceptable only where able bodied people would be expected; no frail people or cyclists expected
>20 m/s	Unacceptable

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.

Wind Flow Mechanisms

When the wind hits an isolated building, the wind is accelerated down and around the windward corners, Figure 5; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward and sides of the building. In Figure 5 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 generally, the larger the horizontal element 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 5 shows wind is accelerated substantially around the corners of the building. When balconies are located on these corners they are likely to be breezy, and will be used less by the owner due to the regularity of stronger winds. Owners quickly become familiar with when and how to use their balconies. If the corner balconies are deep enough, articulated, or have regular partition privacy fins then local calmer conditions can exist.

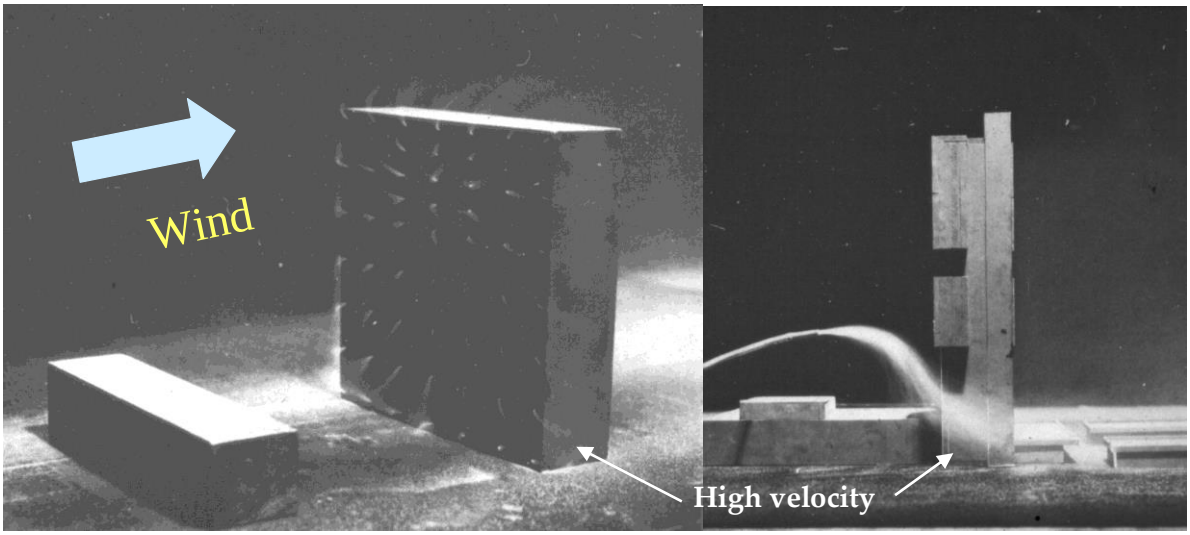

Figure 5: Flow visualisation around a tall building

Environmental Wind Assessment

From a wind perspective the only difference between the current approved and proposed schemes presented in Figure 2 and Figure 3 is that the height of Tower A has increased by 9 m on the smaller upper section of the tower. The increase in height is expected to induce slightly more downwash from the building, however this is not expected to have a significant impact on the ground-level wind conditions measured and presented in our previous wind-tunnel test reports (CPP 2010, CPP 2015b).

The previous wind-tunnel test results show that the development site is exposed to winds from the north-east and this is the critical wind direction for this site, Table 2. The existing wind conditions along George Street to the west of the site are classified as suitable for business walking from a comfort perspective, and exceeds the distress criterion. For the previous application, a programme of wind-tunnel testing was conducted for a range of building configurations to investigate amelioration measures for the site; a summary of the results are presented in Table 2. It was found that with

suitable planting and amelioration measures along Alfred Street, the wind conditions along George Street can be improved compared with the existing conditions.

Table 2: Summary results – Lawson criteria wind speeds in m/s

Configuration	Point 14		Point 16	
Site – surrounds	Comfort	Safety	Comfort	Safety
A Existing – existing	Bus Walk 8.5	Able Body 17.4	Bus Walk 8.6	Able Body 17.7
B Proposed – existing	Standing 5.8	Pass 10.3	Bus Walk 9.7	Able Body 19.8
C Tower A only – existing	Standing 5.9	Pass 10.6	Bus Walk 8.3	Able Body 17.1
D Proposed – potential	Standing 6.0	Pass 11.2	Bus Walk 9.2	Able Body 19.1
E Proposed + awning wall - existing	Walking 6.3	Pass 11.6	Bus Walk 9.2	Able Body 18.9
F Proposed + walls - existing	Walking 6.5	Pass 12.3	Walking 7.8	Able Body 15.6
G Proposed + walls + trees – existing	Walking 7.0	Pass 13.2	Bus Walk 8.2	Able Body 16.3
H Proposed + walls + trees + notch - existing	Bus Walk 9.0	Able Body 18.0	Walking 7.7	Able Body 15.3

Conclusions

Cermak Peterka Petersen Pty. Ltd. has provided an expert opinion qualitative assessment of the impact on the surrounding local wind environment of the proposed Sydney 1 development at 1 Alfred Street, Sydney. The change in massing of the building compared with the current approved scheme is expected to marginally increase the local wind speeds along George Street. It is expected that all areas would be classified as suitable for pedestrian walking, or better, from a comfort criterion. All locations are expected to pass the distress criterion except on the corner of George Street where it is expected to exceed the criterion, as is currently the case with Goldfields House. It has been illustrated previously that with appropriate amelioration measures along Alfred Street, the wind conditions can be improved compared with the existing wind conditions. These amelioration measures can be developed more fully during detailed design.

References

Cermak Peterka Petersen, (2010), Wind Tunnel Tests for: One Alfred Street, Sydney, CPP project 5423, October 2010.

Cermak Peterka Petersen, (2015a), Wind Assessment for: Sydney 1, 1 Alfred Street, Sydney, CPP Project 8366, November 2015.

Cermak Peterka Petersen, (2015b), Wind Tunnel Tests for: Sydney 1, 1 Alfred Street, Sydney, CPP project 8392, July 2015.

City of Sydney, (2011), "Central of Sydney Development Control Plan 1996".

City of Sydney, (2012), "Sydney Development Control Plan 2012".

Lawson, T.V., (1990), The determination of the wind environment of a building complex before construction, *Department of Aerospace Engineering, University of Bristol*, Report Number TVL 9025.